A MANUAL OF SURGICAL TREATMENT

A Manual of Surgical Treatment

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In Six Parts

PART IV

The Treatment of the Surgical Affections of the Joints (including Excisions) and the Spine

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To

THE RIGHT HON.

LORD LISTER, LL.D., P.R.S.,

THE FOUNDER OF MODERN SURGERY,

WITHOUT WHOSE WORK MUCH OF

THIS BOOK COULD NOT HAVE

BEEN WRITTEN.

AUTHORS' PREFACE.

GENERAL PREFACE.

THE subject of Surgery has now become so extensive that any work attempting to deal with it in an exhaustive manner must necessarily be so large and unwieldy as to be suitable only for purposes of reference, or for the use of those who devote themselves exclusively to its practice. In any text-book of convenient size the information given in certain branches of the subject must therefore be considerably condensed, and, as the first essential for the beginner is to have the fullest knowledge of the nature and characters of the diseases that he has to study, special stress is usually laid upon pathology, symptomatology, and diagnosis. For the practitioner, on the other hand, who is already acquainted with these points, the great essential is full and detailed information as to the best methods of treatment.

We have ourselves frequently experienced the want of detailed information, especially as regards the after-treatment of our cases, and have had to learn the best methods of procedure from experience. Nothing can of course replace experience, but it is often of the greatest advantage to have a detailed record of that of others upon which to base one's work. It is this want that the present work is intended to supply. We have tried to put ourselves in the place of those who have to treat a given case for the first time, and we have endeavoured to supply them with details as to treatment from the commencement to the termination of the illness. We have assumed that the reader is familiar with the nature and diagnosis of the disease, and we only refer to the pathology and symptoms in so far as it is necessary to render intelligible the principles on which the treatment is based, and the various stages of the disease to which each particular method is applicable.

We have purposely avoided attempting to give anything like a complete summary of the various methods of treatment that have from time to time been proposed: to do so would merely confuse the reader.

Only those plans are described which our experience has led us to believe are the best, but with regard to these we have endeavoured to state exactly and in detail what we ourselves should do under given circumstances. In some cases no doubt several methods of treatment are of equal value, and while we have only discussed at length that which we have ourselves been led to adopt, we have referred shortly to the others.

We have not mentioned all the exceptional conditions that may be met with, but we have endeavoured to include all the circumstances with which the surgeon is most commonly called upon to deal. The task has been one of some difficulty, the more so as we have had, to a certain extent, to break new ground. This must serve as our excuse for the many shortcomings in the work.

PREFACE TO PART IV.

We have pleasure in acknowledging obligations to several friends who have given us much assistance in bringing out this volume. First among these is Dr. Percy Lewis of Folkestone, who has very kindly given us permission to reproduce *in extenso* the admirable manual of Medical Exercises that forms the Appendix to the chapter on Scoliosis. This is taken *verbatim* from his book *On the Relief and Cure of Spinal Curvature*, and is so comprehensive that we have not ventured to make any additions to it; the figures illustrative of the text are either copied from his work or are designed upon the same lines as those appearing there. Certain other illustrations in the same chapter are from the same source. Dr. Leslie Walsh of Bath has also been good enough to furnish us with a full and practical account of the thermal treatment as carried out for rheumatoid arthritis at Bath, for which we owe him many thanks. Dr. G. A. Sutherland, Dr. Lambert Lack, and Dr. J. Curtis Webb have given much highly-appreciated help in seeing the sheets through the press.

The Illustrations are nearly all from photographs or original sketches and have been made by Mr. T. P. Collings; the exceptions to this are the illustrations of instruments—which have been most kindly furnished by Messrs. Down Brothers; Fig. 8 from Helferich's *Manual of Fractures and Dislocations*—which we owe to the courtesy of the Council of the New Sydenham Society; Figs. 54 and 74 from Holmes's *System of Surgery*—for which we are indebted to Messrs. Longmans; and Figs. 135, 136, and 138 from Bradford and Lovett's well-known work.

In answer to several critics who have reproached us for not having mentioned certain methods of treatment to which they personally are

addicted, we would desire once more to reiterate the fact that the object we originally set before ourselves was to describe as fully as possible only those methods of treatment which have proved most efficient in our hands. To this plan we have adhered; and therein also will be found our justification for the omission of certain newly-introduced methods of treatment which may prove of great value, but which are as yet too recent to enable a definite verdict to be pronounced upon them. To describe all methods of treatment would be to convert a manual into an encyclopædia.

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TABLE OF CONTENTS.

PART IV

DIVISION I.

THE SURGICAL AFFECTIONS OF JOINTS.

SECTION I.—INJURIES OF JOINTS.

CHAPTER I.—DISLOCATIONS: GENERAL CONSIDERATIONS.

PAGE

DEFINITION—CLASSIFICATION—CAUSES, 1-2

TREATMENT: Of *Simple Dislocations*: Reduction—Prevention of Recurrence—Preservation of Function—Of *Complicated Dislocations*: Fracture—Injury to Vessels or Nerves—Of *Compound Dislocations*: Recent—Long-standing—Of *Unreduced Dislocations*, 2-8

CHAPTER II.—DISLOCATIONS OF THE CLAVICLE.

DISLOCATIONS OF THE ACROMIAL END: Displacement—Treatment: Of Upward Dislocation—Of Downward Dislocation—Of Unreduced Dislocation, 9-12

DISLOCATIONS OF THE STERNAL END: *Treatment*, 12-13

CHAPTER III.—DISLOCATIONS OF THE SHOULDER.

VARIETIES—DISPLACEMENT, 14-15

TREATMENT: Of *Simple Dislocation*: Kocher's and Traction Methods of Reduction—Of *Complications*: Fracture—Injury to Axillary Vessels and Nerves—Of *Compound Dislocation*—Of *Unreduced Dislocation*: Replacement of Head of Bone by Operation—Excision, 15-32

CHAPTER IV.—DISLOCATIONS OF THE ELBOW.

DISLOCATION OF BOTH BONES—*Backwards*: Complications—Treatment of Simple, Complicated, Compound and Unreduced Forms—*Backwards and Laterally*: Inwards and Outwards—*Forwards*, 33-40

PAGE

DISLOCATIONS OF EITHER BONE ALONE: *Ulna alone—Radius alone*: Treatment: Of Dislocation Forwards, Backwards and Outwards—*Unreduced Dislocation*: Treatment—"*Pulled Arm*": Treatment, 40-44

CHAPTER V.—DISLOCATIONS OF THE WRIST AND FINGERS.

DISLOCATION OF THE WRIST: Treatment—OF THE CARPAL BONES: Treatment—OF THE METACARPAL BONES: Treatment, 45-46

OF THE PHALANGES: *At the Inter-phalangeal Joints*: Treatment—*At the Meta-carpo-phalangeal Joints*: Treatment of Dislocation of the Thumb, 46-49

CHAPTER VI.—DISLOCATIONS OF THE HIP.

CAUSES—VARIETIES: Regular and Irregular Dislocations, 50-51

TREATMENT OF REGULAR FORMS OF DISLOCATION: Of *Backward Dislocation*. Upon the Dorsum Ilii—Into the Sciatic Notch—Of *Forward Dislocation*: Into the Thyroid Foramen—Pubic Dislocation, 52-58

TREATMENT OF IRREGULAR FORMS OF DISLOCATION, 58

TREATMENT OF UNREDUCED DISLOCATIONS: Operation, 58-60

CHAPTER VII.—DISLOCATIONS OF THE PATELLA.

CAUSES—VARIETIES: *Outwards—Inwards*: Treatment—*Vertical*: Causes—Treatment, 61-62

Unreduced Dislocation, 62-63

CHAPTER VIII.—DISLOCATIONS OF THE KNEE AND ITS CARTILAGES.

DISLOCATIONS OF THE KNEE: *Varieties*: Of the Tibia Forwards—Of the Tibia Backwards—Lateral Dislocations—*Treatment*, 64-65

DISLOCATION OF THE SEMILUNAR CARTILAGES: *Varieties—Results—Treatment*: in Recent Cases—In Recurring Cases: Palliative and Operative Measures—Removal of Internal Semilunar Cartilage, 65-69

CHAPTER IX.—DISLOCATIONS OF THE ANKLE AND FOOT.

DISLOCATIONS OF THE ANKLE: *Varieties*: Backward Dislocation—Forward Dislocation—*Treatment*: When Complicated by Fracture of either Malleolus, 70-71

DISLOCATIONS OF THE FOOT: *Sub-astragalar Dislocation*: Treatment—Excision of the Astragalus—*Dislocation of the Astragalus alone*: Treatment—*Other Dislocations of the Tarsus and Metatarsus*, 71-75

CHAPTER X.—SPRAINS OF JOINTS.

DEFINITION—CAUSES—LESIONS—RESULTS, 76-77

TREATMENT: Of Slight Sprains—Of Severe Sprains—When there is Rupture of a Ligament—When Portions of Bone have been Detached, 77-81

Chapter XI.—Wounds of Joints.

PAGE

Varieties, 82

Treatment of Recent Wounds of Joints: Punctured Wounds—Clean-cut Wounds—Contused Wounds, 82-87

Treatment of Suppurating Wounds of Joints: Amputation—Drainage—Continuous Irrigation—the Water Bath, 87-91

SECTION II.—DISEASES OF JOINTS.

SUB-SECTION I.—DISEASES OF JOINTS IN GENERAL.

Chapter XII.—Inflammatory Affections of Joints.

Acute Inflammation:

Acute Synovitis: Causes and Symptoms—*Treatment*, 91-94

Acute Suppurative Arthritis: Causes—Pathological Changes—Results—*Treatment*: When an attempt is made to save the Limb—When no attempt is made to save the Limb—When Acute Arthritis affects Joints that cannot be removed by Amputation, 94-98

Gonorrhœal Arthritis: Pathology—Varieties—*Treatment*: Of the Simple Rheumatic Form—Of the Ordinary Acute Variety—Of Cases accompanied by Excessive Effusion—Of Cases complicated by Suppuration, 98-104

Other Forms of Infective Arthritis: Symptoms—Treatment, 104-105

Chronic Inflammation:

Chronic Synovitis with Effusion: Causes and Treatment of Slight and Severe Cases, 105-107

Chronic Synovitis with Synovial Thickening: *Of the Synovial Fringes*: Treatment—*Of the Substance of the Synovial Membrane*: Treatment, 105-110

Chapter XIII.—Tuberculosis of Joints.

Pathological Changes: Primary Osseous Deposits—Primary Synovial Disease, 111-112

Symptoms, 112-113

General Points in Treatment:

General Treatment: Climatic—Dietetic—Medicinal, 114-116

Local Treatment: *Palliative Measures*: Rest—Extension—Counter-irritation—Free Incision—Pressure—Injection of Iodoform Emulsion—Bier's Method—*Operative Measures*: Indications for Operation—Choice of Operation: Amputation—Arthrectomy—Excision, 116-129

Special Points in the Treatment of the Various Stages: Localised Deposits in the Bone which have not yet reached the Joint—Localised Deposits in the Synovial Membrane—Empyema tuberculosum and Hydrops tuberculosus—Where an Osseous Deposit has burst into the Joint—General Synovial Disease without Destruction of Cartilages or Inflammation of Bone, and without Abscesses—Cases Complicated by Unopened Abscesses—Cases Complicated by Septic Sinuses—Cases accompanied by Anchylosis and Deformity, 129-137

Chapter XIV.—Syphilitic Affections of Joints.

PAGE

Joint Affections during Secondary Stage: Treatment—During Tertiary Stage. General and Local Treatment—In Hereditary Syphilis: Treatment—Syphilitic Dactylitis, 138-140

Chapter XV.—Nervous Affections of Joints.

Affections due to Organic Lesions:
Charcot's Disease Pathological Changes—Symptoms—Complications—Treatment, 141-144
Joint Affections from Neuritis, etc., 144
Joint Neuroses: *General Treatment*: Weir Mitchell Treatment—Hypnotism—*Local Treatment*: Tenotomy, 144-148

Chapter XVI.—Rheumatoid Arthritis.

Acute Rheumatoid Arthritis: Causes, Symptoms, and Treatment, 149-150
Chronic or Mon-Articular Rheumatoid Arthritis: Causes—Pathological Changes—*Treatment*: General—Local: Thermal Treatment—Super-heated Air—Electricity—Ambulatory Treatment—Operative Measures, 150-157

Chapter XVII.—Loose Bodies in Joints.

Causes—Treatment: Arthrotomy, 158-160

Chapter XVIII.—Anchylosis.

Varieties: *Anchylosis due to union between the Articular Surfaces:* Treatment—*Fibrous Anchylosis between the ends of the Bones—Fibrous Adhesions inside or outside the Capsule*—Treatment—*Anchylosis due to the Adhesion of Muscles around the Joint*, 161-163

Sub-Section II.—Diseases of Individual Joints.

Chapter XIX.—Diseases of the Hip Joint.

Inflammatory Affections:
Simple Acute Synovitis: Treatment, 164
Infective Arthritis: After Typhoid Fever: *Treatment*—Gonorrhœal—Pyæmic: *Treatment*, 164-167
Chronic Synovitis, 167
Tuberculous Disease:
Seats—Course—Clinical Stages—Prognosis, 167-170
Treatment: *Of the First Stage*: Primary Bone Disease—Primary Synovial Disease—*Of the Second Stage—Of the Third Stage*: When there is an Unopened Abscess—When there are Septic Sinuses—*Of the Fourth Stage*, 170-187
Excision of the Hip: By an Anterior Incision—By an External Incision—By a Posterior Incision, 187-192
Rheumatoid Arthritis: Treatment, 192-193
Charcot's Disease: Treatment, 193
Hysterical Disease: Treatment, 193-194
Loose Bodies, 194

Chapter XX.—Diseases of the Knee Joint.

PAGE

Acute Synovitis: Symptoms and Treatment, 195-197
Chronic Synovitis: Treatment, 197
Papillary Synovitis: *Treatment*—Irritant Injections—Excision of Hypertrophied Synovial Membrane, 198-199
Acute Suppurative Arthritis: Treatment, 199
Gonorrhœal Arthritis, 200
Syphilitic Affections, 200
Tuberculous Disease: *Pathological Changes*: Localized Tuberculous Deposits—Diffuse Infiltration—*Treatment*: Of Localized Deposits, Synovial and Osseous—Of General Tuberculous Disease: Expectant and Operative—of the various stages, 200-221
Rheumatoid Arthritis, 221
Charcot's Disease, 221-222
Hysterical Conditions, 222
Hæmophilia, 222
Internal Derangements of the Knee Joint: *Loose Cartilages*: Treatment—*Detachment of the Ligamenta Alaria*: Treatment—*Injury to the Semilunar Cartilages*: Treatment—Of First Attack—Of Recurrent Cases, 222-227

Chapter XXI.—Diseases of the Ankle and Tarsus.

Acute Arthritis: Varieties—Treatment, 228-229
Chronic Synovitis, 229
Rheumatoid Arthritis, 230
Charcot's Disease, 230
Syphilitic Affections, 230-231
Tuberculous Disease of the Ankle Joint: Course—*Treatment*: Of Primary Osseous Deposits—Of Synovial Thickening—When Abscesses or Sinuses are present—Of Recovery with Deformity, 231-237
Tuberculous Disease of the Tarsus: *Of Individual Bones*: Of the Os Calcis—Of the Base of the First Metatarsal—Of other Tarsal Bones—Treatment—*Diffuse Tarsal Disease*: Treatment—Tarsectomy, partial and complete—Amputation through the Leg, 237-248

Chapter XXII.—Diseases of the Shoulder Joint.

Inflammatory Affections: Acute and Chronic Synovitis—Acute Suppuration, 249
Tuberculous Disease: Treatment: Expectant—Operative, 249-255
Rheumatoid Arthritis: Treatment, 255-256
Charcot's Disease, 256

Chapter XXIII.—Diseases of the Elbow Joint.

Inflammation of Bursa beneath Biceps Tendon: Treatment, 257
Acute Suppuration: Treatment, 257-258
Acute and Chronic Synovitis: Treatment, 258
Rheumatoid Arthritis, 258
Loose Cartilages, 258
Charcot's Disease, 259
Tuberculous Disease: Treatment: Expectant—Operative: Arthrectomy of the Elbow—Excision of the Elbow, 259-264

CHAPTER XXIV.—DISEASES OF THE WRIST AND HAND. PAGE

DISEASES OF THE WRIST:
ACUTE INFLAMMATION: Treatment—CHRONIC INFLAMMATION: Treatment—TUBERCULOUS DISEASE: Expectant and Operative Treatment, 266-273
DISEASES OF THE PHALANGEAL JOINTS:
SPRAINS: Treatment—SYNOVITIS—GOUTY ARTHRITIS: Treatment—RHEUMATOID ARTHRITIS: Treatment—TUBERCULOUS DISEASE: Treatment—SYPHILITIC DACTYLITIS, 273-275

DIVISION II.

THE SURGICAL AFFECTIONS OF THE SPINE.

CHAPTER XXV.—INJURIES OF THE SPINE.

CAUSES—RESULTS, 276-277
SPRAINS: Symptoms—Treatment; in Recent Cases—in Long-Standing Cases, 277-279
HÆMATO-RACHIS: Symptoms—Treatment, 279
CONCUSSION OF THE SPINE: Symptoms—Treatment—"Railway Spine," 279-281
HÆMORRHAGE INTO THE CORD OR HÆMATO-MYELIA. Symptoms—Treatment, 281
DISLOCATION AND FRACTURE-DISLOCATION: *Dislocation*—Reduction—*Fracture-Dislocation*—Symptoms—Prognosis—Treatment: of Fracture of the Bodies—Of Fracture of the Spinous Processes and Laminæ; Laminectomy—Of Complications, 282-293
WOUNDS OF THE SPINE. Stabs: Treatment—Bullet Wounds: Treatment, 293-294

CHAPTER XXVI.—SPINA BIFIDA.

DEFINITION—VARIETIES—CLINICAL CHARACTERS, 295-297
TREATMENT: *Palliative*—Shields—*Operative Measures*: Injection of Morton's Fluid—Excision: Cases suitable for Excision—Osteoplastic Procedures—Treatment suitable for the Individual Forms, 297-303

CHAPTER XXVII.—KYPHOSIS: SCOLIOSIS.

KYPHOSIS:
Causes—Symptoms—Treatment, 304-306
SCOLIOSIS:
Causes—Pathological Changes—Symptoms—Examination—Progress—Treatment: *Prophylaxis*—When there is obliquity of the pelvis—When heavy weights are carried upon one side—When there is weakness of the spinal muscles—When there has been disease within the thorax—*When Scoliosis has developed*—The Scoliosis of Infancy—The Scoliosis of Childhood—The Curvatures of Adolescence—The Scoliosis of Adult Life, 306-325
MEDICAL GYMNASTIC EXERCISES FOR SCOLIOSIS, 325-340

Chapter XXVIII.—Tuberculous Disease of the Spine.

PAGE

Disease of the Spine:
Seats—Symptoms—Treatment: *Of Spinal Disease in General*—Rest—Extension—Supports—*Of Complication*: Paralysis: Laminectomy—Abscess. *Of the Disease in Special Situations*, 341-354

Disease of the Sacro-iliac Synchondrosis:
Symptoms—Treatment, 355-356

Chapter XXIX.—Spondylitis Deformans: Acute Osteo-Myelitis: Actinomycosis: New Growths of the Spine: Hysterical Spine: Sacro-coccygeal Tumours.

Spondylitis Deformans: Symptoms and Treatment, 357

Acute Osteo-Myelitis, 357

Actinomycosis, 358

New Growths: *Of the Vertebræ*: Symptoms and Treatment—*Of the Spinal Cord*: Treatment, 358-360

Hysterical Spine, 360

Sacro-coccygeal Tumours, 360-361

INDEX, 362

LIST OF ILLUSTRATIONS.

PART IV

FIG.		PAGE
1.	Dislocation of the Acromial End of the Clavicle,	10
2.	Dislocation of the Sternal End of the Clavicle,	13
3.	Kocher's Method of Reducing Dislocations of the Shoulder (First Stage),	16
4.	,, ,, ,, ,, ,, (Second Stage),	17
5.	,, ,, ,, ,, ,, (Third Stage),	18
6.	,, ,, ,, ,, ,, (Fourth Stage),	19
7.	,, ,, ,, ,, ,, (Final Stage),	19
8.	,, ,, ,, ,, ,, (Dissections showing the course taken by the head of the bone) (*Helferich*),	20
9.	The Right-angled Traction Method of Reducing Dislocation of the Shoulder,	21
10.	The Heel-in-Axilla Method of Reducing Dislocations of the Shoulder (First Stage),	22
11.	The Heel-in-Axilla Method of Reducing Dislocations of the Shoulder (Final Stage),	23
12.	Method of Reducing a Dislocation of Both Bones of the Fore-arm Backwards,	34
13.	Splint for use after Dislocation of Both Bones Backwards Accompanied by Fracture of the Coronoid Process,	36
14.	Apparatus for use after Dislocation of the Head of the Radius Forwards,	42
15.	Incision to Expose the Head of the Humerus,	43
16.	Tin Finger Splint,	46
17.	Method of Reducing a Dislocation of the Thumb (First Stage),	47
18.	,, ,, ,, ,, (Final Stage),	48
19.	Forceps for Reduction of Dislocations of the Thumb,	49
20.	Division of the Glenoid Ligament in Reduction of a Dislocation of the Thumb (diagrammatic),	49
21.	Reduction of a Dorsal Dislocation of the Hip by Bigelow's Method (First Stage),	52
22.	,, ,, ,, ,, ,, ,, (Second Stage),	53
23.	,, ,, ,, ,, ,, ,, (Final Stage),	54
24.	Reduction of a Dorsal Dislocation of the Hip by Traction,	55
25.	Reduction of a Thyroid Dislocation of the Hip by Bigelow's Method,	56
26.	Reduction of a Thyroid Dislocation by Traction,	57
27.	Anterior Incision for Exposing the Neck of the Femur,	59
28.	Diagrammatic Representation of the Operation for Unreduced Dislocation of the Patella,	63

FIG.		PAGE
29.	Incision for removal of the Internal Semilunar Cartilage,	68
30.	Excision of Astragalus,	72
31.	Wire-Netting Splint,	73
32.	Boot for use after Excision of Astragalus,	74
33.	Constant Irrigation applied to the Knee Joint,	89
34.	Interrupted Plaster of Paris Splint for Wounds of the Knee Joint,	90
35.	Anterior Suspension Bar for Wounds of Joints,	91
36.	Incisions for Arthrectomy of the Knee,	126
37.	Extension by Weight and Pulley for Hip Disease,	172
38.	Thomas's Hip Splint,	173
39.	Weight Extension in Hip Disease when the Flexion is great,	174
40.	A Double Thomas's Splint for Hip Disease,	175
41.	Method of Application of the Double Thomas's Splint for Hip Disease,	176
42.	Phelps's Box,	177
43.	Method of Application of Phelps's Box,	178
44.	Barker's Flushing Gouge,	181
45.	Excision of a Wedge from the Neck of the Femur in old Hip Disease,	185
46.	Sub-trochanteric Osteotomy of the Femur for old Hip Disease,	186
47.	Excision of the Hip by an Anterior Incision,	188
48.	Saws for Division of the Femur,	188
49.	Excision of the Hip by an External Incision,	190
50.	Excision of the Hip by a Posterior Incision,	191
51.	Incision for Exposing a Tuberculous Deposit in the Internal Condyle of the Femur,	204
52.	Thomas's Knee Splint,	206
53.	Incisions for Arthrectomy of the Knee,	209
54.	Relation of the Epiphyseal Cartilage to the Bone Section in Excision of the Knee (*Holmes's System of Surgery*),	214
55.	Incision for Excision of the Knee,	215
56.	Cuneiform Excision of the Knee for Anchylosis with Deformity,	220
57.	Incision for the removal of the Internal Semilunar Cartilage,	226
58.	Boot for use in Charcot's Disease of the Ankle Joint,	230
59.	Incisions for Arthrectomy or Excision of the Ankle,	233
60.	Method of exposing the ends of the Tibia and Fibula in Arthrectomy of the Ankle,	235
61.	Incision for Excision of the Os Calcis,	240
62.	Anterior Suspension Bar applied after Arthrectomy of the Ankle,	241
63.	Incision for Removal of a Tuberculous Deposit in the Base of the First Metatarsal,	242
64.	Incisions for Partial Tarsectomy for Tuberculous Disease of the Tarsus,	245
65.	Mikulicz's Operation,	247
66.	Apparatus for use in Tuberculous Disease of the Shoulder,	250
67.	Weight Extension applied for Tuberculous Shoulder Joint Disease,	251
68.	Incision for Excision of the Shoulder,	253
69.	Removal of the Head of the Humerus in Excision of the Shoulder,	253
70.	Incisions for Arthrectomy of the Elbow Joint,	260
71.	Method of protruding the Articular Ends in Arthrectomy of the Elbow,	262
72.	Apparatus for promoting Flexion and Extension of the Elbow after Excision,	265
73.	Lister's Wrist Splint,	268
74.	Lister's Excision of the Wrist (*Holmes's System of Surgery*),	270
75.	Incisions for Laminectomy,	289
76.	Laminectomy Pliers,	289
77.	Removal of the Laminæ in Laminectomy,	290

FIG.		PAGE
78.	Method of Retaining the Laminæ in Laminectomy,	290
79.	Incisions for Excision of a Spina Bifida,	299
80.	The Flap Method of Excising a Spina Bifida,	300
81.	The Type of Desk and Chair suitable for Children's use,	314
82.	Dowd's Machine (*Percy Lewis*),	321
83.	"Rachilysis" applied in the Standing Position,	322
84.	"Rachilysis" as applied in the Sitting Position (*Percy Lewis*),	323
85.	Spinal Brace for Scoliosis (*Percy Lewis*),	324
86 to 131.	Diagrams to illustrate the Medical Gymnastic Exercises (*Percy Lewis*),	327 to 339
132.	Double Extension for Tuberculous Spinal Disease,	346
133.	Phelps's Box,	347
134.	Method of Application of Phelps's Box,	348
135.	Taylor's Brace (*after Bradford and Lovett*),	349
136.	Taylor's Brace Applied (*after Bradford and Lovett*),	350
137.	Poroplastic Collars for Spinal Disease,	351
138.	Taylor's Brace as modified for use in Cervical Spinal Disease (*after Bradford and Lovett*),	352

DIVISION I.

THE SURGICAL AFFECTIONS OF JOINTS.

SECTION I.—INJURIES OF JOINTS.

CHAPTER I.

DISLOCATIONS: GENERAL CONSIDERATIONS.

DEFINITION.—By the term dislocation is understood a displacement of the ends of the bones which enter into the formation of a joint, so that the articular surfaces no longer maintain their relative positions.

The displacement may be partial or complete. By a **complete dislocation** is meant a complete alteration of the normal relative positions of the articular surfaces of the bones so that the end of one bone over-rides the other; this is most common when the joint affected is of the ball-and-socket variety, but it may occur in almost any joint in the body. In a **partial dislocation**, on the other hand, there is only an incomplete displacement of the articular surfaces—usually lateral—without any over-riding; this is most common in hinge-joints such as the elbow or the knee.

CLASSIFICATION.—Dislocations may be classified according to their cause into the following three main groups:

1. **Traumatic dislocations**, where a healthy joint is dislocated as the result of violence.

2. **Pathological dislocations**, or those resulting from disease. The chief factor in the production of this form is disease in the joint capsule which gives way and allows displacement of the ends of the bones; examples of this are seen in tuberculous disease, osteo-arthritis, Charcot's disease, etc.

3. **Congenital dislocations**, which are due either to malformation, to some displacement *in utero*, or possibly to violence at or immediately before birth.

We shall here deal only with the first class of dislocations, namely, those which result from injury.

CAUSES.—Exciting.—The cause of the dislocation may be: (*a*) *indirect violence*, as when a fall upon the hand results in dislocation of the humerus; (*b*) *direct violence*, as when a blow on the point of the shoulder dislocates the clavicle; (*c*) *traction*, as when, in lifting a child by the hand, the head of the radius is dislocated; or (*d*) *muscular contraction*, as in dislocation of the humerus caused by throwing a ball, playing single-stick, etc.

Predisposing.—In addition to these, there are various predisposing causes of dislocation, such as: (*a*) *The nature of the joint.* Ball-and-socket joints such as the shoulder, are, from their anatomical conformation, more liable to dislocation than such well-fitting joints as the elbow. (*b*) *The age of the patient.* This affects the question in two ways. Dislocation is most common in the adult. In the young, a joint injury is more likely to cause a separation of the epiphysis; while in the old, the bones are more brittle, and therefore fracture is more likely to occur than dislocation. (*c*) *The condition of the muscles which surround the joint.* If these be wasted from disuse or disease, or if they be, so to speak, taken by surprise, a force that would otherwise possibly produce no injury either to bone or joint may quite easily bring about a dislocation.

TREATMENT.—From the point of view of treatment all dislocations may be considered according as they are (1) simple; (2) compound; or (3) of long-standing. Further, from the same point of view, any of these forms of dislocation may be complicated; (*a*) with fracture of the bone either in the immediate vicinity of the dislocated joint or at some distance from it; (*b*) with severe damage—such as rupture—of vessels or nerves near the joint; (*c*) with simple pressure on nerves, leading to paralysis or paresis; and (*d*) with adhesion of vessels, nerves, and other tissues to the dislocated articular surfaces; this last complication is met with when the dislocation has existed for some time.

TREATMENT OF SIMPLE DISLOCATIONS.

The treatment of a simple dislocation must fulfil three requirements: (1) the restoration of the displaced articular surfaces to their normal positions: (2) the prevention of the recurrence of the dislocation; and (3) the preservation of the functions of the joint.

REDUCTION OF THE DISLOCATION.—Obstacles to reduction.—The chief factors opposing the reduction of a dislocation are the following:

(*a*) *Muscular contraction.* The muscles in the vicinity of the joint are usually in a state of spasmodic contraction from the irritation caused by the laceration of the ligaments and the presence of the articular end of the bone in a new position. One of the most important points in successful reduction is to overcome this spasmodic contraction.

This may be effected either by the administration of a general anæsthetic, or by steady traction in a suitable direction, which stretches and tires out the muscles, and so overcomes their resistance. Of the two methods the administration of an anæsthetic is far the better procedure, and we would recommend its employment if possible in all cases of dislocation. In any attempt to reduce a dislocation without an anæsthetic it is generally extremely difficult to overcome the contraction of the muscles if the patient be at all powerful, while excessive pain may be caused, and a fresh and unnecessary laceration of the tissues will almost certainly result. The only cases in which an anæsthetic should be deliberately withheld are those in which there is some constitutional affection contra-indicating its use, those in which the situation of the dislocation is such that interference with breathing would be likely to result during its administration, or those in which the dislocation is only partial and can be readily enough reduced without it.

(*b*) *Entanglement of one of the articular ends with some of the structures in the vicinity of the joint.* The end of the bone may be grasped by the edges of the laceration in the capsule through which it protrudes, or by some of the muscles, tendons or ligaments in the neighbourhood, or may become firmly hitched against some bony prominence.

It will therefore be necessary to employ appropriate manipulations to get the articular surfaces into proper position. These manipulations are specially designed to disentangle the articular end from any structure around the joint with which it may have become engaged, and they will therefore naturally vary with the anatomical conditions of the particular joint to which they are applied. They will be described in connection with individual dislocations, and all that need be said here is that their main object is to bring the head of the bone opposite the rent in the capsule through which it has escaped, and then to force it back through that rent into its normal position.

(*c*) *The interposition of neighbouring structures—especially tendons—between the articular surfaces.* The best example of this occurs in dislocations of the ankle. In joints, such as the temporo-maxillary, furnished with an inter-articular fibro-cartilage, this structure may be displaced and interfere with the proper reposition of the articular surfaces.

When the ends of the bones have been brought into their proper relative positions, the surgeon must make quite certain that the movements of the joint are perfectly free and full in all directions. Should it be found that an obstacle, such as a piece of tendon or ligament is caught between the ends of the bones, the case should by no means be left alone. If further manipulations, intelligently directed to getting rid of the interposed structure fail, there should be no hesitation in opening the joint and removing the obstruction. An operation of this nature must of course be done with the strictest antiseptic precautions, but if the surgeon be an adept at such work he need have no

much irritation. The dislocation should then be reduced, and two or more drainage tubes of moderate size introduced into the joint at suitable spots.

The edges of the wound should be brought together as far as possible, at any rate the portion of the wound made by the surgeon should be accurately stitched up, while a few stitches should be put in the remainder if the edges be not too severely bruised. If after the lapse of forty-eight hours there be no appearance of inflammation in the wound, no elevation of temperature or other sign of sepsis, the tubes may be taken out and the case then treated like an aseptic wound of a joint (see Chap. XI.). The joint should be kept at rest upon a splint for the first three or four days, but, as soon as the drainage tube is removed, passive movements should be begun and the case treated much as if it were a simple dislocation.

In long-standing cases.—When a compound dislocation has occurred some time before the patient comes under observation, and when sepsis is already established, the condition is infinitely more serious. Under such circumstances it is hardly justifiable to think of reducing the dislocation; to do so would be simply to produce a more or less closed cavity, into which free suppuration from the joint surfaces is taking place. In the majority of cases it will probably be safest either to excise the joint or to amputate the limb.

When the patient is old and the septic symptoms are violent, amputation will be the better practice; but in young subjects, and particularly in those in whom the septic condition is not very acute, the removal of the articular ends of the dislocated bones will generally suffice to secure a good result. This will leave a cavity from which it is possible to obtain free drainage, and when this is established it may even be hoped—as, for instance, in the case of the elbow—to get a movable joint.

After-treatment.—This will be partly that of a septic wound and partly that of an excision. The cavity should be thoroughly drained, antiseptic dressings applied, so as to prevent the entrance of fresh septic material, and the limb put at rest upon a splint for a few days. As soon as the acute symptoms show signs of abating, passive movements should be begun and carried out as in ordinary cases of excision.

TREATMENT OF UNREDUCED DISLOCATIONS.

Dislocations that have remained unreduced for any length of time are very serious, because attempts at reduction upon the ordinary lines are likely to fail for various reasons. In the first place, after the ends of the bones have been displaced for any time they contract firm adhesions to surrounding structures, such as muscles, vessels, nerves, etc., and considerable force may actually fail to tear through these adhesions. When the bone is adherent to vessels or nerves, attempts at reduction, even though made with quite a moderate degree of force, may tear through these structures, and give rise to the most disastrous consequences. Again, there are always

marked alterations in the capsule of a joint which is the subject of an unreduced dislocation; it becomes shrunken and altered in shape, and there are such extensive adhesions both to the structures around and to the articular surfaces that the end of the bone can no longer be got within the capsule. Lastly, changes take place with such remarkable rapidity in the articular ends of the bones themselves that the bone surfaces no longer fit each other when the dislocation is reduced, and therefore displacement is apt to recur on the slightest provocation.

It will be obvious from what has just been said that the treatment must vary according to the length of time that has elapsed since the dislocation occurred. The first point that will naturally come up for consideration is whether it will be possible to reduce the dislocation by the same manipulations that would be called for were the injury recent. This of course depends entirely upon the changes that have occurred in the joint and the articular surfaces. These in their turn are governed by the length of time that has elapsed since the dislocation, and vary within somewhat wide limits, so that it is therefore impossible to lay down any very definite time within which it is wise to attempt such a reduction. Speaking broadly, however, we may say that in the case of the shoulder it is seldom that a dislocation can be reduced by simple manipulation after three or four weeks have elapsed since the injury, and it is hardly safe even to attempt reduction after a period of seven weeks. We shall have to refer to the subject again when dealing with the unreduced dislocations of individual joints.

Should the time that has elapsed be too long to render an attempt at reduction advisable, or should such an attempt have been made and have failed, there are three courses open to the surgeon. After a certain time the displaced end of the bone tends to form for itself a fresh joint in its new position, and this in some cases may prove so serviceable that it is quite as good as any that could be obtained for the patient by any operative or other measures. Under these circumstances therefore the surgeon will be well advised to leave the case to nature.

In many cases, however, the displaced bone presses upon nerves and causes great pain, and moreover the movements are generally so imperfect that something must be done to give relief. The second course is to cut down upon the displaced ends, replace them in position, and thus more or less completely re-establish the joint. This fortunately is sometimes possible, even when a long time has elapsed since the accident. Before the end of the bone can be got into place, it is usually necessary to divide a number of structures—particularly muscles—surrounding the joint, and it is further imperative as a rule to mechanically alter the shape of the joint surfaces so as to restore their original contour and thus to prevent spontaneous recurrence of the dislocation. The actual chances of success from this procedure can however only be ascertained after the surgeon has cut down and obtained direct inspection of the parts. If it be possible to replace

the head of the bone without any extensive division of important structures, a very satisfactory result indeed is likely to be obtained.

The third course which remains for adoption when both of the foregoing are impracticable, is excision of one or both of the articular surfaces of the affected joint. It is generally sufficient to excise one articular surface alone in order to reduce the dislocation and to restore movement in the joint; this point will be gone into more fully in connection with dislocation of individual joints.

CHAPTER II.

DISLOCATIONS OF THE CLAVICLE.

Either end of the clavicle may be dislocated; the acromial is the one more frequently affected.

DISLOCATIONS OF THE ACROMIAL END.

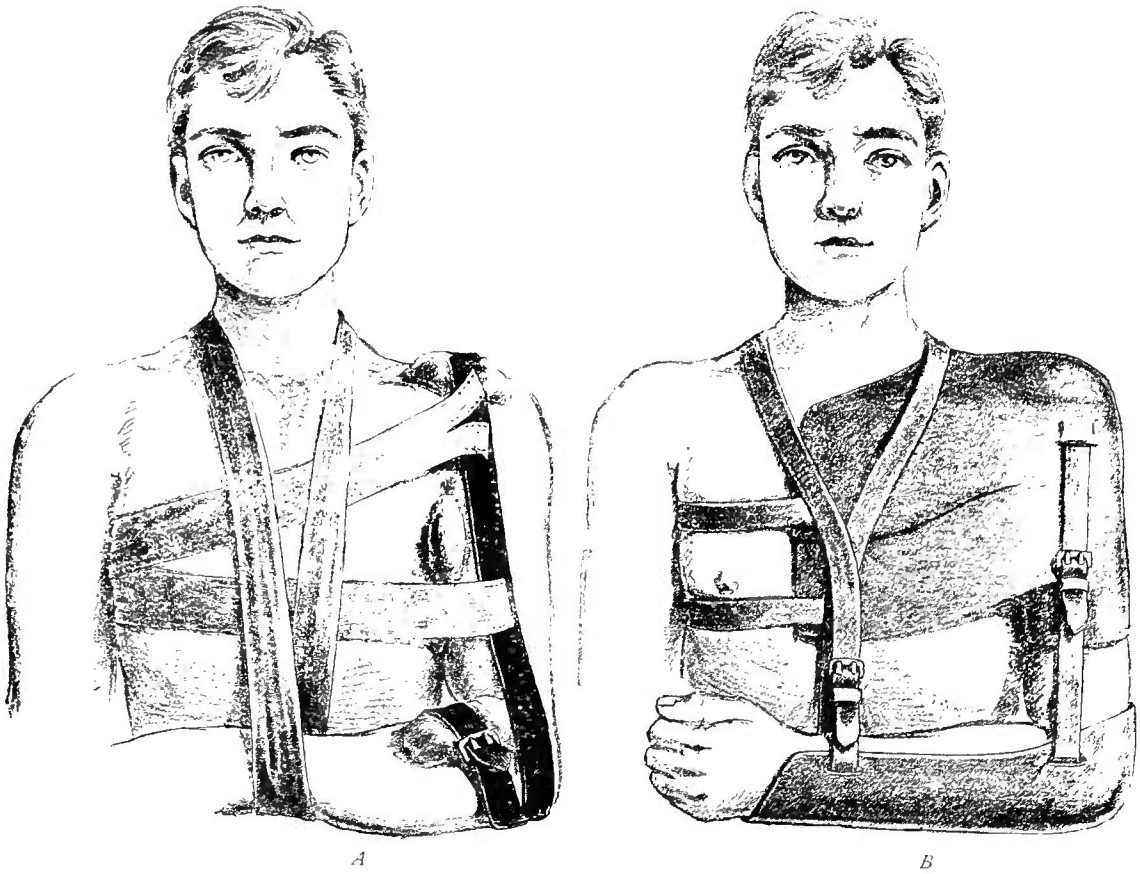
Strictly speaking this is really dislocation of the scapula from the clavicle. Although more frequent than dislocation of the sternal end, the injury is still far from common. It is usually caused by falls or blows upon the back or outer side of the shoulder, which push the scapula forwards. Falls or blows upon the point of the shoulder, on the other hand, are more prone to produce fracture.

DISPLACEMENT.—The acromial end of the clavicle almost invariably projects above the acromion process of the scapula, whilst the latter is displaced somewhat forwards and downwards; there is generally a slight dropping of the shoulder. Cases have, however, been met with where the clavicle has been displaced below the acromion, and in some exceedingly rare cases it has even been found below the coracoid process.

TREATMENT.—(a) **Of dislocation upwards.**—As a rule this is very difficult and somewhat unsatisfactory. Reduction of the dislocation is perfectly easy; it is only necessary to carry the shoulder forcibly backwards and upwards, to push up the elbow and to press down the acromial end of the clavicle. This brings the articular surfaces into good position; but the difficult part of the treatment is to maintain the reduction while repair is taking place. A certain amount of deformity is almost certain to recur, and this will be permanent. Fortunately, however, it rarely interferes at all with the usefulness of the limb, and heavy manual labour can often be performed as well as ever, even with a considerable deformity; occasionally, on the other hand, there may be much interference with the patient's work.

Splints.—The point of greatest difficulty in the treatment is that, however

well the arm be fixed immediately after the reduction of the dislocation, there is a constant tendency for it to drop, when the end of the clavicle immediately projects upwards. Perhaps the best plan is, after reducing the dislocation by pushing the shoulder upwards and backwards, to support the arm in a large elbow-sling fixed around the neck, to place a thick pad in the axilla, another over the outer end of the clavicle, and a third over the front of the fore-arm close to the elbow. An ordinary broad leather



A *B*

FIG. 1.—DISLOCATION OF THE ACROMIAL END OF THE CLAVICLE.

A. Shows the first method described in the text. The strap—kept from slipping by the two bands passing beneath the opposite axilla—is seen passing over the point of the shoulder and around the elbow, where the two turns are often fastened together to keep them from slipping. A wrist-sling only is shown in the figure for the sake of clearness; it should be a large elbow-sling, and the arm should be bound to the side.

B. The second method described. There is a pad over the acromial end of the clavicle, beneath the shoulder-cap which is firmly buckled to the elbow-sling.

strap is then carried over the pad upon the clavicle, around the elbow and over the pad upon the fore-arm (see Fig. 1, *A*). When this is tightened up, it presses down the outer end of the clavicle, and also pushes the elbow upwards and backwards. The chief trouble with this apparatus is that the strap is constantly slipping down over the point of the shoulder, and to prevent this it is necessary to fix straps or bandages to it opposite the anterior and posterior folds of the axilla, and to fasten the ends of these together beneath the opposite axilla. The arm is then bound to the side with an ordinary bandage, with the elbow somewhat

pushed forward. This apparatus may be kept on for three or four weeks, the strap being tightened whenever it gets loose, and after it is left off, the arm should be supported in a large elbow-sling for another two or three weeks.

A more efficacious but somewhat more complicated apparatus is shown in Fig. 1, *B*, and is made by applying a shoulder-cap, between which and the acromial end of the clavicle a firm pad is inserted, and supporting the elbow in a moulded elbow-sling. The sling and the shoulder-cap can then be braced firmly together by straps or elastic tubing, and the humerus is thus forcibly pushed upwards.

Wiring.—The above methods are applicable to the ordinary cases where the displacement is not great. When, however, the displacement is very marked and there is considerable over-riding of the articular ends, and more particularly when there is inability to raise the arm properly from the side, operative interference may with advantage be practised. A curved incision is made with its convexity forwards, the flap dissected back, and the joint exposed; the dislocated surfaces can then be replaced in position and the torn ligaments stitched together. Although it is easy to reduce the dislocation thus, it may be found no easy matter to keep the articular surfaces in contact. Recurrence of the deformity may take place as easily as when reduction is performed without an operation, and if this be the case it will be requisite to drill the joint, and pass a wire between the clavicle and the acromion, so as to mechanically fix the ends together. The bones should be drilled obliquely, so that the wire passes through both articular surfaces, which are got into accurate position when the wire is twisted up. A wire of No. 5 French gauge—*i.e.* 5 mm. in circumference—will suffice. This, however, has the disadvantage that it abolishes the movements between the clavicle and the scapula, which are very important for the proper performance of the antero-posterior movement of the latter. Nevertheless it may have to be done, as it gives strength to the arm and is often of considerable value to the patient. No restriction need be placed upon movement after the operation, as the parts will be held firm by the wire. Gentle passive movements, gradually increasing in range, may be begun at the end of the first fortnight.

Unreduced dislocations.—In long-standing cases accompanied by marked disability it may be necessary to have recourse to operation in order to give the patient a useful arm. Here the surgeon should excise the joint by removing the cartilaginous surfaces, and the clavicle should then be fixed to the acromion by means of a stout silver wire (No. 5 French gauge) passed vertically through the whole thickness of the clavicle, and similarly through the acromion process. This will usually fix the bones quite firmly.

(b) **Of dislocation downwards.**—When the end of the clavicle is wedged beneath the acromion or the coracoid process, the patient should be placed under an anæsthetic, when it will generally be easy to disentangle the bone by carrying the shoulder forcibly backwards and outwards. There will not be the same tendency to upward displacement after reduction

as in the former case, nor will there be any likelihood of the downward displacement recurring, as the weight of the limb is sufficient to prevent that. The arm should be fixed to the side, and the elbow supported in a large elbow-sling.

DISLOCATIONS OF THE STERNAL END.

Owing to the great strength of the rhomboid ligament, dislocation of the sternal end can hardly occur except as the result of extreme violence; this accident is therefore of very rare occurrence, and is usually accompanied by other serious injuries. The commonest displacement is forwards, in front of the sternum: in other cases, however, the sternal end may be driven backwards behind that bone, or directly inwards, so that it lies in the supra-sternal notch. The dislocation is generally the result of severe violence applied to the point of the shoulder, and the direction of the dislocation depends to some extent on the direction in which the shoulder is carried by the injury. If it be pushed forwards, the sternal end may be displaced backwards and *vice versâ*: whereas if it be depressed the sternal end will be displaced upwards.

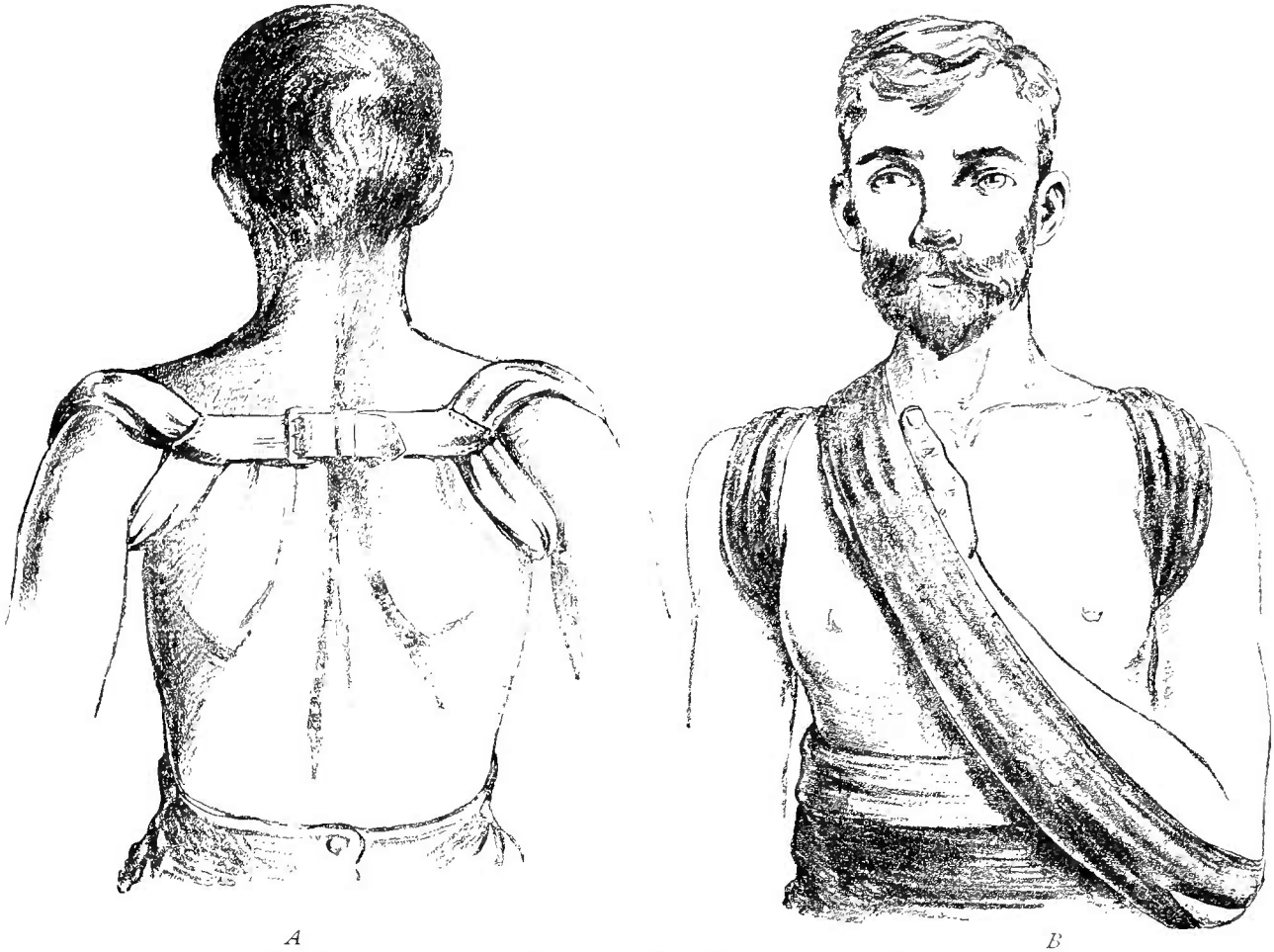
The result of the dislocation is considerable interference with the movement of the upper extremity. In addition to this, severe dyspnœa or even dysphagia from pressure upon the trachea or œsophagus are met with when there is backward displacement. When the sternal end is displaced directly upwards the rhomboid ligament is torn as well as those of the joint proper.

TREATMENT.—As in dislocations of the acromial end, it is often a matter of the greatest difficulty to keep the ends of the bones in position after reduction. It is generally best to place the patient under an anæsthetic, and to carry the shoulder forcibly backwards and outwards, when the sternal end of the bone can be pushed into position. When severe dyspnœa is present, an anæsthetic should be avoided; the best plan then is to have the patient sitting upon a chair while the surgeon, standing behind the patient with his foot upon the same chair, places his knee against the spine and, grasping one shoulder in each hand, pulls them forcibly backwards. When the shoulders have been carried sufficiently far back the sternal end of the bone is disengaged, and either slips into place or can be pushed forwards by the fingers.

It needs a good deal of care, however, to prevent the deformity recurring. The best plan is to brace the shoulders back by means of handkerchiefs applied as for fractured clavicle (see Fig. 2, *A*). At the same time the elbow should be supported and brought well forward over the chest (see Fig. 2, *B*).

Unreduced dislocation.—In long-standing cases, where the dislocation has not been reduced, and in some recent cases when the end of the bone is displaced backwards and presses on the trachea, and cannot be got

into place by manipulation, it may be necessary to cut down and remove the sternal end. For this purpose a curved incision with its convexity upwards should be made over the inner end of the clavicle, which is exposed when the flap is turned down. The periosteum is then incised parallel with the long axis of the bone, and most carefully stripped off by a rugine. A suitably curved copper spatula is then passed around the bone immediately beneath the periosteum, and the sternal end is nipped off by a pair of powerful cutting pliers, after which it is seized



A *B*

FIG. 2.—DISLOCATION OF THE STERNAL END OF THE CLAVICLE. The shoulders are first drawn well back by the handkerchiefs braced together, as shown in *A*. Finally the forearm is flexed across the chest and the elbow supported by the oblique band of strapping seen in *B*.

by bone forceps and most carefully removed, any structures retaining it being peeled off by the help of a rugine and a few touches of the point of the knife kept accurately in contact with the bone. At this stage of the operation extreme care is required, because there is always a risk that adhesions may have occurred between the end of the bone and the innominate vein, but the risk of any accident from this is comparatively slight if the periosteum be peeled off completely before the end of the bone is removed.

The wound is sewn up without a drainage tube, and the arm is kept in a large elbow-sling until healing is complete, when the sling may be abandoned and the patient allowed to use the limb.

CHAPTER III.

DISLOCATIONS OF THE SHOULDER.

This accident usually occurs in adults, and is only rarely met with either in early childhood or in old age. After escaping from the capsule, the head of the bone may pass forwards, backwards, or downwards, the particular form of the dislocation being determined mainly by the direction of the force and the position of the arm at the time of the injury. The primary displacement may also be modified subsequently by muscular action or by further violence; this especially applies to the downward dislocation. The violence which generally produces the injury is a fall or blow upon the hand or the elbow, with the arm abducted and slightly rotated outwards. The result is that the greater tuberosity of the humerus comes into contact with the posterior edge of the glenoid cavity of the scapula, and thus the head of the bone is thrust violently against the anterior inferior part of the capsule; this gives way, and the head of the bone passes downwards below the glenoid cavity.

VARIETIES.—In all the forms of dislocation the primary displacement is **sub-glenoid**. As the head of the bone passes downwards it comes into contact with the anterior edge of the long head of the triceps, and, unless the direction of the force be such as to drive the head backwards, the result of contact with this structure is displacement forwards; in its progress in this direction the head comes to lie below the coracoid process —the so-called **sub-coracoid dislocation**—which is much the most common of the dislocations of the shoulder.

When the violence is more extreme, the head of the bone may be thrust beyond the coracoid process until it lies beneath the clavicle—this form is spoken of as **sub-clavicular dislocation**. Still more rarely the head of the bone travels backwards; this is the result either of a fall with the hands fully outstretched, or of direct violence applied to the front of the shoulder. Here also the lower part of the capsule is torn, but generally somewhat more posteriorly than in the former instance, and the head is carried back and lodges in the infraspinous fossa—this is spoken of as a **sub-spinous dislocation**.

Among the rarest forms may be mentioned the **sub-acromial dislocation**, in which the head of the bone passes upwards into contact with the acromion, and the **supra-acromial dislocation**, in which it actually lodges above it. These last two forms are excessively rare, and, as the treatment is practically the same as for the other varieties, we need not refer to them further.

DISPLACEMENT.—**Sub-coracoid dislocation.**—In this, the most common variety of dislocation, the head of the bone lies beneath the coracoid process, the upper arm being directed somewhat backwards and outwards so that the elbow is away from the side. The fore-arm is supinated, there is marked flattening of the shoulder, and the head of the bone can be made out in its new situation.

Sub-clavicular dislocation.—The signs of this variety are usually those of the preceding one in an exaggerated degree; not uncommonly the coracoid process is fractured by the head of the humerus as it passes upwards towards the clavicle.

Sub-glenoid dislocation.—Here there is generally much pain from the pressure of the head of the bone upon the nerves, and from the stretching of the parts; the elbow projects markedly from the side, the arm is slightly elongated, and the head of the bone can be readily felt in the axilla. There may be absence of pulse at the wrist from pressure on the axillary artery, or a rapid œdema of the hand from pressure on the vein.

Sub-spinous dislocation.—The arm is generally rotated inwards, is nearer to the side than in the other forms, and the long axis of the humerus is directed slightly forwards.

TREATMENT OF SIMPLE DISLOCATIONS.

Reduction should of course be effected as early as possible, and means must then be taken to retain the head of the humerus in the glenoid cavity.

REDUCTION.—Reduction may be effected in one of two ways: either *by manipulations*, having for their object relaxation of the capsule and the muscles and the re-introduction of the head of the bone through the rent in the former; or *by traction*, which brings the head of the bone down opposite the rent in the capsule through which it is made to re-enter the joint cavity.

Whenever possible the patient should be put under a general anæsthetic. The pain of a dislocation is generally very severe, and by it the powerful muscles around the joint are kept in a state of such violent contraction that they often offer great resistance to reduction; when the patient is anæsthetised, on the other hand, manipulations, effected with the greatest ease, often suffice to replace the head of the bone. Indeed, it is not at all uncommon to find, in the ordinary sub-coracoid cases, that by the time the patient is fully under the anæsthetic, the dislocation has

spontaneously reduced itself. When, however, no anæsthetic is at hand, the pain that the patient suffers may be so severe as to demand immediate reduction without waiting. The best method of reduction for dislocation downwards or forwards is by manipulation: the particular method of manipulation that is most generally useful is that introduced by Kocher and usually called by his name. It is performed as follows:

Kocher's method.—When the patient is not under an anæsthetic he sits bolt upright in a chair, and an assistant steadies the trunk and fixes

FIG. 3.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *First Stage.* The trunk is firmly fixed by a stout towel passed round the back of a chair and held by an assistant. The elbow is then flexed to a right angle and firmly approximated to the chest-wall.

the scapula, either with his hands or with a towel passed around the body. It is most essential that not only the scapula but the entire trunk should be steadied during the manipulations, as otherwise the patient may, by swaying the body about, defeat them entirely. A good plan is to fasten the trunk to the back of a strong chair by means of a stout jack-towel. The surgeon stands or kneels a little in front of the patient on the affected side, and first of all flexes the fore-arm to a right angle and then steadily approximates the elbow to the side (see Fig. 3). This stretches the upper part of the capsule and causes the head of the bone to hitch against the

edge of the glenoid cavity, and the next step in the manipulation causes it to rotate upon this and not upon its own vertical axis (see Fig. 8, *A*). The arm is then firmly rotated outwards until outward rotation can be carried no further (see Fig. 4). This brings the head of the bone outwards from the coracoid process to beneath the acromion, and relaxes the outer and posterior portion of the capsule, which has been unduly on the stretch (see Fig. 8, *B*). The whole arm is now brought forwards and upwards, full outward rotation of the humerus being still maintained, until the limb is

FIG. 4.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Second Stage.* While the elbow is kept at a right angle and firmly pressed to the side, the forearm is rotated outwards as far as it will go.

almost at a right angle to the body (see Fig. 5). This relaxes the front and upper part of the capsule so that the gap in the capsular ligament is freely open, while at the same time the head of the bone comes down almost to its normal position (see Fig. 8, *C*). The last step in the manipulations is to rotate the arm inwards, and to carry the elbow somewhat across the front of the chest, making the fingers touch the opposite shoulder (see Fig. 6) which brings the head of the bone back through the rent in the capsule (see Fig 8, *D*); at this point the head generally slips into

position almost imperceptibly. The arm is finally brought down to the side (see Fig. 7) to which it is fastened after being supported in a large elbow-sling.

Although for the sake of clearness these manipulations have been described in stages, the process is a continuous one in practice and should be carried out rapidly and forcibly. It is important to their success that the trunk should be carefully fixed by the assistant.

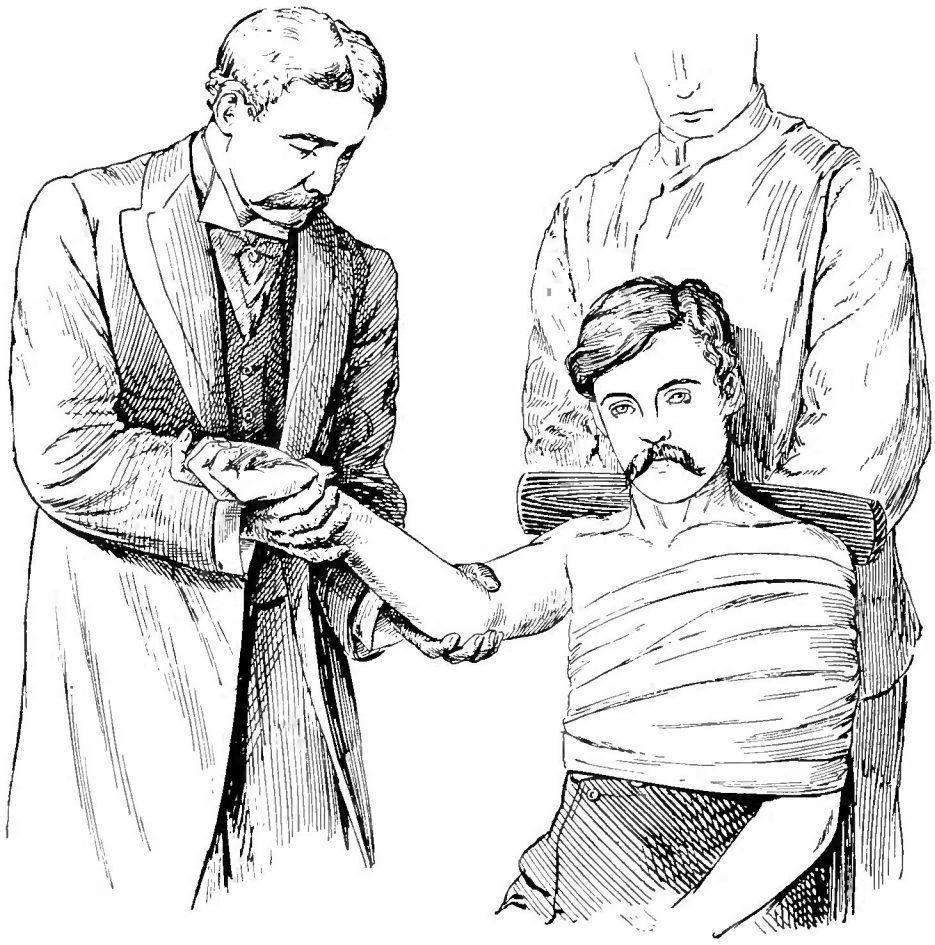


FIG. 5.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Third Stage.* While full outward rotation is maintained, the arm is carried upwards parallel to the antero-posterior plane of the body until it is almost horizontal.

In some cases the re-position of the bone is not noticeable, and it is not until after the manipulation has been completed that an examination of the shoulder shows that it has been successful.[1]

[1] There should be no difficulty in ascertaining whether or not the dislocation has been reduced. The roundness of the shoulder, due to the prominence of the greater tuberosity in its proper place beneath the deltoid, at once denotes success. Moreover the hand can be brought to the opposite shoulder, and a ruler laid flat upon the outer aspect of the arm can no longer be made to touch both the external condyle and the acromion as when dislocation was present.

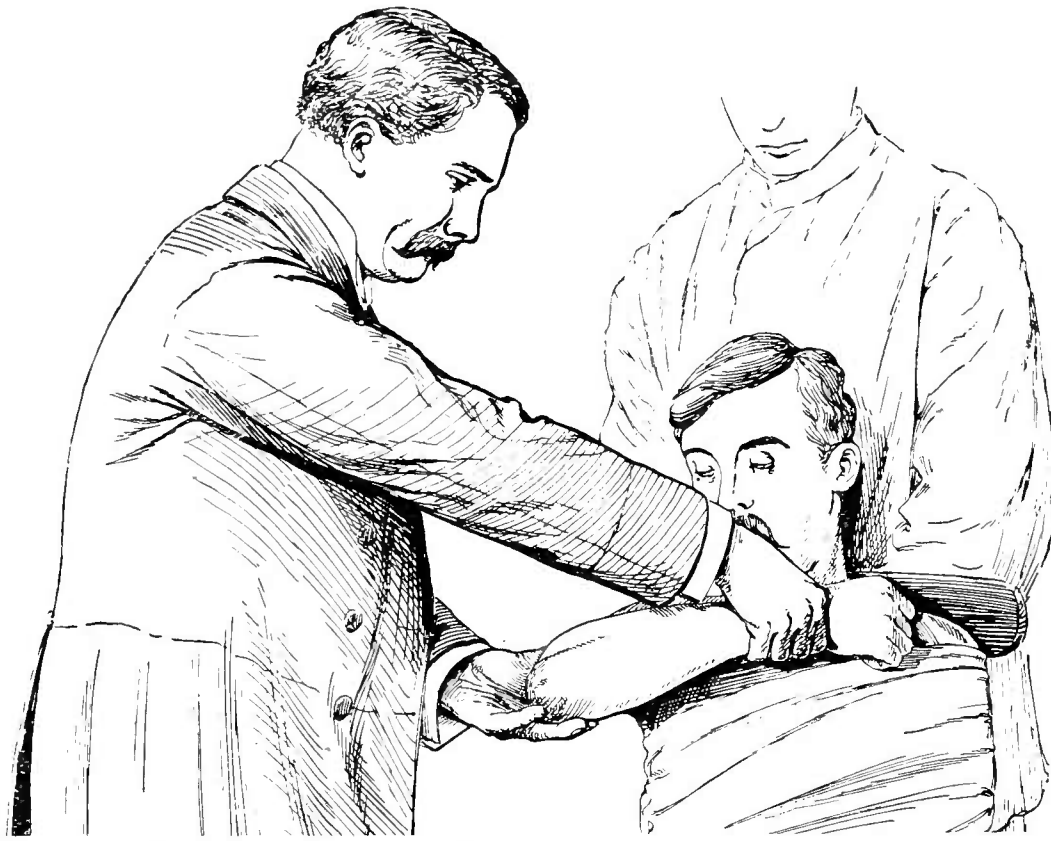


FIG. 6.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Fourth Stage.* When the horizontal position is reached, the arm is rotated inwards, the forearm being carried through rather more than a right angle from left to right.

FIG. 7.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Final Stage.* The elbow is now brought down to the side.

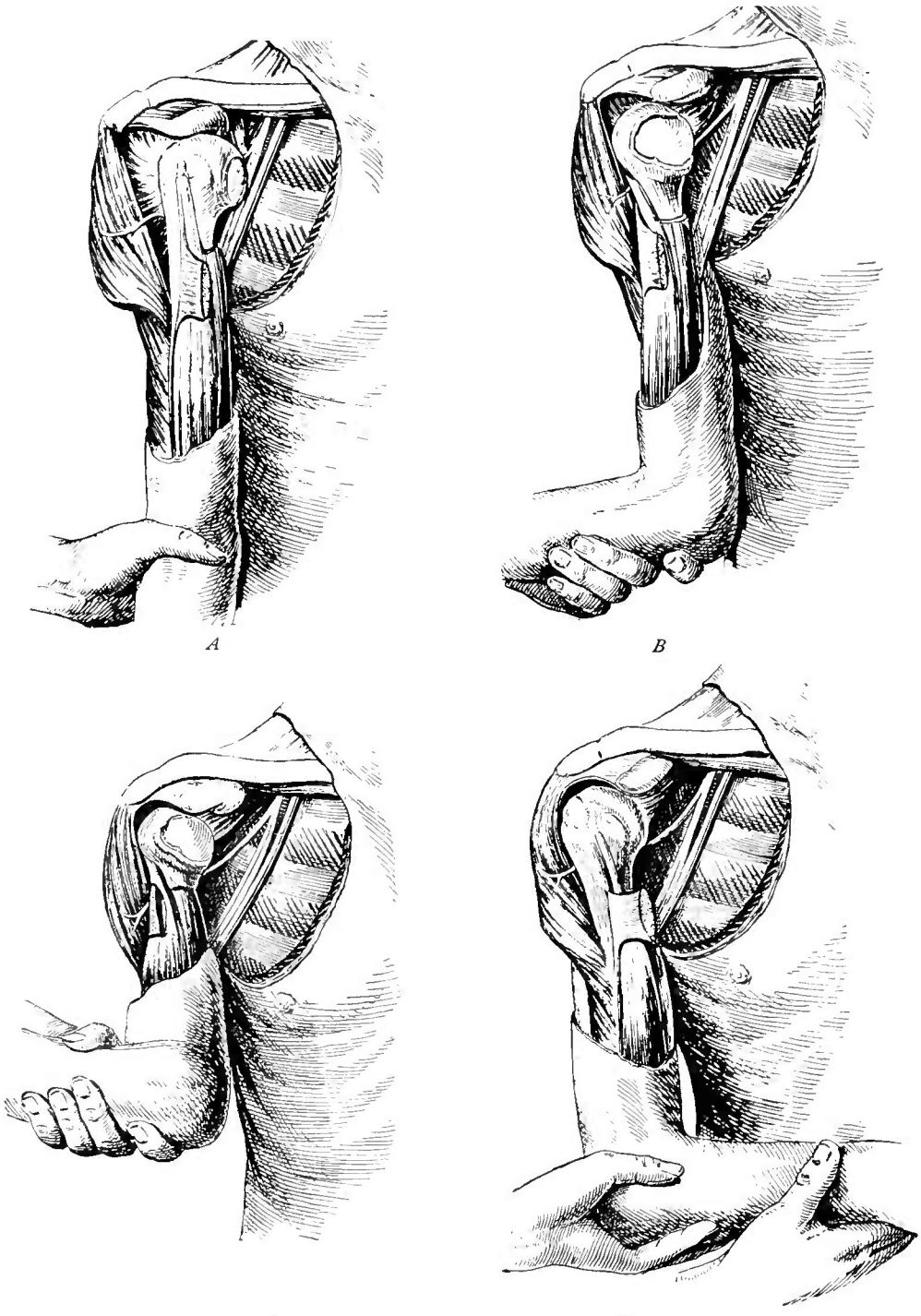


FIG. 8.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Dissections showing the course taken by the head of the bone.*

A. Elbow approximated to the side. The head of the bone is carried a little outwards, but there is no very great alteration in position.

B. Arm rotated fully outwards. The head of the bone is carried well outwards away from the brachial plexus, and the rent in the capsule is stretched.

C. Arm elevated. This brings the head of the bone well under the acromial arch and stretches the rent in the capsule to its utmost.

D. Arm rotated inwards. The head of the bone passes back into place through the rent in the capsule. (*Helferich.*)

Traction methods.—In muscular subjects, however, Kocher's method is not always successful without an anæsthetic; and if it fail, some form of traction must be resorted to.

Outward traction.—The method that seems to combine the most satisfactory results with the least pain to the patient and bruising of the parts is the following:—The patient is laid flat upon the back on the ground or on a low couch, and the surgeon sits or kneels beside him; the fore-arm is flexed to a right angle, and traction is made so as to bring the arm gradually out from the side until it is at right angles to the trunk. An assistant, if available, makes counter-extension by means of a jack-towel

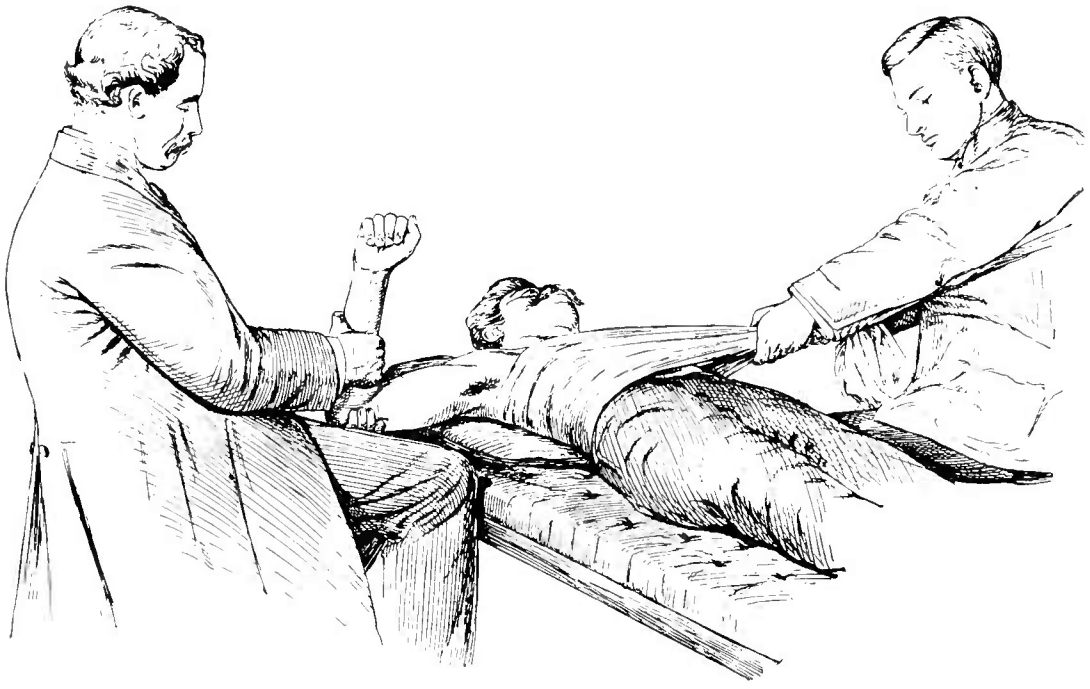


FIG. 9.—THE RIGHT-ANGLED TRACTION METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. If no assistant be available the surgeon may exert counter-extension by his unbooted foot against the axillary border of the scapula.

passed transversely around the upper part of the chest, while the surgeon keeps up steady traction at right angles to the body (see Fig. 9). If no assistant be present, the surgeon must sit upon the floor at right angles to his patient and place his unbooted foot against the scapula so as to fix it while he makes the traction. Sometimes the head of the bone is felt to slip in with a jerk, but most commonly it does so very gradually, so that, after the traction has been continued until the muscles are tired out and the parts are fully relaxed, the surgeon finds that the dislocation has been reduced when the arm is brought to the side. If plenty of assistance be at hand, the extension and counter-extension can be entrusted to assistants while the surgeon manipulates the head of the bone into place as the muscles become tired out.

Downward traction.—The older method was to reduce the dislocation by means of the heel in the axilla. This no doubt is very effectual and should be resorted to if the other methods fail; it is also probably the

easiest method of reduction for those who have but slight experience. The patient is laid flat upon his back on a couch or on the ground, and the surgeon sits down facing the patient on the affected side, and after removing his boot, places his foot in the axilla. The pressure of the foot should be somewhat outwards towards the arm, the object being partly to fix the scapula and partly to provide a fulcrum which will force the head of the bone outwards into its normal position as the traction is made. If the pressure be made too much inwards, the vessels and nerves may be bruised, or indeed the ribs may be fractured. The forearm is seized above the wrist and steady traction is made in a direction downwards and somewhat outwards, the surgeon leaning a little away from the patient for the purpose (see Fig. 10). After the traction has been continued long enough to tire out the muscles, the limb is firmly approximated to the side by

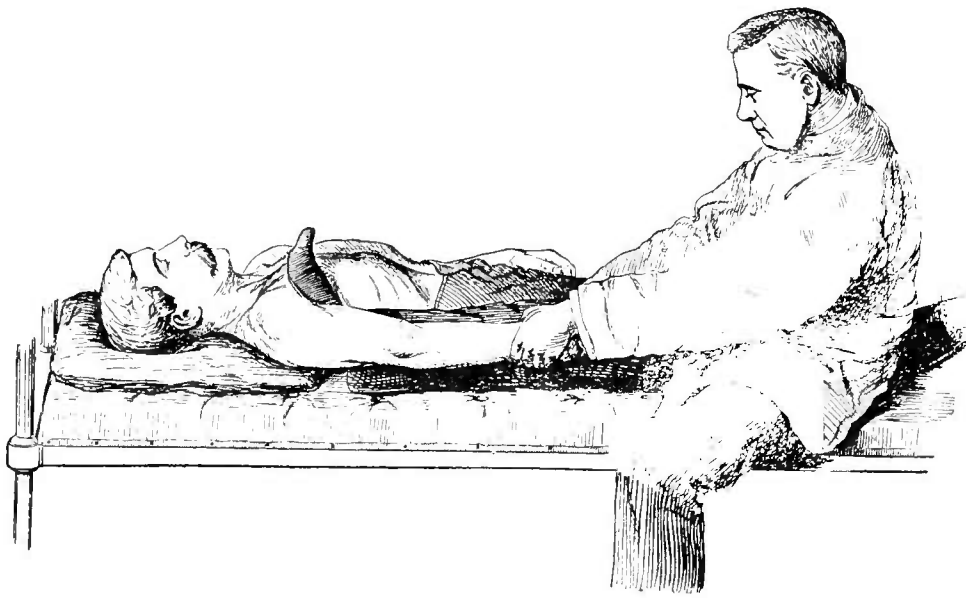


FIG. 10.—THE HEEL-IN-AXILLA METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *First Stage.* Steady traction is made downwards and as much outwards as the surgeon can manage by leaning over away from the patient.

carrying the forearm nearly to the middle line of the trunk, and the result is that the head of the bone is felt to slip into its normal position (see Fig. 11).

In sub-glenoid dislocations, traction, either transversely to the trunk or with the heel in the axilla, very readily brings the head of the bone into position. *In the sub-spinous and the sub-acromial forms*, an anæsthetic should always be used if possible; reduction, by traction downwards and forwards is then easy. The arm should be slightly rotated inwards, so as to disengage the lesser tuberosity from the edge of the glenoid cavity, and, after the traction has been continued for some time, the arm should be rotated outwards and carried forwards across the chest; the scapula must be properly fixed by an assistant.

After-treatment.—After the dislocation has been reduced, means must be taken to prevent recurrence which is very likely to result from any

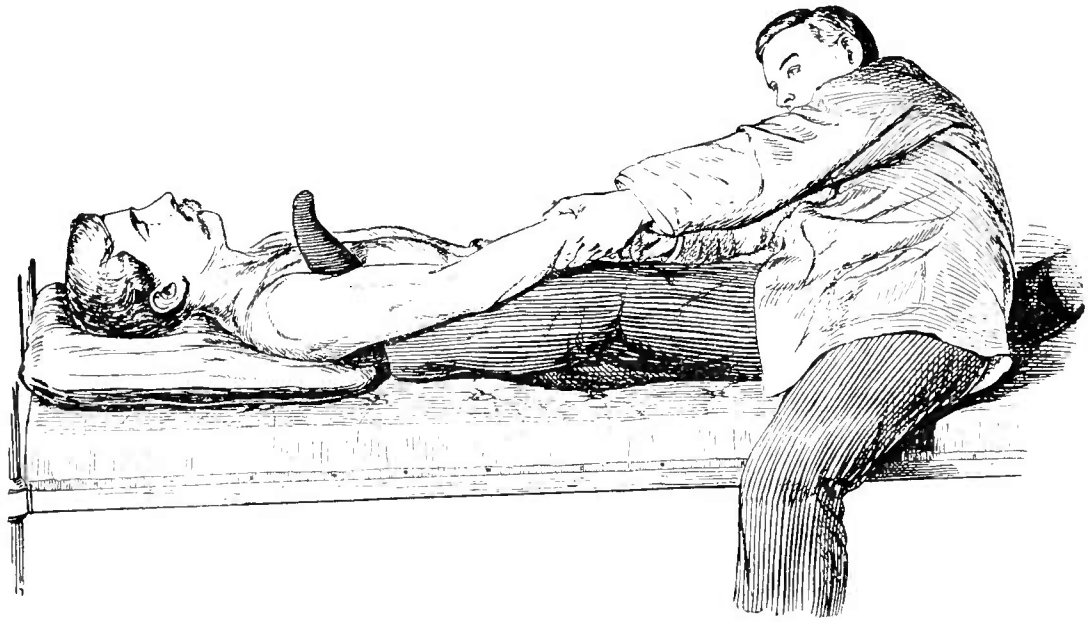


FIG. 11.—THE HEEL-IN-AXILLA METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Final Stage.* When full extension has been made, the limb is swung across the middle line and the head of the bone should slip into place.

injudicious movement while the rent in the capsule is still unhealed. Some restriction must be placed upon the movements of the joint, at any rate during the night, when it is well to bind the arm firmly to the side by a handkerchief or a bandage; during the day it usually suffices to keep the limb supported in an elbow-sling. While guarding against the danger of recurrence, the opposite error of an unduly strict immobilisation of the joint must be carefully avoided, because, should the arm be kept at rest for any length of time, adhesions in the joint are very likely to result from the accident, and this is a very difficult condition to deal with in the shoulder. Passive movements and massage should therefore be commenced not later than a day or two after the injury. The joint should be carefully moved by the surgeon, and massage of the muscles surrounding it should be employed. In performing movement the risk of the head of the bone slipping out of the capsule must be guarded against by keeping the arm well rotated inwards when the limb is abducted.

In the intervals between the movements the patient should keep the arm in a large elbow-sling, which should not be fastened to the side during the day; he should be encouraged to move the limb, and to use it for any purpose so long as he does not take it out of the sling. For a week or ten days however the arm should be bound to the side at night lest the displacement recur from any sudden movement during sleep. We would especially warn the practitioner against keeping the arm at rest too long. The results, especially in elderly subjects, are most disastrous. The shoulder joint becomes practically useless, and no treatment, however

vigorous, has any marked effect upon it. As a rule it takes nearly six weeks for recovery to be complete.

TREATMENT OF THE COMPLICATIONS OF DISLOCATION OF THE SHOULDER.

There is of course in all cases considerable bruising of the muscles inserted into the tuberosities of the humerus—more particularly of the sub-scapularis. These injuries are generally recovered from without any trouble.

1. *Fracture of the humerus* may complicate the dislocation; the fracture may occur either low down in the shaft of the bone or through the surgical or the anatomical neck.

2. *Injury to the neighbouring vessels or nerves*—particularly the axillary artery, the brachial plexus, or the circumflex nerve—may be met with, especially in sub-glenoid or sub-coracoid dislocations. The injury may vary from simple bruising to complete rupture; in the majority of dislocations of the shoulder these structures are bruised to some extent.

1. Dislocation of the shoulder joint complicated by fracture.—This accident has already been discussed in speaking of fractures of the upper end of the humerus (see Part III., p. 73), and little need be added to what will be found there upon the subject.

Treatment.—(*a*) **When the fracture is in the shaft.**—Should the fracture occur low down in the shaft of the bone, it is generally quite easy to reduce the dislocation first, and then to put up the fracture in the ordinary manner. The principal importance of this particular injury is that it is apt to be complicated by stiffness of the shoulder joint, and special measures have to be taken from the first to prevent this. As a rule there should be no difficulty in securing a satisfactory result, for if the fracture be properly reduced and immobilised, the humerus can be moved as a whole, and passive movements of the joint effected with but very slight disturbance of the fracture. It is highly important not to keep the fore-arm fixed to the side until consolidation has occurred. If this be done, a hopelessly stiff shoulder will certainly result.

(*b*) **When the fracture is in the neck.**—When however the fracture is situated high up in the humerus, in the neighbourhood of the surgical or the anatomical neck, the gravity of the case is very considerably increased, for the small size of the upper fragment will render it excessively difficult, if not impossible, to reduce the dislocation. Formerly, as we have already said, it was recommended that the fracture should first be set and allowed to consolidate and that afterwards an attempt should be made to reduce the dislocation. For reasons which we have mentioned when speaking of unreduced dislocation (see p. 7) this is very bad practice and should certainly not be followed. It has also been suggested that when the dislocation cannot be reduced, passive movements should be commenced at once

without attempting to immobilise the fracture, so as to obtain a false joint between the fractured surfaces, and so to maintain the usefulness of the arm.

In our opinion the best practice is as follows. The patient is put fully under an anæsthetic, and an attempt is made by grasping the head of the bone in the axilla to reduce it by any manipulation that is most likely to succeed. Should this be successful, the fracture is then set in the ordinary manner, and the treatment conducted upon the usual lines. Special care is requisite here in avoiding stiffness of the shoulder, which will be more likely to happen than in the ordinary cases, because of the serious damage to the bone and the soft parts in the vicinity of the injured joint. Another great difficulty is that the fracture is very likely to be disturbed when the passive movements of the joint, which are imperatively necessary, are carried out. Hence the greatest care must be taken to steady the fragment as much as possible by grasping it with one hand while the joint is being moved by the other.

Should, however, the manipulations under the anæsthetic fail to reduce the dislocation—as they are not at all unlikely to do—the joint should be cut down upon and the head of the bone replaced in position. An operation of this sort is doubly trying to the antiseptic precautions, in that it probably involves both a compound fracture and a wound into a joint, and it should not be attempted unless the surgeon be absolutely confident of his power to prevent sepsis. The method aims at attaining perfectly free access to the joint, ascertaining and removing any cause of obstruction, replacing the head of the bone in position, sewing up the rent in the capsule, and subsequently if necessary mechanically fixing the fractured surfaces in their position.

The best method of exposing the joint is through an incision which commences just external to the tip of the coracoid process, and runs downwards and slightly outwards for four or five inches along the anterior border of the deltoid. The margin of the muscle is defined and pulled outwards, the fascia beneath it is divided and the deeper parts are exposed. Should more room be necessary for the proper display of the parts, it may be obtained by curving the incision outwards below so as to divide a portion of the insertion of the deltoid into the humerus. The muscle is then turned outwards as a sort of flap, and it is easy to stitch the detached portion into position again at the end of the operation. After the deep fascia has been opened and the wound well retracted, the structures about the shoulder joint are easily identified. The rent in the capsule is visible, and the situation of the fracture is obvious. Traction should be exerted upon the arm in the downward and slightly outward direction, so as to get the lower fragment of the humerus out of the way, and then it is generally quite easy, without dividing any structures, to grasp the head of the bone directly, and to make it re-enter the joint through the rent in the capsule, which can be sewn up with a continuous suture of fine catgut.

The chief obstacle to the return of the head is generally the sub-scapularis tendon, but this can usually be easily dealt with when the parts are fully exposed. The fracture of the humerus may next be treated, and it is well to take the opportunity to secure the fractured surfaces together by means of wires introduced as shown in Part III., Fig. 18. During the whole operation the wound should be kept irrigated with a 1-8000 sublimate solution. The wound is then stitched up without a drainage tube, and the arm put up as for fracture of the upper end of the humerus (see Part III., p. 67).

As soon as the wound has healed, which should be in about ten days, gentle passive motion must be begun, so as to prevent adhesions in the joint. If gentleness be employed in doing this, there is not much fear of unduly disturbing the fracture, as the wire keeps it steady, and, with careful attention to massage and passive motion, a good result should be obtained when the fracture is through the surgical neck.

When, however, the anatomical neck is the seat of the fracture, the prospects of a satisfactory result are not nearly so good. The rounded head of the bone may be completely detached, and the probability then is that it will not unite satisfactorily to the shaft, even though it be secured mechanically to it; the best result will probably be obtained by simply removing the loose portion and smoothing off any rough surface that may be left behind. The arm is then brought into its proper position, the rent in the capsule closed, and the wound sutured as before. In this case passive movement should be carried out vigorously from the first, as there is now no fracture to be considered, the only object being the early establishment of the free mobility of the joint. In fact, the case is simply one of partial excision of the joint without division of any muscles.

Again, in some of the severer cases of combined dislocation and fracture it may be found that the fracture, which is mainly through the anatomical neck, is comminuted, and the head considerably broken up. Here it will be best to remove the comminuted portion and to smooth off any projections from the shaft of the bone with a chisel or a gouge. This is advisable because, although union might occur in the fracture, there would probably be so much callus thrown out that the movements of the joint would be seriously hampered; in any case, the removal of the comminuted portion enables passive movement to be begun early and practised vigorously, as there is then no danger of interfering with the consolidation of the fracture.

After-treatment.—The after-treatment is that appropriate for fractures of the surgical neck (see Part III., p. 67). The usual cyanide dressings are applied, a shoulder-cap is put on, and an internal rectangular splint is employed. As a rule the splints can be left off at the end of four weeks from the date of the injury.

2. Injury to the axillary vessels and nerves.—The axillary artery is the vessel most usually affected; in sub-glenoid dislocation

especially it is often stretched over the head of the bone and there is a temporary arrest in the circulation through it. The circulation is, of course, restored as soon as the displacement is remedied. In the more severe cases, however, the vessel may be severely bruised, and this may be followed by thrombosis. A much more serious condition is met with when the vessel is torn either partially or completely across as the result of extreme violence. One of two things will then happen: either the ruptured artery is so twisted or the head of the bone so presses upon it that there is no free escape of blood; or, a more common result, very profuse hæmorrhage takes place and the axilla becomes enormously distended with blood. The patient may then either bleed to death in a very short time, or, if the rent be small and the escape of blood slower, the hæmorrhage will ultimately become partially arrested and a large diffuse axillary aneurism will occur. This condition is very easily recognised. The swelling in the axilla is very marked and may increase visibly, while the patient soon becomes faint from loss of blood. As a matter of fact, should the surgeon not happen to be present at the time of the accident, it is not at all unlikely that the patient will die before assistance can be procured. This accident is however extremely rare in recent cases; it is usually met with in attempts to reduce a dislocation of several weeks' standing.

Treatment of injury to the artery.—When the condition is recognised, the first thing to be done is to compress the subclavian artery against the first rib, while arrangements are being made to cut down upon and secure the injured vessel. The method of compressing the subclavian artery has been mentioned in detail in Part II., p. 336; it may be effected by depressing the shoulder forcibly and either compressing the artery with the thumb as it passes over the first rib, or by wrapping the handle of a large key in a handkerchief or piece of lint and using that as a substitute for the thumb, which very easily gets tired.

As soon as possible an incision should be made as for ligature of the third part of the axillary artery (see Part II., p. 337), but somewhat freer; the clots are turned out and the torn ends of the vessel secured and tied. The subclavian should meanwhile be compressed. If the extravasation be extreme, and particularly if there be any doubt as to the efficiency of the compression of the subclavian, an incision should first be made above the clavicle, as for ligature of the third part of the subclavian (see Part II., p. 322), which should extend through the skin and deep fascia, and through which an assistant may introduce his thumb and so directly feel the vessel and compress it accurately against the rib whilst the incision into the axilla is being made. The surgeon is thus enabled to turn out all the clots thoroughly and to search carefully for the divided ends of the vessel, which may be difficult to find until the clots have been evacuated. After the vessel has been ligatured above and below the rent, the wound should be stitched up and a large drainage tube inserted in order to provide against the oozing which will be likely to occur.

Treatment of injury to the nerves.—When the brachial plexus is injured it is often difficult to diagnose the exact nature of the lesion. It is not uncommon to find the head of the bone pressing so forcibly upon one of the axillary nerves as to produce paralysis or anæsthesia. If this be simply due to pressure it will be quite temporary; in other cases it may be more or less permanent, and is then due either to bruising of the nerve and possibly some extravasation of blood into its sheath or to actual rupture.

The first thing is to reduce the dislocation, when, if there be no complication calling for incision, the case must be watched to see whether the nerve recovers its functions. Recovery will occur if there be mere bruising or slight extravasation of blood, and in a fortnight or three weeks, if massage be practised and electricity[1] applied in the meanwhile, there should be fairly complete restoration of function. If, however, no recovery has taken place by this time, it may be assumed that the nerve is more or less permanently damaged, and an attempt must be made to restore its functions by operation. The nerve must be cut down upon and examined, and the ends, if torn, must be accurately sutured; if it be compressed by blood or cicatricial tissue, the blood must be turned out or the cicatricial tissue removed; if, without solution of continuity, the nerve structure has been practically destroyed by bruising at the point of pressure, excision of the damaged part with immediate union of the divided ends will be indicated. These operations have been fully described under injuries of nerves (see Part II., Chap. XVIII.).

TREATMENT OF COMPOUND DISLOCATION.

This complication is of extreme rarity, and when it occurs is usually only part of a very extensive injury; there is generally such damage to the surrounding parts, either in the way of fracture of the bony structures in the neighbourhood or injuries to the vessels or nerves in the axilla, that it not at all uncommonly calls for amputation. Should, however, the condition of affairs justify an attempt to save the limb, the surgeon must enlarge the wound, disinfect it and the skin around thoroughly in the manner already described (see p. 5), and must then replace the head of the bone, insert a medium-sized drainage tube at the most convenient spot, suture the rent in the capsule, and treat the case on the ordinary lines. Passive movement must be begun in the joint within four or five days of the injury, or there will be great danger of adhesions occurring.

Should the attempt at disinfection fail, or should the case not be seen until some days after the injury, when suppuration is established, the treatment will be that for a suppurating joint (see Chap. XII.).

[1] The galvanic current is best. The negative pole should be applied over the injured nerve, the positive being over the spine. A current of 6 to 8 milliampères, passed for ten minutes daily, is often very valuable.

The articulation must be freely opened up, every facility provided for the escape of pus, and irrigation of the joint, or the water-bath employed. If the condition be grave, the question of excision or amputation will also arise, and will be determined by the rules laid down for the treatment of septic wounds of joints (see Chap. XI.).

TREATMENT OF UNREDUCED DISLOCATION.

It is not uncommon to meet with unreduced dislocation of the shoulder. This may be due to the injury not having been recognised at the time, to the patient not having sought advice, to the surgeon having been under the impression that he has reduced the dislocation while really he has failed to do so, or to the dislocation having recurred after reduction. In any case the affection is a serious one. The head of the bone in its new position very soon contracts adhesions to the surrounding structures, and, in sub-glenoid and sub-coracoid dislocations, the vessels and nerves are stretched directly over the head of the bone, and adhesions are extremely likely to form between them.

The chief trouble in reducing a dislocation of the shoulder of long-standing arises from these adhesions, and the principal danger is from adhesions between the head of the bone and the axillary vessels and nerves, particularly the former. Besides this, the capsular ligament rapidly shrinks and becomes distorted, while the glenoid cavity becomes shallow and filled up with soft tissues. Therefore, in attempting to reduce a long-standing dislocation of this kind, we are confronted with three principal difficulties. In the first place, there is the mechanical one caused by the adhesion of the head of the bone to the surrounding structures and the shortening of the muscles and tendons attached to the tuberosities; in the second place, there is the difficulty of replacing the head in position after these obstacles have been overcome, owing to the alterations in the capsule and the filling up of the glenoid cavity; and lastly, there is the danger caused by the adhesion of important structures, like vessels and nerves, to the head of the bone. All these changes occur very rapidly, so that it is only when the dislocation has remained unreduced for a very short time that the surgeon is warranted in attempting to reduce it.

It is somewhat difficult to lay down any rule as to the exact length of time after a dislocation of the shoulder has occurred within which it is safe to attempt reduction. Cases are known in which reduction has been successfully accomplished as long as two months or more after the injury. On the other hand, however, rupture of the axillary artery has resulted from attempts to reduce a dislocation of four weeks' standing. We should be inclined to lay down the rule that it is not advisable to attempt the reduction of a sub-coracoid or sub-glenoid dislocation after four or five weeks have elapsed from the time of the injury, and that it is practically unjustifiable to attempt it after seven weeks.

Even within the period mentioned, attempts at reduction must be carried out with extreme care, and somewhat on the following lines. The patient must be put fully under an anæsthetic, and the first step of the procedure should be not necessarily to reduce the dislocation but, by moving the limb in all directions, to break down adhesions which the head of the bone has contracted. This is done very cautiously at first, the limb being gradually made to move through a wider range. When apparently all the adhesions have been broken down, an attempt should be made, first of all by Kocher's method (see p. 16) to get the head of the bone back into position. As a rule this will not succeed, but it does good by loosening various adherent structures that oppose reduction. The method that will be most likely to succeed is that by traction, and traction at right angles to the trunk (see p. 21) should be tried in the first instance. Should this fail, an attempt may be made with the heel in the axilla (see p. 21). Should this not succeed, a cautious trial may be made by pulley extension, the scapula and upper part of the body being fixed by a round-towel encircling the chest, and then, while firm outward extension is made, the head of the bone may sometimes be manipulated into position, partly by the knee in the axilla and partly by rotating the arm, using the fore-arm as a lever.

If pulleys be used, they should be attached by a skein of worsted to the arm above the elbow,[1] and thus undue strain upon the ligaments of that joint is avoided; moreover, the traction can be more accurately directed than if the extension were made from the wrist, as the long axes of the fore-arm and the upper arm do not coincide. This attempt at reduction by pulley should be carried out with the greatest care, and should not be too long continued.

If, after a fair trial of these methods, it be found that the head of the bone will not come into place, the question arises whether the patient should be left alone or whether anything further can be done. The surgeon may be justified in leaving matters alone when, from the head of the bone having formed a fresh socket, the arm has so regained its usefulness that the patient does not suffer any very serious inconvenience. This result is most likely to occur in sub-spinous dislocations, in which the new joint may give the patient a fair range of movement, especially if he be old.

Operative methods.—On the other hand, in sub-glenoid and sub-coracoid dislocation the patient may not only have a practically useless arm, but he may suffer such intense pain that life is intolerable. As these accidents

[1] A simple method of attaching pulleys to the limb so as to avoid any pressure-effects is to encircle the lower third of the arm in a wet boracic lint bandage, and over this to attach a stout skein of worsted by a loose clove-hitch just above the condyles of the humerus. When this is in position it is thoroughly wetted and fastened in place by an ordinary bandage also thoroughly soaked. The pulleys (see Part III., Fig. 49) are then hooked on to the loop of the skein.

not infrequently occur in young and vigorous adults, operation is often absolutely necessary to enable them to obtain a wider range of movement.

A considerable number of cases have now been operated upon, even as long as eight months or more after the dislocation, in which the head of the bone has been replaced in position with most satisfactory results; in the more recent cases, at any rate, these results are far more satisfactory than those obtained by excising the head of the bone and leaving the long axis of the arm in its faulty position. Therefore in all cases of intense pain, and in all those where the patients are young and healthy, we should recommend that the primary aim of the surgeon should be to see whether he cannot *replace the head of the bone by operation*, and he should only proceed to the alternative of excising the head of the bone if he finds that this is impossible.

The joint may be readily exposed by the incision recommended for fractures complicating dislocation (see p. 25); it should run along the anterior border of the deltoid from the outer aspect of the coracoid process, curving outwards and backwards at its lower extremity over the insertion of the deltoid, which should be detached from the humerus. The flap containing the deltoid is then pulled forcibly outwards, the deep fascia divided, and the pectoralis major pulled inwards by large broad retractors. This exposes the head of the bone and the structures to which it is adherent. The next point is to examine the position and condition of the vessels and nerves, particularly with regard to the question of whether they are adherent to the bone. The fibrous structures in the region of the anatomical neck should be carefully divided, and gradually detached from the head and neck all round by a periosteum detacher, taking care to keep quite close to the bone. If the vessels and nerves be adherent, they will of course be detached along with these structures, and thus the risk of their being torn is reduced to a minimum. After the head and neck of the bone have been fully cleared, forcible extension is applied to the humerus, either by an assistant who grasps the limb above the elbow, or by means of pulleys attached as above. While extension is being made, any resistant bands will be put on the stretch, and can be localised by the finger and divided.

The next point is to investigate the condition of the glenoid cavity. It will almost invariably be found that the capsule is so distorted and adherent as to be of no use, and the glenoid cavity itself will probably be filled up with soft tissue. The latter should be carefully dissected out, so as to restore the cavity to its normal depth, and any remains of the capsule that can offer the least resistance to the re-position of the head should be entirely dissected away. The remains of the capsule are often of no use whatever, as a new capsule has to be formed. As a rule the head of the bone can now be replaced, but in some cases of very long-standing it will be necessary to divide some of the muscles attached to the tuberosities before this can be done. The muscles most likely to require detachment are the supra- and

infra-spinatus : the sub-scapularis should not be interfered with if, by separating its tendon and pulling it down, it is possible to get the head of the bone into position, but sometimes it may be necessary to divide it. In any case the division of the muscles should be practised very gradually so as to see the effect that successive divisions of the breadth of the muscle produces, as if only a portion of the insertions of the muscles into the tuberosities be left intact, satisfactory union will take place in the remainder without any necessity for suturing the divided muscle at the end of the operation.

The wound is now stitched up. If there be sufficient capsule remaining, the aperture in it may be sutured, so as to help to retain the head of the bone in position. This will be of considerable help, as there is otherwise a great tendency for the head to slip forward again owing to the shallowness of the glenoid cavity and the profound alteration in the capsule; in the after-treatment special care will have to be directed to this point.

The usual cyanide dressings are employed, but a drainage tube is unnecessary. A large pad of wool must be placed in the axilla outside the dressings, and the elbow is then brought to the side and pushed somewhat forwards, the fore-arm being carried obliquely across the chest. The arm is bandaged firmly to the trunk and a special large pad of wool should be placed over the front of the head of the humerus so as to resist any tendency to displacement forwards.

In about a week careful passive movements should be begun, and these should be carried out at first under an anæsthetic. The elbow is grasped in one hand and the shoulder joint in the other, so as to keep the head of the bone in position and prevent its being displaced forwards. The movements may be practised without removing the dressing, and should be continued daily up to about the end of three weeks, when they should be carried out twice a day. This passive movement is one of the most important points in the treatment, as there is a constant tendency to the rapid formation of adhesions, which might, if unchecked, entirely neutralise the good result obtained by the operation.

Excision of the head of the bone should only be done when an examination of the condition of the parts through the incision recommended above convinces the surgeon that it is impossible to put the head of the bone back into position. It is of course quite readily done after the detachment of the vessels and soft tissues described above (see p. 31), and may be performed either by sawing or chiselling through the neck of the bone, the soft parts on the opposite side being protected by a suitably bent broad copper spatula. Unless, however, a considerable amount of the bone be taken away, the movements are comparatively imperfect, as the long axis of the humerus is in a wrong position.

CHAPTER IV

DISLOCATIONS OF THE ELBOW.

The elbow joint is frequently dislocated, and the accident commonly occurs before the age of sixteen. This is probably due to the fact that the coronoid process is then of comparatively small size, and, as it has not completely ossified, it may be very readily separated from the ulna.

Dislocation may take place backwards, forwards, inwards, or outwards, and besides these typical forms, the bones of the fore-arm may be displaced in two directions at once, the most frequent being dislocation backwards and inwards and dislocation backwards and outwards. Besides dislocation of both bones of the fore-arm together, either bone may be dislocated separately. The radius, if dislocated alone, may pass either backwards, outwards, or forwards, whilst if the ulna alone be displaced it is dislocated backwards.

DISLOCATION OF BOTH BONES OF THE FORE-ARM.

In the majority of cases when both bones are dislocated they are displaced directly backwards, but in some cases an inward or an outward displacement may be combined with this. All the other forms of displacement, *i.e.* directly inwards, directly outwards or forwards, are very rare.

DISLOCATION OF BOTH BONES BACKWARDS.—As a rule this injury is caused by a fall upon the hand with the elbow fully extended and the fore-arm supinated. The result is that the elbow is hyper-extended, and the anterior and the internal lateral ligaments are ruptured and allow the coronoid process to slip back over the lower end of the humerus, and thus the bones of the fore-arm become dislocated backwards. In some cases, however, fracture of the coronoid process, or, more frequently, detachment at its epiphyseal line, occurs. The head of the radius passes backwards along with the ulna, the radio-ulnar articulation being uninjured.

The extent to which the bones are displaced backwards depends upon the damage done to the external lateral ligament, and to the tendon

of the brachialis anticus or to the coronoid process into which it is inserted. Should these structures remain intact, the displacement is comparatively slight, as the coronoid process usually hitches against the lower end of the articular surface of the humerus; whereas if they be torn through, the process passes backwards until it lodges in the olecranon fossa. The essential factor that determines whether the displacement shall be simply backwards or to one side as well is the direction of the force producing the injury. If the arm be driven inwards or outwards as the ligaments give way, the dislocation will be both backwards and in one or other of these directions.

Complications.—Dislocations of the elbow may be complicated either with a fracture of some part of the articular surfaces or with injuries to vessels or nerves in the neighbourhood; the dislocation may also be compound.

Treatment.—**(a) Of simple dislocation.**—This is usually quite easy. An anæsthetic should be administered if possible, and as a rule the bones slip into place after very slight extension as soon as the patient is fully under its influence.

FIG. 12.—METHOD OF REDUCING A DISLOCATION OF BOTH BONES OF THE FORE-ARM BACKWARDS. The knee fixes the lower end of the humerus. Traction is made with the limb as nearly extended as possible, and then the joint is flexed across the knee.

When no anæsthetic is employed, reduction may be easily effected by standing sideways in front of the patient (who sits in a chair), putting the foot upon the seat of the chair and inserting the bent knee into the bend of the affected elbow (see Fig. 12). The end of the humerus rests against the surgeon's patella, and the elbow should be slightly flexed. The fore-arm is then grasped just above the wrist joint with one hand, and the upper arm steadied with the other, and traction is made more or less in the long axis of the arm until the muscles are tired out. The joint is then rapidly flexed around the knee, the traction being meanwhile kept up, when the ends of the bones slip into place. The preliminary extension in the long axis of the limb is designed to disengage the edge of the coronoid process from the lower end of the humerus, and the flexion of the elbow around the knee causes this to slip forward over the lower end of the humerus, which is steadied against the surgeon's patella. It is always easy to tell that reduction has been satisfactorily accomplished, as the bones spring into position with a sharp snap, and the movements of the joint are at once restored.

After-treatment.—Unless the coronoid process be broken off, there is practically no danger of recurrence of the dislocation. Should this happen soon after reduction, it is a strong diagnostic indication that the coronoid process has been fractured. The after-treatment when the coronoid process is intact consists simply in employing an elbow-sling and applying evaporating lotions, such as the lead and opium lotion (see Part I., p. 8.), to diminish the synovial effusion. Massage may be applied to the fore-arm and elbow joint from the day following the injury, and in four or five days passive movements should be practised. The patient may also be encouraged to move the elbow for himself inside the sling, which may be abandoned after a fortnight to three weeks, when the functions of the joint should be perfectly restored.

(b) **Of complications.**—**1. Fracture of the coronoid process.**—As there is here a constant tendency for the displacement to recur, it will be necessary to fix the bones by splints. The best plan in ordinary cases is to use a posterior rectangular splint along the back of the arm and fore-arm —the latter being in a position of full supination—with a large pad in the angle of the splint immediately behind the tip of the olecranon, so as to push that process well forward (see Fig. 13). Massage and passive movements are begun in a week, the latter being performed by the surgeon himself, who takes care to press down the olecranon while the limb is being extended, so as to prevent it being pushed backwards.

It is very rarely that the coronoid process is completely detached; it usually retains some connection with the ulna by means of the periosteum or the fibres from the brachialis anticus, and therefore this treatment generally suffices to obtain good union. When, however, the detachment is complete, something else is necessary. The arm should be flexed as fully as possible so as to approximate the broken surfaces, and should be kept in that

position by a posterior moulded splint. Should this treatment not suffice, it may be necessary to cut down upon the process and fasten it in position (see Part III., p. 91).

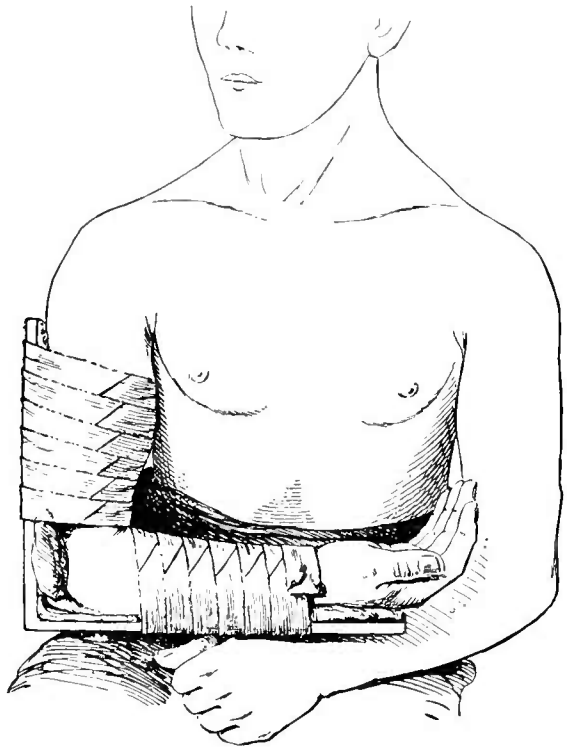


FIG. 13.—SPLINT FOR USE AFTER DISLOCATION OF BOTH BONES BACKWARDS ACCOMPANIED BY FRACTURE OF THE CORONOID PROCESS. The elbow is flexed to a right angle and the forearm is fully supinated. A large pad is inserted between the point of the olecranon and the splint.

2. Detachment of the internal epi-condyle.—In young subjects the strain upon the internal lateral ligament often tears off the internal epi-condyle instead of rupturing the ligament. The injury is of slight importance, and all that is usually necessary is to employ an external angular splint with the elbow at a right angle, and the fore-arm midway between pronation and supination. Massage and passive movements should be begun during the first week; as a rule the detached process unites to the rest of the bone fairly readily, although union generally takes place by fibrous tissue.

3. Fracture of the articular surface of the humerus.—This may sometimes be met with as a complication of dislocation, and will require to be treated upon the lines laid down for that particular form of fracture (see Part III., p. 77) after the dislocation has been reduced. It will generally be advisable to cut down upon the fracture.

4. Injuries to vessels and nerves.—Anything like severe damage to these structures is a very rare complication of dislocations of the elbow. Naturally there is a certain amount of pressure exerted both upon the vessels and nerves by the projecting lower end of the humerus when

the bones of the fore-arm are displaced backwards, but, owing to the intervention of soft structures, the pressure is not severe as a rule, and the interference with the circulation and innervation is usually temporary, and completely disappears when the dislocation is reduced.

Should, however, either the artery or the median nerve be torn across, the treatment must be the same as in similar injuries connected with dislocations of the shoulder (see p. 26), that is to say, the vessel must be tied, and the nerve, if torn, sutured. The indications for operative interference already laid down for the shoulder apply equally here.

(c) **Of compound dislocation.**—A compound dislocation of the elbow backwards is not at all common. Sometimes, however, as the result of severe violence, the olecranon process or the lower end of the humerus is forced through the skin, and projects externally. The treatment will follow the lines already laid down for compound dislocation in general (see p. 5). The skin around the wound must be thoroughly disinfected, the wound itself enlarged and freely swabbed out with strong mixture, or, if it be obviously very dirty, pure carbolic acid may be applied. In carrying out either of these procedures it is important not to introduce the strong antiseptic into the joint unless the articulation itself be soiled. It is sufficient to wash out the latter first with a 1-2000 and then with a 1-8000 sublimate solution.

Drainage tubes should always be inserted in the joint. The best points at which to insert them are on either side, one rather behind the external condyle, to drain the back and outer side of the joint, and one in front of the internal condyle to efficiently drain the front. The ordinary antiseptic dressings are applied, and the elbow is put up at right angles. Should the wound remain aseptic, the drainage tubes are taken out in the course of three days, and at the end of a week passive movement is carried out daily. As soon as the wound has healed, the splint should be discontinued, and massage and active and passive movements practised vigorously for four or five weeks.

It is not always possible to secure a good result by simple disinfection and drainage. If there be a compound dislocation associated with considerable soiling of the joint, and particularly if there be a comminuted fracture of the lower end of the humerus, *immediate excision* will probably on the whole give the best result. If an attempt were made to save the joint by disinfection and drainage, a long time would be required for healing, while very extensive adhesions would certainly result, and would almost inevitably lead to a stiff joint; whereas the functions of the articulation are extremely well preserved after excision, and the period of convalescence is comparatively short.

The excision in these cases will as a rule be somewhat irregular, and the amount of bone removed will depend to a certain degree upon the extent of the injury to the bone; generally, however, the mistake made is in taking away too little rather than too much. When the lower end of the humerus

is broken up, the surgeon is often tempted to content himself with removing the comminuted portion, but as a rule it will be found that when the ulna and radius are left untouched there is a great tendency to stiffness subsequently. It is always well, therefore, even although only the lower end of the humerus be damaged, to excise the usual amount of the bones of the fore-arm, and to perform the operation sub-periosteally in the manner which will be described when we describe excision of the elbow joint (see Chap. XXIII.).

When the dislocation is accompanied by very widespread damage to important structures in the neighbourhood as well as to the bones, it may be necessary to have recourse to *amputation*. In determining the question as to whether amputation is to be done, the surgeon will be guided by much the same considerations as in determining the similar question in connection with fractures (see Part III., p. 35).

(d) **Of unreduced dislocation**.—In the elbow it is often possible to effect reduction as long as six weeks after the injury without damaging any important structures. The patient should be placed under an anæsthetic and, before reduction is attempted, the joint should be flexed and extended freely so as to break down adhesions. Forcible traction, if necessary by pulleys, is made to bring the fore-arm sufficiently down, and the elbow is then rapidly flexed and the coronoid process thus brought forward over the lower end of the humerus.

When a longer interval has elapsed, the surgeon will generally have to consider the advisability of some form of *operative procedure*. It is seldom justifiable to leave the patient with an unreduced dislocation of the elbow, because, even should it be necessary to have recourse to excision, a far more useful joint can be obtained than will ever be likely to result from attempts to form a fresh joint by forcible movements. The difficult point to decide really is, whether an attempt should be made to replace the bones in position, or whether the surgeon should at once proceed to excise the joint. In a considerable number of cases the bones have been replaced in position, and where there has been no marked alteration in the joint surfaces,—as will probably be the case if no very long time has elapsed since the injury—the result has been very satisfactory.

In order to get the bones into position, two vertical incisions, each about four inches long, should be made, one over the external, and the other over the internal condyle. Care must be taken not to damage the ulnar nerve at the upper end of the inner incision, whilst in the outer one, the posterior interosseous nerve must be avoided below. When the condyles are exposed, the soft parts are detached by a rugine in front and behind, until the joint has been thoroughly opened up. When traction is made, the surgeon can now feel the structures that are tense, and should divide them, so long as they do not contain important structures: the bones can then be brought into position. As a rule

the structures requiring division consist of the remains of the anterior part of the capsule and the external lateral ligament and the adhesions which have formed in their neighbourhood; unless there be very marked shortening of the triceps, the bones will come into proper position as soon as these structures have been divided.

The wounds are stitched up, the usual dressings applied, and the limb placed on a rectangular splint with the elbow at right angles and the fore-arm fully supinated; movements of pronation and supination are commenced from the first day, and, three or four days later, flexion and extension in addition. These movements, it must be confessed, cause considerable pain at first, and it may be advisable to move the arm under an anæsthetic once or twice a week, so as to insure that it moves throughout its proper range. If for any reason this be inadvisable, a third of a grain of cocaine may be dissolved in twenty minims of boiled water, and injected, four minims at a time, in various spots around the joint before the passive movement is made; this will practically abolish the pain. If the patient perseveres with the massage and movements the result is often extremely satisfactory.

When, however, it is evident that the bones cannot be got into position, or when, owing to the length of time since the injury, they have undergone considerable alteration, excision is the best practice. This should always be done by lateral incisions of the same kind as those just described, and it is well, before proceeding to remove any bone, to detach the soft parts freely, to make traction on the fore-arm, and to divide any tendons or ligamentous structures which prevent the arm from coming down. Unless this be done, more bone than is desirable will have to be removed in order to obtain satisfactory movement, and an unduly loose joint may result (for excision of the Elbow see Chap. XXIII.).

COMBINED BACKWARD AND LATERAL DISLOCATION.—When there is lateral as well as backward dislocation, the surgeon simply has to bear in mind that, besides bringing the bones of the fore-arm downwards, they must also be brought inwards or outwards as the case may be. When operating for long-standing dislocations of this kind, it is advisable to make the lateral incision first upon the side to which the fore-arm is dislocated, because in this situation the adhesions are much more numerous and firmer than on the other.

DISLOCATION OF BOTH BONES LATERALLY.—Both bones of the fore-arm may be dislocated outwards or—much more rarely—inwards, without any dislocation backwards. The dislocation may be partial or complete.

Dislocation of both bones outwards occurs from falls upon the hand when the elbow is partially flexed, the force being applied in such a direction that it drives the bones outwards. Generally the radius passes sufficiently outwards to be quite free of the humerus, and it is usually also slightly displaced forwards from the lesser sigmoid cavity. The ulna, on the other hand, rests upon the capitellum. In the incomplete

variety the radius remains in contact with the articular surface of the humerus.

Treatment.—The dislocation is easily reduced under an anæsthetic by slight extension combined with pressure inwards, the bones slipping readily into position. When no anæsthetic is used the patient should sit upon a chair, while the surgeon grasps the limb, extends it, and brings it across his knee, as described for dislocations backwards (see p. 35); the articular surfaces readily slip into position. The after-treatment is the same as that for dislocation backwards.

Dislocation of both bones inwards.—This is very rare, on account of the downward projection of the inner condyle of the humerus, and very considerable force is required to produce it.

Treatment.—This is similar to that just described, except that the fore-arm is pressed outwards instead of inwards during reduction.

DISLOCATION OF BOTH BONES FORWARDS.—This accident is sometimes met with either as the result of a severe blow upon the back of the flexed elbow, or from forcible traction—as when the arm is caught in machinery. Both bones are displaced forwards, and the olecranon lies in front of the articular surface of the humerus. The severity of the injury necessary for the production of the dislocation is so great that generally all the ligaments of the joint are ruptured and not uncommonly the dislocation is compound.

Treatment.—Reduction is effected under an anæsthetic by fixing the upper arm and then forcibly flexing the elbow to its utmost limit and at the same time pushing the fore-arm downwards and backwards. As soon as the olecranon reaches the lower part of the articular surface of the humerus it clears its edge and the bones slip readily into position. The after-treatment is the same as that for dislocation of both bones backwards (see p. 35).

DISLOCATION OF EITHER BONE ALONE.

DISLOCATION OF THE ULNA ALONE.—This is such a rare injury that doubts have been thrown upon its occurrence, and more exact information, which is only to be obtained by means of skiagraphy, is required before much can be said about it. The dislocation is backwards; the orbicular ligament is ruptured, but the head of the radius remains in its normal position with regard to the lower end of the humerus.

Treatment.—The treatment will be the same as that for dislocation of both bones backwards (see p. 35).

DISLOCATION OF THE RADIUS ALONE.—This is a much more frequent injury, and it is not at all uncommon for the head of the radius to be dislocated **forwards** whilst the ulna retains its normal position. The accident usually occurs in children, and generally results either from falls upon the outstretched hand or from the common practice

of lifting children by the hands. A severe strain is thus thrown upon the orbicular ligament, which ruptures, and allows the head of the bone to escape upwards in front of the outer condyle of the humerus. The accident may also be caused by a direct blow upon the upper end of the radius, such as would occur in falls upon the outer side and back of the elbow. The dislocation renders flexion beyond a right angle mechanically impossible on account of the apposition of the head of the radius to the front of the articular surface of the humerus. The fore-arm is usually in a position midway between pronation and supination.

Treatment.—There is often much difficulty in replacing the head of the bone, owing to the obstacle offered by the orbicular ligament, which not uncommonly falls into and fills up the lesser sigmoid cavity of the ulna. Moreover, the head of the bone is very apt to slip out of place again after successful reduction, owing to the pull of the biceps.

It is well to employ a general anæsthetic in attempting reduction, because it may be necessary to employ manipulations for a considerable time in order to get the remains of the orbicular ligament out of the lesser sigmoid cavity, and because more nicety of manipulation is required than is possible without the aid of an anæsthetic. The elbow is bent to a right angle and traction is made upon the fore-arm, whilst the head of the radius is pressed backwards into position with the thumb of the hand that fixes the arm. The head of the bone is usually quite easily got nearly into place, but the reduction must not be looked upon as satisfactory unless the surgeon finds that the bone remains in position with the aid of only very slight pressure from the thumb, and that pronation and supination are perfectly free. If the divided ends of the orbicular ligament curl up between the head of the radius and the ulna, these movements will be hampered, and the head of the bone will betray a constant tendency to slip out of position, particularly when full pronation is performed.

After-treatment.—When the surgeon is satisfied that reduction is complete, the elbow should be put up at right angles upon a posterior rectangular splint with the fore-arm in the position of full supination, and a moulded anterior splint of guttapercha or poroplastic material with a pad between it and the front of the head of the radius should be employed to press the latter back (see Fig. 14).

Care must be taken to prevent the arm from being used too early, lest dislocation should recur; at the same time it is important to begin passive movements at latest within a week from the time of the accident, as otherwise extensive adhesions may form. The movements should always be carried out by the surgeon himself, and should be chiefly directed to maintaining the power of rotation. While they are being done, displacement of the head of the radius should be guarded against by pressure applied over it by the thumb. These passive movements should be repeated once or twice daily, and in the intervals the splint and pad are re-applied and should be kept on for the first three weeks;

after that, the patient may be allowed to discard the splint, moving the arm for himself, but keeping it constantly in a sling for another two weeks, at the end of which time the arm may be left free; the patient should be cautioned not to carry heavy weights or attempt any forcible movements for at least another fortnight.

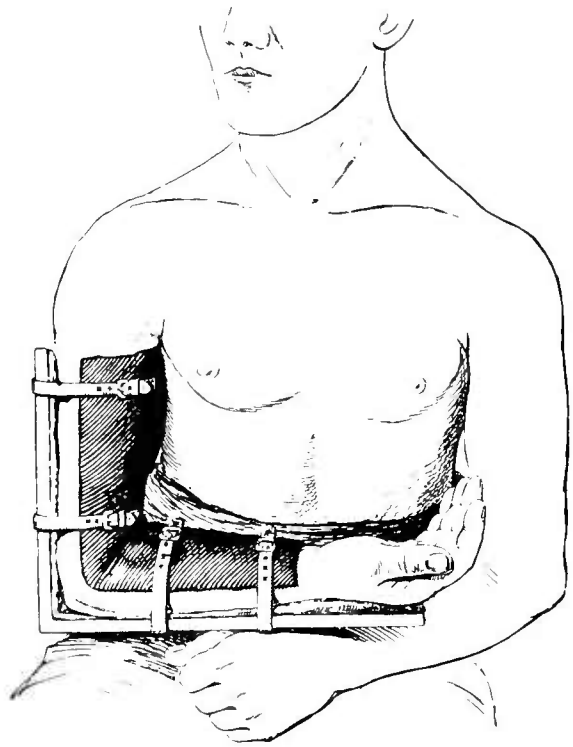


FIG. 14.—APPARATUS FOR USE AFTER DISLOCATION OF THE HEAD OF THE RADIUS FORWARDS. The posterior rectangular splint and the portion of the forearm are the same as in the preceding figure. The anterior splint is a moulded one, and has a pad between it and the front of the head of the radius.

Operative measures.—Unless the surgeon can assure himself that reduction is satisfactory, it will be necessary to expose the articulation and remove the remains of the orbicular ligament from between the bones; otherwise the dislocation will certainly recur and will entail very considerable disability which requires for its cure an operation at a later date and under much less favourable circumstances.

When it is impossible to secure satisfactory reduction of the dislocation under an anæsthetic the wisest plan is to cut down upon the head of the radius and replace it in position. This is quite readily done by the angular incision recommended by Kocher for excision of the elbow. The joint is flexed to an angle of 150°, and an incision is commenced one inch above the external condyle and carried down along the external supracondyloid ridge to the head of the radius, and thence to the subcutaneous border of the ulna three inches below the tip of the olecranon (see Fig. 15). This incision runs between the supinator longus and the triceps above, and between the extensor carpi ulnaris and the anconeus below, and

exposes the radio-humeral joint at once without damage to any important parts; it should be about $2\frac{1}{2}$ inches long.

The capsule of the joint is now incised at its posterior aspect, when the head of the radius is seen. The orbicular ligament should be defined and the two torn ends held aside, after which it is easy to press the head of the bone into proper position. The torn ends of the orbicular ligament should be stitched together if possible; the feasibility of this will depend upon the position of the rent in the ligament. Should the latter be torn close to its insertion into the ulna it may be a very difficult matter to repair the injury from the posterior incision; but, as a rule, the trouble may be got over by passing two or three catgut stitches through the end of the torn ligament and then through the periosteum, or the insertion of the ligament close to the bone, before the dislocation is reduced. These stitches are left loose and are only tied after the head of the radius has been got into position.

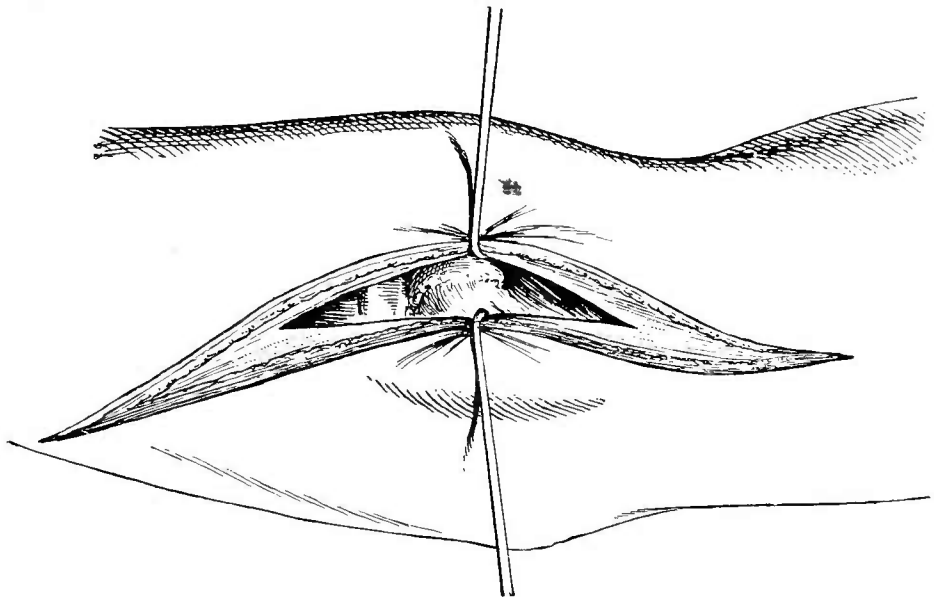


FIG. 15.—INCISION TO EXPOSE THE HEAD OF THE RADIUS. The deep fascia and the capsule of the joint have been incised directly over the head of the bone.

The wound is sewn up without a drainage tube, and the ordinary dressings are applied; the after-treatment will be practically the same as that for dislocation reduced successfully by manipulation.

Dislocation of the head of the radius **backwards** or **outwards** is of very rare occurrence, and the treatment will be that of the form just described. Similar difficulties are met with in these forms of dislocation and must be treated in a similar manner. Some rare cases have also been described in which the head of the radius has been dislocated forwards whilst the ulna has been driven backwards, but these hardly require special description.

Unreduced dislocation.—We have met with several cases in which dislocation has either passed unnoticed or at any rate has not been reduced, and where months and even years have elapsed before the patient has applied for advice. The trouble complained of is that flexion is very

imperfect and cannot be carried out even up to a right angle, whilst the movements of pronation and supination are considerably interfered with.

Treatment.—When the dislocation is of long-standing, it is obviously impossible to obtain satisfactory reduction by mere manipulation, as the alterations in the radio-ulnar joint are such as to entirely preclude all idea of this. In two or three cases we have obtained a satisfactory result by cutting down upon the articulation in the manner just described, and removing the head of the bone. When this has been done, and the sigmoid cavity cleared of fibrous tissue as thoroughly as possible, the upper end of the bone can be pressed back into its normal position. If sufficient bone be removed to enable complete flexion to be carried out, the result is extremely satisfactory.

The wound is sewn up without a drainage tube, and no splint is employed: a mass of dressing, especially thick over the front part of the upper end of the humerus, is put on to immobilise the joint, and the arm is carried in a sling. The passive movements of pronation and supination are practised from the day following the operation, and as soon as the wound has healed, all dressings are left off, and the patient is encouraged to move the arm, whilst energetic passive movements are persisted in.

"Pulled arm."—Before leaving the question of dislocation of the head of the radius, it is necessary to refer to those cases, so frequently met with in children, in which severe pain is suddenly felt in the neighbourhood of the superior radio-ulnar articulation accompanied by entire loss of pronation and supination, as the result of pulling the child up suddenly or swinging him round by the fore-arm. The child screams on any attempt to rotate the radius and the limb is usually more or less powerless, and in a position midway between pronation and supination. Several explanations of this condition are put forward, the most probable being that the head of the radius has been partially withdrawn from the orbicular ligament, and that, as a result, folds of the synovial membrane covering the ligament lie over the head of the radius and are nipped between it and the articular surface of the humerus.

Treatment.—That this explanation is the most probable one seems proved by the fact that the condition is easily remedied by fixing the elbow joint, firmly grasping the wrist, and then suddenly pronating and supinating the arm fully, if necessary deflecting the whole of the fore-arm somewhat outwards. As a rule the head of the bone slips back into position at once, and the movements of the joint become free and painless.

CHAPTER V

DISLOCATIONS OF THE WRIST AND FINGERS.

DISLOCATIONS OF THE WRIST.

Dislocation of the carpus from the radio-ulnar arch is of very rare occurrence, as the force necessary to produce it is far more likely to cause a Colles's fracture. Dislocation may occur either forwards or backwards, the latter being the more common form, and the injury usually results from heavy falls or violent blows upon the outstretched palm, the hand being forcibly bent backwards and the wrist joint over-extended. The condition is difficult to diagnose from Colles's fracture, with which it is often confounded; the points of diagnostic importance are the maintenance of the normal relative positions of the styloid processes and the absence of any displacement of the hand to the radial side in dislocation.

Treatment.—This is usually quite easy, and can be carried out without an anæsthetic. The dislocation is readily reduced by traction, which brings the articular surfaces into contact, and there is but little tendency to recurrence of the deformity. It is well to lay the hand upon an anterior splint for a few days and to employ the ordinary evaporating lotions (see Part I., p. 8), as there is often considerable effusion into the joint and the tendon sheaths around it. Massage should be practised from the first.

The splint may be left off in about a week and the arm kept in a sling for two or three weeks longer, whilst massage and passive movement are persevered with. The result is usually quite satisfactory.

DISLOCATIONS OF THE CARPAL BONES.

Dislocation of one carpal bone from another, although sometimes met with, is of such extreme rarity that the accident does not require any special mention; it usually occurs in connection with crushes of the hand or run-over injuries, and, under these circumstances, it is usually best to remove the displaced bone.

DISLOCATIONS OF THE METACARPAL BONES.

Dislocation of the metacarpal bones from those of the carpus is also of extreme rarity. When it occurs the metacarpal bones are usually displaced backwards.

Treatment.—The dislocation should be reduced by the employment of traction and pressure under an anæsthetic, and, after the bones have been got into position, the hand should be placed upon a splint for a week and evaporating lotions employed. Massage and passive movements of the fingers and wrist should be begun from the first, as otherwise there is a marked tendency to stiffness and interference with movement, especially in elderly subjects.

DISLOCATIONS OF THE PHALANGES.

The phalanges may be dislocated either from the metacarpal bones or from one another.

DISLOCATION AT THE INTER-PHALANGEAL JOINTS generally results from falls or blows upon the outstretched finger. The displacement is generally lateral, although it is sometimes backwards, and not at all uncommonly the dislocation is incomplete.

FIG. 16.—TIN FINGER SPLINT. The oval portion lies in the palm, while the finger is received into the trough.

Treatment.—Reduction is readily effected by exerting traction upon the tip of the finger and bringing the phalanx into its proper line. After reduction, the digit should be put on a tin finger-splint (see Fig. 16) and evaporating lotions may be employed to reduce the swelling. Passive movement should be begun from the first and regularly practised, so as to prevent any possibility of stiffness.

DISLOCATION AT THE METACARPO PHALANGEAL JOINTS is rare except in the thumb and the little finger, in the former of which the accident is not at all uncommon. As there are special difficulties in connection with the reduction of dislocations of the thumb we shall describe this somewhat more fully.

Dislocation of the thumb.—Dislocation of the first metacarpo-phalangeal joint usually occurs from blows or falls upon the abducted thumb. The extremity of the thumb is driven backwards, so that the anterior ligament is overstretched and ruptured; the base of the first phalanx passes backwards, and the head of the metacarpal projects forwards through the rent in the anterior part of the capsule, the two sesamoid bones near the insertion of the flexor brevis pollicis, embracing the neck of the bone, one on either side. The ruptured glenoid ligament is carried backwards on to posterior surface of the neck of the metacarpal, and forms the great obstacle to reduction.

Treatment.—In a recent case, reduction is attempted by trying to disengage the head of the metacarpal bone from the flexor brevis which

embraces it. The metacarpal bone of the thumb is flexed into the palm and firmly fixed by one hand whilst the thumb is grasped with the other and hyper-extended almost to a right angle, whilst traction is at the same time maintained (see Fig. 17). The object of this is to try to disengage the

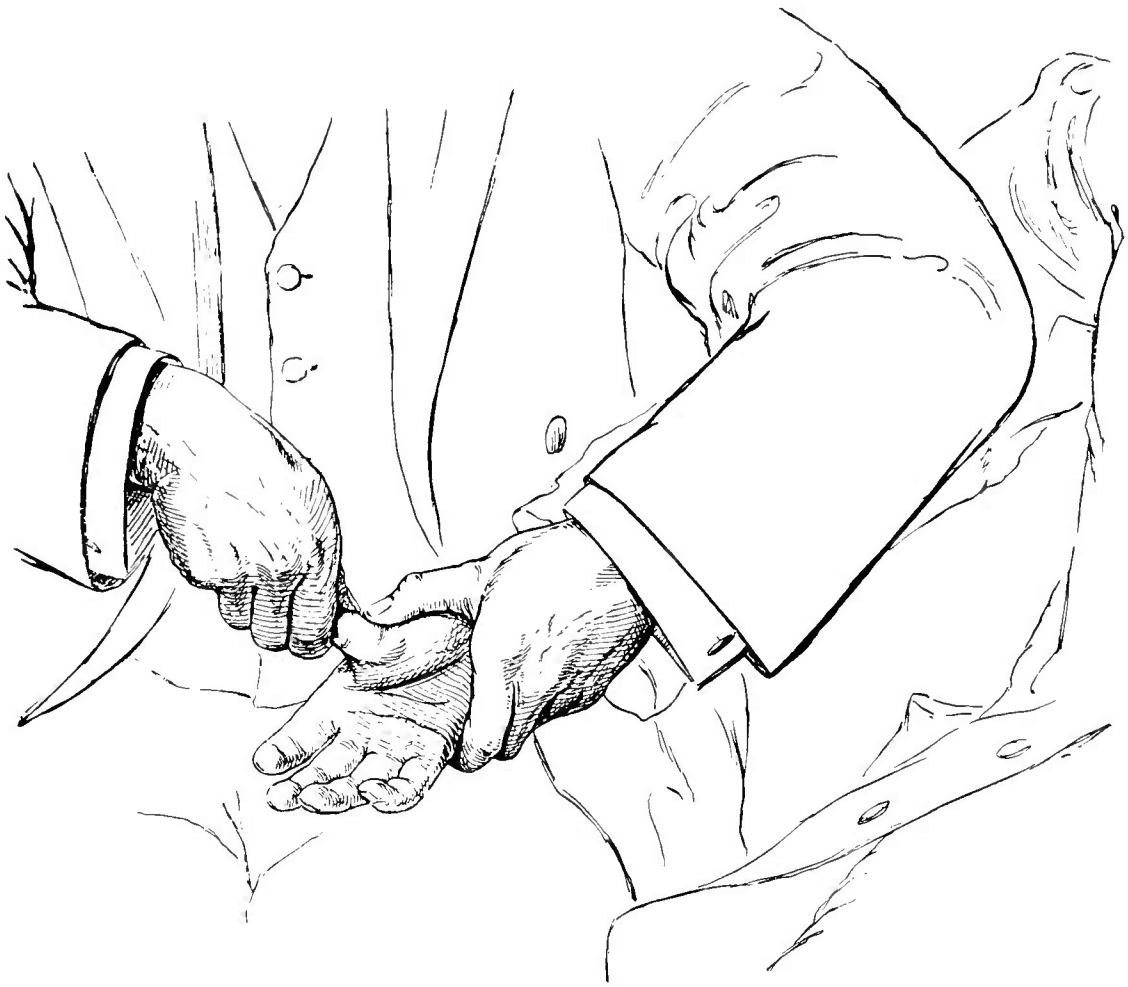


FIG. 17.—METHOD OF REDUCING A DISLOCATION OF THE THUMB. *First Stage.* With the left hand the metacarpal bone is pressed well down into the palm while firm downward pressure is exerted by the thumb against the base of the phalanx which is hyper-extended by the right hand.

anterior edge of the base of the phalanx from the posterior aspect of the head of the metacarpal. It is often difficult to apply sufficient traction with the unaided fingers, but considerable help may be got either by a clove-hitch around the thumb or by special forceps invented for the purpose (see Fig. 19). When sufficient traction in the hyper-extended position has been applied, the base of the phalanx is firmly pushed forwards and the thumb is rapidly flexed into the palm (see Fig. 18). This relaxes the flexor brevis pollicis by adducting the thumb, and the extension applied to the phalanx brings the orifice through which the head of the metacarpal bone has passed opposite to the head again, when, by continuing the extension and suddenly flexing the joint, the head may pass back through the aperture and come into position.

Frequently, however, it is found impossible to reduce these dislocations

in this manner, and, where this is the case, operative interference is called for: this may take the form either of tenotomy or of an open operation, the latter method being in our opinion far the better. A free median incision is made over the palmar surface of the articulation and the protruding head of the metacarpal bone is at once exposed. It is then quite easy to define the encircling tendon of the flexor brevis pollicis, with its sesamoid bones and the glenoid ligament. The tendons of the flexor brevis are hooked aside by retractors and the torn portion of the

FIG. 18.—METHOD OF REDUCING A DISLOCATION OF THE THUMB. *Final Stage.* While the base of the phalanx is kept well pushed down, the thumb is firmly and fully flexed into the palm.

glenoid ligament is pulled out of the way by catch-forceps. The head of the bone can then be pressed into position, after slight extension has been made in the manner just described.

One or two fine catgut stitches may be put into the rent in the capsule, the wound sewn up, the ordinary dressings applied, and a moulded splint of block tin or guttapercha put upon the thumb. The splint is much the same as that described for the finger, namely, a trough which embraces about half the circumference of the digit, with a flat piece projecting into

the palm (see Fig. 16). Passive movements may be begun at the end of the first week.

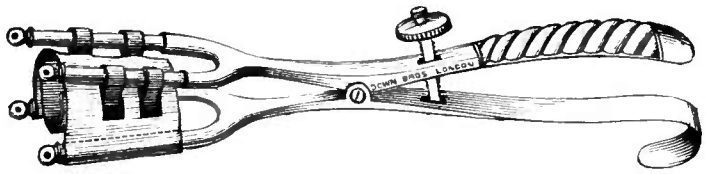


FIG. 19.—FORCEPS FOR REDUCTION OF DISLOCATIONS OF THE THUMB. The traction is made by these forceps in an exactly similar manner to that shown in the preceding figures.

Some surgeons prefer to avoid an open incision and resort to tenotomy. If this be done it must be remembered that the structure to be divided is not the tendon of the flexor brevis pollicis but the glenoid ligament. The division of the displaced glenoid ligament is best carried out as it lies upon the posterior aspect of the neck of the metacarpal bone, and the knife should be made to cut from the base of the phalanx upwards along the

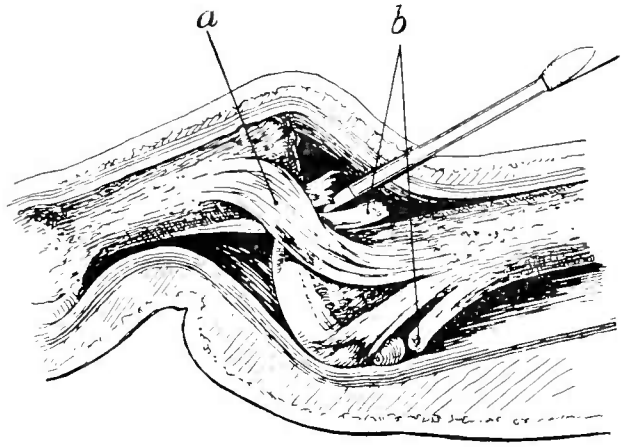


FIG. 20.—DIVISION OF THE GLENOID LIGAMENT IN REDUCTION OF A DISLOCATION OF THE THUMB (*diagrammatic*). The lateral ligaments *a* remain intact while the glenoid ligament *b* is ruptured and a portion of it is carried up by the dislocated phalanx upon the neck of the metacarpal. This portion is being divided by the tenotome which is made to cut upwards along the neck of the bone, *i.e.* from the head towards the base.

neck of the metacarpal (see Fig. 20). The glenoid ligament will then be split vertically. The knife should be introduced from the dorsal surface of the thumb, just above and to one side of the centre of the base of the phalanx, avoiding the extensor tendon, which can usually be readily felt. After the ligament has been divided, the manipulations described above will generally suffice to reduce the dislocation. The subcutaneous incision, however, is somewhat difficult to carry out effectually, and cannot be recommended in preference to the open method.

Similar procedures may be required for dislocations at other metacarpo-phalangeal joints. When the dislocation has remained unreduced for a long time, it will be necessary to remove the head of the metacarpal bone. This is quite a simple operation, and if sufficient bone be removed and passive movement be properly carried out, a satisfactory result will be obtained. It is very seldom necessary to remove any portion of the phalanx.

CHAPTER VI.

DISLOCATIONS OF THE HIP.

CAUSES.—Dislocation of the hip usually occurs in healthy adult males as the result of very severe violence applied to the lower extremity while the hip joint is flexed and abducted; similar violence applied to the fully extended limb is more likely to give rise to a fracture of the neck of the femur than to a dislocation.

VARIETIES.—Two great groups of dislocations are met with: (1) The ordinary or *regular* dislocations of the hip, which again may be divided into two varieties, the posterior and the anterior dislocations; and (2) the rarer or *irregular* dislocations, in which there is co-existing injury to structures which remain intact in the regular forms.

The points that have to be remembered in connection with these dislocations are, in the first place, that the acetabulum is shallowest at its lower part, where it is also somewhat defective, and that a very strong ligament, called from its shape the **Y**-ligament, extends from the neighbourhood of the anterior superior spine of the ilium downwards across the front of the joint and ends in two bands, one of which passes vertically downwards towards the base of the lesser trochanter, whilst the other runs outwards more or less horizontally to be inserted into the outer and upper end of the anterior inter-trochanteric line. This ligament is extremely strong, and very great violence is required to rupture it. The condition of this **Y**-ligament is the principal factor which determines the production of any particular form of displacement; in the regular dislocations it is always intact. It is, moreover, one of the chief agents in aiding reduction. Another structure which plays an important part in dislocations of the hip is the tendon of the obturator internus muscle. This muscle arises from the inner surface of the obturator foramen and the fascia covering it, passes out of the pelvis through the great sacro-sciatic notch, where it is joined by the two gemelli, and with them is inserted into the digital fossa at the back of the femur. The tendon acts as a powerful reinforcement to the posterior part of the capsule of the

joint, and when the head of the bone is dislocated backwards it determines the particular form of dislocation; when the head of the bone lies below the tendon, the displacement is known as a sciatic dislocation, and when it lies above it, as a dorsal dislocation.

The regular dislocations are all primarily subcotyloid, as the head of the bone always escapes from the acetabulum at its lower part, the inferior portion of the capsule usually being torn. This subcotyloid position, however, is one of unstable equilibrium, and a further displacement invariably occurs, the head always passing either backwards or forwards, the direction that it takes being mainly determined by the direction of the force producing the injury, and the position of the limb at the time of the accident.

The regular dislocations.—The regular dislocations of the hip, that is to say, those in which the **Y**-ligament and the margin of the acetabulum remain intact, are usually divided into four principal varieties, in two of which the head of the bone passes backwards, while in the remaining two it is found in front of the acetabulum. These dislocations are classified as follows:

(1) The most common are the backward dislocations, and of these the true **dorsal dislocation** is the more frequent. The head of the bone, after leaving the acetabulum, passes backwards and upwards around its posterior margin, and finally rests upon the dorsum ilii, above the tendon of the obturator internus.

(2) Instead of passing above the latter tendon, the head of the bone may rest below it, and is thereby guided backwards until it reaches the sciatic notch; this is termed the **sciatic dislocation.**

(3) After leaving the acetabulum, the head of the bone may pass obliquely inwards and forwards until it rests over the obturator foramen—the so-called **thyroid dislocation.**

(4) Instead of passing on to the thyroid foramen, the head of the bone may travel upwards and inwards, and is then found in the neighbourhood of the spine of the pubes—the so-called **pubic dislocation.**

Two other regular forms of dislocation are described, namely, the **supra-spinous**, in which the head of the bone lies above the anterior superior iliac spine; and the **everted dorsal** form, in which the head of the bone lies upon the dorsum ilii, but is directed forwards instead of backwards. In both of these dislocations, however, which are extremely rare, the outer limb of the **Y**-ligament is torn through.

The irregular dislocations.—These are always accompanied by a rupture of the **Y**-ligament or by fracture of a portion of the acetabulum; the result of either of these injuries is that the head of the bone, instead of always passing out through the lower part of the capsule and then travelling either forwards or backwards, may leave the acetabulum anywhere, and generally passes in the upward direction. In these cases many of the symptoms characteristic of the chief forms of regular dislocations may be absent.

TREATMENT OF THE REGULAR FORMS OF DISLOCATION.

In all the regular dislocations of the hip, the best method of reduction is by the performance of manipulations designed to cause the head of the femur to pass back into its proper position along the same path that it followed as it escaped from the joint. This is a point of great importance, as reduction may thus be effected without the necessity for overcoming the exceedingly powerful muscles which surround the joint. In all cases it is very important that a general anæsthetic should be employed although, undoubtedly, the bone may sometimes be quite readily replaced without one.

DISLOCATION BACKWARDS. — (a) **Dislocation upon the dorsum ilii.**—Wherever possible the method of reduction by manipulation —called after Bigelow, who introduced it—should be attempted.

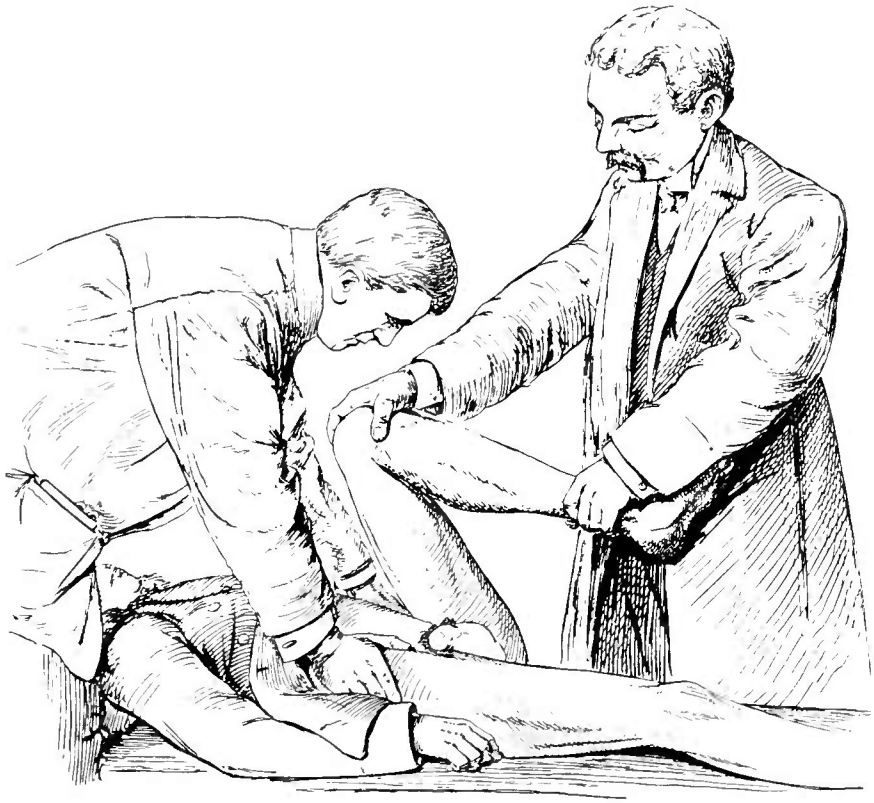


FIG. 21.—REDUCTION OF A DORSAL DISLOCATION OF THE HIP BY BIGELOW'S METHOD. *First Stage.* While the assistant steadies the pelvis, the surgeon flexes the affected limb to its utmost limit, and at the same time slightly adducts it and rotates it inwards so as to disentangle the head of the bone.

Bigelow's method.—The patient is laid flat upon the back upon the floor, or upon a low flat couch, and the surgeon, standing upon the affected side, raises the thigh, and flexes it fully upon the abdomen, whilst an assistant fixes the pelvis (see Fig. 21). In doing this, the knee should be flexed to a right angle, and is useful in the later stages as a lever for rotating the limb. As the full flexion is carried out, the femur should be

rotated somewhat inwards and slightly adducted; by doing this the Y-ligament is relaxed, and the head of the bone is disentangled. When flexion has been carried to its fullest limit, downward pressure should be made upon the knee, so as to depress the head of the bone, and at the same time the limb should be strongly rotated outwards. Abduction is next carried out to its fullest limit (see Fig. 22), the result being that the head

FIG. 22.—REDUCTION OF A DORSAL DISLOCATION OF THE HIP BY BIGELOW'S METHOD. *Second Stage.* The fully flexed limb is now abducted to its utmost limit, and rotated fully outwards.

of the bone passes downwards behind the acetabulum, and then forwards to a point opposite the rent in the capsule. The limb is finally rapidly circumducted outwards, and brought down parallel to its fellow (see Fig. 23); the head of the bone is thus made to enter the rent and slip into the acetabulum. The success of these manœuvres depends upon the integrity of the Y-ligament, which forms a fixed point around which the head of the bone rotates.

Reduction by traction.—Should reduction by manipulation fail, either because the opening in the capsule is too small, or because the Y-ligament has been injured, attempts should be made to reduce the dislocation by traction. The patient should be fully anæsthetised and laid upon his back as before, while an assistant firmly fixes the pelvis. The surgeon then flexes the hip joint to a right angle, and at the same time adducts and rotates the thigh inwards so as to disentangle the head of the bone (see Fig. 24). Firm vertical extension is then made upon the thigh, at first quite steadily and later on in a series of jerks, when, after a time, the head of the

bone will probably slip into the acetabulum with a distinct snap. Should no assistant be available to steady the pelvis, this may be done by the surgeon's unbooted foot pressing directly downwards upon the anterior superior iliac spine of the same side. The traction is exerted at right angles to the long axis of the body, because if employed with the limb fully extended it would be absolutely ineffectual, as the Y-ligament then prevents the descent of the head of the bone; it is strong enough to bear without rupture more pressure than the surgeon can bring to bear. On the other hand, when the thigh is flexed to a right angle upon the abdomen, the Y-ligament is relaxed, and the head of the bone is allowed

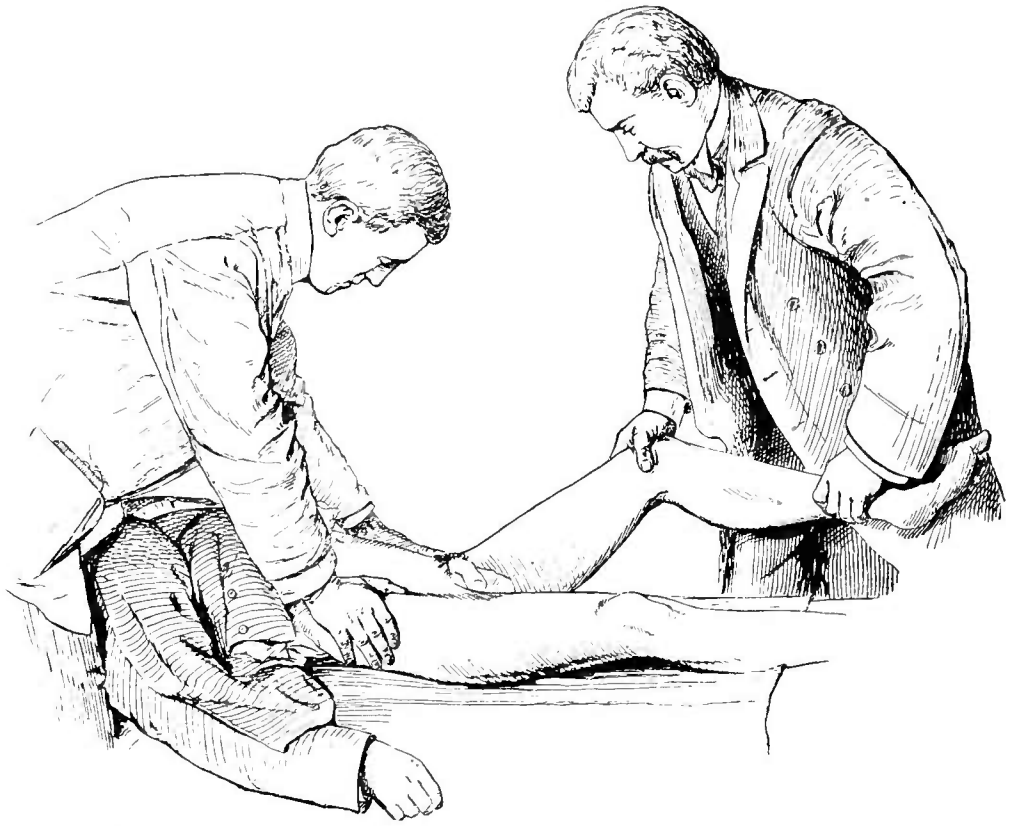


FIG. 23.—REDUCTION OF A DORSAL DISLOCATION OF THE HIP BY BIGELOW'S METHOD. *Final Stage.* The limb is circumducted outwards and brought down to the middle line parallel with its fellow.

to pass back into place through the rent in the capsule. Care must be taken not to employ too much force, as fracture of the neck of the femur has resulted from too violent attempts to reduce dislocations in this way.

Pulleys.—When the patient is very muscular, more satisfactory extension can be obtained if it be possible to fix a pulley directly above him. The pulley is attached to a skein of worsted fastened around the lower part of the thigh. Another plan, which is more particularly adapted for use in children, in whom the pelvis is small and difficult to fix, is to turn the patient over upon his face upon a high table, to bring the pelvis to the edge and then, whilst the trunk lies flat upon the table, to make steady traction

vertically downwards upon the affected limb, which will then hang flexed at a right angle over the edge of the table. When there is difficulty in reducing the dislocation in either of these ways, the cause is probably an insufficient opening in the capsule, and, to enlarge this, the limb should be circumducted several times as freely as possible, when in all probability renewal of the manipulations will enable the dislocation to be successfully reduced.

After-treatment.—This is extremely simple, as the tendency to recurrence of the dislocation is very slight. The patient should be put to bed and the lower extremities may be tied together, whilst evaporating lotions, or an ice bag (see Part I., p. 9) are applied for two or three days to reduce

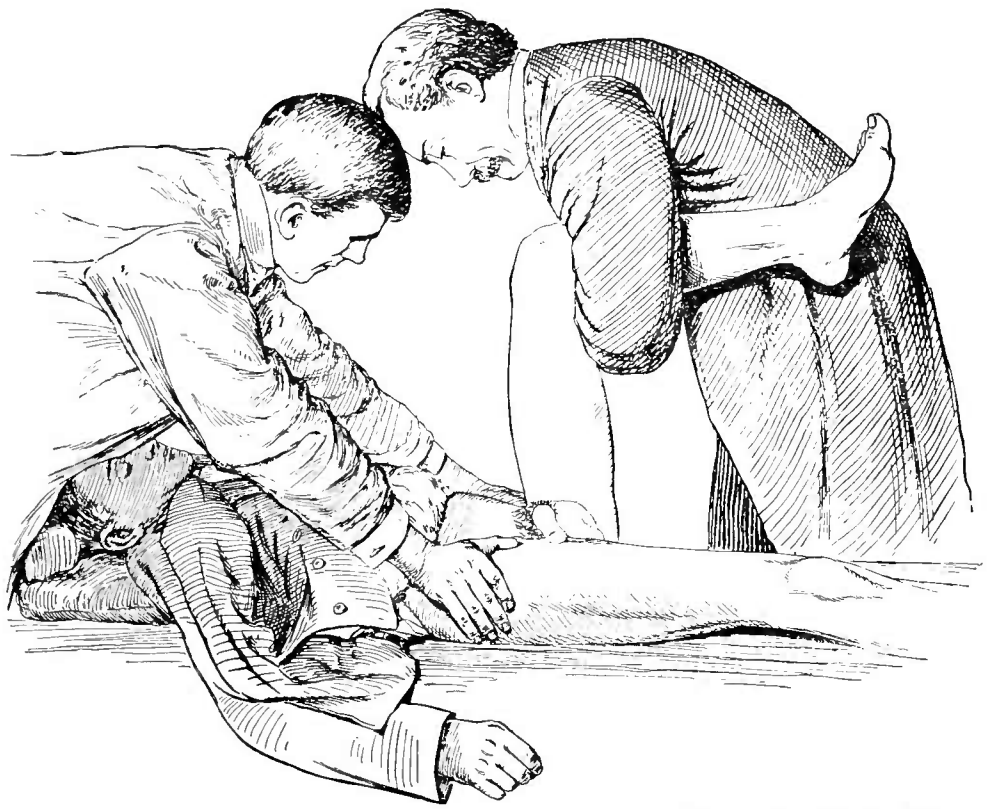


FIG. 24.—REDUCTION OF A DORSAL DISLOCATION OF THE HIP BY TRACTION. The pelvis is steadied by an assistant and the surgeon makes traction at right angles to the pelvis by grasping the limb as shown above.

any swelling that may result. After three days a certain amount of passive movement may be carried out carefully, and within a week the patient may be allowed to stand and walk. For some weeks, however, he should be warned against too great flexion or abduction of the limb, because these movements might reproduce the dislocation as long as the rent in the capsule remains unhealed.

(b) **Dislocation into the sciatic notch.**—Here reduction is effected in a similar manner, except that as a rule the hip joint requires to be flexed to its extremest possible degree first of all so as to disengage the head of the bone from beneath the tendon of the obturator internus.

DISLOCATIONS FORWARDS.—Reduction of these dislocations is effected very similarly except that the movements of manipulation must be more or less the reverse of those already described.

(a) **Dislocation into the thyroid foramen.**—*Bigelow's method.*—The patient is anæsthetised and placed flat upon the back, whilst the pelvis is fixed and the thigh is flexed and abducted sufficiently to disengage the head of the bone from the obturator foramen. The limb is next rotated inwards, strongly adducted and then brought down parallel to its fellow, whilst the inward rotation is kept up (see Fig. 25). This has the effect of fixing the trochanter through the agency of the Y-ligament and the obturator internus tendon, whilst the head of the bone is forced upwards and outwards into the acetabulum.

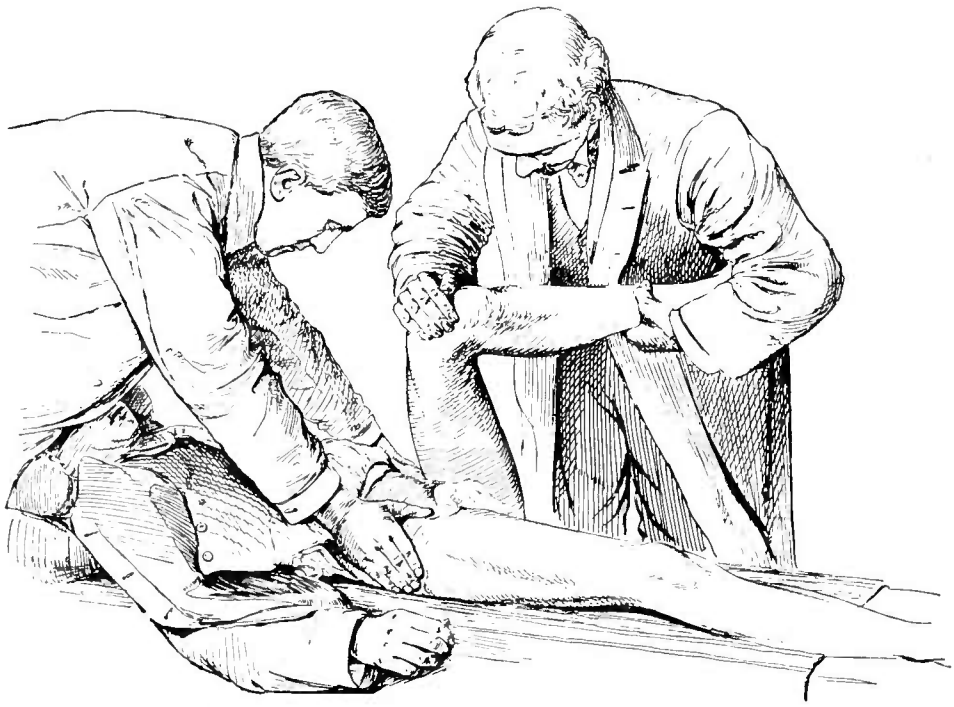


FIG. 25.—REDUCTION OF A THYROID DISLOCATION OF THE HIP BY BIGELOW'S METHOD. The limb is fully flexed, adducted and rotated inwards, and is finally brought down to the middle line by circumducting it inwards.

Reduction by traction.—Should the attempt to reduce the dislocation by manipulation fail, recourse must be had to traction. The patient is fully anæsthetised, and placed upon the floor or upon a low couch. The surgeon flexes the thigh to a right angle with the pelvis, and first of all slightly abducts it so as to disengage the head of the bone. A strong jack-towel is then passed transversely around the upper part of the thigh, and whilst an assistant fixes the pelvis, the surgeon makes extension vertically upwards with the limb rotated somewhat inwards, a second assistant pulling upon the towel so as to drag the head of the bone directly outwards (see Fig. 26). The result of the combined traction is that the head of the bone passes into the acetabulum.

Should the surgeon fail to reduce the dislocation by either of the methods just described, the best thing is to convert the dislocation into one upon the dorsum ilii. This can generally be readily done by flexing the limb

and then forcibly circumducting it inwards. Indeed, it commonly happens during the attempts to reduce the dislocation that the head of the bone slips past the lower margin of the acetabulum and travels round upon the dorsum of the ilium. When a dorsal dislocation has thus been produced, reduction can readily be effected by the manipulations already described (see p. 52).

FIG. 26.—REDUCTION OF A THYROID DISLOCATION BY TRACTION. This closely resembles the traction method for the dorsal dislocations, except that a second assistant makes traction outwards at right angles to the long axis of the femur with a towel passed round the limb, so as to pull the head of the bone outwards from the thyroid foramen.

(b) **Pubic dislocation.**—In this form it is well in any case to combine manipulations with traction, as there is generally some difficulty in fully flexing the thigh, owing to the neck of the bone hitching against the brim of the pelvis. The patient should be placed under an anæsthetic, and the thigh flexed as far as possible and somewhat abducted so as to disengage the head of the bone from the brim of the pelvis. Outward traction is then applied by the agency of a jack-towel passed transversely around the upper third of the thigh so as to pull the head of the bone downwards and outwards and to disengage it from the pubes. When this has been done, the limb can be more fully flexed, and it should be then still further abducted and rotated inwards, which completes the disengagement of the head. The lateral traction may now be relaxed, and the dislocation can be reduced by rotating and circumducting the limb inwards, and finally bringing it down parallel with the sound limb as for reduction of thyroid dislocations. This plan of combining manipulation and traction aims at converting the pubic dislocation into the thyroid form by disengaging the

head of the bone from the brim of the pelvis. The thyroid dislocation is then reduced in the ordinary manner.

TREATMENT OF THE IRREGULAR FORMS OF DISLOCATION.

In these forms manipulation is of no avail because the **Y**-ligament is torn and there is therefore no fixed point around which the head of the bone can be made to rotate. Traction is the only procedure that is of use, and it should be employed in the downward and forward direction with the thigh somewhat flexed; while this is being carried out, the surgeon should alternately rotate the limb inwards or outwards, and at the same time adduct or abduct it, according to the position that the head of the bone occupies with regard to the acetabulum; this will generally succeed in reducing the dislocation.

When the **Y**-*ligament only has been torn*, there is usually no difficulty in retaining the head of the bone in position after reduction, but it is expedient to keep the joint at rest for some weeks before the patient is allowed to stand, so as to facilitate the repair of this structure. The best splint to employ is a long Liston (see Part III., p. 111), but this must be taken off once or twice a day for passive movement designed to prevent adhesions.

When the margin of the acetabulum has been broken off, the after-treatment is much more difficult, as there is a constant tendency to recurrence of the displacement. It is imperative, therefore, to keep up extension,—which is best done by weight and pulley (see Part III., p. 23),—until union of the fractured surfaces is complete. In the meanwhile careful passive movement must be carried out at intervals by the surgeon.

TREATMENT OF UNREDUCED DISLOCATION.

When a dislocation of the hip has remained unreduced for a short time, marked changes take place in the joint. The head of the femur becomes broader than normal, whilst the acetabulum becomes shallower and may be completely filled up with fibrous tissue, which in parts may undergo ossification. The ruptured capsule also becomes shortened and adherent, so that after the lapse of a few weeks, reduction of the dislocation, either by manipulation or by traction, is a matter of absolute impossibility. As a rule, if more than six weeks have elapsed from the time of the accident, it is hardly possible to reduce the dislocation, and operative measures will therefore be necessary.

Operative Measures.—Immediately prior to operating for the relief of unreduced dislocation, the limb should be freely moved in all directions. All movements should be carried to their fullest limit, and extension by pulleys should also be had recourse to, so as to break up as fully as possible any adhesions that may have formed.

The skin is then thoroughly disinfected, and an incision about four inches long running downwards and forwards from just beneath the anterior superior iliac spine is made in the interval between the tensor vaginæ femoris and the sartorius. The deep fascia of the thigh is opened, the two muscles above mentioned are pulled apart, and the region of the neck and head of the bone is exposed (see Fig. 27). In order to get satisfactory access to the acetabulum, it will generally be found necessary to detach some of the muscles from the ilium. Division of the tensor vaginæ femoris and the anterior part of the gluteus minimus may be necessary, as they will probably be somewhat shortened, and will not only oppose proper retraction of the wound, but will also interfere with the extension of the limb necessary to bring the head of the bone into position.

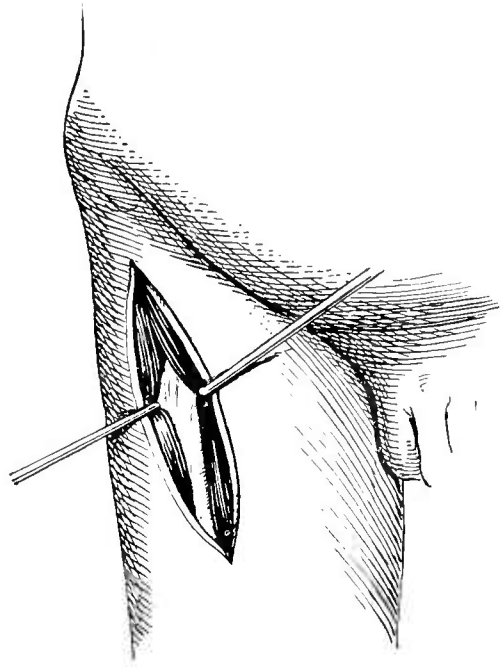


FIG. 27.—ANTERIOR INCISION FOR EXPOSING THE NECK OF THE FEMUR. The two muscles hooked aside are the Sartorius on the inner, and the Tensor Vaginæ Femoris on the outer side of the limb. This exposes the neck of the bone directly; the fibres of the capsule are shown in the figure.

The capsule of the joint is next incised, and the Y-ligament defined and divided. The incision into the capsule should be near its insertion into the neck of the femur, and the division of the Y-ligament may also be at that spot. The divided capsule is pulled aside to expose the acetabulum, out of which the soft parts must be cleared by a gouge so as to fit it for the reception of the head of the femur. Traction is then effected by an assistant or by pulleys, and any resisting structures are divided; not infrequently the tendon of the obturator internus must be cut. After this has been done, the head of the bone can usually be brought into the acetabulum. The wound is sewn up without a drainage tube, the ordinary gauze dressings are applied, and the limb fixed upon a long Liston splint, and, if there be considerable shortening of the muscles, weight extension may be employed for the first three weeks. For this purpose heavy weights, from seven pounds upwards, will be required.

After about three weeks, the splint and the extension may be discontinued, and massage and passive movements must be carefully and thoroughly carried out. After six weeks the patient may be allowed to get about with a crutch or a stick; but he must not bear much weight upon the limb, and must be warned against abducting or flexing it to any great degree for at least another six weeks. The results are usually quite satisfactory.

When, however, division of the resisting structures does not allow the head of the bone to come into position, the question of what further can

be done will naturally arise. If the pressure on the sciatic nerve, which is often a source of considerable pain to the patient, has been relieved by the operation, there is no particular advantage in removing the head of the bone, as has been suggested. The great trochanter will slip up and down over the side of the pelvis, much in the same manner as the head of the bone does, and from that point of view the patient will be no better off. The best thing is probably to try and form a new acetabulum upon the iliac bone, in the new position that the head of the bone occupies, and so to substitute a stable and movable joint for the unstable and useless one resulting from the dislocation.

To do this, a portion of the pelvis is gouged away opposite the head of the bone, until a shallow bed is formed in which the head can lie. Instead of removing the portions of bone so raised, it is well to simply gouge them upwards and then bend them at right angles to the pelvis, so that they form a sort of buttress preventing the head of the bone being pulled further up. In the course of a few weeks considerable callus is thrown out around the portions of bone detached in this way, and thus an obstacle to the further dislocation of the head upwards is obtained.

The after-treatment consists mainly in the employment of good extension for some weeks, so as to prevent the head of the bone being thrust up forcibly against the buttress thus formed, until the latter has undergone solidification. Passive movement should also be employed from the first so as to form a new joint.

When the unreduced dislocation of the femur is accompanied by fracture of the acetabulum, the condition is more difficult to treat. There can be no possibility of restoring the limb to its normal condition, and all that can be done is to attempt to refresh the detached fragments of the acetabulum if they are sufficiently large, and to peg them to the pelvis; then to scoop out the acetabulum and to turn the fragments of bone up, as before, so as to provide a buttress for retaining the head of the bone in position. Unfortunately the results are not at all satisfactory in either of the latter cases, although it must be claimed as a distinct improvement that, when a buttress has been formed, the head of the bone no longer slides up and down as it did before.

CHAPTER VII.

DISLOCATIONS OF THE PATELLA.

CAUSES.—The accident may occur either from unduly forcible contraction of the quadriceps or from a direct blow upon one edge of the bone. Dislocation is often predisposed to by a previous lax condition of the ligaments, resulting from chronic synovitis with effusion, and it is naturally much more common when genu valgum is present.

VARIETIES.—The patella may be dislocated outwards or inwards, or it may be rotated vertically upon its long axis. Of these, dislocation outwards is far the most common, no doubt owing to the fact that the patella lies more over the external condyle than over the internal; this is still more marked when any degree of genu valgum is present.

(a) **Dislocation outwards.**—In dislocation outwards, the capsule over the inner condyle is torn and the patella slips over the external condyle and lies therefore upon the outer side of the knee. The accident may occur either when the knee is flexed or extended; when due to muscular action, dislocation generally occurs with the knee bent.

Treatment.—The treatment of this form of dislocation is very simple, and reduction may generally be accomplished quite easily without an anæsthetic. The knee joint should first be fully extended and the thigh flexed upon the pelvis, so as to relax the extensors of the thigh, when comparatively slight pressure and manipulation will cause the bone to slip inwards into its normal position.

After-treatment.—There is usually considerable synovial effusion as a result of the accident, and there may be some bleeding into the joint. The limb should therefore be placed on a back splint, and cold, either in the form of an ice-bag or Leiter's tubes (see Part I., p. 9), should be applied immediately after reduction. When the effusion has become stationary, its absorption may be aided by massage. In the intervals, firm elastic support should be afforded to the limb by a bandage applied outside a large mass of cotton wool; in other words the treatment will be much the same as that for sprains of the knee joint (see Chapter X.).

The rent in the capsule takes some time to heal, and the patient must

be very careful in moving the knee. Passive movements, during which the patella must be steadied so as to prevent any recurrence of the dislocation, must be employed from the first. The patient should not leave off the splint or walk about for at least three weeks after the injury. Should the effusion still be present at the end of that time, the period of treatment must be prolonged until it has disappeared. When the patient first gets about, it is well that he should wear either an elastic bandage around the knee over a mass of cotton wool or some form of elastic knee-cap so as to prevent the possibility of recurrence of the dislocation. In about three months' time he can safely do without support of any kind.

(b) **Dislocation inwards.**—This is an extremely rare condition, and generally results from a direct blow upon the upper and outer aspect of the bone. The treatment is practically the same as that of the commoner variety just described; an anæsthetic may be necessary.

(c) **Vertical dislocation.**—A more common condition is a vertical dislocation of the patella upon its long axis, the bone being turned upon itself through an angle of nearly 90° so that one edge is caught in the groove between the condyles of the femur whilst the other points directly forwards. The bone is usually twisted so that the anterior surface is directed outwards while the articular surface looks inwards; more rarely the position may be reversed.

Causes.—A vertical dislocation is almost always due to direct violence applied from the front and one side. The capsule is necessarily torn, and the rent usually takes place over the internal condyle.

Treatment.—The reduction of this form of dislocation is somewhat more difficult than the last, but is readily accomplished if the patient be placed under an anæsthetic. When the quadriceps is fully relaxed, pressure upon the uppermost edge of the patella should be applied so as to rotate the bone back into position; this will generally occur with a marked snap. If this manœuvre be unavailing, it is probably because the upper part of the bone is engaged in the inter-condyloid notch, and to overcome this downward pressure must also be applied. Should this fail, the knee may be somewhat flexed and the bone thus disengaged, when pressure upon the edge of the bone will at once cause it to slip back into position.

Should reduction under an anæsthetic fail—which however, it is very rarely likely to do—it may be necessary to make a small incision through the capsule on one side of the patella, and to introduce an elevator beneath the lower edge of the bone so as to lever it upwards while pressure is at the same time made upon the uppermost edge, when the bone will be at once got into position. The after-treatment in these cases is precisely similar to that for dislocation outwards.

UNREDUCED DISLOCATION OF THE PATELLA.

A dislocation of the patella may either be unrecognised, or reduction may have failed, and the patient may apply for relief, weeks and even

months after the occurrence of the injury. We have met with two such cases, and have operated in both instances with satisfactory results.

The operation was performed through two free vertical incisions, one on either side of the patella, that on the outer side being made to divide the shortened capsule, which by its contraction prevented the patella from coming into position; from the one on the inner side an elliptical portion of the cicatricial tissue which represented the capsule was excised (see Fig. 28, *A*). As soon as these incisions were made, reduction was quite easy.

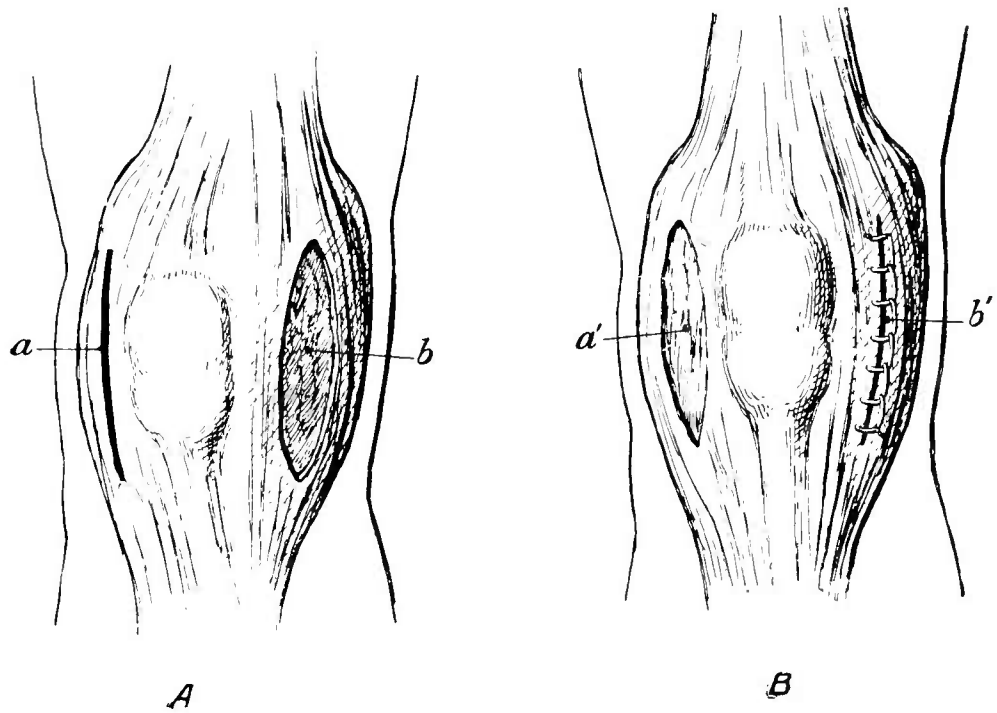


FIG. 28.—DIAGRAMMATIC REPRESENTATION OF THE OPERATION FOR UNREDUCED DISLOCATION OF THE PATELLA. *A. The first stage of the operation.* A free vertical incision *a* is made on the side of the patella towards which it is dislocated, while the cicatricial tissue formed about the rent in the capsule *b* on the opposite side is excised. *B. The final stage.* When the patella is pulled into position, the gap *b* becomes the sutured incision *b'*, and the incision *a* the gap *a'*.

The only important points in this operation are to divide the capsule to the outer side sufficiently freely to prevent any hindrance to the patella coming into place, and to excise through the inner incision enough of the capsule and the cicatricial tissue to keep the patella in position, when the margins of the incision are stitched together with fine catgut (see Fig. 28, *B*). After the skin wound is sutured, the limb is put on a back splint in the semi-flexed position.

As soon as the wound has healed, the treatment is practically that for the ordinary outward dislocation of the patella. Passive movement is begun in a fortnight, and massage and passive movement are continued until the knee has regained its full measure of mobility. Spontaneous movement, however, should not be allowed until five weeks after the operation, when the patient may be permitted to commence walking, wearing an elastic bandage.

CHAPTER VIII.

DISLOCATIONS OF THE KNEE AND ITS CARTILAGES.

DISLOCATIONS OF THE KNEE.

Traumatic dislocation of the knee joint is a very rare occurrence, as may easily be understood from a consideration of the size of the joint and the strength of the ligaments concerned. Very severe violence is required to produce dislocation, and hence these injuries are usually complex ones, being either compound, or complicated with fracture of the bones in the immediate neighbourhood.

VARIETIES.—The knee may be dislocated forwards, backwards, or laterally, and the dislocation may be complete or incomplete; usually it is incomplete.

Dislocation of the tibia forwards.—This may occur from direct violence, such as a severe blow received upon the front of the lower end of the femur when the limb is in a position of full extension; the lower end of the femur is thus driven directly backwards. Generally, however, the accident occurs from indirect violence, as, for example, when the foot becomes caught in a hole and fixed, whilst the weight of the body carries the upper end of the femur forward, and thrusts the lower end forcibly backwards against the posterior ligament of the knee joint, which gives way. This structure is generally torn completely, whilst the other ligaments of the joint are also ruptured to a greater or less extent, the amount of damage regulating the amount of displacement. The vessels and nerves in the popliteal space generally lie in the inter-condyloid notch of the femur and are more or less severely pressed upon: should the artery be atheromatous it may be completely torn across. This form of dislocation is the most common.

Dislocation of the tibia backwards, although extremely common as the result of disease, is comparatively rarely of traumatic origin. Should it occur, it will probably result from violence applied either to the head of the tibia in front or to the lower end of the femur behind, when the knee is in a flexed position.

Lateral dislocations of the knee are still rarer, outward dislocation being perhaps less infrequent than the inward form. They are almost always incomplete.

TREATMENT.—This as a rule is very simple, as there is little difficulty in reducing most of these dislocations, especially as they are generally partial, if the patient be put fully under an anæsthetic. The lower end of the femur should be firmly fixed by an assistant, whilst the surgeon makes traction on the leg and employs the movements necessary for the reduction of the dislocation. Thus, in dislocation of the tibia forwards, reduction is readily effected by traction and subsequent flexion of the knee joint. When the tibia is dislocated backwards, traction is also employed, whilst the head of the bone is pushed forwards into position. In lateral dislocations, traction alone may suffice, but if necessary lateral pressure may be made upon the tibia so as to push it into position.

After-treatment.—The principal difficulty in the treatment lies in the after-effects of the injury. Very extensive damage is done to the joint, considerable effusion of blood may occur into it, and extremely severe swelling and inflammation will supervene. Time must also be allowed for union of the ruptured ligaments to occur, or else a permanently weak joint will be left. The limb should be put up on a straight splint, and cold, either in the form of an ice-bag or Leiter's tubes (see Part I., p. 9), applied to diminish the effusion. Very cautious passive movement should be begun during the second week so as to prevent adhesions in the joint. In the early stage it is often necessary to move the limb under an anæsthetic, as the internal damage is very considerable and movement may cause great pain. Three weeks or so after the accident, a firm leather splint may be moulded to the joint, and the patient allowed to get about, the splint being removed two or three times a day for passive and active movements and massage. As a rule it is necessary to wear a lace-up knee-cap for several months.

DISLOCATION OF THE SEMILUNAR CARTILAGES.

VARIETIES.—Of the two cartilages the internal is far more commonly displaced. It may be torn from its attachment to the spine of the tibia both in front and behind, or it may be detached at one end, the other remaining unaffected, or both its attachments may remain intact whilst the union between the cartilage and the edge of the tibia may be ruptured. The common condition is for the anterior end of the cartilage to be detached from the spine and from the edge of the tibia for some distance. Much more rarely the cartilage may be split either longitudinally or transversely, and this may be either partial or complete.

RESULTS.—As a result of these injuries the cartilage may either slip backwards and forwards over the head of the tibia with the movements of the joint, or its detached end may curl up in the interior of the joint

and practically form a loose body within it; this constitutes a formidable obstacle to movement.

During some violent movement of the knee, particularly rotation of the tibia upon the femur, a sudden pain is felt in the joint, the knee becomes semi-flexed and the patient is unable to straighten it; very commonly the pain is so acute that the patient falls. Sometimes a prominence may be felt in the position of the displaced cartilage; in other cases a depression may be felt where the cartilage ought to be. The "locking of the joint" is succeeded by more or less severe synovitis, lasting sometimes only a few days, sometimes for several weeks. The condition is very likely to recur, and patients are constantly seen who, in consequence of want of proper care after the first accident, are liable to get the cartilage caught and the knee locked whenever the foot is slightly twisted.

TREATMENT.—The treatment may be divided into that appropriate for cases seen immediately after the first occurrence of the dislocation, and that for those in whom the condition is constantly recurring.

(a) **When the patient is seen immediately after the accident has occurred for the first time,** the first point in the treatment is to *reduce the dislocated cartilage.* This can generally be readily done by first of all fully flexing the knee, rotating it inwards, and then quickly extending. Should the cartilage be prominent, pressure must be made over it whilst the manipulations are being carried out. An anæsthetic is hardly ever necessary.

The limb should then be put upon a *splint* in the extended position, and the effusion which results in a few hours should be subdued by the application of *cold.* As soon as the effusion has subsided, a firm *apparatus,* such as a lace-up leather splint or a stout Bavarian or poroplastic splint, extending from the middle of the thigh to the middle of the calf, should be employed to keep the knee fully extended, and this should be worn continuously for at least three months. This splint should be worn night and day, and should only be taken off for the purpose of careful *massage and passive movement,* which should be commenced in about three weeks' time, in order to break down any adhesions that may have formed and to prevent the occurrence of fresh ones. It should be practised once daily for about a quarter of an hour at a time, and pressure should meanwhile be kept up with the thumb over the internal semilunar cartilage.

Much depends upon the care with which the primary injury is treated. The difficulty in obtaining a good result is due, in the first place, to the slowness with which the cartilage unites, and secondly, to the great tendency there is to the formation of adhesions within the joint. Of the two evils, it is better to allow the adhesions to form to some extent so as to get union of the cartilage first; the adhesions may, if necessary, be broken down later on under an anæsthetic, and may be kept under by massage and passive movement. This is far better than paying attention first of all to the mobility of the joint, because every time that the knee

is extended after being flexed there is a tendency for the cartilage to be pushed forward out of position.

A point of considerable practical importance to the patient is that massage of the calf and thigh muscles should be employed from the first, to prevent the wasting that must otherwise result from the fixation of the knee. Unless this be done, the limb is very weak when the splint is left off, and its power is only slowly regained. This weakness may easily lead to a recurrence of the injury.

(b) **When the dislocation of the cartilage constantly recurs,** either in spite of these precautions or because they have not been taken, the further treatment is a point of considerable importance. The dislocation will recur often after the most trivial injuries, the patient is in constant danger of falling and may thereby sustain serious injuries, whilst the usefulness of the limb is enormously diminished, and, in addition, there are frequent attacks of synovitis, for which the patient is compelled to lie up. The choice lies between palliative and operative measures, and of these the latter are far preferable whenever the choice is left to the surgeon. Nothing but operation will prevent the recurrence of the dislocation; palliative measures should be employed only when the patient refuses operation, or when there is some constitutional condition contra-indicating its performance.

Palliative measures.—Where no operation is employed, the patient should have the following instructions, especially when the dislocation affects the internal semilunar cartilage. Walking must be performed with the knee more or less stiff, and with the toes turned inwards; the latter measure is important, because the dislocation generally recurs when the tibia is rotated outwards upon the femur. A splint which will impede flexion of the knee must be worn, and this of course involves giving up most athletic games. The elastic bandage or knee-cap which is sometimes ordered is quite useless. The best form of splint to prevent the flexion of the knee is a well-moulded lace-up leather or poroplastic splint, similar to that employed in recent cases. A variety of other apparatus has been devised; for example, it is common to find a kind of spring truss designed to effect constant pressure by a spring over the inner tuberosity of the tibia, and thus to keep the cartilage back in position. Apparatus of this kind, however, is entirely inefficient, and unless the patient consents to an operation he is condemned to more or less marked disability of the limb, which is likely to be permanent.

Operative measures.—The operation for detached semilunar cartilage is, if carried out with careful antiseptic precautions, practically devoid of danger, and the results obtained from it are such as to abundantly justify the patient in submitting to it. An incision is made over the inner aspect of the knee with its convexity forwards, and reaching to the inner margin of the patella, commencing below about an inch below the upper edge of the tibia, and extending upwards as far as the adductor tubercle (see Fig. 29).

The flap of skin and fascia is then dissected up and turned backwards, and this exposes the front and inner part of the capsule of the joint. This structure should then be incised more or less horizontally about a quarter of an inch above the edge of the tibia, and the joint cavity freely opened. The patella is then pulled well over to the outer side, when the cartilage is easily exposed and its condition inspected.

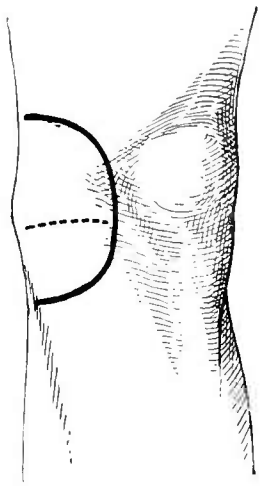


FIG. 29. — INCISION FOR REMOVAL OF THE INTERNAL SEMILUNAR CARTILAGE. The thick line indicates the incision marking out the skin flap, the dotted one that through the capsule of the joint.

It will be necessary to determine whether the cartilage can be replaced in position and stitched there, or whether a portion or the whole of it should be removed. As a rule the best plan is to remove as much of the cartilage as can easily be reached through the wound. This is especially necessary if this structure be split, when, as there is no chance of its uniting satisfactorily, the portion anterior to the rupture should be removed. Similarly, when the cartilage is torn away from its anterior attachment and its end lies curled up in the joint, there is no prospect of stitching it successfully into place, and a portion of it should be removed.

In order to remove the cartilage, the knee should be somewhat flexed so as to increase the aperture in the capsule, and the cartilage seized and pulled forcibly forwards by a pair of tenaculum forceps; a tenotomy knife is inserted into the joint and made to divide the cartilage as far back over the inner tuberosity of the tibia as it can reach. As a rule, of course, this does not remove the whole cartilage, a small portion near the posterior attachment being generally left behind, but it is found by experience that this does not interfere with the subsequent mobility of the limb. Indeed, the movements of the joint are not impaired by the removal either of portions or practically of the whole of the cartilage, and the patient appears to get on quite as well without this structure as with it.

When there is merely detachment of the convex border of the cartilage from the tuberosity of the tibia, an attempt may be made to promote union between the cartilage and the tibia by scraping the detached surface of the former with a knife, and then securing it by three or four fine catgut stitches to the periosteum over the margin of the inner tuberosity. Should there be any trouble in doing this, or should the stitches cut out after their insertion, there need be no hesitation in excising the cartilage instead of wasting time over unsuccessful attempts to refix it.

It is well to carry out the whole of the operation under irrigation with a 1-8000 sublimate solution, and at the end of the operation the joint should be thoroughly flushed out with this, so as to remove any clots; the incision in the capsule should be accurately sutured with fine catgut. The flap is then laid down and the wound stitched up without a drainage tube.

The usual antiseptic dressings are applied, and the limb is placed for a few days on a back splint which is raised upon a pillow. As soon as the wound has healed, which should be in a week or ten days, the stitches may be removed, and passive movements should be begun and should be gradually increased in range. At the same time the splint may be taken off, and the patient allowed to move the limb in bed. Massage may also be employed to prevent wasting of the muscles, and after three or four weeks the patient can walk; but he should for the first week or two have the joint supported by an elastic bandage applied over a mass of wool, in order to prevent the slight effusion into the joint which is likely to occur when weight is first borne upon it. At the end of six weeks this may usually be discarded, and from that time onwards it will be found that the mobility of the knee is free and that the patient has lost the constant liability to locking of the joint from which he suffered. The result of these operations, with careful antiseptic precautions, is extremely satisfactory.

CHAPTER IX.

DISLOCATIONS OF THE ANKLE AND FOOT.

DISLOCATIONS OF THE ANKLE.

VARIETIES.—Dislocations of the ankle joint are not infrequent, but they are in most cases complicated with fracture of one of the bones entering into the articulation; in fact, dislocation of the ankle without fracture is only possible in one of two directions, namely, forwards or backwards, and even in these forms there is a tendency for the tip of the malleolus to be broken off. The common form of dislocation of the foot—*i.e.* the dislocation outwards that is met with in Pott's fracture—has already been fully described (see Part III., Chap. VIII.).

Of these two forms of dislocation uncomplicated by fracture, *dislocation of the foot backwards* is the more common. The whole of the tarsus is carried bodily backwards behind the tibio-fibular arch, which therefore comes to lie in front of the astragalus and rests upon the scaphoid and cuboid bones. The accident generally results from indirect violence of considerable severity. It more commonly occurs when the toes are pointed, and the internal malleolus is not infrequently fractured. *Dislocation of the foot forwards* also occurs from indirect violence, but generally when the foot is in a position of excessive dorsal flexion.

TREATMENT.—Reduction should be practised under an anæsthetic. An assistant fixes the leg whilst extension is applied to the foot; as downward traction is made, the deformity is first increased in order to disentangle the edge of the astragalus from the edge of the tibio-fibular arch against which it is lodged. When sufficient traction has been made, the foot is either flexed or extended according to the nature of the displacement; when the foot is displaced backwards, the plantar flexion of the foot is increased, the foot is forcibly pulled forwards and downwards, and then rapidly dorsi-flexed. In a dislocation of the foot forwards, movements in exactly the reverse direction are practised; traction is made and the dorsal flexion is increased: then, while traction is maintained, the foot is pushed backwards and is finally flexed forcibly downwards.

Fracture of either of the malleoli does not add much to the difficulty of the treatment. When the dislocation has been reduced, the limb should be put on a back splint with a foot-piece at right angles for a few days, and an ice-bag or Leiter's tubes should be applied to the fractured malleolus. In any case passive movement and massage should be carried out from an early period so as to prevent the occurrence of adhesions (see Part III., p. 156).

When there is no fracture, the movements should be begun on the day following the accident; when there is a fracture present, the after-treatment will be practically that for fracture of the lower end of the tibia or fibula, as the case may be. The passive movements should be begun after the first three or four days.

DISLOCATIONS OF THE FOOT.

SUB-ASTRAGALAR DISLOCATION.—In this type of injury the whole of the foot with the exception of the astragalus undergoes dislocation, the latter bone remaining in its normal position beneath the tibio-fibular arch. The essential lesions here are rupture of the connections between the astragalus and the os calcis on the one hand, and those between the former bone and the scaphoid on the other. The foot usually undergoes a double displacement, being dislocated either forwards or backwards and to one side; the most common displacement is backwards and either inwards or outwards, more commonly the latter.

In the most usual displacement, *i.e.* backwards and outwards, the head of the astragalus rests upon the upper surface either of the scaphoid, or of the internal cuneiform bone. The posterior articular surface of the astragalus generally lies upon the anterior articular surface of the os calcis, the dislocation at the calcaneo-astragaloid joint being only partial.

The injury is generally produced by indirect violence, such as occurs when a patient alights from a height upon the toes which are deflected to one side, while the weight of the body forces the ankle and the astragalus forwards, and to the other side. The lateral displacement depends upon the particular position of the foot when the violence is applied. In the usual form the foot is extended, and there is a prominence on the instep in the neighbourhood of the scaphoid due to the protrusion of the head of the astragalus. The tendo Achillis is unduly separated from the back of the tibia, and is much tenser than normal, whilst the heel is unduly prominent.

Treatment.—This dislocation is often very difficult to reduce. This is partly due to the tension of the tendo Achillis, and probably partly also to a hitching of the sharp posterior edge of the articular surface of the astragalus in the interosseous groove of the os calcis. It may also in part be due to the fact that the tendon of the tibialis anticus may get beneath the neck of the astragalus, and prevent it from being brought properly into position.

In attempting reduction the patient should always be fully anæsthetised, and an assistant is required to fix the leg with the knee fully flexed. The affected foot is grasped by one hand over the instep and the other over the heel, and firm downward traction is made in order to disengage the astragalus: at the same time the toes should be somewhat depressed. When full extension has been made, the whole foot is pressed forward by the hand over the heel, when the astragalus may slip into place, dorsal flexion being employed as it does so. It is common to have to repeat these manipulations several times before it is possible to reduce the dislocation, but the surgeon may be unsuccessful even after repeated trials.

Should manipulations fail, it will be necessary to expose the dislocation, as it cannot be left unrelieved, on account of the extreme uselessness of the foot which results. An incision is made along the inner border of the foot, commencing about an inch above the internal malleolus, and running downwards and forwards over the neck of the astragalus. This exposes the tendon of the tibialis anticus, and when the wound is thoroughly retracted the nature of the obstacles to reduction can be investigated. Should the main obstacle be the slipping of the tibialis anticus tendon beneath the neck of the astragalus, the head of the bone can be levered up, and the tendon may be hooked aside whilst the foot is forcibly pushed forwards, and the astragalus slipped back into position.

Should it be found impossible to reduce the dislocation even after this exploration, the best treatment is to proceed immediately to excision of the astragalus, which can be effected partly through the incision already made, and partly through a somewhat similar one on the outer side.

Excision of the Astragalus.—The inner incision is practically identical with the one that will have been already made. It should commence over the anterior border of the tibia and run downwards over the ankle as far as

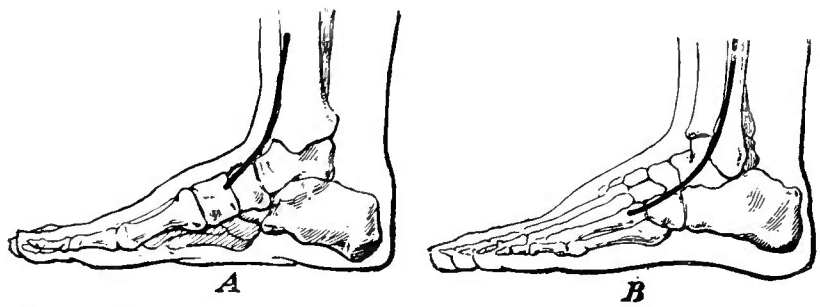


FIG. 30.—EXCISION OF ASTRAGALUS. *A* shows the incision on the inner, *B* on the outer side of the front of the ankle.

the scaphoid. It should not go directly down to the bone, the tibialis anticus tendon being defined and hooked out of the way before the incision is deepened. The outer incision commences two inches above the tip of the external malleolus, and is carried downwards and forwards parallel to the one on the inner side to a point opposite the lower extremity of the cuboid (see Fig. 30). This incision is at once carried down to the bone,

and the soft parts are stripped up from the front of the joint by a periosteum detacher until the finger can be passed from one incision to the other, when a copper spatula is introduced beneath the soft tissues, which are thus raised from the bone and held out of the way. The bone can now be readily extracted by seizing it with strong forceps and pulling it forcibly forwards and to one side, any structures that retain it being carefully divided by the point of the knife. Most of its ligamentous attachments are already torn through by the injury. The tendon of the flexor longus hallucis must be carefully separated from its groove by a periosteum detacher.

Directly the astragalus has been removed, the parts come into good position, and the subsequent results are extremely satisfactory. A perfectly

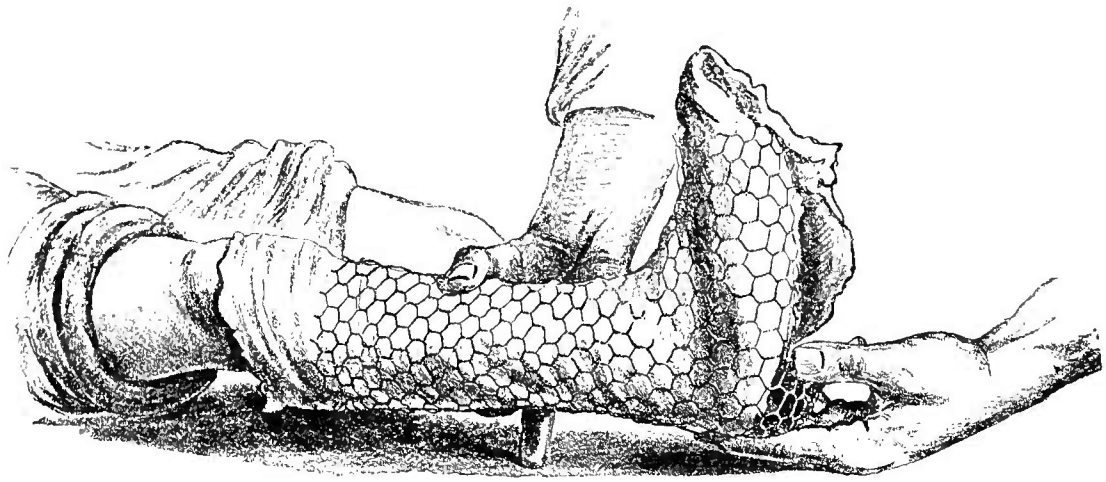


FIG. 31.—WIRE-NETTING SPLINT. The illustration shows the method of incorporating these splints with the dressing. A few layers of gauze are placed directly over the wound, and then a large sheet of the gauze is wrapped around the limb; outside this the wire-netting is moulded to the limb, and when this has been done, the gauze is turned down over the free edges of the splint, and more dressing is added over the region of the wound outside the netting. In the figure above, two lateral splints of this netting are being applied.

sound joint with free movement is obtained, a far better result than is got by leaving the condition alone or by simply removing portions of the bone.

After the wound has been stitched up without a drainage tube, and the usual cyanide dressings applied, special care must be taken to prevent inversion of the foot, and the best splints for this purpose are either Croft's plaster of Paris splints or wire netting splints already described (see Fig. 31), which are put on immediately over the first few layers of dressing and are moulded to the part so as to keep the foot strictly at right angles to the leg and to prevent inversion or eversion (see Part III., p. 11).

The chief point to remember in the after-treatment is that there is a constant tendency for the foot to become inverted, and special care must be taken to guard against this. The splints should be kept on for about six weeks, being taken off occasionally for the purpose of passive movement, and at the end of that time the patient should be furnished with a suitable boot and may be allowed to walk. The boot should have lateral irons

fastened to a band around the upper part of the leg and hinged opposite the ankle joint (see Fig. 32). This should be worn for the best part of a year, when it will generally be found that the tendency to inversion has disappeared.

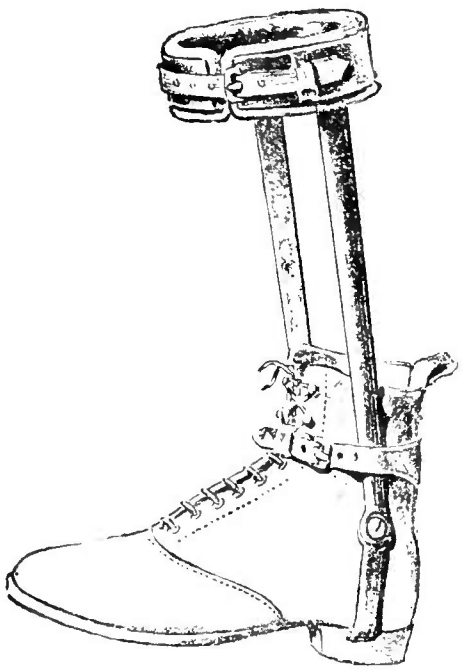


FIG. 32.—BOOT FOR USE AFTER EXCISION OF ASTRAGALUS. This is merely a boot fitted with stout lateral leg-irons which are fastened into the heel below and furnished with an ordinary hinge-joint opposite the ankle. The chief object of the apparatus is to prevent inversion of the foot.

In long-standing cases, where the dislocation has remained unreduced, excision of the astragalus with the subsequent division of any adhesions which prevent the foot coming forward, is by far the best plan, and gives a satisfactory result.

DISLOCATION OF THE ASTRAGALUS ALONE.—The astragalus may be detached both from the bones of the leg above and those of the foot below, and may thus be completely separated from all its articular connections. It may be displaced in various directions; most commonly it passes more or less directly forwards, but it may also be dislocated backwards or to either side. The injury is usually caused by very severe violence, and is not at all infrequently complicated by fracture of the bone itself; it is also not uncommonly compound, either as a direct result of the violence, or from subsequent sloughing of the skin which is tightly stretched over the prominent head of the bone. It usually results from violence applied to the foot in the fully extended position, as may occur in alighting from a height upon the toes, or in machinery accidents, where the limb is violently pulled and twisted in a complicated manner. Dislocation of the bone backwards is produced by extreme violence applied whilst the foot is fully flexed, but this is a very rare accident.

Treatment.—Reduction is usually a matter of extreme difficulty, and general anæsthesia is essential. The knee should be fully flexed and the leg fixed by an assistant. Traction should be exerted downwards upon the foot bodily so as to separate the os calcis as far as possible from the tibio-fibular arch. While this is maintained at its utmost extent, attempts are made to press the astragalus back into position between the os calcis and the tibia. The separation of the bones of the foot from those of the leg may be aided by dividing the tendo Achillis.

When, however, these attempts at reduction fail, it is imperative to take further steps at once, as otherwise gangrene of the skin over the projecting bone is almost certain to follow. The best plan is to cut down through

a lateral incision on each side, that on the inner side commencing an inch above the articular surface, just in front of the malleolus, and running downwards and forwards to the internal cuneiform bone; on the outer side the incision should run from just above and in front of the external malleolus downwards and forwards to the cuboid. In deepening the inner incision the tendon of the tibialis anticus should be carefully preserved, and the whole of the soft tissues lying over the astragalus should be separated from the bone and lifted up by passing a broad copper spatula beneath them. This enables the condition of the parts to be investigated; it is then often possible, by making forcible traction upon the foot, to directly press the astragalus back into position.

Should it still be impossible to do this after further exposure of the parts and retraction of any structure that opposes reduction, the bone should be removed. This will be all the more urgently called for when the astragalus is completely detached from all the surrounding structures, and when, consequently, its nutrition is likely to be seriously damaged. The functional result will be excellent.

OTHER DISLOCATIONS OF THE TARSUS AND METATARSUS.—The remaining dislocations occurring about the foot are of great rarity and of very slight importance, and they do not therefore need any detailed description.

Dislocation at the transverse tarsal joint has been described, and, if it occur, it should be reduced by manipulation under an anæsthetic by making firm traction upon the front part of the foot.

The metatarsal bones may also be dislocated from the tarsus either individually or as a whole. This is usually the result of extreme violence, and is generally accompanied by other injuries.

Reduction is effected under anæsthesia by making traction upon the front part of the foot and applying pressure over the prominent bases of the metatarsus.

Dislocations at the metatarso-phalangeal joints also occur. These are in every way comparable to similar dislocations occurring in the hand and the treatment is exactly the same, but they are of much greater rarity. We need not, therefore, repeat what has already been said on the subject (see p. 46).

CHAPTER X.

SPRAINS OF JOINTS.

DEFINITION.—By the term "sprain" is understood an injury produced in a joint when its movements are carried beyond their normal physiological limits or when the bones entering into its formation are deflected in some unnatural direction, without, however, undergoing actual dislocation.

CAUSES.—These injuries may be caused by a great variety of accidents; the commonest are falls, which either carry flexion or extension beyond their normal limits or force the bones forming a joint in some wrong direction; or twists such as occur when a patient suddenly turns round and, keeping the foot fixed, causes the femur to rotate forcibly upon the tibia. Sprains may also be caused by violent muscular action, but this is a much less frequent cause than those already mentioned.

Various conditions predispose to sprains; amongst the most common are a previous injury of a similar nature which leaves a weak joint behind it, or anything, such as a deformity—for example, knock-knee, club foot, etc.—which places the joint at a mechanical disadvantage and alters the normal line of transmission of the body-weight.

LESIONS.—The actual lesion which occurs when a joint is sprained varies considerably in different cases and is often difficult to determine accurately. Probably the chief effect of the injury always falls first on the ligaments of the joint, and they are damaged to a more serious extent than any other structures entering into the articulation. In the mildest forms the ligaments are merely over-stretched; in others they may be slightly torn. In the more severe cases a portion of the capsule of the joint is ruptured, and one or other of the ligaments is torn wholly or in part from its attachment to the bone. In the most serious cases of all, portions of the bone itself may be detached along with the ligament.

The amount of damage to the ligaments depends largely upon their form, strength, and structure; broad, thin, flattened ligaments are more often damaged than those that are comparatively thick and strong. Very

severe injury, indeed, is required to damage these latter, and it is more common to find them detached from their insertion into the bone. In joints furnished with an intra-articular fibro-cartilage this structure may be partially or entirely detached—a condition which gives rise to the series of symptoms already referred to in dealing with dislocations of the semilunar cartilages of the knee. In the most severe forms of sprain the injury is not limited to the ligaments but may affect the muscles surrounding and strengthening the joint, which may be actually torn from their attachments.

RESULTS.—The results of these injuries will vary with the severity of the lesions. In any case the immediate effect is the occurrence of pain, and more or less swelling of the joint rapidly ensues. Unless the case be efficiently treated, a feeling of weakness and pain in the joint will be present on movement, which may last for a long time or may even be permanent.

In the milder cases, when the ligaments are stretched rather than torn, there is comparatively slight swelling immediately after the accident, but a synovitis may subsequently occur and may give rise to much trouble. In the more severe cases there is usually considerable effusion of blood at the time of the injury, and this will produce a certain amount of immediate swelling of the joint; this swelling is increased later on by the occurrence of synovitis.

The remote effects of sprains result partly from this synovitis and partly from the imperfect union that not uncommonly occurs in the torn fibres of the capsule. The latter condition is especially troublesome later in the course of the case, and gives rise to that feeling of weakness which is so common a result of neglected sprains. Unless the synovitis be actively treated it may lead to a permanent weakness of the joint from over-distension of the capsule, or from adhesions between various parts of the synovial surfaces, which, although fibrinous at first may organise into fibrous tissue, and thus obliterate a portion of the joint cavity. It is also well to bear in mind that, when there is considerable hæmorrhage, the blood is very slowly absorbed from the articular cavity in which it remains fluid for a considerable time.

Another result of a neglected sprain also deserves mention. When a considerable portion of the capsule of the joint, or a broad flattened ligament has been ruptured, the torn portion may not unite satisfactorily, but may project into the joint, and may become nipped between the articular surfaces during movement. This will give rise to serious disability.

TREATMENT.—From what has been said it is evident that a sprain of a joint is a serious matter, and should not be lightly treated, as the persistent trouble which so frequently follows the injury is undoubtedly due to imperfect appreciation of the ill results that follow neglect. The common saying that a sprain of a joint is worse than a fracture is explained by the fact that the care devoted to a fracture is seldom

bestowed upon a sprain, with the result that blood remains in the joint for a long time in a fluid state, that the union of the torn ligaments is defective, that there is a tender cicatrix in the capsule, and that fibrous adhesions form between the opposing synovial surfaces.

The treatment of a sprain must obviously depend to a large extent upon the severity of the injury and the joint affected, but there are certain principles common to all cases. The first indication is clearly to check the extravasation of blood into the joint, while the second is to promote absorption of the blood already poured out; a third and equally important indication is to obtain satisfactory healing of the injured ligaments, and to restore the movements of the joint to their normal range.

In every case the treatment for a sprain should commence with free movement of the joint in all directions, so as to make sure that no portions of torn capsule or synovial membrane lie between the articular surfaces. Should they do so, suitable movements of the joint will probably cause them to come into position.

1. *Slight sprains.* After this has been satisfactorily done, the joint should be put up absolutely at rest upon a suitable *splint* in a position such as to give the patient the greatest ease; and it is well to combine with this the application of *cold*. The use of cold is of great advantage, not only in checking the extravasation of blood following immediately upon the injury, but in subduing the inflammation that is sure to result, and therefore lessening the subsequent synovitis; it also gives far greater comfort to the patient in the early stages than do hot fomentations, which have the marked disadvantage that they tend to promote the bleeding which it is so important to avoid. When the affection is in the lower extremity, the patient should be put to bed and the joint fixed upon a suitable splint, which is elevated upon a pillow, and ice-bags or Leiter's tubes (see Part I., p. 9) are applied; when the joint affected is in the upper extremity, a large comfortable sling should be put on, and evaporating lotions or a Leiter's coil may be applied to the joint.

At the end of the first twenty-four hours gentle *massage* may be commenced, but it should always be performed either by the medical man himself or by some duly qualified person, as the employment of massage in unskilled hands at this early stage might be a source of danger by doing damage to the ligaments if torn. The object of the massage is to get rid of the effusion that has occurred into and around the joint, and more particularly to promote the absorption of the effused blood. It should consist merely of gentle stroking in the upward direction, without any attempt at passive movement or kneading; and it should be practised only for about a quarter of an hour the first day. At the commencement of the sitting it will probably be found that the lightest pressure causes the patient a good deal of pain, but, as the massage is persevered with, the pain becomes less, until, at the end of

the sitting, the rubbing will be borne without complaint. After the massage is finished, cold should again be applied for the next twenty-four hours, and the limb left upon the splint. Massage should then be repeated, and on the second occasion it will probably be found possible to continue it for at least half an hour with great comfort to the patient, and, if the effusion be not very great, it will be well to employ it twice instead of once.

At the end of the second day *pressure* may be employed in the intervals between the massage. Several layers of cotton wool in even sheets, free from lumps, should be applied around the joint, and outside this a bandage should be very firmly applied. If enough cotton wool be put on, the bandage may be drawn as tight as the surgeon is able to pull it, without any risk of undue pressure being exerted. This bandage may be left on until the next day, when it is removed for the repetition of the massage. At the end of the third day it will be safe in the ordinary slight cases to leave off the splint and to trust to massage and bandaging to complete the cure. The bandage best suited to the case is the elastic form.

2. *Severe sprains.* For the first few days the joint should remain upon the splint originally applied, regarding which it may be remarked that the position chosen for the limb should be that which combines the maximum of comfort to the patient with the maximum of usefulness of the limb subsequently should it by any chance become stiff. After the lapse of three or four days a *Croft's splint*, or a suitably moulded leather or *poro-plastic casing* fixing the joint, should be substituted, and this may be applied over the cotton wool, through which firm pressure is exerted when the splint is fastened up. The massage should be continued twice daily, and it will generally be found that the patient is able to bear it, applied with increasing vigour, for a gradually increasing period.

After the third day the limb should be carefully moved each time before the massage is employed. The *passive movements* should be extremely gentle at first, and gradually increasing in range as the patient is able to bear them; care must be taken in practising them not to throw any strain upon the injured ligaments. For example, should the injury be mainly in the internal lateral ligament of the knee joint, the greatest care must be taken in practising passive movement not to deflect the leg outwards at all.

It will be found that, if treated in this way, the majority of simple sprains where there is no widespread rupture of ligaments will be quite well in ten days or a fortnight. Treatment, however, should not be discontinued for another two or three weeks, during which time massage should be diligently practised, and in the intervals the patient should wear either a cotton wool or *an elastic bandage.* Indeed, it is well after the more severe type of sprain to make the patient continue to wear the bandage for six weeks or more, rather with a view of giving him a sense

of security and strength about the joint than from any actual good that it does. Should a feeling of weakness still persist, great benefit will be derived from *douching the joint* with cold water. The limb should not be immersed in a cold bath, but a strong jet of water, as cold as can be borne, should be directed upon it from a suitable distance with as much force as the patient will stand. The joint should be douched from different directions for about three minutes at a time, and massage should follow directly.

Should the effusion continue to increase after the first twenty-four hours, or should it be found that the blood in the joint is not quickly absorbed, it is well to remove as much of it as possible from the articular cavity by *aspiration* or by a trochar and canula, with rigid precautions against sepsis. Blood left in the joint keeps up synovitis, prolongs the treatment, and thus retards recovery. In these more severe cases three weeks' rest or more should be insisted upon before the joint is allowed to be used. It is generally necessary to keep up pressure upon the joint for about three weeks after it has been tapped; during the last week of this, however, the patient may be allowed to practise active movements for himself, although he must not bear any strain upon the joint. The after-treatment will be the same as that just described.

3. *When there is obviously rupture of one of the ligaments* of the joint, the case must be treated with still greater care, as there is considerable risk of imperfect union and a permanently weak joint. This condition is more particularly likely to happen in the ankle, where a part of the external lateral ligament is not infrequently ruptured. The limb should be carefully fixed upon a splint specially designed to obviate all possibility of movement in any direction that would separate the torn ends of the ligament, and the further treatment is much the same as that already detailed, special care being taken not to press upon or strain the ruptured ligament in any way. It is very desirable that the person who performs the massage in these cases should be acquainted with the anatomical structure of the joint; massage, therefore, should be performed by the medical man himself and not by the ordinary masseur.

Something like six weeks' complete rest is required for the union of a ruptured ligament, and the limb should be therefore kept upon the splint for that length of time. The formation of adhesions can easily be kept down if proper care be taken to practise passive movement during this period. To put a joint upon a splint and leave it there without massage or movement for six weeks, although it may result in the union of the torn ligament, will undoubtedly lead to the formation of adhesions which will require an immense deal of care and trouble to get rid of, and which may perhaps never be entirely broken down. On the other hand, it is perfectly possible, by practising cautious passive movement almost from the commencement, to allow the ligament to unite without any delay, and at the same time to secure a joint that is perfectly free from ad-

hesions; all that is necessary is to bear in mind the anatomy of the articulation.

4. *When portions of bone have been detached with the ligament*, the treatment is practically the same as that for a fracture. The limb is put upon a splint in the proper position, and rest and massage are employed, with careful movements after the first two or three weeks. Should the detached piece of bone be large, and should there be any difficulty in getting it into position, it may sometimes be necessary to cut down upon it and fasten it in place.

CHAPTER XI.

WOUNDS OF JOINTS.

It is customary to divide wounds of joints into the penetrating and non-penetrating varieties, but strictly speaking the latter are not really wounds of joints at all; their only importance is that they may be accompanied by sepsis which eventually terminates in suppuration within the joint. In speaking of wounds of joints we shall confine ourselves to those which actually penetrate the articulation—a condition readily recognised in most cases by the escape of synovial fluid or, when the wound is of large size, by actual inspection.

VARIETIES.—From the point of view of treatment, wounds of joints may be divided into punctured wounds, which are generally quite small, and large wounds which freely expose the interior. These latter may again be sub-divided according as they are clean-cut or contused; the treatment will differ in each case. In a punctured wound, caused by a sharp instrument penetrating the joint, there is often no introduction of septic material into the joint cavity; whereas in both the other forms septic contamination of the joint will almost certainly occur.

Again, in considering the question of treatment, distinction must be made between wounds that are quite recent and those in which some time (24 hours or longer) has elapsed since their infliction. The great importance of this subdivision lies in the fact that, in the former group of cases, any micro-organisms that may have gained access to the joint will not have had time to multiply and become diffused throughout the joint and the surrounding tissues, whilst in the latter this serious event will have taken place.

TREATMENT OF RECENT WOUNDS OF JOINTS.

1. Punctured Wounds.—Here it is generally safe to regard the articular cavity itself as free from infection; punctured wounds are inflicted by a slender pointed instrument, and the probability is that any

organisms present upon it will be removed during its passage through the skin and subcutaneous tissues. This is of the highest practical importance, because it will not be necessary to open the joint immediately and to wash it out with an antiseptic; to do so would in the great majority of instances only irritate the joint quite unnecessarily. On the other hand, all the tissues superficial to the joint must be looked on as possibly infected, and treated accordingly.

Thus the first step in the treatment will be to carry out a *thorough disinfection* of the skin for a considerable distance around the wound; this should be done in the usual manner (see Part I., p. 161). When that has been done, the wound in the subcutaneous tissues should also be disinfected. For this purpose it is often necessary to enlarge the opening in the skin, and, considering the extreme gravity of these cases should the joint become infected, it is well to disinfect this part of the wound most vigorously; in most cases indeed it is advisable to apply undiluted carbolic acid.

We must here give a special warning against an extremely common practice in these cases, namely, the introduction of a probe in order to ascertain whether or not the wound communicates with the joint. In the cases to which we are alluding there is no particular object in obtaining this information. It is far best to assume that the joint is penetrated, and to disinfect the wound in the skin and the soft parts without touching the joint. Beyond rendering it certain that the capsule of the joint is wounded—which is not a matter of the least importance—the only effect of employing a probe is the very possible introduction of septic material from the wound to the interior of the joint, and thus the precipitation of a disaster which would otherwise not occur.

After the wound in the skin has been enlarged sufficiently to allow of free access to the soft parts and the application of undiluted carbolic acid to them, it is well to leave the wound widely open and not to insert any stitches. The irritation produced by the acid is probably sufficient to prevent union by first intention; at the same time, no drainage tube is necessary. The edges of the wound may be allowed to fall together, and the usual antiseptic dressings should be employed, whilst the limb is placed on a splint, with the joint in the most comfortable position.

After-treatment.—The dressings should be changed on the following day in order to ascertain the condition of affairs in the joint, but unless the temperature has risen considerably, or unless there be very severe pain and swelling in the joint, there need be no apprehension of septic infection. An injury of this kind not at all infrequently gives rise to considerable synovial effusion, and it is chiefly to ascertain the condition of the joint in this respect that it is advisable to change the dressings the next day.

If after the lapse of 24 hours there be no sign of inflammation in the wound, if the temperature be low, and if there be no more pain than is to be accounted for by the effusion into the joint, it may be taken for

granted that asepsis has been attained, and the dressing need not again be changed for four or six days, should no other indication arise in the meanwhile.

The limb should be kept at rest until the wound has either healed entirely or is quite superficial. As soon, however, as this has happened, the splint should be left off, and measures taken to subdue any synovial effusion, or to break down any adhesions that may have resulted from the synovitis. In other words, massage and passive movement, gentle at first but gradually increasing in duration and in vigour, should be performed as has already been described for the treatment of sprains.

2. Clean-cut Wounds.—When the wound into the joint is of considerable size, an inspection of the articular cavity can be obtained by retracting the edges. The injury is caused by some sharp instrument, such as a knife or an axe.

Under these circumstances it is necessary to assume that in the large majority of cases the joint has been infected, however slight the amount of infection may be; the treatment must therefore differ materially from that just described.

First of all the skin must, of course, be thoroughly shaved and disinfected, whilst the wound in the soft parts must be efficiently cleansed. To do this it is best first to wash the wound out thoroughly with strong mixture, and then to apply undiluted carbolic acid to all its recesses. To prevent these strong antiseptics gaining access to the interior of the joint, the wound in the capsule must be shut off by a piece of sponge placed over it at the bottom of the wound. After the superficial wound has been disinfected, the joint cavity must be cleansed; if necessary to ensure complete access, the opening must be enlarged. It usually suffices to wash out the joint with a 1-1000 solution of corrosive sublimate. All the recesses should be freely irrigated for quite ten minutes with this solution, by means of which blood-clots are also washed out. Immediately after this, irrigation with a 1-8000 sublimate solution should be substituted for the stronger lotion, so as to dilute and wash it away. It is always well to avoid the use of carbolic lotion; it possesses no particular advantages over the sublimate in its germicidal action, while it is far more likely to irritate; its use is therefore distinctly contra-indicated unless there be extensive and obvious soiling of the joint, when the undiluted acid may have to be used.

A large drainage tube is next introduced into the joint, partly with the object of removing the synovial effusion which is certain to occur from the irritation of the antiseptic, and partly in case the disinfection should not be complete. If the external wound be large, one or two catgut stitches may be inserted at each angle, but the wound should be left open throughout the greater part of its extent; its edges will generally fall fairly well together except where the drainage tube is. The tube should be of a very large size, as if a small one be employed, it may readily become obstructed by lymph or clot and so fail to drain the fluid from the joint. The usual

antiseptic dressings are applied, and the limb is put on a splint in a comfortable position.

After-treatment.—The dressing should be changed next day, partly because there will be free oozing and partly to ascertain the condition of the wound. As a rule the serous effusion will necessitate a change of dressing daily for the first week or more; at the same time there need be no anxiety about sepsis should there be no rise of temperature or symptoms of acute inflammation about the wound after the first 36 hours. The drainage tube should be retained for the first five or six days, for if it be removed too soon there may be a free and troublesome synovial effusion.

The later treatment is much the same as that already mentioned. The limb is kept upon the splint until the wound heals or has become quite superficial; but in these cases passive movement should be freely employed by the surgeon after the first three days in order to prevent the formation of adhesions in the joint, which are much more likely to occur than after punctured wounds. The best plan is, each time after taking off the dressings, to throw a large piece of gauze dripping wet with a 1-2000 sublimate solution over the wound so that the whole of the knee is covered by it, and then, keeping it in position by the hand that steadies the femur, to perform the passive movements. As soon as the wound has become superficial, more vigorous steps must be taken to promote the functions of the joint by massage and passive movement, and these must be persisted in until the movements are completely restored.

When the attempt to obtain asepsis fails the after-treatment must be on the same lines as those which will be presently laid down for the treatment of septic wounds of joints (see p. 87); in fact, the condition is then almost the same as if the patient had not come under the surgeon's care until some days had elapsed since the injury.

3. Contused Wounds.—Here the soft structures superficial to the joint are bruised, and as a rule there is marked soiling of their surfaces. We may take as the two main types of this kind of injury, first a machinery accident, where the skin is torn and the joint opened, and secondly a compound dislocation, in which the bones are forced through the skin. In both cases there is a contused lacerated wound in the soft tissues, and in both the cavity of the joint will probably be much soiled. In the first type of case the tissues will be soiled by dirt or grease, while in the second the ends of the bones will be infected by clothing or, when the injury takes place in joints that are not covered by clothes, by contact with the ground or some other object. Unless disinfection be extremely carefully carried out, an aseptic wound can hardly be hoped for, and these cases are therefore very serious.

A general anæsthetic is indispensable to efficient treatment. The skin is first thoroughly shaved and disinfected, and the wound if necessary enlarged so as to expose all the recesses of the joint. All contused and lacerated parts must be freely cut away with scissors, and the surfaces thus left

should be thoroughly scrubbed with a nail-brush and strong mixture, and then the whole wound external to the joint should be sponged over with undiluted carbolic acid. It is a point of the greatest importance to remove the contused and lacerated tags of tissue; to merely apply undiluted carbolic acid is not sufficient, for the antiseptic is unable to gain proper access to the whole of the soiled area unless the worst parts are clipped away.

The joint cavity is now laid freely open, all its recesses explored and undiluted carbolic acid applied to them. Should the injury be due to dislocation, this should be reproduced in order to get proper access to the ends of the bones and to enable the surgeon to thoroughly scrub and clean them. This procedure doubtless seems extremely severe; but the irritation resulting from thorough disinfection of this kind is a very small matter compared with the grave risk of sepsis, which will almost inevitably occur unless the treatment of the joint surfaces themselves is of the most vigorous possible description.

An attempt is now made by irrigating the joint cavity, first with a 1-2000 and later with 1-8000 sublimate solution, to remove as much as possible of the strong antiseptic, and so to diminish the violence of the subsequent irritation. This final irrigation however should not be carried out until at least ten minutes or a quarter of an hour have elapsed since the application of the stronger antiseptics, so as to give them time to produce their full action.

Drainage tubes of the largest size should be introduced into the joint at the most suitable spots so arranged that every recess is freely drained. Not only should these tubes be introduced through the wound, but in many cases it is advisable to make counter-openings at various points. No attempt must be made to stitch up the rent in the capsule; possibly one or two stitches may be put in the skin if the wound in the soft parts be very large or irregular. The usual antiseptic dressings are applied and the limb put upon a splint.

After-treatment.—The occurrence of sepsis will be indicated by the presence of inflammation and fever within 48 hours; should no fever occur, or should the ordinary aseptic pyrexia (which will almost certainly occur) subside in 48 hours, it may be confidently surmised that sepsis has been avoided, and the number and size of the drainage tubes may be reduced. A day or two later all the drainage tubes may be removed with the exception of a moderate-sized one which should be left for two or three days longer, when, if all goes well and the discharge be slight, drainage may be discontinued entirely. Daily dressings are of course necessary, and at each one the skin around the wound should be thoroughly disinfected, and every means taken to avoid septic contamination.

The risk of subsequent stiffness will be far greater here than in the preceding cases, and therefore, as soon as it is evident that all danger of sepsis is over, passive movements should be practised every time the dressings are changed, the wound being carefully covered with wet gauze

meanwhile so as to prevent air being sucked into the joint. When the wound has healed, more vigorous movement must be employed once or twice daily, and it may be found necessary to give the patient an anæsthetic in order to break down the adhesions from time to time, much in the same manner as will be subsequently described when dealing with anchylosis of joints (see Chap. XVIII.). If sepsis can be avoided, a practically perfect result can generally be obtained, provided that the after-treatment be carried out with vigour and perseverance.

TREATMENT OF SUPPURATING WOUNDS OF JOINTS.

Wounds of joints in which free suppuration is established may have to be dealt with, either because the surgeon has failed to obtain asepsis in recent cases, or because the case does not come under notice until some days after the injury, when sepsis has already become established. The condition with which we then have to deal is a suppurative arthritis, and is one of extreme gravity. There is usually violent inflammation of all the structures of the joint, resulting in its complete disorganisation; the synovial membrane is intensely congested and swollen; the articular cartilages become destroyed and exfoliate; the bone beneath becomes inflamed and sometimes necrosed, whilst there may be a septic osteo-myelitis extending from the articular ends of the bone. The best result that can be hoped for in these cases is recovery with anchylosis, which is usually bony; but in the majority of cases the result is far from being so satisfactory. Abscesses form around the joint; acute osteo-myelitis extends along one or other of the bones entering into the formation of the joint, and septicæmia and pyæmia very commonly result. It is true that a fairly moveable joint has been obtained after recovery, but such cases are very rare.

Bearing these facts in mind, the first question that must arise in treatment is whether it is advisable in any individual case to attempt to save the limb, or whether it is not better to perform immediate amputation. The answer to this will depend very largely on the condition of the patient and the character of the wound. As far as the condition of the patient is concerned, his age and general condition, particularly with regard to the presence of any constitutional disease, are of the greatest importance. In an old subject, in one who is feeble or is the subject of albuminuria or some other grave constitutional disease, the best chance in the majority of cases is undoubtedly given by amputation. When, however, the patient is young, vigorous, and quite healthy, and particularly when symptoms of pyæmia or osteo-myelitis have not supervened, a vigorous attempt to save the limb is quite justifiable. The exact means adopted must of course depend upon the local condition. Should the inflammation not be very acute, and should the case be seen at a comparatively early stage, the surgeon should certainly try to save the joint. If, on the other hand, the inflammation be very acute, the pain extremely severe, and the

suppuration profuse, or if there be abscesses around the joint or signs of osteo-myelitis or pyæmia, an attempt to save the limb will probably be futile, and the best procedure is to amputate above the joint.

Amputation.—When it is determined to amputate, the operation will of course be performed through the bone above the joint; in doing the operation, the medullary cavity at the seat of the bone section must be minutely inspected to see whether the inflammation has reached it. Should this be the case, either a second amputation must be performed higher up, or the remains of the bone or bones must be completely dissected out as far as the joint above.

Drainage.—When it is determined to attempt to save the joint, the first essential is to provide free drainage, and the second is to fix the limb in such a position as will be most useful to the patient when recovery with anchylosis occurs. In order to establish free drainage, suitable incisions must be made into the joint so as to open up and drain every recess in it. Small incisions and small drainage tubes are of little or no value; the surgeon cannot well err in the direction of having too many tubes or too large incisions. The skin around the joint should be disinfected in the usual manner.

When these incisions have been made, the joint should be well washed out with a weak antiseptic, such as 1-8000 sublimate solution, but no attempt should be made to thoroughly disinfect it; were this done, it would certainly result in failure, and could only give rise to increased irritation of the synovial membrane.

After-treatment.—The two best methods are continuous irrigation and the use of the water-bath, and of these the former is preferable. Before continuous irrigation is performed, the limb should be fixed in a suitable position upon a splint, so as to completely immobilise the joint. The most satisfactory splint for this purpose is one made of wire-netting or perforated zinc of suitable strength (see Fig. 31) cut to the proper shape and moulded so as to fit the limb accurately. The great advantage of this splint over any other is that the discharge cannot soak into it and make it foul, that it can be incorporated with any dressing or even applied next the skin, whilst at the same time it is easily procurable anywhere, does not require to be specially made, is very cheap and can be readily sterilised by boiling. When the splint has been applied, irrigation should be provided. This has already been dealt with in Part I., p. 30, but we may recapitulate the principal points here.

Continuous irrigation.—The skin around the wound should be smeared with some greasy preparation, such as eucalyptus or iodoform and vaseline, whilst the limb is placed over a bath or, if necessary, over mackintoshes, so arranged that the fluid issuing from the joint shall be conducted into a suitable receptacle. The nozzle of a tube from an irrigator, placed just above the level of the patient's body, should then be introduced into the orifice of one of the drainage tubes entering the joint at its highest level

(see Fig. 33). The fluid, which should be at the body temperature, should only be allowed to travel slowly through the tubes, and if necessary the nozzle should be disconnected from time to time and attached to different drainage tubes so as to effectually flush out the whole of the joint. It is important in irrigating joints to avoid the use of antiseptics which coagulate albumen, and the best lotions are very weak solutions of permanganate of potash, sanitas, or tincture of iodine.

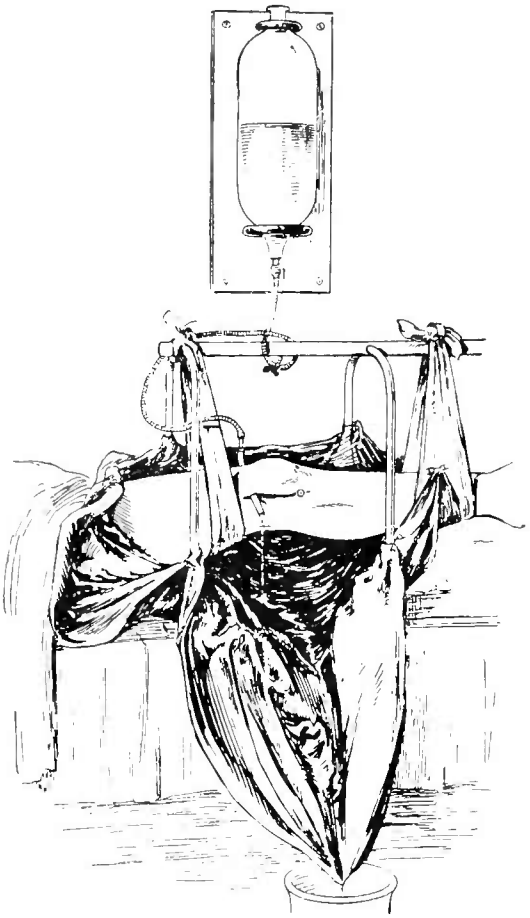


FIG. 33.—CONSTANT IRRIGATION APPLIED TO THE KNEE JOINT. The nozzle of the irrigator is inserted into one end of the supra-patellar drainage tube and a constant flow is thus maintained through the joint. The fluid is conducted by means of a mackintosh, appropriately arranged as above, into a suitable receptacle. For the sake of clearness, the splint fixing the joint has been omitted.

The water-bath.—When irrigation cannot be practised the limb should be immersed in a water-bath (see Part I., p. 32) containing one of the fluids just mentioned. The limb should be kept in the bath night and day, and should only be taken out for the purpose of cleaning out the bath.

Should it be impossible to employ either irrigation or the water-bath, the next best treatment is to use the ordinary cyanide gauze dressings, for a certain amount of benefit will be derived from the disinfection of the discharge that occurs in them, although the wound itself is widely infected. The dressings should be changed at first twice daily, and later on, when the discharge decreases, once a day. When this method is employed it is, as a rule, unnecessary to wash out the joint each time the dressings are changed; it may be done if preferred, but care should be taken to avoid

irritating antiseptics such as carbolic acid or even sublimate. Some benefit may possibly result from running a stream of warm boracic lotion through the tubes when the pus is very thick; but should a stronger antiseptic be employed, it will certainly cause irritation, and may, in fact, kill the superficial layer of granulation tissue and thus actually provide a nidus for fresh bacterial growth, or may open up a route for the entrance of organisms into the body. The risk thus produced is not counter-balanced by any germicidal action on the part of the antiseptic, for it cannot possibly exert any influence in combating the septic process.

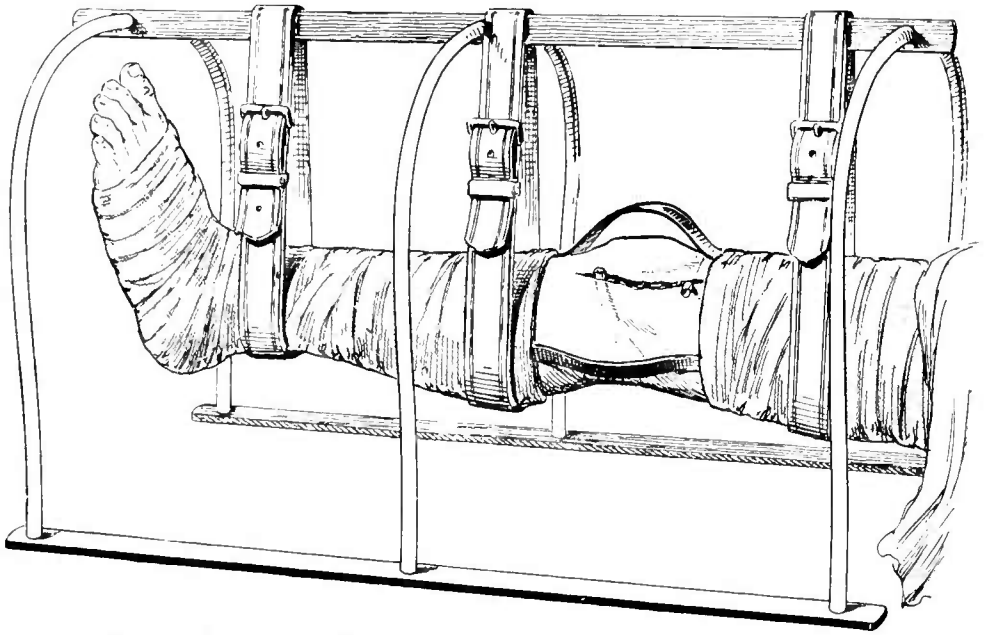


FIG. 34.—INTERRUPTED PLASTER OF PARIS SPLINT FOR WOUNDS OF THE KNEE JOINT. The metal bands which maintain the interval between the plaster bandages around the thigh and those around the leg are bent outwards so as to allow dressings to be applied to the joint.

When these dressings are employed, the wire splint should be placed outside the first few layers of gauze, and, as a rule, will not require changing oftener than once in three days. Even the slight movement inseparable from changing the splint is very apt to cause the patient severe pain, and it is best therefore, as soon as the discharge diminishes, to fix the limb in a plaster of Paris apparatus so designed as to leave sufficient room for proper access to the joint and the application of the dressings. For this purpose nothing is better, in the case of the knee, for instance, than the interrupted plaster splint recommended for compound fractures (see Fig. 34). The plaster bandage is made to take a firm hold of the middle of the thigh and the middle of the leg, whilst the metal bars hold the two portions firmly together and at the same time allow free access to the joint. Another splint that is useful either for the knee or for the ankle is the anterior suspension bar (see Fig. 35).

Great care should always be taken to fix the limb in the position most serviceable to the patient when anchylosis afterwards occurs. For example,

the knee joint should be slightly flexed; the elbow should be bent at a right angle with the fore-arm midway between pronation and supination; when the shoulder is affected, the elbow should be directed slightly away from the side; in the case of the wrist the metacarpus should be thrown backwards; in the hip, the lower extremity should be slightly abducted and completely extended; in the case of the ankle, the foot should be at right angles to the leg.

As the discharge diminishes and becomes less purulent, the drainage tubes may be gradually dispensed with, and the counter-openings allowed to heal. Gentle passive movement should be attempted as soon as the wound has become superficial, but the greatest care must be taken in this respect, because recrudescence of the inflammation may easily be brought about by it. It is, however, a point of importance, because, should passive movement be possible before bony anchylosis has occurred, we may be able to obtain a restoration of some degree of movement in the joint.

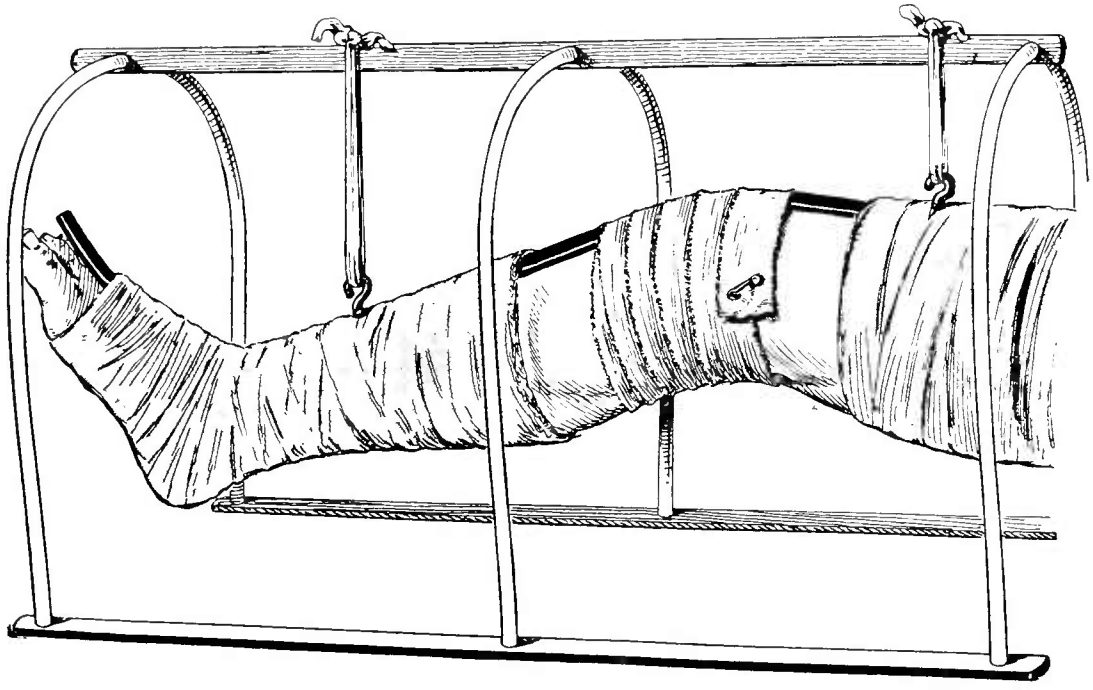


FIG. 35.—ANTERIOR SUSPENSION BAR FOR WOUNDS OF JOINTS. The figure shows the splint applied for a wound of the knee joint. The metal bar is secured to the limb by plaster of Paris bandages above and below the joint, which is left free for the application of dressings. The apparatus is slung from a cradle by the two hooks shown above.

The movements should be carried out so as not to cause pain to the patient, and steadily increased in range from time to time. In some very rare instances more or less complete restoration of movement has taken place. Wherever some amount of movement remains and no increase of inflammation is produced by the passive motion, this should be persevered with for months if necessary in the hope of obtaining a useful joint. On the other hand, should bony anchylosis have occurred, the joint must be left alone. Any attempt to promote movement by breaking up the bony union will not only result in failure as far as movement is concerned, but may very readily light up the inflammatory condition once more.

SECTION II.—DISEASES OF JOINTS.

SUB-SECTION I.—DISEASES OF JOINTS IN GENERAL.

CHAPTER XII.

INFLAMMATORY AFFECTIONS OF JOINTS.

Inflammation of joints may be either acute or chronic, and the process may involve one or all of the structures entering into the composition of the articulation.

ACUTE INFLAMMATION.

Acute inflammation may affect either the synovial membrane alone—when it receives the name of acute synovitis; or the whole of the structures of the joint—when it is generally spoken of as acute arthritis.

ACUTE SYNOVITIS.—Acute synovitis may be due to various causes, such as injury, gonorrhœa, specific fevers, rheumatism, etc. Its chief characteristic is rapid effusion into the articular cavity accompanied by considerable pain. The joint becomes distended with fluid, and the skin in superficial joints may be reddened; frequently, however, it is only slightly more vascular than that over the corresponding joint on the opposite side, but it is generally warmer to the touch. There is considerable pain on pressure over the inflamed joint, although movement or jarring one bone against the other is generally easily borne. The presence of fluid in the joint is a constant and marked feature. At first this fluid is readily coagulable, a character which it loses later on.

The affection may subside, in which case the effusion that has been poured out becomes absorbed. On the other hand, the affection may become chronic, in which case the effusion loses its coagulable character and is poured out in an increasingly large quantity, until the cavity of the joint becomes distended with serous fluid and the capsule considerably

stretched. In all cases of synovitis there is a tendency to the formation of adhesions between the opposing surfaces of the synovial membrane. These adhesions arise from the material effused into the joint, and are at first simply of a fibrinous character; they may subsequently become organised into firm fibrous adhesions and then form a serious obstacle to the mobility of the joint. It must be remembered that in every joint capable of free movement the synovial membrane is much more extensive than the joint itself—a condition necessary to allow of proper movement. Hence, in whatever position the joint may be, the synovial membrane is always thrown into folds with its opposing surfaces in contact at some point or other. In acute synovitis, the lymph poured out on the opposing surfaces of these synovial folds glues them together when the limb is kept at rest, and, unless the folds be separated, the lymph will organise, and will either produce adhesions between the two surfaces or even complete obliteration of that portion of the synovial membrane, so that attempts to move the joint are unavailing.

Treatment.—The treatment depends to a certain extent upon the cause, and will be referred to again in speaking of acute synovitis as it occurs under various circumstances; generally speaking there are, however, certain essentials for the satisfactory treatment of any given case.

In the first place *absolute rest* of the affected joint is of primary importance; the limb should be fixed on a splint in the position which will be most useful should adhesions form which cannot afterwards be got rid of. The second important indication is the employment of soothing applications such as *fomentations*. If there be much pain, the fomentations may be sprinkled with laudanum, and they should be frequently renewed (see Part I., p. 12). Should the synovitis be very acute, considerable benefit may be derived by commencing treatment with the application of *leeches* around the joint, following this up by the employment of fomentations.

When the pain has subsided, the fomentations may be given up and *pressure* applied, preferably by means of a cotton wool and starch bandage (see p. 100); the degree of pressure that this should exert will be regulated by the sensations of the patient; it should never be sufficiently tight to cause pain, and it will generally be found that the pressure can be increased in the course of a few days. The object of this is to bring about rapid absorption of the fluid in the synovial cavity.

After pressure has been employed for two or three days it will be found advantageous to substitute for it *massage*, which should at first consist of gentle rubbing and should gradually be increased in extent and in vigour as the patient is able to bear it. In ordinary cases of acute synovitis, *passive movement* may generally be begun about the third week, but this must depend largely upon the cause of the affection. As soon as passive motion is begun, the splint should be left off, and the limb supported by a firm elastic bandage.

A mistake very commonly made in these cases is to defer the massage and passive movement for too long a time on account of the pain that may accompany their use; it is extremely important to remember that the young adhesions themselves are often highly sensitive, and one must not, therefore, be guided entirely by the amount of pain experienced on movement. The best guide as to whether movement is doing good or the reverse is the absence or presence of swelling in the joint after its employment; should swelling occur, it is clear that a certain amount of synovitis has been set up by the movements, and it will be necessary therefore to abandon this part of the treatment for a time and to substitute rest for it. On the other hand, should no swelling occur, the movements need not be discontinued simply because they cause the patient pain. The pain in the early stages is probably due to tearing through or stretching the young adhesions, and, as these are gradually got rid of, the pain steadily diminishes; on the other hand, the pain, if due to ill effects produced by movement, will increase every day, because it results from actual inflammation set up by the treatment. In some cases, when the movements cause considerable pain and, when, nevertheless, it is imperative to move the joint in order to prevent adhesions, the pain may be considerably diminished by injecting small quantities of eucaine or cocaine around the joint in the manner described in Part I., p. 121, for the production of local anæsthesia. In the worst cases the anæsthetic may be injected into the joint itself (10 drops of a 2 per cent. solution) when it will be found that in about ten minutes considerable movement can be carried out without causing pain.

The employment of movement as soon as possible after the subsidence of the inflammatory stage of acute synovitis is a matter of the utmost moment, and if it be carried out steadily, gently, and carefully from a very early period there will be no great trouble with adhesions, and very probably there will be no necessity for breaking them down under anæsthesia at a later date. Should it be necessary, however, to enforce prolonged rest on the joint in order to subdue the inflammation, the adhesions will necessarily become so firm that they may have to be so treated; this matter will be referred to again in connection with anchylosis (see Chap. XVIII.).

ACUTE SUPPURATIVE ARTHRITIS.—This is an acute inflammation involving all the structures entering into the composition of a joint; the condition is due to the presence of pyogenic organisms.

Causes.—Acute arthritis may follow an open wound into a joint, but it may also occur without any wound in diseases such as pyæmia, acute septic infection and acute epiphysitis, in which pyogenic organisms have gained access from the blood.

Pathological changes.—When pyogenic organisms gain access to a joint they lead to inflammation of all the structures forming it. The synovial membrane becomes intensely congested and swollen, and pours out large quantities of synovial fluid mixed with pus; the bone beneath the

cartilages becomes inflamed; the cartilages themselves partly soften and partly exfoliate; whilst the ligaments of the joint become swollen and softened, and before very long the entire articulation becomes completely disorganised and the bones are dislocated by muscular action.

Results.—There is a very considerable risk of a fatal result, which is generally caused by some form of septic disease, such as septicæmia or pyæmia. There may be the formation of abscesses around the joint and deformity of the limb due to partial dislocation of the articular surfaces from the pull of strong muscles which are no longer opposed by the ligaments. At a later period, when the affection is subsiding, the opposed surfaces of the joint become adherent, the synovial pouches being obliterated by the formation of firm fibrous adhesions, whilst fibrous tissue forms between the cartilaginous surfaces of the bones, or, should the cartilages have been entirely destroyed, actual bony union between the opposing joint surfaces may take place.

Treatment.—The treatment of acute suppurative arthritis has practically already been described in detail in speaking of the treatment of septic wounds of joints (see p. 87), and also to a certain extent in dealing with the treatment of acute epiphysitis (see Part III., p. 179). The first point that the surgeon has to decide is whether an attempt should be made to save the limb; this depends upon the constitution of the patient and upon the severity of the local condition. The point of the greatest importance as regards the general condition is whether the patient is vigorous and young, and whether marked general depression or rigors have occurred. The points of chief importance in the local condition are the severity of the inflammation, the presence or absence of abscesses around the joint, and the amount of pain from which the patient suffers.

When an attempt is made to save the limb, the first essential is to provide free exit for the pus. The patient should be fully anæsthetised and the skin thoroughly disinfected. *Free incisions* must then be made into the joint in such situations as to provide for efficient *drainage* of all parts of the articulation. These incisions must be very free, for it is quite certain that, unless the joint be effectually drained, amputation will be absolutely necessary. No hesitation need be felt about making these incisions, for anchylosis will occur in any case, and large incisions will therefore not interfere with the ultimate usefulness of the limb, while they may make all the difference to the possibility of retaining the limb or of actually saving the patient's life.

When the suppuration is in the knee joint, for example, we make long vertical incisions on each side of the patella, extending from the top of the synovial pouch above to the border of the tibia below; and besides these, openings are also made at the side and back of the joint so as to drain the posterior part of the cavity. These lateral and posterior incisions are best made by introducing a pair of stout dressing forceps through the wounds on either side of the patella, and pushing them through the

capsule and soft tissues, first at the sides of the joint, and afterwards at the back, and cutting down on the closed blades through the skin. The forceps are protruded through the openings in the skin, when the blades are forcibly separated and the soft tissues sufficiently separated to allow of the passage of a drainage tube. A large tube should be inserted on each side, one end emerging from the incision beside the patella and the other through the opening over the condyle; besides these, tubes should be inserted through the counter-openings at the posterior aspect of the joint. It is well also to pass a long piece of tubing transversely beneath the quadriceps tendon, and to make the ends emerge on each side from the incisions beside the patella.

In the other joints the position of the tubes will vary, but wherever possible they must be inserted at the most dependent points, as otherwise drainage will be defective. In the hip, for example, it is well to cut down upon the joint by the anterior incision employed for excision of the hip (see Fig. 27); when the joint is opened, a pair of stout dressing forceps may be pushed through the posterior part of the capsule and made to protrude in the buttock where they are cut down upon, and through the aperture thus made a tube may be pulled in so as to drain the posterior part of the joint. In the ankle, an opening should be made in front of each malleolus and another behind the outer malleolus so as to drain the posterior part of the joint. In the elbow, the openings should be one on each side of the olecranon so as to drain the olecranon fossa, and others should be made in front of each condyle so as to drain the front of the joint. In the shoulder, the best drainage is obtained through the vertical incision usually employed for excision of the shoulder (see Chap. XXII.) reinforced by another just in front of the posterior fold of the axilla which drains the posterior part of the capsule. In the wrist, proper drainage is very difficult to obtain, and can only be got by laying the joint freely open in several places, especially upon the posterior and inner aspect.

After efficient drainage has been provided, *continuous irrigation* with warm boracic lotion, warm Condy's fluid (2 grains to the ounce), or a weak solution of sanitas, should be employed in the manner already described in speaking of septic wounds of joints (see p. 88); or the limb may be placed in a *water bath* (see p. 89). We may repeat here the caution we have already given, namely, that the joint must on no account be washed out with an irritating antiseptic.

The limb should be fixed upon a wire *splint* with the joint in such a position as will be most useful when anchylosis occurs. The splint should be changed as a rule every two or three days, and should be applied outside the first few layers of gauze. Should it be impossible to employ either irrigation or the water bath, the ordinary cyanide gauze dressings, wrung out of warm boracic lotion should be applied round the limb and surrounded by a mackintosh so as to form an antiseptic fomentation. As the discharge

diminishes, the mackintosh can be left off, so that the dressings become dry dressings; salicylic wool should then be employed outside them.

As the discharge diminishes, the drainage tubes should be gradually shortened until finally they are removed. It is well to leave to the last those that drain the most dependent parts of the joint. For example, in the knee joint the lateral drainage tubes should be shortened so that they project merely from the lateral aspect of the limb and no longer emerge through the anterior opening. Similarly those which pass across the joint may be cut in two so that there is a tube on each side, and these should be carefully shortened. In all cases where joints are drained, care must be taken that the drainage tube does not slip into the articular cavity. For this purpose they may be secured either by knotted threads or by safety pins as already described (see Part I., p. 27). The drainage tube in the most dependent situation should be removed last.

When the treatment is successful it will generally be found that the cartilages have not undergone complete destruction, and that bony anchylosis does not therefore occur. Firm fibrous union between the ends of the bones, and extensive adhesions in the capsule are certain to take place, and therefore, as soon as the wound has healed, or indeed as soon as the septic condition has disappeared, massage and passive movements should be at once commenced so as either to break up the adhesions or to stretch them sufficiently to obtain a certain amount of movement. These attempts should be extremely gentle at first, because the tissues are still highly vascular, and if too much be done inflammation may result, even though the wound be healed. As time goes on, the extent of the movements may be increased, and active movement may then be combined with passive motion. In a month or six weeks after healing, the adhesions may, if necessary, be broken down gradually under an anæsthetic, as will be described in detail in connection with anchylosis (see Chap. XVIII.).

No attempt should be made to save the limb when the general condition of the patient is bad, or when there is spreading osteo-myelitis or general septic infection, as indicated by asthenic fever, rigors, and hectic temperature. Similarly, when, after an attempt to save the joint, the bones become exposed, the pain is intense, and abscesses form around the joint, some more radical measures will have to be employed. The proper practice is to amputate through the shaft of the proximal bone should this be healthy; should there be osteo-myelitis, however, the amputation must be through the articulation above.

Whenever amputation is performed through the shaft of one of the affected bones, the greatest possible care must be taken to go well above the joint, and the medulla at the point of bone section should be examined in order to make sure that osteo-myelitis is absent. Should pus be found in the medulla, a second amputation must be done higher up, or should the first amputation have been performed near the upper end of

the bone, the latter should be dissected out of the stump as far up as the joint above.

Some surgeons advocate excision in these cases, but in our opinion the operation is to be strongly condemned, for it must be remembered that the joint is full of virulent organisms, and that, as the excision opens up the cancellous tissue, the organisms will find it extremely easy to penetrate the bone, and to set up acute osteo-myelitis of the most severe type. It is of course true that, after the excision has been performed, an attempt may be made to disinfect the wound by sponging it over freely with undiluted carbolic acid; but, owing to the widespread distribution of the organisms, the attempt at disinfection very commonly fails, and the patient will then run the most serious risks. On the other hand, if the limb be removed well above the joint and quite wide of the infected region, the patient will run no such risks.

When acute arthritis affects joints that cannot be removed by amputation, as for example the sterno-clavicular, the temporo-maxillary, etc., the only alternative is to excise the articulation. When the joint has been opened up, the pus should be washed out and the articular cavity swabbed freely with undiluted carbolic acid before any bone is removed. After ten minutes or so have been allowed to elapse for the carbolic acid to produce its effect, a sufficient amount of bone is taken from the articular surfaces to lay the joint cavity freely open, and then, when the bleeding has been arrested, the raw surfaces should be sponged over again with the undiluted acid. The cavity should finally be packed with cyanide gauze impregnated with iodoform, and the skin incision left freely open. By operating in this way, a cavity is produced which corresponds rather to that left after opening an acute abscess than to an incision into a joint. This is quite feasible in the joints mentioned, whereas it is impossible in such joints as the knee, the elbow, etc., after excision. As a rule the case may be expected to do well, and should two or three days pass without infection of the medulla, recovery is usually assured.

GONORRHŒAL ARTHRITIS.—During an attack of gonorrhœa, an inflammation of the joints clearly associated with that disease occasionally occurs. The affection is often rheumatic in type, and attacks not only the fibrous structures of joints but also various similar structures about the body, such as the plantar fascia and ligaments. Gonorrhœal arthritis is a somewhat rare complication of gonorrhœa; it may affect one or more joints, and is not infrequently multiple. It is commonest in the knee; the ankle and the hip are also frequently affected, whilst almost any joint in the body may be attacked. It does not occur at any fixed period in the disease, but it is most usually met with between the third and sixth weeks.

Pathology.—There is no obvious relation between the acuteness of the gonorrhœa and the occurrence of the articular affection, and the exact relation between the two diseases is somewhat obscure. When the

urethral affection has arrived at the gleety stage it is not uncommon to find by inspection through the urethroscope that there is some actual ulceration in the urethra, and it is probable that at this point the gonococci enter the blood and by it are carried to the articulation. In support of this view is the fact that the trouble not infrequently follows the passage of an instrument during the sub-acute or chronic stage.

On the other hand, some constitutional condition seems to exist, which at any rate predisposes to the occurrence of the arthritis, for it is not uncommon to find that certain patients suffer from the affection every time they contract gonorrhœa. The disease occurs chiefly in men, but is also met with in women.

Examination of the fluid found in the affected joint shows, in the majority of instances, the presence of gonococci, but in a fair proportion of cases no organisms at all have been found; whilst in others again, of the more acute type, the ordinary pyogenic organisms are present. It is probable that the last cases are pyæmic rather than purely gonorrhœal.

Varieties.—Clinically the disease varies in acuteness in different cases. From the point of view of treatment we may differentiate four groups.

(*a*) The simplest form, which is not uncommon, is that of a painful affection of the joint without any distinct swelling or synovial effusion. There is slight tenderness on pressure, with pain on moving the limb, and occasional shooting pains in the joint. In all probability there is here an inflammation of the fibrous structures around the joint rather than an affection of the synovial membrane itself.

(*b*) The typical gonorrhœal arthritis is the acute or sub-acute form. The first symptom is stiffness and slight swelling of the joint, which is soon followed by acute pain, lasting for several days, and accompanied by some effusion into the synovial cavity. The fluid thus poured out is either clear or somewhat turbid from the presence of white corpuscles. In a week or ten days the acuteness of the trouble subsides, when a similar condition may affect another joint, and not at all infrequently symptoms of gonorrhœal inflammation occur in the fasciæ and ligaments elsewhere in the body. Recovery in these cases is usually protracted, and relapses are frequent.

(*c*) In other cases the disease is chronic from the first, and consists rather in a persistent accumulation of fluid in the joint than in an acute inflammatory attack; the condition, in other words, is more one of hydrops articuli than of acute synovitis.

(*d*) Extremely acute cases are occasionally met with in which actual suppuration occurs in the joint. As we have already remarked, these are in all probability rather of a pyæmic than of a purely gonorrhœal nature.

The tendency of this affection is to spontaneous recovery—generally after a protracted convalescence. The acute form of the disease is

however very likely to lead to extensive adhesions in the joint, which will entail considerable stiffness unless great care be taken in the treatment. On the other hand, those cases accompanied by extensive effusion may lead to so marked and prolonged a distension of the capsule, and consequent laxity of the ligaments, that there may be a permanent weakness of the joint left, which may be a source of very considerable trouble to the patient. In the severe cases accompanied by suppuration the result may be very disastrous, either from disorganisation of the joint, or from the occurrence of general septic infection.

Treatment.—There are one or two points common to the treatment of all the various types above referred to. In the first place it is of great importance to *subdue the urethral inflammation* as soon as possible, and this is best done by topical applications; internal remedies, such as oil of sandal and copaiba, have little influence upon the lesion in the urethra, which is of an essentially chronic nature, while they are very apt to depress the patient, to upset his digestive functions, and thus to do harm. The chief reliance must therefore be placed on intra-urethral medication, which may be effected either by the use of suitable injections, or, better, by topical applications made through the urethroscope in the manner that will be described when dealing with Gonorrhœa.

A second point of great importance in all cases is that means must be taken to *subdue the inflammation in the joint* as quickly as possible, and in this connection the great tendency to adhesion and stiffness of the joint subsequently must be remembered; therefore prolonged rest must not be insisted upon, and *passive motion* must be resorted to early. Further, it is of importance to warn the patient that, after having had one attack of gonorrhœal rheumatism, he is very likely to be affected similarly should he again contract the urethral affection.

(a) **Of the simple rheumatic form.**—Here there is little or no effusion into the joint, the symptoms are not acute, and the treatment is comparatively simple. The best results are obtained in the early stage by the employment of counter-irritation combined with a certain amount of rest. *Rest* is best obtained by enveloping the affected joint in a number of layers of cotton wool and fixing these firmly in position with a bandage; this will exert pressure and restrict movement. When the joints affected are in the upper extremity, the arm should be kept in a sling; when the lower extremity is the seat of the affection, the patient need not be confined to bed, but should be prevented from walking as much as possible, and should be confined to a couch, or should be provided with a suitable foot-rest. When the inflammation is about the tarsal joints, it is imperative that the patient should not bear any weight upon the foot, as otherwise there is a great risk of the supervention of flat-foot. *Counter irritation* is also of great value, and in the milder cases the linimentum iodi may be painted over the joint affected until the skin becomes sore; this should be employed in addition to the pressure above described.

As soon as the pain has disappeared—which should be in two or three days' time—the *pressure* may be increased by applying an elastic bandage outside the wool, and at the end of a week or ten days a short course of massage and passive movement will generally restore the functions of the joint completely. In the less accessible joints, such as the hip and the shoulder, pressure is not so easily applied, and more severe counter-irritation is indicated. The application of one or more blisters, combined with rest to the articulation, will generally suffice.

Constitutional remedies are of little or no avail in these cases. The ordinary specific remedies for rheumatism, such as salicylate of soda and salicin, are practically of no use; the best *drugs* to employ are quinine and iron. Quinine should be given in doses of three to five grains twice or thrice daily, and iron is useful when the patient is anæmic; it should be given in the form of Blaud's capsules in ten-grain doses three times daily after food. The patient should be careful not to expose himself to cold and wet, and flannel underclothing should be insisted upon. At the same time attempts must be made to cure the urethral affection as quickly as possible.

Although the majority of these cases recover without any trouble, some of them are very obstinate; this is particularly so when the tarsal joints or the plantar ligaments are affected. Under these circumstances a change to a warm climate or a sea voyage is often required to effect a permanent cure.

(b) **Of the ordinary acute variety.**—Attention must be first directed to moderating and arresting the inflammation; secondly, the effusion must be got rid of; thirdly, the risk of stiffness in the joint must be avoided. The limb should be fixed upon a suitable splint, and, if the lower extremity be the seat of the mischief, the patient should be confined to bed. Indeed in the early stage the pain is usually so great as to practically prevent the patient from getting about.

As in all other acute inflammations, the bowels should be cleared out by a sharp purge, and the diet should be light and nutritious; no stimulants should be given, at any rate in the early stages. The drug treatment is much the same as that for the variety already described.

In the local treatment, after applying a *splint* (the best splints for the different joints will be referred to in speaking of affections of the individual articulations) measures must be taken to subdue the acuteness of the inflammation. In the early stages, and especially in superficial joints, such as the knee, the application of *leeches* is extremely beneficial. After the leeches have become detached, warm *fomentations* should be employed, with a little laudanum sprinkled on them if there be much pain. In the very early stages some authorities recommend ice in preference to leeches, but on the whole it will be found that the latter are more satisfactory. In many cases the pain, particularly at night, is so severe that a general narcotic such as morphine has to be administered.

After rest and fomentations have been employed for a few days, the

acuter symptoms generally pass off, the pain subsides, and the second indication in the treatment, namely, the removal of the synovial effusion, requires consideration. When the fluid is not excessive in amount *counter-irritation* will usually suffice. The joint should be freely blistered, fresh blisters being put on as soon as the old ones have healed, whilst rest to the limb and confinement to bed are persisted in. As a rule two or three blisters in succession are required, and as an interval of five or six days is necessary between each blistering, this stage of the treatment will extend over two or three weeks.

The joint will now as a rule be in a condition for more energetic treatment, which should consist of massage, gentle passive motion and the employment of pressure in the intervals between the manipulations. The *massage* should at first be very gentle, and, as the effusion subsides, *passive motion* may be begun. The vigour with which the massage is applied, and the extent to which the passive movements are carried, must be gauged by the sensations of the patient and the local conditions, more especially the inflammatory symptoms. As a rule, massage may be employed once daily for about a quarter of an hour; after a few days, this period may be gradually increased and the massage practised twice daily. *Pressure* by means of cotton wool and a bandage (see p. 100), reinforced later on by an elastic bandage, should be applied to the joint in the intervals between the massage, and the splint may be left off.

As the inflammatory condition subsides, treatment must be directed against the occurrence of adhesions. This is best done by passive movement and massage on the lines already laid down, and these movements, which should be gentle at first, should be carried out with increasing vigour as the patient is able to bear them. Coincidently with the massage and passive movement, the use of splints and bandaging should gradually be abandoned. During the whole of this period, the case should be carefully watched for any increase in the inflammatory symptoms, which would tend to show that the treatment is being pushed too rapidly.

Occasionally the effusion persists or even increases in spite of this treatment; when this is so, the case will fall more justly into the next group to be described, *i.e.* those accompanied by excessive effusion, and the treatment there described must be followed.

In freely movable joints, such as the knee, these attacks of acute or sub-acute arthritis are generally pretty readily recovered from, but when the affection occurs in the tarsal or the wrist joints there is often considerable difficulty in restoring the functions of the articulations completely because the inflammation does not remain limited to the synovial membrane of the joint itself, but affects the tendon sheaths and the ligaments and fascial structures around, so that more extensive adhesions have to be dealt with.

A very good method of getting rid of any stiffness that remains after a careful and prolonged trial of passive movement and massage is by means of superheated air applied around the joint. This is done for about half

an hour prior to the massage and movement. This method will be referred to when we deal with rheumatoid arthritis (see Chap. XVI.).

(c) **Of cases accompanied by excessive effusion.**—As distension of the joint is very prejudicial to its ultimate recovery, the stretching of the ligaments being apt to leave the joint loose afterwards, it is of great importance that steps should be taken to get rid of any fluid which is not absorbed after a proper trial of the measures just recommended. This may be done in the first instance by *aspiration*. The greatest care must of course be taken to disinfect the skin and the aspirating needle, and the puncture should be covered by collodion. It is well to blister the joint immediately after aspiration has been performed, and, as soon as the blister has healed, to keep up pressure. In a good many cases, however, the fluid will re-accumulate unless some more vigorous steps be taken.

Some surgeons, after aspiration, *wash out the joint* with a three per cent. solution of carbolic acid. Schuchardt states that he has obtained still better results by irrigating with a one per cent. watery solution of protargol. We ourselves are in the habit of using a 1-2000 sublimate solution. A small incision should be made through the skin sufficient to allow the entrance of a properly disinfected trochar and cannula of fair size. In the knee joint this is best done in the supra-patellar pouch. The trochar and cannula are introduced into the synovial cavity, the former is withdrawn, and the fluid completely evacuated by pressure, when the irrigating fluid is injected into the joint in sufficient quantity to thoroughly distend it. The finger is then placed over the end of the cannula so as to prevent the egress of the fluid, whilst the capsule of the joint is squeezed in various directions so as to distribute the fluid evenly over the interior. The finger is then removed from the cannula and the fluid is squeezed out. This procedure may be repeated two or three times, when the joint cavity is distended with sterilised water, and emptied as thoroughly as possible, so as to get rid of the mercurial solution; unless this be done, a smart attack of synovitis is likely to follow, as the sublimate solution is rather too irritating to be left in the joint. Although such an attack of acute synovitis not infrequently cures the dropsical condition of the joint, just as it cures hydrocele, it is apt to give rise to the effusion of a considerable amount of fibrinous material into the joint, and this may give trouble from the formation of adhesions. After the joint has been thoroughly irrigated, it should be put on a splint and blistered and treated in the manner just described; in the majority of cases a cure will result.

(d) **Of cases complicated by suppuration.**—These are practically cases of pyæmia, and the treatment must therefore consist in *free drainage* of the joint by incision and the insertion of drainage tubes. In many cases the septic condition is not very virulent and large incisions are not therefore called for, two or three full-sized drainage tubes (No. 20) being sufficient. Where, however, the condition is more acute, or where the inflammation

continues in spite of the insertion of drainage tubes, more vigorous measures must be taken, and these are practically the same as those already described for acute suppurative arthritis (see p. 96). Fortunately the affection is not, as a rule, as acute as after a penetrating wound of a joint, and simple drainage is generally sufficient to lead to a cure.

OTHER FORMS OF INFECTIVE ARTHRITIS.—Infective arthritis may occur in various acute constitutional diseases, being most common in specific fevers, such as small-pox, scarlet or typhoid fever. A similar condition may also occur in dysentery or pneumonia, and it is one of the common phenomena met with in pyæmia or septicæmia. In the latter cases there is no difficulty in understanding how the affection occurs, but its relation to the specific fevers is not yet quite clear.

Symptoms.—These more or less resemble those of the second type of gonorrhœal arthritis; that is to say, the inflammation is usually acute or sub-acute, and it does not, except in the pyæmic cases, necessarily end in suppuration. *In the non-suppurative form* the question arises as to whether the disease is really set up by the specific organisms producing the fever, or whether it is mainly due to some constitutional tendency on the part of the patient. The problem is very much of the same nature as that in gonorrhœal rheumatism, and the symptoms are closely allied. The disease may be confined to one joint, but it not uncommonly occurs in several. It resembles gonorrhœal arthritis moreover in that it does not exhibit the typical migratory character of ordinary acute rheumatism, and it not at all infrequently passes on into the condition of chronic effusion into the joint, so often met with in the third type of that affection.

When one or more joints are affected, they are generally inflamed at the same time, or the inflammation in the second joint comes on before that in the first has subsided. In typhoid fever the hip joint is not infrequently affected, and a peculiar character of this affection is that spontaneous dislocation is very apt to occur; in fact, it may sometime happen during convalescence from typhoid fever that spontaneous dislocation of the hip occurs without any previous symptoms having called attention to the affection of the joint. *When suppuration occurs* the condition is generally very grave as it is practically one of pyæmia.

Treatment.—This closely resembles that of gonorrhœal arthritis and consists in the application of leeches and warm fomentations accompanied by rest in the early stages; this is followed by counter-irritation and pressure as the inflammation subsides, and at a still later stage by massage and passive movement designed to get rid of adhesions. Should dislocation occur, as in the hip, no time should be lost in reducing it, and its recurrence should be guarded against by employing extension and suitable apparatus.

The general condition of the patient must also be attended to. In the first instance, the treatment suitable for the disease which is the original cause of the trouble should be employed, while later on general tonic

treatment by iron and quinine, good hygienic conditions, nourishing food and a moderate amount of stimulants will be called for.

When suppuration takes place, the treatment must follow the lines laid down for acute suppurative arthritis (see p. 96). The arthritis here, although of a suppurative character, is not usually very virulent or destructive, and it is not uncommon for an excellent result to be obtained by drainage alone.

CHRONIC INFLAMMATION.

CHRONIC SYNOVITIS.—By chronic synovitis is meant a chronic inflammation of the synovial membrane which may be accompanied by: (*a*) marked effusion into the joint, or (*b*) thickening of the synovial membrane, which may assume a villous character.

1. Chronic synovitis with effusion.—This may follow an attack of acute synovitis or may be chronic from the first. In the latter case it may arise from a sprain or an injury to the joint, or it may commence without any apparent cause, and is then probably the result of some indefinite constitutional condition. More usually, however, it is due to some local cause, such as excessive use of the joint or, in the lower extremity, to long standing or walking. It may also be associated with some changes within the joint, such as an injury to the cartilage, particularly when the joint is furnished with an inter-articular fibro-cartilage. It may also be due to a roughness of the synovial membrane, such as hypertrophied synovial fringes; or again it may be produced by a loose body in the joint.

Whatever be the cause, the result is that the joint becomes markedly distended with a clear, limpid and serous fluid, whilst in many cases the synovial membrane remains practically normal. The distension of the joint is usually comparatively slow and remains stationary for a long time, so that in the early stages the patient continues to use the joint fairly freely, and only notices that it is slightly stiffer than the other. When rest and appropriate treatment are employed, the fluid will diminish or even disappear entirely, but, as soon as the joint is used again, there is apt to be a recurrence. When the effusion has lasted some time, laxity of the fibrous capsule and the ligaments of the joint results, so that ultimately the articulation may be altogether disabled.

The affection is very chronic, and very difficult to get rid of; unless efficient treatment be brought to bear upon it, the result may be very serious. This is all the more likely to be the case because patients suffer so little that they are apt to neglect the affection, and this is particularly so in those who have to earn their living. It is not until the disability produced by the stretching of the ligaments is so great as to prevent the patient using the joint that he seeks advice.

Treatment.—The points to be aimed at in the treatment of chronic

synovitis with effusion are first of all to remove the cause, if possible; secondly, to remove the fluid; thirdly, to cure the inflammatory condition; and fourthly, to restore the functions of the joint.

The cause should always be removed, if possible; a most careful examination must be made to ascertain which of the causes enumerated is present. Very often, however, no definite conclusion can be come to on this point because it cannot be made out owing to the distention of the joint. This is particularly so when the affection is caused by hypertrophy of the synovial fringes or by the presence of a loose body.

Under these circumstances the next thing to do is to *remove the fluid, and cure the inflammatory condition.* The most efficient way of doing this is by rest, and if the joint affected be in the lower extremity, the patient must lie up, and the limb must be fixed upon a splint. The rest should at first be absolute, as the disappearance of the fluid will be much delayed if the patient be allowed to get up, even for a few hours. In the case of the knee, for example, the limb should be placed on a back splint with the joint slightly bent, and the extremity elevated upon a pillow. Blisters should then be freely applied both over the lateral aspects of the joint, and over the supra-patellar pouch. As soon as one blister has healed, a second should be applied, and after that a third, if necessary, and so on at intervals of about a week. If the fluid be markedly less after two or three blisterings, massage should be carried out twice daily, and in the intervals pressure should be applied by means of cotton wool and a bandage (see p. 100). When the fluid has entirely disappeared, the joint should be strapped with Scott's dressing (see p. 119), and the patient may then be allowed to get about. The fluid generally disappears under this treatment in three or four weeks' time, but the great trouble is that, as soon as walking is resumed, it is very apt to reappear.

Should the fluid re-accumulate it is evident that it would only be waste of time to repeat the treatment, and something more radical is required. Should no cause, such as the presence of hypertrophied synovial fringes, etc., be found, the patient should be again put to bed and the fluid withdrawn by an aspirator. The blistering and the former treatment may then be repeated, in the hope that no further recurrence will take place after removal of the fluid.

Should the fluid, however, re-accumulate in spite of aspiration, the best means at our disposal is to *wash out the joint* with some slightly irritating fluid; the one we prefer for the purpose is a 1-2000 sublimate solution. This is done in a manner similar to that for gonorrhœal arthritis (see p. 103).

As an alternative to washing out the joint in this manner, or as a method of treatment when this has failed, we may mention *aseptic drainage* of the joint. Some surgeons indeed prefer this method to the simple irrigation, and provided absolute reliance can be placed on securing asepsis, there is no doubt that this is the more effectual procedure. Particular

care is necessary to secure perfect asepsis, as suppuration in a comparatively healthy joint is a very disastrous occurrence.

An incision should be made through the capsule of the joint sufficiently large to admit a medium-sized drainage tube (No. 14), which is introduced well into the joint cavity, stitched to the skin, and surrounded by the usual antiseptic dressings. These dressings will require to be changed daily at first, and at less frequent intervals subsequently, according to the amount of discharge present. In most cases this treatment is sufficient to entirely subdue all tendency to effusion into the joint in about ten to fourteen days, when the drainage tube should be left out and the wound allowed to heal.

As soon as healing has occurred, massage and passive movement must be begun and gradually increased in amount, so long as they do not produce any further effusion. In the intervals, the limb should be strapped with Scott's dressing, and after about three weeks the patient may be allowed to get about, careful watch being maintained to see that no further effusion takes place.

In the most obstinate cases, and particularly those in which there is a loose body in the joint, even this method will not succeed, and the most careful examination must always be made to ascertain whether anything of this nature is present. The most common condition keeping up this chronic synovitis is the presence of enlarged synovial fringes in the joint, a condition which will be referred to immediately, and therefore we are inclined to advise that, whenever the surgeon feels compelled to employ drainage of the joint, it is well to make the incision into the capsule sufficiently large to introduce the finger and to actually examine the interior, so that any abnormal condition may be at once dealt with.

2. Chronic synovitis with synovial thickening.—The thickening may affect either the surface or the substance of the synovial membrane.

(a) **Of the synovial fringes.**—This condition is not at all uncommon, and is frequently the primary cause of obstinate cases of chronic synovitis with effusion. The change in the synovial membrane varies from hypertrophy of a few fringes—generally at the point where the synovial membrane joins the cartilage—to an almost universal papillomatous condition of the surface. If one of these fringes be floated in water it presents an appearance exactly resembling that of seaweed. A microscopical examination of the fringes shows that they consist simply of fibrous tissue with loops of blood-vessels, without any marked signs of inflammation unless they have been repeatedly nipped between the articular ends, in which case they become swollen and inflamed. In some cases also there is a very marked deposit of fat in the fringes, so that large fatty masses hang into the joint—a condition that has been described under the name of "lipoma arborescens."

This condition is but seldom described, and in many text-books is not referred to at all, probably because it is only in quite recent years that joints have been opened by exploratory incisions, and the condition

therefore actually verified. It is not, however, nearly so uncommon a cause of pain and effusion into joints as may be supposed. The fundamental cause of this condition is still extremely obscure. We have included it among the inflammatory affections, but we feel by no means certain that it is really of this nature. It is described here merely because it is more convenient to consider it in this connection on account of the chronic synovitis to which it constantly gives rise. By some it is considered to be allied to rheumatoid arthritis, and no doubt the condition is found in many rheumatoid joints; on the other hand, a most extensive papillomatous condition of the synovial membrane may be met with without any other sign of rheumatoid change in the joints, or without, as far as present experience goes, that condition supervening later.

The affection is very commonly multiple, and may involve several joints. Those most frequently attacked are the knee and the ankle, and the result is not only persistent effusion of fluid into the joint, but also frequent attacks of sudden disability, which closely resemble those caused by loose cartilages, and which are due to nipping of the fringes between the ends of the bones. Besides the effusion of fluid, which may or may not be considerable in amount, there is often tenderness on pressure over various parts of the joint. When the articulation is palpated, it is often possible to feel the fringes moving about under the finger and giving rise to a marked crepitation.

Schuchardt, who has investigated the subject, gives the following as the most frequent seats of proliferation in the various joints: in the shoulder the fringes mostly occur round the scapular articular surface, in the bicipital groove and in the neighbourhood of the anatomical neck of the humerus; in the elbow they are met with most frequently about the head of the radius, beneath the annular ligament and in the pockets of synovial membrane in front and behind; in the radio-ulnar joint they are especially on the dorsal surface; in the hip they are most frequent in the neighbourhood of the head of the bone; in the knee they surround the patella and are present at the reflection of the synovial membrane and in the suprapatellar pouch. In the last joint we have found them most frequently over the lateral reflections of the pouch so that they can be felt over the condyles; they also occur in connection with the ligamentum mucosum; in the ankle they occur at the anterior attachment of the synovial membrane to the tibia.

Treatment.—This is unfortunately very difficult, and it is not easy to see how a uniformly good result can be obtained. Should the trouble be limited to one joint, it is clear that the most promising measure is the radical one of dissecting away the whole of the affected area of the synovial membrane, and, wherever this dissection does not involve removal of the entire synovial membrane, we have obtained most excellent results, particularly in the knee. Should, however, the case be one where the condition is more or less universal, the whole of the synovial membrane

must necessarily be removed, and there is therefore considerable subsequent restriction of movement; in fact, under these circumstances, it is hardly possible to hope for complete restoration of function in the joint afterwards. Where only one joint is affected this is not necessarily a matter of very great importance, but should a number of joints be attacked, it is of course a most serious undertaking to dissect away the synovial membrane in each. At the same time it must be remembered that the condition completely cripples the patient, and that a painless though somewhat stiff joint is preferable to one so painful that the patient cannot use it.

When, however, the fringes are very numerous, it would seem worth while to make an attempt in the first instance to cause them to adhere, before proceeding to operate for their removal. This may to some extent be done by setting up a subacute synovitis in the joint, and we have therefore in one or two instances washed the articulation out with a 1-2000 sublimate solution, without irrigating it afterwards with sterilised water as recommended for chronic synovitis (see p. 103). This has been done in order to produce a considerable amount of fibrinous effusion which will lead to adhesions and thus fasten the papillæ to the surface of the synovial membrane, so that they no longer float about in the joint cavity and irritate the synovial membrane, or get caught between the articular ends. This method has led to considerable improvement in the cases in which we have employed it. No constitutional remedies are of any value.

The treatment therefore that we should advise is, whenever the affection seems limited to one part of the synovial membrane, to open the joint freely with full antiseptic precautions, and to clip away the enlarged papillæ as completely as possible. This gives rise to considerable oozing into the joint, which, however, will stop partly from mere exposure to the air and partly by irrigating the joint with hot sublimate solution (1-8000).

When, however, the affection is extensive, and particularly when more than one joint is attacked, we would advise that the joint be laid freely open, the enlarged papillæ clipped away, and the joint filled up with a 1-2000 sublimate solution. A large drainage tube is inserted, the remainder of the incision in the capsule is stitched up, and the usual antiseptic dressings are applied, the limb being put on a suitable splint. The drainage tube may be left out at the end of ten days and the wound allowed to heal; when this has happened, passive movement is begun in order to avoid excessive adhesions in the joint.

(b) **Of the substance of the synovial membrane.**—These are chiefly cases in which synovitis has been prolonged, and the best example is seen in the knee, where, as the result of some injury, a thickening, most prominent about the fatty pad beneath the ligamentum patellæ, persists. In some cases, no doubt, a certain amount of thickening of the whole of the synovial membrane may be present, but it is very rare to find a thickening of the entire synovial membrane which is not of a

tuberculous or syphilitic origin. As a rule any thickening that is felt is due to the presence of the fringes of which we have already spoken.

When there is a limited thickening of the synovial membrane, such as that in connection with the fatty pad beneath the ligamentum patellæ, the best treatment is careful and prolonged massage accompanied by the employment of douches, and, if necessary, a visit to one of the thermal stations, where the hot-air treatment and the proper douches can be obtained. These cases are very troublesome, and the condition may be so persistent that it may be advisable to cut down upon the thickened area and remove portions or the whole of it.

CHAPTER XIII.

TUBERCULOSIS OF JOINTS.

Tuberculosis is one of the most common affections of joints and may end in very serious disorganisation of the articulation. The disease is due to the growth of the tubercle bacillus, aided by some predisposing or exciting cause, and most commonly follows a slight injury or sprain in one who is the subject of tuberculosis elsewhere or in whose blood tubercle bacilli happen to be present.

PATHOLOGICAL CHANGES.—As a rule the disease begins as a localised deposit in the joint. It is only in very rare cases, more particularly in acute tuberculosis, that the affection commences with an eruption of tubercles over the whole of the joint. As met with in surgical practice, the typical form of the disease is the result of the spread of the tuberculous virus from one or more foci, until in time the whole joint is affected. These primary foci may be situated either in the cancellous ends of the bone or in the synovial membrane, and both the early symptoms of the disease and its treatment will differ very considerably according to the mode of origin. Primary deposits of tubercle in the bone are perhaps more common in children, whilst in adults the affection more frequently starts in the synovial membrane; on the whole, however, there is not a great difference between the frequency in the two cases.

Primary osseous deposits.—These produce in the first place a localised tuberculous osteo-myelitis, and, as the deposit extends, one of two results may follow. The softening of the bone in which the tubercle is deposited may continue and may lead to the formation of a *soft caseating deposit*; on the other hand, sclerosis of the bone trabeculæ may occur, with marked thickening of the bone, caseation of the tissue in the remains of the alveolar spaces, ultimate necrosis of this portion of the sclerosed bone and the *formation of a sequestrum*. Hence, where there is a tuberculous focus in a bone, a soft caseating deposit or a tuberculous sequestrum or both may be met with. This tuberculous focus gradually

increases in size and makes its way to the surface of the bone, which it may reach either beneath the articular cartilage—which is most frequently the case—or just at or even beyond the point of reflection of the synovial membrane on to the bone. When the deposit reaches the under surface of the articular cartilage it perforates it, and thus a communication is established between the joint cavity and the tuberculous deposit. The result is rapid infection of the whole surface of the synovial membrane; this is generally marked by the onset of acute symptoms in a case in which they had previously been only slight. These cases were formerly described under the name of "acute ulceration of cartilage.'

On the other hand, when the deposit reaches the surface about the point of reflection of the synovial membrane on to the bone, the tuberculous material does not escape into the joint cavity at any rate at first, but leads to infection of the neighbouring synovial membrane and a gradual spread of the disease from this point over the rest of the joint; these cases resemble in many respects those of primary synovial disease.

Primary synovial disease.—When the tuberculous disease begins primarily in the synovial membrane it usually commences at one particular spot and from this gradually infects the remainder. Two different conditions are met with here; in the one there is a localised deposit which gives rise to the *thickened synovial fringes* hanging down into the joint and forming a sort of pedunculated loose body; on the other hand, the disease, spreading from the primary focus, may extend uniformly over the whole of the synovial membrane and lead to *general thickening* of it.

The further history of cases of synovial disease is that after the membrane has become more or less uniformly affected, the thickened structures spread gradually over the cartilages from the point of reflection of the synovial membrane, destroy them and then extend into the cancellous spaces at the ends of the bone, leading to the condition known as *tuberculous caries*. Abscesses also frequently form in the substance of the synovial membrane and these burst either outwards, inwards, or in both directions, leaving sinuses leading down to carious bone. Ultimately, if recovery takes place, anchylosis with various deformities results.

SYMPTOMS.—The symptoms of tuberculous joint disease depend on the stage of the disease, and on whether it is primarily osseous or synovial. In the very earliest stage of the *primary osseous affection* the symptoms are not at all marked. At most the patient complains of a feeling of weight and slight aching about the end of the bone, which is found to have undergone localised thickening. In the case of the lower extremity there may also be a slight limp in walking, although there is actually no limitation of, or pain on, movement. Should such a group of symptoms occur in a patient previously the subject of tuberculous disease, or in one who has a bad tuberculous family history, the suspicion of tuberculous joint mischief is very strong.

At a later stage, when the osseous deposit establishes a communication

with the joint, and leads to sudden infection of its interior, these slightly marked symptoms suddenly become acute; the patient is seized with pain; there is considerable swelling of the joint, with starting pains at night, and marked flexion. It is very often not until these acute symptoms have appeared that any history is given of previous trouble in the joint.

The after-history of these cases is that the joint cavity becomes filled with semi-purulent fluid, the synovial membrane is thickened, although not very markedly, while abscesses form and burst around the joint, leading to sinuses connected with carious bone; the general health suffers greatly, for the patient cannot sleep at night on account of the excruciating starting pains in the limb which come on just as he dozes off; he gradually wastes, and acute tuberculosis not infrequently ends the case.

When the disease is primarily synovial, or when an osseous deposit reaches the surface of the bone at the point of reflection of the synovial membrane on to it, the symptoms are much less acute, and the changes consist mainly of thickening of the synovial membrane, at first often localised but gradually increasing in extent.

In the early stage there is but slight interference with the free mobility of the joint, and little or no pain; as the affection of the synovial membrane advances, movement gradually diminishes, and when the cartilages become destroyed, the more severe symptoms, such as starting pains at night with abscesses around the joint, etc., begin to appear. A patient with pure synovial joint disease is generally more or less free from pain as long as the limb is kept at rest.

In the rare cases in which there is *a localised thickening of the synovial membrane* forming a more or less pedunculated mass projecting into the joint, the symptoms at first are effusion into the joint with some tenderness on pressure over the thickening, which may suggest the presence of a loose body. The nature of the case is soon made evident by the gradual extension of the disease to the rest of the synovial membrane.

In all these cases of tuberculous joint disease a very remarkable and early feature in the case is the rapid wasting of the muscles which act upon the joint. In the case of the knee the thigh muscles waste with great rapidity, so that the enlargement of the articulation appears greater than it really is owing to the muscular atrophy. This condition is common to many acute joint diseases, but is more marked and more rapid in the tuberculous form than in any other, and it is probably caused to some extent by a neuritis spreading from the articular nerves.

GENERAL POINTS IN TREATMENT OF TUBERCULOUS JOINT DISEASE.

From the point of view of treatment, tuberculous joint disease may be divided into the following groups:

1. Localised tuberculous deposits in the bone, before the joint has become affected.

2. Localised tuberculous deposits in the synovial membrane of the pedunculated variety.

3. Cases of empyema tuberculosum and hydrops tuberculosus.

4. Cases in which the tuberculous deposit has burst into the joint and has produced sudden violent infection of it.

5. Cases of general thickening of the synovial membrane without any marked bone disease.

6. Cases in which there are unopened abscesses around the joint.

7. Cases in which these abscesses have burst and have left sinuses.

8. Tuberculous disease accompanied by anchylosis and deformity, with or without sinuses.

In connection with the treatment of tuberculous joint disease it is necessary in all cases to ascertain whether there is tuberculosis elsewhere, *e.g.* in the lungs, glands, abdomen, etc. Before referring to the treatment of the types of disease enumerated above, it will save repetition to give briefly a description of the methods of treatment applicable to tuberculous diseases of joints in general.

(a) **GENERAL TREATMENT.**—There are certain points of great importance in the general treatment of those who are the subjects of tuberculous joint disease. In the first place, the patient should be placed under the best possible hygienic conditions. He should have plenty of fresh air, and whenever possible should be sent into the country, the particular *locale* depending largely upon the idiosyncrasies of the individual. It is too much the rule to send these patients at once to the seaside, for it must be remembered that some are much better in a dry inland spot than at the seaside; before deciding where the patient is to go it is essential to ascertain if possible from which of these localities he is likely to derive most benefit. Again, some do better in a warm climate, whilst others suffer from the heat and prefer a cooler resort.

Climatic.—For those who are best suited by the seaside in a cool and bracing climate, any of the ordinary English watering-places on the East Coast from Deal to Cromer, or on the Yorkshire coast, may be recommended. As a rule, patients are sent to Margate, but there is no particular virtue in that spot over many other places upon the East Coast. For patients who do well at the seaside, but who require a warmer climate, there are various suitable resorts on the South Coast from Folkestone to Bournemouth. For those who do best in an inland bracing atmosphere, the Yorkshire moors are excellent, whilst for others, who require a somewhat warmer climate, Devonshire seems to be the most suitable.

In the country, the patient should be kept out of doors as much as possible, and measures must be taken to prevent movement of or pressure upon the affected joint. The amount of out-door exercise, and the form which it takes, must therefore practically entirely depend upon the joint affected; when the mischief is in the lower extremity, it is always best in the early stages to keep the patient recumbent on a couch, upon which

he may be wheeled out of doors. When the affected joint is in the upper extremity, the patient will, of course, be allowed to walk about from the first. In sanctioning exercise, it is of the highest importance to impress upon the patient that this must be of the gentlest possible description; any slight injury to another joint may quite readily set up similar disease there. The patient should always remember in taking exercise that he is an invalid, and should not therefore join in any violent games, or any unduly vigorous exercise.

Dietetic.—The diet is of great importance. It must be as nourishing as possible, and should consist of the most easily digested foods. A meat diet is preferable to a vegetable one; the consumption of potatoes and vegetables containing much potash should be largely restricted.

Medicinal.—Drugs are also valuable in the treatment of tuberculosis, the chief reliance being placed on *cod-liver oil* in one of its various forms, particularly as an emulsion. This drug should be given even though the patient appears to be fat and well nourished, but it should not be given in too large doses, as it may upset the digestion. It is usually best to begin with a teaspoonful twice a day, and to gradually increase it until a tablespoonful is being taken thrice daily; it is well to intermit it in warm weather. *Iron* is of considerable value should the patient be anæmic, whilst *guaiacol* in capsules of from two to three minims three times a day is also to be recommended. The latter drug may, if preferred, be administered by subcutaneous injection.

Unfortunately, it is only comparatively well-to-do patients who can properly avail themselves of the best hygienic treatment, which, to be of any real value, should be persevered with until recovery is complete; this usually means a period not of weeks or months, but of years. With the poor, such treatment is quite out of the question at present, and it seems very advisable that every hospital for the treatment of these diseases should have a department in the country to which the patient can be sent and kept under careful treatment for as long as may be necessary. At Paddington Green Children's Hospital we carry this out by having a Convalescent Home in the country to which tuberculous cases are sent as soon as the local condition permits, and at which they are kept as long as may be necessary. The Home is within reach of town, and the treatment can therefore be superintended from time to time by those who have had charge of the case from the first. To send a patient with tuberculous joint disease—especially if any operative interference has been practised—to one of the ordinary Convalescent Homes for the usual period of three weeks is not only quite useless but is actually objectionable, in so far as the patient passes out of the hands of the surgeon who had the original charge of the case at a period at which it is inadvisable to make any change in the local treatment. It is extremely desirable that Homes to which tuberculous surgical cases can be sent, such as that in connection with Paddington Green Children's Hospital, should be established in con

nection with all the hospitals. The great advantage is that children can be kept there as long as may be necessary, and that appropriate local treatment can be carried out under the immediate supervision of the surgeon who originally operated upon the case.

This question of securing proper hygienic conditions for a patient not only affects the ultimate recovery, but also has an important bearing upon the treatment, because, when prolonged rest and other hygienic measures are out of the question, it is often advisable to undertake operative interference at an earlier date, and upon a wider scale than would be necessary in those able to afford the thorough and prolonged treatment sketched above.

Although the foregoing conditions are of the very greatest importance, they generally fail unless supplemented by careful local treatment. In the early stages of the disease, indeed, the local treatment is of greater importance than the general; should it be necessary to decide between the two, thorough local treatment should be practised first, and the general treatment carried out afterwards.

(b) **LOCAL TREATMENT.**—It will save repetition if we refer shortly to the various methods of local treatment first; we shall afterwards consider the applicability of each method to the various types of disease already enumerated.

Palliative measures.—In the first place, a number of methods of treatment are employed which do not act directly by destroying the tubercle bacilli, but indirectly by making the tissues better able to resist their attack. In a tuberculous joint there are not only tubercle bacilli and the peculiar tissue (viz. tubercles and tuberculous tissue) produced by their presence, but there is also much chronic inflammation of the tissues around, which is caused by the presence of the tuberculous tissue, and which in its turn paves the way for extension of the disease. It is by the production of this chronic inflammation in the tissues around that the tubercle bacillus overcomes their resistance and is thus enabled to prepare for itself a suitable soil for growth. The bacillus in many cases is unable to grow at all, or grows only with difficulty in contact with perfectly healthy tissues, but if the latter be weakened by a previous attack of inflammation or by injury (which plays its part by producing a certain amount of inflammation) the bacillus is able to grow with much greater freedom.

Against the co-existing chronic inflammation.—Hence where it is not deemed advisable to take radical measures to root out the tubercle bacilli and the tuberculous tissue, it is very important to try and subdue the chronic inflammation of the tissues around, so as to place the latter in a better position to resist the advance of the bacillus.

Indeed, the main feature of what may be spoken of as the "expectant" treatment of tuberculous joint disease, as opposed to the radical methods, is the employment of measures directed against chronic inflammation. We have already (see Part I., Chap. I.) discussed very fully the procedures

indicated in chronic inflammation, and we need here only say a few words as to their applicability in the affection we are considering.

Rest.—Quite apart from the presence of the tubercle bacillus, the chronic inflammation may be kept up by movement, by the presence of septic organisms, or by pressure of the diseased surfaces against one another. The first requisite therefore is to place the part absolutely at rest, and it is very striking to see the improvement that sometimes results from this even in very bad cases. The means adopted will vary with the joint affected, and will consist essentially in the application of suitable splints.

Extension.—In many cases of joint disease, however, particularly when the cartilages have been destroyed and the articular surfaces are carious, the inflammatory condition is not kept up so much by movement as by the tonic contraction of the muscles surrounding the joint, which press the inflamed bony surfaces against one another; in fact, one of the most prominent symptoms enabling the surgeon to diagnose extension of the disease to the bone is this fixation of the joint; in the early stages this is not due to any form of anchylosis but is brought about almost entirely by reflex contraction of the muscles surrounding the joint. The result of this is pressure of two inflamed surfaces against one another which keeps up the inflammation in the bone; rapid destruction of the bony surfaces which are in contact also takes place. This is well seen in the hip, for example, where there is flattening of the upper surface of the head and enlargement of the acetabulum upwards and backwards. It is very important to remember that this condition of contraction is almost pathognomonic of extension of the disease to the bone and destruction of the articular cartilages. In pure synovial disease there may be very marked swelling of the joint, but there will be comparatively little interference with movement within certain limits, and there will be nothing like complete rigidity.

Hence, when the bone is inflamed it will be impossible to obtain proper rest to the joint by any form of fixation apparatus. The muscles would still be able to contract and press the inflamed surfaces together and thus perpetuate the inflammatory condition. It is therefore necessary to combine with the immobilisation of the joint a moderate amount of extension of the limb; this should be just sufficient to tire out the contracted muscles, to cause them to relax, and thus to avoid the violent pressure of the inflamed surfaces against each other.

Many surgeons have strongly condemned extension, under the impression that the object was to actually separate the joint surfaces from one another, and they have pointed out that no real separation of the joint surfaces can be effected unless weights are employed heavy enough to inflict great injury upon the articulation by stretching and irritating the inflamed ligaments, and also to cause injury to healthy joints below. There is no doubt that this view is perfectly correct; but as actual separation of the joint surfaces is not the object of extension, and as its only aim is to tire

out the muscles and prevent them from pressing the inflamed surfaces together, only a very moderate weight is required to effect this, and the objections therefore fall to the ground.

When the case is one of pure synovial disease without marked rigidity of the muscles, there is no object in employing extension unless there be deformity; in fact, extension would almost certainly do harm by stretching the inflamed ligaments, and would thus keep up the chronic inflammation. On the other hand, when the bone surfaces have become affected, great and immediate relief usually follows the employment of a moderate degree of extension; the pain ceases, and the nocturnal startings, which are the most distressing symptoms of this condition, are overcome. It must, however, be remembered that an amount of extension which at first is necessary to relieve the patient's pain may, if it be continued after the tonic contraction of the muscles has been overcome, cause a recurrence of the pain from stretching of the diseased ligaments. It is not at all uncommon to find that, while a weight of about five pounds will at first relieve the pain in a case of joint disease in an adult, the pain will recur after a week or two as a result of the stretching of the inflamed ligaments after the muscular contraction has been overcome. A mistake commonly made in these cases is to think that the recurrence of pain implies that the contraction of the muscles has overcome the weight, and that the latter must be increased accordingly. It implies, on the contrary, that the contraction has been overcome, and that the weight is too great and should be diminished. That this is so is borne out by the fact that the recurrent pain is not accompanied by starting pains at night. It is therefore most important to watch the results of all cases in which extension is employed, and to reduce the weight as soon as it is evident that the muscular resistance has been overcome.

Counter-irritation.—Benefit is also derived in many cases from the employment of other measures which are of value in chronic inflammation unaccompanied by tuberculosis. Among these, one of the most important is counter-irritation, which, although a favourite remedy in chronic inflammation and formerly also in tuberculous joint disease, has been very much given up in the latter because it naturally could have no specific action against the tubercle bacillus itself. Its true therapeutic effect in diminishing the chronic inflammation has been much overlooked. The forms of counter-irritation which are of most value in these cases are blisters and the actual cautery. In pure synovial disease improvement sometimes follows the application of a succession of *blisters*, applied over or around the articulation, a fresh blister being applied as soon as the raw surface produced by its predecessor has healed. When, however, the bone is inflamed, and more particularly when the joint is deep seated, a much more effectual method is the application of *the actual cautery*. The most striking results are obtained from it in cases of hip and shoulder-joint disease, and in spinal caries. It does not seem to be of any particular

value in pure synovial disease or in the more superficial joints, such as the knee.

The cautery should be freely applied at a white heat, and should be passed rapidly two or three times over the skin; the burned area should be fairly extensive. In the spine, the cautery should be applied along each side of the spinous processes over the whole of the affected region. For the hip or shoulder joints, a burn two or three inches broad should be made in front of and behind the articulation. After the cautery has been used, warm boracic fomentations are applied until the slough has separated, when savin ointment, diluted with an equal part of vaseline, and mixed with 5% of cocaine or an equal quantity of orthoform should be used, and the sore thus resulting should be kept open if possible for about six weeks. The best results are probably obtained when only a superficial portion of the cutis is destroyed, and when, therefore, many nerve endings are exposed. The chief objection is, however, that it is very difficult to keep these sores from healing rapidly, whilst the savin ointment often causes so much pain that it has to be abandoned. When the sores heal too quickly they must be opened up again, either by a fresh application of the cautery or by potassa fusa. The cautery should of course be applied under a general anæsthetic, preferably, gas.

Free incision.—Another method of treatment, namely, free incision into the inflamed tissues, which we have already described in speaking of chronic inflammation, has also been used in tuberculous joint disease. In chronic periostitis of a non-tuberculous nature this is a most effectual remedy, and a good deal of improvement has followed free incisions through the thickened synovial membrane in cases of tuberculous joint disease. At the same time, however, there are other operative measures of greater value, and therefore simple arthrotomy, or free incision into the diseased joint, has practically been abandoned.

Pressure.—Pressure is also one of the methods employed to overcome chronic inflammation, and it is of considerable value in tuberculous joint disease. It is, however, mainly of use in cases of pure synovial mischief; it should be very carefully employed and must be given up if it produces pain. The usual method of employing it is by *strapping the joint with Scott's dressing*, *i.e.* unguentum hydrarg. comp. spread upon chamois leather; this is cut into strips about two inches wide and long enough to more than surround the joint. The skin should be shaved and the strips applied, overlapping each other, beginning below; as each strip is applied, considerable pressure should be brought to bear on it, just as in applying ordinary strapping. Scott's dressing ensures a combination of mild counter-irritation with pressure, and it is well to surround it with a mass of cotton wool, over which may be applied an elastic bandage, but the latter must not be tight enough to cause definite constriction.

A good substitute for cotton wool is the material known as silk waste, which has the advantage that it retains its elasticity longer than does the

wool. If preferred, a silicate bandage may be put on outside the wool instead of the elastic one, so as to maintain a constant steady pressure. The dressing should not be renewed oftener than once a week; in some cases it can be left a good deal longer. When it is removed the parts should be washed and shaved afresh.

Sometimes the Scott's dressing irritates the skin, and in this case its place may be taken by simple pressure applied through the medium of a mass of cotton wool or silk waste, fixed on by a silicate bandage; if this be put on sufficiently thickly the bandage may be pulled as tight as the surgeon can apply it without fear of causing undue pressure.

As a rule pressure is only of use when recovery is taking place; when the disease is active it is very likely to cause irritation and actually to increase the inflammation. Hence, it should not be employed in the initial stages of the affection. Massage, which is of much value in the later stages of simple chronic inflammation, is not permissible in tuberculous disease.

Injection of iodoform emulsion.—Lately the use of injections of iodoform and glycerine and the artificial production of venous congestion—the method known as Bier's—have been very much advocated, especially in Germany; the former method certainly often gives remarkably good results. The emulsion contains ten per cent. of iodoform, and in our opinion it is well to prepare it most carefully so as to insure freedom from micro-organisms, for iodoform is not an active antiseptic, and, although glycerine destroys septic organisms, it is hardly safe to trust entirely to its germicidal powers. We therefore recommend that the iodoform used for the emulsion should first be allowed to stand submerged in a 1-20 watery solution of carbolic acid for at least 48 hours, the bottle being frequently shaken so as to insure the free access of the acid to the powder. Instead of using pure glycerine for the emulsion, we are in the habit of adding to it a two-thousandth part of corrosive sublimate. The iodoform is strained from the carbolic acid, and is mixed with the glycerine in the proper proportion—ten per cent. The emulsion should be put in a sterilised bottle and allowed to stand for another 24 hours before use.

The emulsion is injected into the joint cavity, into the thickened synovial membrane, or into both, the amount employed varying with the age of the patient. In children the total amount used may be as much as from one to four drachms, whilst in adults double that quantity may be employed should the joint permit. Indeed, in joints that have been distended with fluid, a still larger quantity than this may be used, provided that the synovial membrane has not been scraped. No serious symptoms are likely to result from this, although no doubt they have followed the injection of large quantities of iodoform and glycerine into chronic abscesses. Poisonous symptoms may be due on the one hand to an excessive dose of iodoform, or on the other to the glycerine. The symptoms produced by iodoform are essentially mental disorder, delirium,

pyrexia, rapid pulse, spasmodic movements and the presence of iodine compounds and sometimes albumen in the urine. Glycerine alone, however, may produce rise of temperature, blood pigment in the urine, increasing rapidity of pulse, vomiting, restlessness, and stupor ending in coma.

In a superficial joint, such as the knee, a fair-sized needle should be introduced into the substance of the synovial membrane, and the emulsion injected into it in small quantities, a drop or two here and there, by means of a strong syringe. The point of the needle should be moved about all over the synovial membrane so as to distribute the emulsion. The needle should finally be made to penetrate the joint cavity itself, into which one or two drachms should be injected and left behind. In children anæsthesia is necessary as a rule, but in adults the injection can usually be made without it. It is not necessary to make more than two or three punctures through the skin: the needle can be pushed from one point to another subcutaneously.

The result is generally an increase in the swelling of the joint, and some pain, which, however, passes off in two or three days. The injection should be repeated about once a week, the frequency, however, mainly depending on the amount of reaction produced. It should be persevered with for a considerable time, until either it is evident that no good is resulting or until the case is well on the way to recovery. Should abscesses occur during this treatment they need not necessarily lead to its abandonment. They should be washed out and injected with iodoform and glycerine in the manner already described (see Part I., p. 247).

Krause has indicated the principal spots in the chief joints where injections can be most conveniently made. *In the wrist* the needle should be introduced below the styloid processes of the radius and the ulna; *in the elbow* it should be inserted over the head of the radius in front, and on each side of the olecranon behind; *in the shoulder*, either from the coracoid process in front or from the junction of the spine of the scapula with the acromion behind. *In the ankle* the most suitable spot is in front of or below the tips of the malleoli, the needle being thrust first inwards and then upwards (it may also if necessary be introduced behind on either side of the tendo Achillis); the best access to the *tarsal joints* is gained from the dorsum or sides of the foot. When it is desired to inject *the hip*, the thigh should be extended, adducted, and slightly rotated inwards and a long needle should then be entered above the great trochanter at right angles to the long axis of the thigh, and pushed in until it strikes the head of the femur, or the neck just beyond the head; it is then guided upwards along the bone until it enters the joint. Another method for the same purpose is described by Bünger as follows. A line is drawn to the tip of the great trochanter from the point where the femoral artery crosses the brim of the pelvis, and the needle is entered at the spot where this line crosses the inner border of the sartorius muscle. If pushed directly upwards it will enter the joint. The back of

the joint can be reached from the posterior border of the great trochanter. To inject *the knee*, the needle should be entered on each side of the patella and also in the supra-patellar pouch above it.

Bier's method.—This method, by which venous congestion of the joint is produced, has been much employed either alone or in combination with the iodoform and glycerine injections just referred to, and some surgeons have reported very good results from its use. Its object is to produce congestion of the parts and so to lead to the formation of fibrous tissue around the tuberculous area which will encapsule it and thus prevent its spread. We cannot say that we think this method one of very wide application, although it may well be employed for a time in combination with the iodoform injections. It can only be used advantageously for the joints below the hip and the shoulder.

The limb is first firmly bandaged from below upwards to within a few inches of the affected joint. Then an indiarubber bandage is wound over a boracic bandage around the limb above the joint sufficiently tightly to interrupt the venous circulation and to cause a distinct dull red discoloration of the skin. This congestion is maintained as long as possible; generally it may be kept up for from 14 to 18 hours out of the 24; when the bandage is removed, elastic pressure should be applied over the joint itself, so as to get rid of the resulting œdema. The site of the pressure must be varied from time to time so as to avoid ulceration of the skin. The method may be continued for several weeks, in fact, as long as good results are produced by it.

When chronic abscesses are present they should, when no further operative procedure is deemed advisable, be opened, washed out and treated in the manner already described for chronic abscess (see Part I., p. 247). When septic sinuses are present and no more radical measures are to be employed, they should be opened up, scraped out and stuffed with iodoform gauze.

Operative measures.—The operative measures called for in cases of tuberculous joint disease are: 1. *Arthrectomy*, or removal of the diseased tissues without more of the healthy structures around than is absolutely necessary.

2. *Excision*, consisting in the removal of all the diseased tissues and certain definite portions of the ends of the bones.

3. *Amputation*, by which the limb is removed well above the limit of the disease.

Both expectant and operative measures may be combined in many instances; when for instance an abscess is present, it may be washed out, injected with iodoform and glycerine, stitched up and the limb put on a splint. Again, sinuses may be thoroughly opened up, cleared out and stuffed with iodoform gauze, after which the limb is similarly immobilised.

Indications for operation.—The following are the chief points in determining whether expectant treatment or operative measures should be employed.

Operative treatment is desirable in the following cases: when chronic suppuration occurs early; when the disease is localised to one part of the synovial membrane or the bone; in many cases at a later stage, when there is a deposit in the bone with general synovial thickening; in cases of diffuse synovial thickening when expectant treatment has failed to arrest the progress of the disease; when a better functional result can be obtained by operative means than can be hoped for by expectant treatment; in adults with deformities which can be remedied only by operation; in many cases complicated by the presence of septic sinuses; in certain cases where phthisis is present, or where the general condition is such as to require immediate and complete removal of the local disease; in adults more frequently than in children; in the poor more often than in the rich.

Expectant treatment should be employed in cases of diffuse synovial disease without suppuration, where none of the indications already given for immediate operative interference are present; in children when there are osseous deposits in parts that cannot be reached without excision, as for example in the hip joint; and in some cases where septic sinuses are present. Much will also depend upon the joint affected; for example, in the hip joint expectant treatment should be presevered with much longer than in the more easily accessible joints.

Many circumstances will influence the choice of the particular operative method to be employed. The principal are the age of the patient, his general condition and the state of the joint itself. With regard to the last factor, the chief points are the presence or absence of chronic suppuration, the presence or absence of sinuses, and the distribution and character of the local disease.

The occurrence of chronic suppuration in connection with tuberculous diseases of bones and joints greatly increases the gravity of the case, and exercises an important influence on the treatment. It usually indicates a progressive form of the affection, whilst the abscesses, if large, and if not treated aseptically, may expose the patient to very great danger from decomposition of their contents and septic inflammation of their walls. So impressed are some surgeons with the unfavourable character of these cases that they recommend radical operations, such as excision or amputation, whenever there is suppuration. This is however going rather too far, and there is no question that, in certain instances, the disease may be recovered from without such severe measures if the abscess be treated by washing it out and injecting iodoform and glycerine on the lines laid down already in speaking of the treatment of chronic abscess (see Part I., p. 247).

In certain joints, in which the results of operation are functionally bad, it is as well, when the condition of the patient is otherwise good, to employ palliative measures before resorting to more radical ones. This is particularly applicable to disease of the hip joint.

The influence which chronic suppuration exerts upon the question of operative measures may be illustrated by the following examples:

1. *The abscess may be unconnected with the joint, but may arise from a tuberculous deposit in the end of the bone which has reached the surface outside to the joint.* Here there is no actual disease of the joint at all, and the best treatment, wherever it is practicable, is to dissect out the abscess, and to completely remove the deposit from the bone; when this is not practicable, the abscess should be laid freely open, as much of the wall removed as possible, and the rest scraped out.

2. *The abscess may be due to a tuberculous deposit in the bone which has reached the surface at the point of reflection of the synovial membrane on to it,* so that in addition to the abscess and the osseous deposit there is thickening of the synovial membrane. The treatment will here be the same as in the first example; the disease should be removed if possible, or at any rate the abscess should be thoroughly cleared out, and the deposit in the bone removed. Whether the thickening of the synovial membrane will require any further treatment will depend upon the local condition of the joint, and on various other circumstances, some of which will be alluded to presently.

3. *The abscess may have originated in connection with the synovial membrane, and may or may not communicate with the joint.* Here there is generally a tendency to caseation of the tuberculous tissue in other parts of the synovial membrane, and in most cases it is advisable not to limit the operation to the abscess itself, but to remove the joint disease along with it. This will necessitate complete arthrectomy in children and excision or amputation in adults. In the case of the hip or the shoulder joints, however, it may be advisable, even under these circumstances, to attempt first of all to treat the abscess alone by washing it out and injecting it with iodoform and glycerine before proceeding to the more radical operation.

4. *Pus may be present in the interior of the joint.* If the patient be young the joint should be laid freely open and the whole of the synovial membrane removed. Portions of the cartilage or bone should also be taken away, and careful search should be made for tuberculous deposits in the latter. In other words, complete arthrectomy should be performed. In adults, excision with complete removal of the synovial membrane is the best practice, unless the bones be extensively diseased or there be other conditions which necessitate amputation.

5. *There may be not only pus in the joint but abscesses around it.* The choice here usually lies between excision and amputation, and in most cases, particularly in old people, amputation is as a rule the better practice. In some cases, in children, it may be well to see what can be done by as thorough a removal of the tuberculous tissue as possible, but even in them the disease very frequently recurs, and amputation has to be resorted to.

6. *The abscess may have burst and have left septic sinuses.* The presence of these septic sinuses influences the operative treatment, not merely by rendering the disease more stubborn, but also by introducing the risk of various septic troubles; one of the radical operations already referred to will be therefore requisite. In some cases, in children, when only one or two sinuses are present and the joint is easily accessible, it may be justifiable to attempt a complete arthrectomy, guarding against infection by sponging the raw surfaces left with undiluted carbolic acid. In adults, also, excision may sometimes be attempted, provided the sinuses be few and the general condition of the patient good; the same precaution should be taken to disinfect the raw surfaces. In most cases in adults, however, especially when the sinuses are numerous, amputation is the best practice, and should be carried out wherever it is feasible.

Choice of operation.—The important question as to which of the three radical operations—arthrectomy, excision or amputation—should be performed in any given case next comes up for consideration.

Amputation.—Amputation may be dismissed in a few words, because no general rules can be made to apply to it. It is the least dangerous of the three radical operations and is accompanied by the least severe shock; in fact, nowadays no special danger attaches to it. Hence in weakly subjects who cannot stand a necessarily prolonged operation like an arthrectomy or an excision, but in whom some radical measure is nevertheless essential, amputation is the best practice. Similarly, when there is phthisis present, or when the patient is going steadily down hill, amputation is better than either of the other procedures. It is often very remarkable to see the improvement that takes place in the condition of the patient and even in the condition of the lungs after amputation through healthy tissues well above the seat of the disease. Similarly, should there be amyloid degeneration of the kidneys or other organs, amputation is the least dangerous of the radical operations. In adults, and especially in old people in whom there is much suppuration about the joint, or in whom there are numerous septic sinuses present, amputation should be preferred in the majority of cases. In the young, when the disease is extensive, and particularly when the bone is widely affected, amputation may be preferable to excision in some joints, such as the knee. When bad recurrence takes place after excision or arthrectomy, amputation is generally necessary. Beyond this, no general rules can be laid down; the decision must be made in each case according to the local condition and the general state of the patient.

Arthrectomy.—By arthrectomy is understood an operation in which the whole of the tuberculous tissue is removed with as little interference as possible with the surrounding healthy structures. In some cases this may merely mean a removal of the osseous deposit. Examples of this are found in cases where the deposit has not yet made its way into the joint and infected the synovial membrane. In other cases again it

involves a complete removal of the entire synovial membrane along with portions of the cartilage and even of the bone. As a rule a complete arthrectomy is a very extensive operation, and one requiring much patience and great care for its satisfactory performance. The whole of the diseased structures must be carefully removed by dissection. Scraping is quite inadmissible except over small areas, particularly in the cartilage, and, if employed at all, must be done with the greatest thoroughness.

As an example of the operation, we may take an arthrectomy of the knee, in which the entire synovial membrane is involved. The first essential is to expose the capsule as completely as possible, and this we are accustomed to do by means of two free longitudinal incisions, one on either side of the patella, and at a little distance from it (see Fig. 36); in the first stage of the operation we do not open the joint. The incision is carried down through the capsule, the limits of which are carefully defined, and then all the tissues superficial to the synovial membrane are dissected off, so that the entire extent of the membrane beneath the quadriceps extensor is thoroughly exposed. When the whole of the front part of the synovial membrane has thus been separated from the tissues above it, a similar dissection is carried out on each side as far back over the condyles as possible. In connection with this, it should be remembered that the folds of synovial membrane extend backwards for a very considerable distance. The lateral ligaments are then divided, and the synovial membrane separated from them.

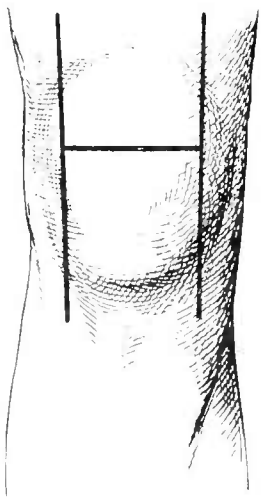


FIG. 36. — INCISIONS FOR ARTHRECTOMY OF THE KNEE. The longitudinal incisions should be very free. The transverse one joining them across the centre of the patella is not always necessary.

The dissection is then carried forwards as far as the edge of the patella on each side, and down to and behind the ligamentum patellæ. This exposes the whole of the anterior and lateral aspects of the synovial membrane, which is then detached all round at its point of reflection on to the bone and the cartilage, and is cut away with scissors on each side as far back as possible. This exposes the joint freely from the front, and a fringe of synovial membrane is then seen around the edges of the cartilages of the femur, tibia, and patella. This fringe is carefully cut away with scissors or a knife.

Access to the posterior part of the joint may, if necessary, be gained by connecting the two longitudinal incisions by a transverse one across the centre of the patella, completed by sawing that bone transversely. Usually, however, we find that if the vertical incisions be made long enough, it is not necessary to add this transverse one, as, by dislocating the patella first to one side, and then to the other, free access can be gained to the whole interior of the joint. The next step is to divide the crucial liga-

ments and thoroughly clean them, or, if they be much destroyed, to remove them entirely; special attention must be paid to the condition of the parts in the inter-condyloid notch, which must be cleaned out as thoroughly as possible right down to the posterior ligament. The joint is then flexed as fully as possible, the semilunar cartilages are removed, and the dissection of the synovial membrane at the back of the joint is resumed. It is, as a rule, quite easy to define the outer surface of the synovial membrane on each side, and to separate it from the capsule; when this has been done, the separation backwards is gradually effected by the finger and some blunt dissector. This separation is continued until the points of reflection of the capsule posteriorly on to the femur above and the tibia below are met with, when the synovial membrane is cut off along these lines, and the fringe left around the cartilages is carefully removed.

After having thus removed all the diseased synovial membrane, the articular ends may be easily protruded through the wound, and the cartilage can be thoroughly examined. Any depressions seen upon the surface should be carefully cleaned out, either with the knife or a small sharp spoon, and any portion of the cartilage that is thinned or loosened should be freely removed, together with a slice of a quarter of an inch or so of the bone beneath. Very frequently the cartilages are covered with a thin layer of soft vascular tissue, which must be removed entirely, either by scraping the surface with the edge of the knife or by scrubbing it with a stiff nail-brush. Wherever the cartilage has been destroyed, a layer of the carious bone, about a quarter of an inch in thickness, should be taken away; this can generally be done with a knife. Of course, should there be a hole anywhere, either in the cartilage or in the bone, leading to a deposit in the articular end, it must be thoroughly cleared out.

After having ascertained by fresh inspection that all the disease has been removed, the wound is closed, the crucial ligaments, if left, being stitched together, and the patella, if divided, wired. A drainage tube is seldom necessary, but, should it be decided to employ one, it should only be left in for two or three days. The limb is put up, with the knee fully extended, in a trough of Gooch's splinting.

We are of opinion that it is better in these operations to avoid the use of a tourniquet; when it is not employed it is distinctly easier to distinguish the diseased tissues from the healthy ones, the pulsation of the popliteal artery can be felt—a point of great importance when dissecting out the synovial membrane posteriorly — and the after-oozing is distinctly less.

After the wound has healed, the limb should be put up on a straight back splint, and no passive movement at all should be attempted. There is no likelihood that, after a free and extensive operation such as this, any great amount of movement will be gained, whilst there is a constant tendency in children for the knee to become flexed, and therefore a

suitably moulded apparatus, designed to keep the limb straight, should be worn for a long time, sometimes for many years.

Excision.—Our present knowledge teaches that the synovial membrane must be removed in this operation with as much care and completeness as in arthrectomy. In addition, however, the ends of the bones are sawn off, and all the cartilage-covered surface is freely removed, so that the operation is shortened, and the chance of leaving disease behind is diminished. The operation will be described in detail when we speak of excisions of the individual joints; here it will be sufficient to discuss the relative value of the two operations, and the points which will determine our choice.

The choice between arthrectomy and excision.—The first point of importance is *the relative danger of the two operations.* The chief risks arise from shock and loss of blood, but these are nearly equal in the two cases. A further risk, namely, *the possibility of dissemination of the disease throughout the body*, is possibly somewhat greater in arthrectomy than in excision; it is certainly greatly increased if scraping be employed in place of clean cutting. There is, however, not a sufficient preponderance of danger in one operation over the other to influence our choice.

A second point is *the chance of successfully eradicating the disease.* It must be admitted that recurrence is less likely to occur after a properly performed excision than after an arthrectomy; in the latter it is always difficult to be sure that the disease is entirely removed from the margins of the cartilages, as small fragments of synovial membrane containing tuberculous tissue may be readily overlooked in this situation, and also in the recesses of the joint, such as the inter-condyloid notch in the knee, the olecranon fossa and the neighbourhood of the orbicular ligament in the elbow, etc. In an excision these parts are effectually cut away. Deposits in the bone are also more likely to be overlooked in arthrectomy than in excision, although even in the latter operation they may occasionally be missed. Nevertheless, experience shows that the greater the care with which the operation is done, the better is the result, and when arthrectomy can be performed, it is on the whole a very satisfactory operation.

The third point for consideration is *the ultimate utility of the limb.* When the cartilages are left intact, bony anchylosis after arthrectomy will not occur, and a certain amount of movement will sometimes be retained, especially if the joint has not been kept at rest too long. In the case of the upper extremity and in the ankle and the hip this is a matter of considerable importance; in the knee on the other hand it is seldom that a satisfactory movable joint can be obtained, and no doubt the joint left after arthrectomy is weaker and more apt to become badly flexed than is the firm anchylosed one obtained by excision. In the latter operation the after-mobility depends in most cases on the amount of passive movement employed, and a perfectly firm joint can of course be obtained when desired.

Besides mobility, another question of the highest importance has to be considered, namely, *the subsequent development of the limb*; this is a matter of such immense importance in children as to practically outweigh all other considerations. In this respect arthrectomy is far more favourable than excision. There should be no interference with the growing portions of the bones in a properly performed arthrectomy unless a deposit actually involves the epiphyseal line, and there should be consequently no arrest of development. In excision in children, on the other hand, the results in this respect are very bad, and in them excision—of the knee joint particularly—is contra-indicated, as it is practically impossible to do a satisfactory excision without interfering with the subsequent growth of the limb. Even after excision of the hip very serious shortening may occur; in some cases indeed there has been as much as eleven inches by the time the child has attained adult life.

The conclusion with regard to the choice between arthrectomy and excision which seems warranted by all the facts is that arthrectomy is the proper radical operation up to sixteen or eighteen years of age, and excision is the operation of choice after that. Exceptions as regards arthrectomy in adults may be made in connection with the diseases of certain joints, particularly the ankle; these will be dealt with later.

SPECIAL POINTS IN THE TREATMENT OF THE VARIOUS STAGES.

We shall now summarise shortly the methods of treatment most suited to the different local conditions already enumerated (see p. 113).

1. Localised tuberculous deposits in the bone which have not yet reached the joint. Unfortunately these cases are but rarely met with in practice, mainly because the patient does not realise that there is anything serious the matter until the joint itself becomes affected. Even when such cases do come under observation, it is extremely difficult to recognise the deposits at an early stage. The chief points in the diagnosis have already been referred to, namely, a localised thickening of some part of the epiphyses of the bones entering into the joint, unaccompanied by marked pain or tenderness, and occurring after some slight accident in a patient who either has a tuberculous family history or is the subject of tuberculosis elsewhere; this thickening tends to increase steadily.

Cases in which the existence of the deposits can be diagnosed do sometimes come under notice sufficiently early, and then the point for consideration clearly is whether it is possible to *remove the deposit* before the joint is affected. In a superficial and easily accessible joint very successful operations of this kind have been frequently done.

It is essential that the joint itself should not be opened, as otherwise it may be infected during the removal of the deposit. The incisions should therefore be planned so as to avoid wounding the synovial membrane; at the same time, however, they must be sufficiently free to

give full access to the affected region. After the bone has been exposed, the periosteum is detached, and then the dense outer shell of the bone is cut away with a gouge over the affected area. When this has been done, the cancellous tissue can usually be readily scraped out with a sharp spoon or one of Barker's flushing gouges, and should be removed until the deposit is reached. Tuberculous tissue is generally easily recognised by the presence of cheesy material; in most soft deposits of any size caseation occurs fairly early. In other cases it is possible to recognise it by its semi-gelatinous character and by the absence of bone trabeculæ. A sequestrum is recognised by the dense, yellow, hard, bony mass in the substance of the cancellous tissue.

When the deposit has been entirely scraped out, a piece of sponge should be packed firmly into the cavity in the bone and kept there until the oozing is arrested. Another small piece of sponge is now dipped in undiluted carbolic acid and, while the edges of the wound in the soft parts are held widely open, the larger piece of sponge is removed and the smaller one is substituted for it. As this application is immediately followed by some oozing which tends to dilute the acid, the procedure should be repeated two or three times, a fresh piece of sponge being introduced to soak up the discharge, and immediately after its removal another dipped in pure carbolic acid being inserted.

The cavity in the bone should next be washed out with a 1-2000 sublimate solution, and then some of the 10 per cent. iodoform and glycerine emulsion (see p. 120) is introduced and the wound stitched up without a drainage tube.

Should the operation have been successful, the wound heals by first intention and the cavity in the bone gradually fills up with fibrous tissue which ultimately undergoes ossification, and the disease is thus eradicated. In order to favour organisation of the clot which forms in the bone cavity after stitching up the wound, the limb should be kept on a splint for several weeks. Unless this be done, the blood-clot will run the risk of being broken up by the movements, and a quantity of serum will have to be let out; this will of course interfere with the rapid filling up of the cavity.

In some cases the presence of a tuberculous deposit may be suspected in bones that are not readily accessible and where therefore there is no question of immediate operation. In these cases complete rest should be insisted upon, together with the application of splints. It is well also to employ counter-irritation by the actual cautery over a considerable area in front of or behind the joint. Full details as to its application and the after-treatment have already been given (see p. 119). In a certain number of cases the cautery seems to arrest the disease; it probably does so by causing a subsidence of the inflammation around the deposit in the bone, which finally becomes encapsuled.

2. **Cases of localised deposits in the synovial membrane.**—This is also

a rare form of tuberculous disease, in the diagnosis of which there is often great difficulty. The deposits may occur either as more or less pedunculated masses hanging into the joint (as described by König), or as simple localised thickenings of the synovial membrane.

The pedunculated masses are very difficult to diagnose, but their nature may be suspected when, in tuberculous patients, irregular masses are felt resembling a fatty tumour more than a loose cartilage. It is more common to find *localised thickenings* of the synovial membrane, and when this condition occurs without any definite cause in tuberculous subjects, its true nature may be strongly suspected.

If these cases be not operated upon at once, the thickening steadily spreads, until finally the whole synovial membrane becomes involved, and the case is then one of typical tuberculous synovial disease. The condition may be met with in any joint, but we have most frequently observed it in the elbow, particularly in the neighbourhood of the head of the radius. It is possible that it has been most frequently noticed in this situation, because a certain amount of interference with the radio-ulnar articulation occurs very early, and so the patient is led to seek advice; whereas should it commence in any other part of the joint, there is less interference with movement, and attention is not called to it until the disease is much more widespread.

The obvious *treatment* is to cut down and remove the mass, whether it be pedunculated or merely a localised thickening. It is well to employ a curved incision, so as to turn aside a flap of the skin and subcutaneous tissues, and then the whole of the thickened tissues, along with a portion of the healthy synovial membrane all round, must be cut away; this is best done with scissors. In a number of cases, particularly in the elbow joint, the result is extremely satisfactory, with no recurrence of the disease and with a perfectly movable articulation.

3. Cases of empyema tuberculosum and hydrops tuberculosus.—Special attention has been called by König to the fact that tuberculous disease of joints sometimes commences as a rapid effusion of fluid into the joint, which in some cases is of the semi-purulent, flaky nature so characteristic of tuberculous pus; in other cases the fluid is clear. He has therefore applied the terms empyema tuberculosum and hydrops tuberculosus to these affections. At first sight it is easy to mistake the case for one of chronic synovitis with effusion, as there is usually no marked pain, although generally there is more than is met with in the latter condition. The diagnosis is generally arrived at by observing that after a short time the synovial membrane begins to get thickened. This is in marked contrast to the simple hydrops articuli, in which the effusion may exist for a very long time without any distinct thickening of the synovial membrane.

The *treatment* should generally be operative. The simplest plan consists in withdrawing the fluid by a trochar and cannula, washing out the joint with a weak sublimate solution (1-6000), and injecting into it two to four

drachms of the 10 % iodoform and glycerine emulsion (see p. 120). Should the fluid re-accumulate, this procedure may be repeated, and in any case the iodoform injections should be repeated once a week. At the same time the limb must be placed on a splint, and the general treatment of tuberculosis attended to.

Should it be found in the course of a few weeks that the disease progresses, it will be necessary to resort to arthrectomy if the patient be a child, or to excision if an adult. The cases which commence with the effusion of a semi-purulent fluid into the joint are usually grave, and imply considerable malignancy of the bacilli.

4. Cases in which an osseous deposit has burst into the joint.—Here a more or less acute infection of the synovial membrane has taken place, and the patient has an acute affection of the joint marked by great tenderness, pain on the slightest movement, starting of the limb at night, and all the symptoms formerly described under the term "ulceration of cartilage." On examining into the history, it will usually be found that, for some time previous to the sudden onset of pain, the patient has limped and complained of a feeling of weight, uneasiness, or actual pain in the limb.

The *treatment* depends to a very considerable extent on the general condition of the patient, his age, the particular joint affected, and so forth. Expectant treatment usually gives very unsatisfactory results, and it is only in joints such as the hip, which are not readily accessible, or when the patient is not in a condition to stand a long operation, that the surgeon will be tempted to employ it. By expectant treatment is meant the use of splints, extension, counter-irritation, and the injection of iodoform and glycerine into and about the joint. Should it be decided to employ it, it should be remembered that at best a stiff joint will be obtained, and that the limb should therefore be put up in such a position as to be most useful to the patient when anchylosis occurs.

It is in some of these cases that the actual cautery applied over deep-seated joints, such as the hip or the shoulder, is of most value. A patient, after suffering agonies from starting pains at night in spite of careful fixation of the joint on splints or extension, will often lose the pain immediately after the application of the cautery. It is, however, not infrequently found that, should the wound be allowed to heal too soon, the pain very quickly recurs.

When improvement does not follow in spite of local treatment, or when the joint is one of those in which free mobility can be counted upon as the result of operation, it is advisable to have recourse to operative measures at once; the choice will lie between arthrectomy, excision, and amputation. The meaning, value, and relative uses of these have already been discussed (see p. 125), and the conclusion there arrived at is that arthrectomy is the proper operation for children in all cases except those that are sufficiently grave to render amputation imperative, whilst for

adults, excision is the best method, with the possible exception of the ankle joint, in which arthrectomy may be recommended. In weakly individuals, elderly subjects, or in cases where the joint disease is very extensive, or where there is tuberculous disease elsewhere, amputation will be called for.

5. General synovial disease without destruction of the cartilages or inflammation of the bone, and without abscesses.—These cases are the most satisfactory from the point of view of expectant treatment, and there is no need to consider the question of operation until it is evident either that no progress is being made or that the local disease is extending. An exception, however, may be made in the case of bread-winners, to whom it is imperative to get back to work within a reasonable time; in them it may be necessary to resort to operative measures earlier, so as to restore them to health more rapidly. When the patient is well-to-do and can afford plenty of time, the first thought should always be of palliative measures. The hygienic, dietetic, and medicinal treatment should be attended to (see p. 114).

In the local treatment, the first point is fixation of the joint without extension. Besides this there is the choice between injections of iodoform and glycerine, Bier's congestive method, counter-irritation, and pressure. On the whole it is perhaps best to begin with pressure, which can be most conveniently exerted in the majority of the joints by Scott's dressing (see p. 119). Should no improvement take place in two or three months, iodoform and glycerine injections should be resorted to, combined in the less severe cases with Bier's congestion method (see p. 122).

It is essential to remember that in all these cases of synovial disease many months at least must elapse before the case can be considered cured; indeed it is better to reckon the time in years than in months, and two or three years should be looked upon as quite a short limit. Should the treatment be abandoned too soon and the patient allowed to move the limb freely or to bear weight upon it, the disease is almost certain to recur, when it will probably take a much worse form than in the first instance. It is far better to err on the side of waiting too long than to run the risk of a recurrence. The chief difficulty in carrying out prolonged treatment of this kind is that the patient is afraid that the limb will become stiff, and while this is no doubt frequently the result, it must be impressed upon him that it is more or less unavoidable; at the same time, however, it is found that in many cases in which the disease has undergone arrest before destructive changes are very far advanced, considerable movement and in some cases even a perfect joint results. This is far more likely to occur after prolonged rest than after attempts have been made to keep up movement during the treatment. As long as movement is allowed, inflammation will continue, and fresh cicatricial tissue will continue to form, so that there will be more adhesions inside the joint and greater contraction of the fibrous structures outside. If the joint be kept properly

at rest, the inflammation will subside quickly, and there will be less formation of cicatricial tissue which will stretch rapidly under the natural movements.

The most important point to bear in mind after recovery is that it is never permissible to attempt to forcibly restore movement. Although the "cure" of tuberculous joints is commonly spoken of, recovery is seldom complete. In the great majority tuberculous material still remains, and, having undergone encapsulation, it gives no trouble so long as no fresh injury occurs. These deposits may remain quiescent indefinitely unless forcible movements be employed, when there is very great risk of opening up the deposits and lighting up the disease once more. Patients are frequently met with who, having suffered in early life from tuberculous joint disease, and thinking that it is time for movement to be improved, go to a bone-setter and have the joint forcibly moved, with the result that the disease recurs in a worse form than before.

When, in spite of careful treatment on these lines, it is obvious that no progress is being made, or when the occurrence of pain or rigidity points to extension of the disease to the cartilages and the bone, operative interference is indicated. Here again the particular operation chosen will depend upon the circumstances of the individual case, arthrectomy being employed for children, excision for adults, and amputation for weakly, phthisical, or very elderly people. The operation should not be long delayed unless it is fairly certain that recovery will take place, for, after all, the results of arthrectomy in children for pure synovial disease are extremely satisfactory, as also are those of excision in adults. Should the operation be too long delayed, these satisfactory results will be impossible, and the only available treatment may be amputation.

6. Cases complicated by unopened abscesses which may or may not communicate with the joint.—Operative measures must here be undertaken at once, because the chance of absorption of the abscess is extremely remote, whilst the risk of its spreading in undesirable directions is very great. The important point for consideration is whether it will not save time, and also be of advantage to the patient, to combine some of the more radical operative measures, such as arthrectomy or excision, with the treatment of the abscess. The decision will depend to a considerable extent on the joint affected, on the local condition, particularly with regard to the number of the abscesses, and on the general condition of the patient. In the hip joint, for instance, it must be remembered that excision does not give a particularly good functional result, and, should only a single abscess be present about the joint, and should the patient be in good health, it is usually best to treat the case on the lines laid down for the treatment of chronic abscess (see Part I., p. 247), without resorting to the more severe operation of excision until it is evident that this is absolutely called for. Something like 70 % of cases of hip joint disease accompanied by a single abscess may thus be cured. On the other hand,

should there be a number of abscesses present, and should the patient be in bad general health, excision of the joint, with as complete a removal of all the diseased structures as possible, is preferable to merely treating the abscess and leaving the primary disease alone.

In the more superficial joints, on the other hand, such as the knee, where it is possible to dissect out the abscess, it is usually best to go on at once to the more radical operation. In most of these joints the functional result after arthrectomy or excision is as good as, or indeed better than can be obtained by expectant treatment, and the length of time required, and consequently the risk of serious complications is very much diminished by the more thorough method. An additional argument in favour of a radical operation under these circumstances is that the formation of an abscess in connection with a tuberculous joint indicates that there is a strong tendency to breaking down of the tuberculous tissue, and that in all probability similar caseating processes are going on elsewhere, and therefore the chances of recovery by natural means are correspondingly less.

The rules already laid down (see p. 125) as a guide to the choice of a radical operation apply here as elsewhere, but perhaps amputation will be more frequently called for than in the other types of the disease, as it is not uncommon to meet with a number of abscesses about the joint, with pus burrowing in various directions; for this condition the only operation that affords a really good chance is amputation. To excise the joint or to perform arthrectomy without removing the abscesses completely would of course be futile, because the cut surfaces would become infected afresh. But the length of time required for the removal of extensive and numerous abscesses will be so great as to jeopardise the patient's life from shock or loss of blood; hence amputation is more frequently indicated.

7. Cases complicated by septic sinuses.—Here, as a rule, operation is called for. In young children in whom there is no actual sequestrum or bony deposit, healing may however occur, even though septic sinuses be present, if the limb be thoroughly fixed and free drainage provided. In children this should therefore be done unless there be some reason to the contrary. The limb should be properly immobilised, free drainage provided by opening up the sinuses as far as may be necessary, and the child should then be placed under the best hygienic conditions. The treatment of septic sinuses in connection with the tuberculous process has already been referred to (see Part III., p. 201).

Should it be found, however, after a reasonable time, that the sinuses show no tendency to heal, and should the discharge from them be free, one of the radical operations must be considered. This will be more called for in adults, especially in old people, in whom there is very little likelihood of the sinuses healing.

At first sight it would seem that arthrectomy is out of the question

because the large raw surfaces left after the operation might be exposed to serious septic inflammation by infection from the sinus. At the same time we have found, as a matter of experience, that if care be taken to scrape and disinfect these sinuses with undiluted carbolic acid before commencing the operation, and then to dissect them out along with the rest of the tuberculous tissue, the chances of sepsis are very slight, particularly if the wound be afterwards sponged over with undiluted carbolic acid, and a very satisfactory result can be obtained. Therefore, contrary to our original opinion, we now hold that the presence of septic sinuses in children is no contra-indication to arthrectomy.

With regard to the choice between excision and amputation, that will depend upon the number of sinuses, on the amount of sepsis present, on the general condition of the patient, and on the presence or absence of tuberculous disease elsewhere. In all cases when the patient is unlikely to stand a prolonged operation, excision is of course out of the question, for the removal of the septic sinuses adds considerably to the length of the operation, and consequently increases the shock and loss of blood.

8. Cases accompanied by anchylosis and deformity with or without sinuses.—These cases occur when the disease has been neglected, or where splints have either not been applied or have only been imperfectly used. The limb may be quite useless from mal position, and the treatment of this complication will depend very much upon the stage at which the disease has arrived, for the case may come under notice either while the disease is still active, or after it has completely subsided and only the deformity is left.

When the disease is still active and there is marked deformity, an attempt may be made either to restore the limb to its proper position by mechanical means, or operative measures may be employed. In the early stages, when the deformity is comparatively slight, it is quite justifiable to attempt to restore the position of the limb by the employment of suitable splints or other apparatus, but in doing this, great care must be taken to rectify the mal-position extremely gradually, and not to employ any force. Cases are not at all infrequently met with where the deformity has been forcibly reduced as a preliminary to further treatment. The result very commonly is that marked exacerbation occurs, and, instead of pursuing a favourable course, the disease passes rapidly on to disorganisation of the joint. Any mechanical attempts to restore the position of the limb during the active stage must therefore be made very gradually and gently, and much can usually be done either by allowing the weight of the limb itself to tell—as is done by Thomas's splint in flexion of the hip joint—or by the employment of very gentle extension either by weights or by elastic bands.

When, however, the disease is more active, there is considerable risk in attempting to restore the limb to its proper position by this means, and under these circumstances the question of operative interference must be

put in the foreground. In cases of active disease with mal-position in children, the best treatment in most cases is to perform arthrectomy, if the joint be accessible. By so doing, the disease is not only removed and the patient cured, but it is generally found that the limb can be readily restored to its normal position. Should there still be an obstacle to re-position after arthrectomy, it is usually caused by a contracted tendon or band of fascia which can be divided. It is necessary to employ a fresh knife for the tenotomy so as not to infect the tendon sheath. In adults, excision should be employed, and if the deformity be great, the limb may generally be brought into good position by removing an extra amount of bone.

When the disease is entirely cured and merely a deformity is left behind, suitable operative measures for the deformity should be employed. These will be excision in adults or arthrectomy or osteotomy in children. The choice between these operations, however, depends so much upon the particular deformity present that we cannot discuss them here

CHAPTER XIV

SYPHILITIC AFFECTIONS OF JOINTS.

During the course of syphilis various joint affections may be met with; they occur during the secondary or the tertiary stage, and are sometimes met with in hereditary syphilis.

JOINT AFFECTIONS DURING THE SECONDARY STAGE.

Two forms of joint trouble are met with during the secondary stage. About the period when the earliest secondary symptoms manifest themselves, it is not uncommon to find the patient complaining of indefinite pain in a joint and a little stiffness, unaccompanied by any marked tenderness on pressure, but generally associated with pains in the bones and muscles. There may be some effusion into the joint, with a certain amount of fever, and several joints may be affected. It is probable that the affection is simply a congestion of the synovial membrane and the other joint structures very similar to the congestive eruptions on the skin.

In the later stages of the secondary period, true synovitis with effusion is sometimes seen. This commences slowly and painlessly, and is accompanied by slight stiffness followed by swelling due to effusion; this, though usually moderate in amount, may sometimes be considerable. The affection is most frequent in the knee, and is not uncommonly bi-lateral. The effusion consists of a clear serous fluid, and there is no tendency to suppuration, nor are there any signs of acute inflammation. A marked characteristic of this secondary syphilitic synovitis is its intermittent character; at one time the joint may be markedly distended, whilst a few days later the fluid may have entirely disappeared; then again, for no known reason, the fluid reappears.

Treatment.—In the joint affections in the early stages of the secondary period, the treatment consists essentially in the *administration of mercury* (see Part I., p. 232). Later in the secondary stage it is of advantage to combine iodide of potassium with this drug.

Pressure is often useful, and may be applied by means of Scott's dressing (see p. 119); it is also well to fasten the joint for a few days upon a suitable splint. When the fluid has disappeared, an *elastic bandage* applied over a mass of cotton wool or silk waste (see p. 119) should be substituted for the splint.

When the effusion continues in spite of anti-syphilitic treatment and the application of local pressure, *counter-irritation* is advisable; this may be effected by a succession of blisters (see p. 118). It is very rare to meet with adhesions in the joint, but, should they occur, they are easily overcome by massage.

JOINT AFFECTIONS DURING THE TERTIARY STAGE.

At this period there may be a deposit of gummatous material either in the synovial membrane or in the sub-synovial tissues. It is most common to find definite nodules or gummata, but occasionally there is a diffuse gummatous infiltration of a part or the whole of the synovial membrane.

When left untreated, these gummata extend on the one hand towards the interior of the joint, and on the other towards the skin, so that finally the skin may give way and leave a typical tertiary syphilitic ulcer extending down to the joint, with which there may actually be a communication. This allows of septic infection, and acute arthritis results.

In the rarer forms, marked by diffuse gummatous infiltration of the sub-synovial tissue, the joint becomes enlarged somewhat irregularly, and the synovial membrane is apparently thickened, so that it may be difficult to distinguish the condition from tuberculosis. The syphilitic thickening, however, is not so uniformly diffused over the whole joint as is the tuberculous lesion, and movement, although restricted, is unaccompanied by pain.

Gummata may also be met with in the epiphyseal ends of the bone, and may open into the joint and cause swelling of the synovial membrane and effusion into the joint. In some very rare cases, moreover, the symptoms which accompany this communication with the joint are fairly acute, and are not at all unlike the result produced by the bursting of a tuberculous deposit into the joint (see p. 113).

Treatment.—(a) **General.**—The most important point is of course to adopt the general treatment suitable for tertiary syphilis (see Part I., p. 235). Large doses of iodide of potassium, commencing with fifteen grains and rapidly going up to thirty or forty, should be administered thrice daily, and this may be advantageously combined with doses of half a drachm to a drachm of the liquor hydrarg. perchlor.

(b) **Local.**—A certain amount of local treatment is also valuable. Benefit will be obtained by applying *mercurial ointment* over the joint, which may be done by rubbing half a drachm of the ointment well into the skin, and then putting on a mass of wool with an elastic bandage, so

as to combine pressure with the mercurial application. It is also well to apply a splint during the early stage; this is more especially called for in the knee joint. This treatment often suffices to cure the disease, but sometimes very rebellious tertiary joint lesions may improve up to a certain point under large doses of iodide of potassium and then come to a standstill. This is more likely to be the case when there is an extensive deposit in the bone rather than an affection of the synovial membrane, and the question of operative interference will then have to be considered.

Operative Measures.—These have been discussed in connection with syphilitic diseases of bone (see Part III., p. 204, and also Part I., p. 236). Should there be a syphilitic ulcer communicating with a gummatous deposit, it will certainly be advisable to scrape away as much of the gummatous material as possible, and to remove any actually diseased bone or any sequestrum that may be present. The internal remedies must be persevered with at the same time. In this way the quantity of morbid material that has to be removed by the agency of the drugs is very much diminished, and the prospects of a speedy cure proportionately increased.

JOINT AFFECTIONS IN HEREDITARY SYPHILIS.

It is not at all uncommon for a joint to become affected in hereditary syphilis as the result of the inflammatory condition of the articular ends of the bone known as osteo-chondritis (see Part III., p. 205). As a rule there is simply some effusion into the joint cavity without any definite syphilitic affection of the joint structures; sometimes, however, there may be a deposit of gummatous material in the synovial membrane. The condition most usually occurs in the knee, generally on both sides, and it may or may not be associated with the presence of gummata in the epiphyses.

Treatment.—This is essentially that already described for hereditary syphilis (see Part III., p. 205 and Part I., p. 236). The treatment usually results in complete recovery.

SYPHILITIC DACTYLITIS.—There is a not uncommon affection termed *dactylitis syphilitica*, which occurs in hereditary syphilis and which is apt to be confounded with the strumous form. In syphilis, however, the affection is primary in one of the joints, whereas in the strumous variety it is essentially an osteo-myelitis of the phalanx. Syphilitic dactylitis is usually multiple, affecting the joints in several fingers, and giving rise to a fusiform swelling, the centre of which is opposite the affected articulation. It is due to a gummatous infiltration of the synovial membrane and yields readily to the treatment proper to hereditary syphilis.

CHAPTER XV

NERVOUS AFFECTIONS OF JOINTS.

AFFECTIONS DUE TO ORGANIC LESIONS OF THE NERVOUS SYSTEM.

In certain cases of disease or injury of the spinal cord or the main nerve trunks certain peculiar and characteristic affections of the joints are met with which are clearly the result of the nervous lesion, and which, as trophic nerves have not yet been demonstrated in joints, are possibly due to vaso-motor disturbances. These affections are most frequent in connection with locomotor ataxia, when the joint trouble receives the name of "Charcot's Disease." They are also common in cases of syringo-myelia. Joint affections have also been noted in connection with other nervous lesions; they occur in some cases of hemiplegia, after injury to the spinal cord, and particularly in connection with injury or inflammation of the main nerve trunk supplying the articulation. In these latter cases the affection usually occurs in the smaller joints such as the fingers, and consists of painful swellings followed by stiffness, and sometimes complete anchylosis, or by more or less complete disorganisation of the articulation.

CHARCOT'S DISEASE.—This affection is practically identical with that met with in connection with syringo-myelia. In locomotor ataxia the joints most frequently affected are those of the lower extremity and especially the knee and the hip; the disease may be monarticular or may affect two or even more joints. It generally occurs at quite an early stage of locomotor ataxia before the onset of the ataxic symptoms. In syringo-myelia, on the other hand, the affection attacks the joints of the upper extremity much more frequently than those of the lower; the shoulder is its most common seat.

Pathological changes.—Among the most striking features of Charcot's disease are the marked and rapid atrophic changes in the articular ends; the cartilages disappear and the bone beneath often becomes so destroyed and altered in shape as to entirely alter the

appearance of the joint. Along with these atrophic changes there is sometimes a tendency to hyperplasia, and new bony outgrowths are met with at the articular edges of the bones, or masses of bone are deposited in the capsule. The relative amount of these changes is influenced largely by the joint affected: in the hip and shoulder, for example, the changes are essentially atrophic, and there is but slight formation of new bone; in the knee and the elbow, on the other hand, and more particularly in the latter, the atrophic changes, which at first are as marked as in the former cases, are followed later by a considerable hyperplasia, and a large amount of new bone may be formed and may help to fix the articulation.

Symptoms.—The most marked characteristics of Charcot's joint disease are the rapidity with which the changes occur—so that the joint may be entirely disorganised within a few days—and the extraordinary painlessness of the whole process. The first symptom is usually sudden swelling of the joint, to which the patient's attention is called by finding that the joint is somewhat stiff. The swelling is mainly due to synovial effusion, but there may also be considerable œdema of the structures around; sometimes the synovial membrane is so distended that it gives way and the fluid diffuses outside the joint. In a few weeks the effusion begins to disappear, but considerable enlargement of the articulation usually remains.

Very soon after the onset of the disease, examination shows that the ends of the bones have undergone the most remarkable alterations. There is coarse, bony grating on moving the joint, while the normal outlines of the bones are quite lost. The ligaments undergo destruction to such an extent that a flail joint results, and the limb can be moved freely in abnormal directions, whilst it is often possible to produce dislocation and to reduce it quite easily; all this causes no pain. When the patient has been bearing weight upon the limb, the greatest destruction of bone will be found at the points of greatest pressure. In the cases accompanied by a tendency to hyperplasia, bony outgrowths will be found after a short time springing from the edges of the articular surfaces and imbedded in the capsule: if this process be extensive, sufficient fixation of the joint may occur after the lapse of some time to enable the patient to bear weight upon the limb.

Complications.—The most important is *septic infection*. It is not uncommon for the capsule to give way, and after a time the skin also, so that there is a sinus leading into the joint, and suppuration may result. It is, however, a remarkable fact that in a considerable number of cases in which no antiseptic precautions have been adopted, suppuration either does not occur, or, when it does, is only very slight, and is not marked by constitutional or local symptoms. Sometimes, however, the reverse is the case and acute arthritis is set up.

A joint that is the seat of Charcot's disease may become affected

later on with *tuberculosis*. Several cases of this kind have been noted, and it is found that they run much the same course as other tuberculous joints.

Treatment.—This is extremely unsatisfactory. Since the joint affection is dependent upon the nervous lesion, it is not to be expected that much can be done unless the primary disease can be cured. Since that is at present apparently impossible, the chance of restoring the functions of the joint is extremely slight. Treatment must therefore be directed to limiting the destructive processes and to giving the joint as great a measure of stability as possible.

Aspiration.—Should the case be seen in the early stages, when the capsule is distended with fluid, something should be done, since the distension is a great menace to the future stability of the joint, because of the stretching and atrophy of the ligaments and capsule that it gives rise to. Consequently the fluid should be withdrawn from the joint and its re-accumulation prevented as far as possible.

Drainage.—The fluid may be removed by aspiration, repeated if necessary, but a more efficient plan is drainage. An incision sufficiently large to admit a moderate-sized drainage-tube (No. 16) should be made into the joint, which is drained for two or three weeks, until the tendency to effusion has passed off. The operation must of course be performed with the strictest antiseptic precautions.

Splints.—The limb should be put on a splint so arranged that the ends of the bone are not pressed against one another. After the drainage has been dispensed with and the wound has healed, the limb should be put up in a plaster of Paris or silicate bandage, which should be renewed from time to time as may be necessary. This keeps the limb in good position and at the same time gives it sufficient rest to allow of the deposit of new bone in situations which will give support to the articulation.

Apparatus.—In about six months' time this casing may be abandoned and some suitable form of orthopædic apparatus should be constructed, which allows the patient to use the limb and at the same time prevents deformity. The apparatus must be worn for the rest of the patient's life, for, although the joint may become fairly firm from the formation of fresh bone, it never becomes strong enough to support the weight alone.

It has been proposed to excise joints thus affected, but the operation may be definitely rejected as absolutely useless. When excision of a joint affected with Charcot's disease has been performed (and we ourselves have had experience of this), the result invariably seems to be that no union occurs between the bone ends; consequently the patient may be considerably worse off than he was before, because the expanded articular ends have been removed by the operation.

Amputation.—Very rarely amputation may have to be considered, the only condition likely to demand it being disease of the ankle joint

where one side alone is affected, and where the ataxic gait has not yet developed. Under these circumstances it may be impossible to control the joint sufficiently by an apparatus to enable the patient to get about, and matters may be much improved by performing a Syme's amputation, so as to enable an artificial foot to be worn. In the great majority of cases, however, any form of operative interference beyond the removal of the effusion in the early stages is not at all promising.

JOINT AFFECTIONS FROM NEURITIS, ETC.—When the joint affection is due to neuritis or to some injury of the peripheral nerves, etc., the question of operation will naturally occur to the surgeon, and will have for its object either the arrest of the neuritis or the union of divided portions of the nerves, after which a certain amount of recovery from the joint trouble may be hoped for. For the treatment of these nerve lesions the reader is referred to Part II., Chap. XVIII

JOINT NEUROSES.

These affections generally occur in women between the ages of eighteen and thirty, but they may be met with at any period from early childhood up to old age; they have also been met with in hysterical men. Any joint may be affected, but the hip and the knee are the most common. In some cases the diagnosis is a matter of extreme difficulty, whereas in others it may be quite easy. In some cases, a typical joint disease may be simulated almost perfectly, but, as a rule, examination reveals a material discrepancy between the symptoms complained of and those which should be present were the case one of organic disease. This is particularly so in respect to the pain, which in hysterical cases is often said to be extremely severe and even excruciating. It will, however, usually be found that the pain is superficial and is not excited on jarring the articular ends together. One of the marked symptoms of the hysterical condition is hyperæsthesia of the skin and structures around the joint. The general condition of the patient also frequently denotes the presence of hysteria.

Another great characteristic of these affections is very marked contracture of the muscles around the articulation, so that the limb is usually flexed and attempts to extend it cause great pain. Notwithstanding this, it will generally be found that there is no thickening of and no marked changes in the joint. These contractures usually disappear completely under an anæsthetic, and do not return until the patient comes round again. Hence, one of the most important points in the diagnosis, and also an important element in the treatment, is the examination of the joint under an anæsthetic.

At a later stage, however, when the disease has lasted for a considerable time, actual organic contractions of the muscles may occur, or adhesions may form in the peri-articular tissues and interfere with the

proper mobility of the limb; under these circumstances, of course, the deformity does not entirely disappear when an anæsthetic is administered.

Treatment.—This is often a matter of very considerable difficulty, and the best results are usually obtained in young patients in whom the line of the treatment must be to encourage movement of the joint, to excite interest in other matters, and so to distract attention from personal ailments, while it may also be advisable to impress the patient by the application of some painful counter-irritant to the joint.

In adults, however, the treatment is very much more difficult, and it is most essential for success to acquire the patient's confidence. Nothing destroys this more than to treat the case as if it were trivial, to make light of the pain, and to set the patient down as an hysterical person with whom there is nothing the matter. The result is that the patient is disgusted and loses confidence in her medical man; when she does this, the sooner she calls in another the better.

A very common plan is to place the patient under an anæsthetic, when complete relaxation of the muscles occurs, and then to apply a splint so as to prevent recurrence of the deformity when the patient recovers from the anæsthetic. The result of this, however, is usually disastrous. As the patient recovers from the anæsthetic, the muscles attempt to contract, and, being unable to do so, intense pain occurs; when the splint is left off fresh contractures often occur.

(**a**) **General.**—It is well not to confine the limb in apparatus, but to encourage the patient to move the joint for herself. At first the amount of the movement may be left to the patient, in which case it will be only slight at first, but, as confidence is gained, the range will be increased. A great aid to this is the employment of massage, which should be persisted in steadily, and continued as long as the patient will bear it. With this will be combined gentle passive movement, gradually increasing in range. At the same time the general health must be attended to, and tonics, particularly iron, should be administered, cheerful surroundings provided, and the patient's attention distracted as much as possible from her own ailments.

The Weir Mitchell treatment.—In bad cases the employment of the rigid Weir Mitchell treatment is of the greatest advantage. This consists in secluding the patient from her friends and relatives, placing her in charge of a nurse, and employing proper measures for feeding. If the patient be allowed to remain at home, it is impossible to avoid attention being constantly called to the joint affection, and considerable sympathy will be manifested with her, notwithstanding any orders that may be given to the contrary. The Weir Mitchell treatment, by isolating the patient from her friends and relatives, prevents the possibility of this, and thus furnishes a powerful help to treatment. Besides this, the careful regular feeding and the employment of massage help markedly, and the majority of these patients improve wonderfully in their general health and may entirely

recover the use of the limb. The following may be taken as the general outline of the treatment; modifications may of course be necessary to suit individual cases.

The first and most essential step is to *isolate the patient* in charge of a suitable nurse. Although not absolutely necessary in all cases, this is of the highest importance to success and quite indispensable in the worst forms. The patient should be removed from her home and not allowed to see relatives or friends without express permission. In bad cases the surgeon will be wise to refuse the case except upon this understanding. When the hysterical condition is not very marked, some relaxation of this rule may be permitted, but great care must be exercised lest the primary object of the plan—viz. the abolition of the injudicious sympathy with which nearly all these patients are surrounded—be thereby defeated.

For the first two or three weeks *the patient should be confined to bed*, even though the joint affected be in the upper extremity, and should not be allowed to sit up, to read, or even to feed herself; as the general condition improves, the patient may be allowed to sit up and finally to get about. Drugs, especially narcotics, should be avoided; the massage and the feeding soon render them quite unnecessary, the patient rapidly losing her pain and sleeping well.

The *massage* should be done by a specially trained masseuse, and not by the nurse in charge of the patient; she has enough to do with her ordinary duties, and is not likely to be able to stand the fatigue that the systematic rubbing entails. This rubbing consists mainly in firmly pinching and kneading the skin and the muscles of the entire body, working upwards from the extremities, and aims at improving the circulation generally and producing those widespread tissue-changes which it is the object of the feeding to repair. The skin is anointed with oil previous to the manipulations, and the muscles operated upon must be as fully relaxed as possible. Specially vigorous manipulations are directed to the joint affected, and passive movements of all the joints in the body should be carried out. At first the rubbing should be done for about twenty minutes once daily, but it should be steadily increased, until, at the end of a week or so, it occupies an hour and a half at a sitting, and is done twice a day. At first it causes great exhaustion and some pain; soon, however, it becomes very grateful and soothing. The use of the Faradic current may be most usefully combined with the rubbing. It should be applied to the entire body, but chiefly to the muscles in the neighbourhood of the affected joint. The two electrodes, well wetted and held about four inches apart, are gently and firmly moved over each muscle in turn, and a current strong enough to cause vigorous contraction is employed. This is done for about half an hour twice a day just before the massage.

The *diet* is, however, the chief part of the treatment. The patient is first placed upon a purely milk diet for two or three days. The milk is given at intervals of three hours, at first in quantities of three or four

ounces, but rapidly increasing up to as much as half a pint at a time, so that before the end of the first week the patient is taking as much as two or three quarts. Within a few days from the beginning of the treatment a steadily increasing amount of solid food is given along with the milk, until the patient is taking without trouble or inconvenience three very large meals daily besides the milk. In favourable cases this should happen within a fortnight of the commencement of the treatment, and the patient should simultaneously be putting on flesh with great rapidity. The massage and electricity apparently cause so much tissue-change that there is no dyspepsia. The exact diet will vary with the case, and for further details upon the subject we would refer the reader to the works of Weir Mitchell[1] or Dr. Playfair.[2]

As the patient begins to improve, the pain rapidly disappears, sleep is refreshing and uninterrupted, and the masseuse is very soon able to handle the affected joint without pain, and even to carry out in it movements of a painless nature and steadily increasing range. It is astonishing to see the rapidity with which an excruciatingly painful and rigidly fixed joint becomes quite painless and freely movable, and it is not uncommon for the patient to be able to use the joint fairly well within the first week. As soon as the improvement commences, it progresses very rapidly until the cure is complete.

Hypnotism.—This may be made an important element in the treatment of some of these cases. When under its influence, the patient should have suggestions made that the joint has become well, and can therefore be freely moved; in a susceptible person such suggestions may lead in a very short time to complete disappearance of all the symptoms. Although hypnotism may be carried to excess in many cases, there can be no doubt that in the treatment of hysterical affections, particularly those of joints, it is of very real value. Sudden mental shock will also often lead to recovery, even when the affection has persisted for a long time, but it is a method of treatment which of course must be more the result of accident than of design.

(**b**) **Local.**—During the earlier stages, any local treatment of the joint besides massage should be avoided. In the later stages, however, when the contracture has gone on to true organic shortening of the muscles, or when there are contractions in the capsule of the joint, surgical measures may have to be employed to overcome them. When it is found that the contracture does not disappear under an anæsthetic, and is due to adhesions about the joint, these should be broken down and treated in the ordinary way (see p. 163), the forcible movements under an anæsthetic being repeated every ten days or so as may be necessary.

Tenotomy.—When the muscles are permanently shortened, recovery

[1] *Fat and Blood.* By S. Weir Mitchell, M.D., Philadelphia.

[2] *The Systematic Treatment of Nerve Prostration and Hysteria.* By W. S. Playfair, M.D., F.R.C.P., London.

cannot take place until tendons have been divided; and although some surgeons consider it dangerous to do this in hysterical cases lest the upper end should be drawn too far away from the lower by the continued muscular contraction, this danger is, as a matter of fact, not a very real one, and we should recommend tenotomy as the proper course to adopt. The joint must then be fixed in proper position until union has occurred, or at any rate for two or three weeks, but in the interval the apparatus should be removed daily for the employment of massage and the other methods referred to above.

In cases marked by excessive pain, some surgeons have proposed excision of the joint or amputation of the affected limb, but the results are likely to be disastrous. The pain recurs higher up, either in another joint or in the nerves of the limb; fresh amputations may be called for, and the condition of the patient is not by any means improved. Active surgical intervention of any kind, even as far as the employment of counter-irritation, should on no account be adopted for hysterical joints in adults.

It sometimes happens that a joint that has been the seat of a hysterical affection may afterwards become affected with some true organic lesion; in such cases, of course, it becomes necessary to treat the latter, but, while doing so, the fact that the patient is hysterical must always be borne in mind, and must to a certain extent influence the treatment.

CHAPTER XVI.

RHEUMATOID ARTHRITIS.

This affection is by no means well understood, and it is extremely probable that under it are included a number of diseases that have not the same origin. This more especially applies to the form often spoken of as mon-articular or chronic rheumatoid arthritis. The disease may be acute, sub-acute, or chronic.

ACUTE RHEUMATOID ARTHRITIS is a fairly well-defined disease which occurs especially in young subjects, usually in females, and runs a more or less acute course.

Causes.—Some authors consider that this affection bears some relation to rheumatism, some that it is due to an altered condition of the blood, some to reflex irritation, some again to a nerve disturbance, particularly disease of the anterior cornua, while latterly it has been ascribed to the action of micro-organisms. Bannatyne and Blaxall describe organisms met with in rheumatoid arthritis, and, although the matter is somewhat doubtful, it is possible that the disease may be due to this cause.

Symptoms.—The affection may be preceded by pain of a neuralgic character. It usually begins as an acute affection of the smaller joints, particularly the fingers, which become swollen and hot; there may be pyrexia of the hectic type. The disease apparently begins in the synovial membrane and is accompanied by a varying amount of effusion, while softening and destruction of the cartilage, with erosion of the subjacent bone, sets in before long. There is generally some apparent thickening of the bone ends, but, judging from the results obtained by skiagrams, this seems to be due to swelling of the synovial membrane and the structures around the joint, accentuated by the muscular wasting. The disease is frequently accompanied by considerable anæmia, and there is often some pigmentation of the skin. A very marked feature is the atrophy of the muscles of the affected limb, which is far too rapid to be accounted for by mere disuse. When the fingers are affected, the joints become spindle-shaped and the digits are deflected to the ulnar side.

Acute or sub-acute rheumatoid arthritis comes essentially under the notice of the physician, and we shall not therefore consider it further.

Treatment.—The treatment mainly consists in putting the affected limb upon a splint and aspirating the joint if necessary. Guaiacol and cod liver oil should be administered, while it is of advantage to remove the patient to a suitable climate where he may receive thermal treatment; the latter point will be again referred to in dealing with the chronic form of the disease (see p. 152).

CHRONIC or MON-ARTICULAR RHEUMATOID ARTHRITIS.—This form of the disease comes frequently under the notice of the surgeon, and is the one concerning the nature of which there has been the greatest dispute and the greatest obscurity. Some authors only include under the heading "rheumatoid arthritis," a form of the disease closely resembling the acute in its distribution; that is to say, it is poly-articular and affects the small joints. The mon-articular form they speak of as "senile arthritis," or, according to the various apparent causes, it is termed "traumatic arthritis," etc. Similar changes, however, occur in all these cases, whether the disease follows on an injury or whether it arises spontaneously, and these changes so closely resemble those found in rheumatoid arthritis proper that it seems wisest to group together all the cases presenting them under the heading of chronic rheumatoid arthritis, whatever be the apparent mode of origin. The parasitic theory as to the origin of rheumatoid arthritis is not sufficiently well established to enable the presence or absence of bacteria to be used as a point of diagnosis, and therefore the cases in which no parasites can be demonstrated cannot be excluded from the group of rheumatoid arthritis.

The disease is usually limited to one or two joints and chiefly affects the larger ones such as the knee or the hip. Its progress is usually steady and but slightly marked by exacerbations. The patient first notices that the joint is stiff and somewhat painful, particularly in the morning, whilst the stiffness passes off to some extent as the joint is exercised. After a time the pain increases and in some instances forms the marked feature of the case. The difficulty in movement may also increase, and, as changes take place in the joint surfaces, the limb may assume abnormal positions; indeed, in some joints actual dislocation may occur.

As time goes on, the stiffness steadily increases, partly from the shrinking of the capsule, but mainly from the formation of osteophytic outgrowths around the joint. Alterations in the shape of the articular ends also interfere with the normal movements. As the disease progresses, the patient becomes more and more crippled, and, if several joints in the lower extremity happen to be affected, he may be entirely bed-ridden.

Causes.—Little or nothing is known as to the causation of the disease. It is certainly more frequent in cold, damp climates than in dry, warm ones, and it is always worse in those exposed to cold and damp. It is also very common to obtain a history that the disease followed an injury,

such as a sprain or twist of a joint, or a fracture in the neighbourhood of or extending into one. Again, a loose cartilage in the joint is very apt to set up changes characteristic of this disease. By some it has been attributed to rheumatism, by some to gout, and by some to a combination of the two; hence the term "rheumatic gout." There is no evidence, however, that either of these diseases plays any part in the affection.

Pathological Changes.—These are particularly marked in the articular cartilage, which becomes converted into fibro-cartilage, and is often worn away by the movements of the joint. As the cartilage disappears, the bone beneath becomes sclerosed, so that the surfaces in contact present an ivory appearance; beneath this dense layer, softening occurs and absorption readily takes place. Bony outgrowths appear in the neighbourhood of the joint, and these may form a ridge around the articular surface, which is often spoken of as "lipping of the articular ends of the bone." Besides this, large bosses of bone may be formed in the same situation, and this may also occur in the synovial fringes or the capsule of the joint, so that movement may be considerably interfered with; portions may even be broken off and form loose bodies in the joint. It is also not uncommon to find bony masses along the insertions of muscles about the joint. The synovial membrane may or may not be thickened; there is generally a villous condition of the surface—an affection practically identical with villous disease of the synovial membrane (see p. 107).

Treatment.—The treatment of chronic rheumatoid arthritis is very discouraging. While it is possible to arrest the progress of the disease to some extent, it is impossible to cure it, since the joint can never be restored to its normal condition. As a matter of fact, it is only in the early stages that any marked improvement can be obtained; in the more advanced cases the trouble progresses, very slightly influenced by any treatment that we are at present acquainted with.

(a) **General.**—The first indication is to remove the patient, if necessary, from any occupation involving exposure to cold or damp, and also to place him in suitable climatic surroundings. For well-to-do people a trip to a *warm, dry climate*, such as Egypt, California, or Queensland, may be advised with confidence: of these, perhaps Egypt is the most suitable. The *general health* must also be attended to, as the patients are usually anæmic and imperfectly nourished; besides being placed under the best possible hygienic conditions, attention must be paid to the diet. A mixed *diet* is best, but it is well to avoid the stronger animal foods and to substitute white or raw meat for them; plenty of fat should be insisted upon, and a too farinaceous diet should be avoided. The patient may also be encouraged to drink large quantities of hot water between meals with the object of eliminating waste or toxic products from the blood. When the patient is very obese, it may be advisable to put him on a diet which aims at reducing the fat. For this purpose practically

nothing but minced beef or mutton with green vegetables, beef tea, and white of egg is a diet that is a good deal in vogue at the present time. With it is combined the consumption of large quantities of hot water between meals.

The best *drugs* are iron, if the patient be anæmic, and arsenic; the latter should be ordered in the early stage of all cases. Guaiacol, in the form of guaiacol carbonate in five to ten grain doses, three times daily in cachets after food, is also recommended. Cod-liver oil is also most valuable, especially for the poorer classes; it should always be given in quantities as large as the patient can bear without interfering with the digestion. It should be given at meal times, and should, in fact, be looked upon as an article of food. When cod-liver oil cannot be taken, proportionate quantities of fat should be added to the diet.

(b) **Local treatment.**—A good deal may be done to arrest the process as far as possible, to prevent stiffness, and to relieve the pain, which is often considerable.

Relief of pressure.—In the first place the joint should be relieved from all undue pressure or movement. When the lower extremity is affected, walking need not be prohibited unless the pain be very severe, but in stout and anæmic patients, it should be restricted as much as possible. When the upper extremity is affected, the limb should be supported in a suitable sling. Great care has to be taken to avoid injuries, such as twists or sprains, as these are well-known starting-points of the disease.

Thermal treatment.—The local treatment which is most generally applicable in all stages is a combination of the thermal bath with massage and movement, and the best results are obtained in the early stages of the disease. If possible, the patient should be sent to some watering-place specially organised for the treatment of these cases; this is far better than attempting to carry out treatment at home. The best thermal stations are Bath, Harrogate, Buxton, Droitwich, or Strathpeffer, in this country, and Aix-les-Bains abroad. Bath is probably the best for the majority of cases requiring treatment in this country; but, should the patient require a more bracing climate, or should he be markedly anæmic, Buxton or Harrogate are preferable. The object of sending patients to these baths is not merely that they should take the waters internally, which no doubt are of some value, but particularly that they may obtain proper douching and massage; the chemical constitution of the waters does not seem to be a very important point. It is probable that the effect is gained rather by the diuretic and laxative effects of the large quantity of water consumed than by any specific substances that it contains.

The essential point in the local treatment is to first expose the joint to heat, and then to employ massage and passive movement. When the patient is sent to a thermal station he should be directed to a medical man in the place who is well acquainted with and superintends the treatment. In order to give some idea of the course undergone by a patient at these

baths, we have asked Dr. Leslie Walsh of Bath to give us a sketch of the treatment, and this we subjoin. His remarks refer more especially to acute rheumatoid arthritis, but they may be made to apply equally to the non-articular forms of which we are now speaking, if local douching be substituted for the general form. Dr. Walsh writes as follows:

"The case having been carefully examined, and found to be a fit one for the baths,[1] I should order, in the case of a fairly strong person, the *deep bath* at a temperature of about 98° F for twenty minutes, followed by a *pack*[2] for fifteen minutes, the patient drinking ten ounces of mineral water while in the pack. If the patient be weakly, however, or suffer from some cardiac lesion, I should order instead of the deep bath a *reclining bath* at the same temperature and for the same time, also followed by the pack.

"The next bath would be taken on the second day after the first—that is to say, with one day's interval; and I should most probably order at this time a douche at 100° F., to be used during the last ten minutes, while the patient is in the bath, and to be specially directed against the painful, swollen, or stiff joints. After another two baths, taken every other day, I should increase the temperature to 99° or 100° F., and the douche up to 103° F If I found the sweating excessive and the patient at all weak, the pack would be made lighter and the time diminished. Some cases improve wonderfully under these baths alone, but most cases of rheumatoid arthritis require in addition some massage, either dry, which is done at home, with or without electricity, or the wet or Aix massage, in which two douches are used, one directing a stream of hot water down the patient's spine in order to keep him warm, and the other so arranged that it plays upon the part while it is being rubbed. The temperature of both douches is usually about 100° F Fifteen minutes is usually the time for an Aix massage bath, one or two rubbers being employed according as to whether the whole body or only some of the limbs are to be treated. The massage bath is often followed by a plunge into the swimming bath at about 80° F., or the Scottish douche, in which two powerful streams of water, one hot and the other cold, are played alternately up and down the patient's spine. A light pack may or may not be used after the Aix massage, but the usual plan is to pack the patient for a short time.

"Other baths used are the *vapour bath*, where the vapour of water is brought into contact with one or more limbs at a temperature up to 108° F. or even higher; another plan is what is termed the *dry douche*, in which the limb to be douched is enclosed in a bath, the rest of the

[1] *I.e.* the patient having no bad cardiac disease or any acute affection.

[2] By the *deep bath* is meant a large bath in which the patient sits or even walks about. Passing into this bath at various levels are pipes through which douches can be directed against any desired part of the body while the patient is in the bath. As regards the *pack*, after the patient comes out of the bath he is wrapped up in hot towels and a big dressing-gown; the number of hot towels and the general thickness of the material in which he is swathed is varied according to the strength of the patient.

body being screened off with a mackintosh arrangement, and a strong stream of water gradually warmed up from 98° to 103° F., or even higher, is allowed to play upon it.

"The time of day for taking the baths is immaterial, and patients have to wait their turn during the season often till late in the afternoon. They drink the water generally twice a day, eight to ten ounces at a time, but many patients cannot take so much as it sometimes causes dyspepsia and often constipation.

"With regard to the frequency of bathing, we are often much handicapped by the short time patients allow themselves for the course. With gout, rheumatism, sciatica, etc., it does not perhaps matter so much, but with rheumatoid arthritis it is very different. The disease itself is debilitating and, if the baths be taken either too often or too hot, the effects are not altogether satisfactory. In these cases I never order baths oftener than every other day, and, if the patient be able to stay about six weeks, a bath twice a week is about often enough, some gentle dry massage being given at home on two other days during the week. For similar reasons I am not inclined to order the baths hotter than about 103° F., although some go to 105° F and even higher."

A visit to one of these watering-places should extend over from three to six weeks, and the patient should be cautioned not to be disappointed should the immediate improvement be comparatively slight. It is not uncommon to find that the condition does not improve for some little time afterwards. Patients who are the subjects of confirmed rheumatoid arthritis should spend several weeks every year at these baths; one visit is of very little value.

Super-heated air.—When a patient is unable to afford the time or money necessary for a visit to one of these resorts, the best local treatment is perhaps exposure of the affected joint to super-heated air. This may be readily done by means of the Tallerman apparatus,[1] in which the joint is enclosed in an apparatus by which it is surrounded with dry super-heated air; it is essential that the air should be dry, as otherwise scalding may result. After the limb has been exposed to the hot air for a quarter to half an hour, massage and passive movement are employed and this should be done twice a day. If the trouble be only slight, exercise may be permitted to a limited extent; should there be pain on getting about, the patient should be wheeled out in a bath-chair or some suitable conveyance on every opportunity.

Electricity.—Electricity is also of value in some of these cases, and it may with advantage be combined with the massage, the form of current used being the galvanic. A very weak current should first be employed, the electrode connected with the negative pole being placed over the upper end of the limb, whilst the positive electrode is applied in the

[1] The Dowsing radiant heat or the Greville electro-thermal baths at a temperature of from 300° to 400° F. may also be employed.

immediate neighbourhood of the joint. The current should be passed for ten or fifteen minutes at a time, once or twice daily immediately after the massage, and after its application the limb should be enveloped in hot flannel.

All patients who are the subjects of rheumatoid arthritis should wear flannel and should keep the joint thickly swathed in it. When there is considerable pain, some benefit may be obtained by using a liniment of one drachm of menthol to three drachms each of linimentum belladonnæ and linimentum camphoris. Another useful local application is a mixture of equal parts of guaiacol and olive oil painted over the joint and surrounded by cotton wool.

The ambulatory treatment.—The most difficult subjects to treat, and those who come most frequently under notice, are poor people who cannot afford to give up their work and who are of course unable to obtain massage, douches, or in fact any of the best methods of treatment. Here probably the best plan is not to aim at restoration of movement of the joint, but rather to attempt to get sufficient consolidation to prevent movement, and thus to some extent to enable the patient to get about without pain as quickly as possible. For this purpose *moulded splints* may be employed to fix the joint: these are most useful when the pain is severe. The latter may be diminished to some extent by means of stimulating liniments, such as that already mentioned, rubbed in night and morning, the joint being exercised at the same time. The patient should keep the limb well bound up in flannel and should be told to avoid exposure to cold and wet as much as possible.

The joint may with advantage be firmly *strapped* with Scott's dressing before the splint is applied. A variety of other counter-irritants are frequently recommended, but they are apparently of very little value with the possible exception of the actual cautery (see Part I., p. 19) applied freely around the joint. This necessitates the patient lying up for something like six weeks, which in many cases is of course impracticable. The general hygienic, dietetic, and medical indications already given should be attended to.

Operative measures.—In advanced and very painful cases of rheumatoid arthritis operative procedures may suggest themselves. Of these we shall consider drilling or gouging the ends of the bones in order to diminish the inflammation, the removal of osteophytes which interfere with the movements of the joint, excision of the joint, and various operations upon nerves, such as nerve-stretching, or freeing nerves that have become adherent around the joint.

When there is very considerable pain and much enlargement of the bone ends, and when the joint is superficial, as for example the knee, considerable, though unfortunately only temporary, relief may be obtained by driving a drill into the enlarged bone or gouging a hole in it: of the two methods the latter is the more efficient. *Gouging* may be done

by making a curved incision over the joint, and turning aside a flap so as to expose the region that it is proposed to open up. The outer shell of the bone is then cut away with a gouge over an area about the size of a two-shilling piece, and, with a sharp spoon, some of the soft cancellous tissue is scooped out. The hole thus made should not go deeply, and should not run near the articular surface. After the bleeding has been arrested, the wound is stitched up and the usual antiseptic dressings are applied. The limb need not be put on a splint, but the patient should stay in bed for about three weeks afterwards, not only in order that the wound may heal, but to allow the clot in the bone cavity to undergo a certain amount of organisation.

This somewhat severe operation is not always necessary, and much improvement may follow simple *drilling* of the bone. For this, an incision is made in the skin sufficient to admit a drill, and through it the latter is pushed well into the bone in various directions. This plan, although not so efficient as the preceding, has the advantage that it does not entail confinement to bed.

When the patient's chief trouble is due to the presence of osteophytes around the joint interfering with movement, much benefit may be obtained by removing them. This should only be done however when one or two main osteophytic growths are causing the trouble, and not when the joint surface is practically entirely surrounded by them. A further advantage of the operation is that any adherent nerves in the neighbourhood may be freed, and also that the bone is opened up to a certain extent so that the advantages following gouging of the bone will result. It is however comparatively seldom that the operation is required; it may be called for in the hip joint, when the patient suffers severe pain from pressure upon the nerves in the vicinity by osteophytic outgrowths or by actual adhesion to the capsule. Should any adherent nerves be found, they should be separated and well stretched (see Part II., p. 262). This gives considerable relief, which however cannot be relied upon to persist.

Some surgeons advocate *excision* when the disease is limited to one or two joints, when the patient is crippled and when previous treatment has completely failed. When several joints are affected, excision can hardly be called for, but when the trouble is limited to one joint, especially when this is in the upper extremity, and is one in which mobility may be reasonably looked for as a result of the operation, there does not seem to be the serious objection to excision which exists in the minds of some. In the hip joint the operation is out of the question; excision gives an extremely bad functional result, and further osteophytic outgrowths are very apt to occur around the divided end of the bone, so that the operation is likely to result in an increase of the trouble.

In the knee, on the other hand, excision may be justifiable when the pain is so great as to prevent the patient getting about, and when this joint is the only one affected. The bones unite with perfect readiness

and a stable limb is obtained. At the same time it must be admitted that excision of one knee may be followed comparatively rapidly by the appearance of the disease in the joint on the other side, and this is probably brought about to some extent by the increased strain thrown upon the movable articulation by the stiff limb. At the same time, the risk of this is not sufficient to warrant our refusing to relieve the patient of his existing trouble by excision. In the elbow, operation gives a very fair result, and in the shoulder, excision, although it seldom gives a perfectly useful joint, often gives marked relief. A point to be remembered with regard to excision in these cases is that the operation need not be the prolonged proceeding that is necessary in tuberculous cases. There is no need to remove all the synovial membrane; it suffices to remove sufficient bone, and the operation is therefore usually unaccompanied by any particular shock.

CHAPTER XVII.

LOOSE BODIES IN JOINTS.

By a loose body in a joint is understood an abnormally movable structure which is apt to get between the articular ends of the bones and to interfere with the movements of the joint.

Causes.—Loose bodies may be subdivided into those originating inside the joint and those introduced from without; the latter should strictly be called foreign bodies, examples being bullets, pieces of glass, etc. The loose bodies having an intra-articular origin may be divided into two classes, namely: (*a*) structures which normally form part of the articulation but which have become detached; and (*b*) those derived from the growth or deposition of structures which form no part of the normal joint. Of the former class a typical example is a detached fibro-cartilage, but this will be more appropriately considered in connection with the particular joints in which the fibro-cartilages occur. Sometimes portions of cartilage may be detached from the underlying bone by injuries, and may form loose bodies. These have already been dealt with (see Part III., p. 133). The common type of loose body in the joint belongs to the second group of which we have spoken, and is formed within the joint. Three conditions may be mentioned: (1) detached hypertrophied villous processes; (2) the so-called "rice bodies"; and (3) the true loose cartilages which are not the result of injury, but are due to the development of cartilage in the synovial fringes.

We have already referred to the villous condition of the synovial membrane (see p. 107), and the rice-like bodies occurring in tendon sheaths and joints have also been discussed (see Part II., p. 219); they are always tuberculous in origin. We need therefore only deal here with the true loose cartilages.

These bodies are usually few in number in any joint and are very often single. They are generally smooth, ovoid, and flattened, and consist of a layer of hyaline cartilage which may be undergoing ossification in the interior. They spring from the synovial fringes, in which

a few cartilage cells left from embryonic life may for some reason undergo development. These bodies are not as a rule entirely free, but are attached by a delicate pedicle to the synovial membrane: this may be so long and narrow as to practically allow the cartilage to move in all directions. Some accident often sets the body quite free in the joint by tearing across or twisting the pedicle, and it would appear that loose bodies may actually increase in size after all organic connection with the synovial membrane has been severed. Loose bodies are not uncommon in connection with osteo-arthritis, but it is doubtful whether they are the result of the rheumatoid change or whether their presence in the joint sets up the rheumatoid condition.

The joint most frequently affected is the knee: the next in frequency is the elbow, but any joint may be affected. The inconvenience caused varies according as the cartilage is loose or attached, and to the play allowed it. If the cartilage be quite loose, it is very apt to become caught between the articular surfaces, when sudden and intense agony is caused, and the joint is temporarily locked. On the other hand, when still attached to the synovial membrane, it may not get between the ends of the bones, and may only cause some slight obstruction to certain movements and some effusion into the joint.

Treatment.—The only treatment of any value is early removal by operation, and it is well to remember that in all such operations a healthy joint is opened, and that therefore the strictest asepsis is necessary. In former days, the operation for the removal of a loose cartilage from a joint was looked upon as one attended with the greatest danger, and it was only undertaken when the patient's life was made useless by the constant catching of the loose body between the bone ends. To guard against the serious risk to life that occurred under these circumstances, various ingenious devices were introduced, such as making oblique or valvular openings into the joint, which we need not mention here. The methods are quite out of date, for, if proper care be taken in the antiseptic management of the case, there is no risk in removing these bodies by an open incision.

Arthrotomy.—The chief difficulty in the operation lies in finding the body, which slips about extremely easily; when there is no pedicle, the German name *Gelenkmaüse* is extremely apt. Unless the body can be located and fixed before operation, it is quite possible to open the joint and still fail to find it. This particularly applies to the knee, in which the cartilage may slip behind the femur and cannot be got out. Therefore in all cases it is well not to operate unless the cartilage be found and fixed before the operation is undertaken, notwithstanding that the surgeon may know from actual examination that there is a loose body in the joint.

In the knee, the best position in which to fix the loose body is on one side of the supra-patellar pouch, preferably over the internal condyle. The patient may be able to keep it in place with the finger, or a piece of

strapping, and a pad may be fixed over it so as to prevent it from slipping whilst the anæsthetic is being administered; during disinfection of the skin the fixation should be seen to by an assistant. A curved incision is made, a flap of skin and subcutaneous tissue is thrown back and the capsule incised directly over the loose body. Before the incision through the capsule is made, care must be taken to arrest all bleeding, as otherwise blood may find its way into the joint and give rise to troublesome adhesions afterwards. Before making the incision into the capsule it is well to thrust a needle firmly into the cartilage so as to fix it, lest it slip away as the incision is made. When the capsule has been opened, a sharp hook is inserted into the cartilage, which is then pulled out.

The incision in the capsule is accurately stitched up with fine catgut, and the flap sutured in place without a drainage tube. The whole operation should be carried on under an irrigation of 1-8000 sublimate solution. When, however, as sometimes happens, the cartilage escapes into the joint at the moment of incision, a very useful manœuvre is to flush the joint out with a 1-8000 sublimate solution under considerable pressure; the result is that the cartilage may be dislodged by the fluid and carried within reach; should this fail, the opening in the capsule must be enlarged sufficiently to expose the interior of the joint and the cartilage searched for. In some cases, however, it may be impossible to find it; the search should then be abandoned, and the surgeon should wait until the cartilage has reappeared before operating again.

After the wound has healed, passive movement should be begun in order to prevent adhesions about the incision in the capsule.

CHAPTER XVIII.

ANCHYLOSIS.

In many of the joint affections previously described there is a tendency to stiffness, or to more or less complete anchylosis. True anchylosis implies absolute rigidity of the joint, and is usually due to actual union between the bones; but, from the practical point of view, it is well to include under this term, other less extensive interferences with movement.

VARIETIES.—Anchylosis may be described under four heads: (1) That resulting from union between the ends of the bones; (2) that due to partial or complete obliteration of the synovial cavity by adhesions; (3) the form resulting from contraction and rigidity of the peri-articular tissues; (4) anchylosis from adhesion of muscles surrounding the joint to the bones in its vicinity. In the treatment of the affection we have also to consider whether the position of the limb is good or bad.

1. Anchylosis due to union between the articular surfaces.—The union may be by fibrous tissue—when the case is spoken of as one of fibrous anchylosis—or it may be due to new formation of bone—when it is termed bony anchylosis. Before bony anchylosis can occur, the cartilage must be completely destroyed, and when it happens, the joint is of course perfectly stiff. When the anchylosis is by fibrous tissue only, there is a certain, though usually a very slight, degree of movement.

Treatment.—(a) **Of bony anchylosis.**—The only circumstances under which the surgeon is called upon to interfere in cases of true bony anchylosis are—(α) when there is much pain; (β) when there is deformity of the limb from anchylosis in faulty position, and (γ) when the patient desires to obtain a movable joint in place of a stiff one. When the joint is in good position free from pain, and when a movable joint is not required, it is unnecessary to employ any treatment.

(α) *Painful bony anchylosis* is of comparatively rare occurrence, but it is occasionally met with when the anchylosis accompanies a still active osteitis of the articular ends; in some cases indeed there may be an abscess in the end of the bone. Under these circumstances it will be

necessary to cut down upon the thickened and painful bone, gouge a hole in it and seek for an abscess as recommended for osteitis and abscess of bone (see Part III.). This treatment usually completely relieves the pain even though pus be not present.

(β) *In bony anchylosis accompanied by deformity* the condition cannot be remedied without dividing the union, and as a rule, it is necessary to remove a certain amount of bone before the limb can be brought into proper position. In a knee, for example, which has undergone anchylosis in the flexed position, it may be necessary to take out a wedge to allow of straightening the limb. In remedying a faulty position of this kind it must be remembered that tendons and other structures around the joint have also altered in length and may therefore offer obstacles to the proper replacement of the bones after the latter have been divided. If these structures be not dealt with, it may be necessary to take away an undue amount of bone before the limb can be brought straight, and this may cause material shortening. Hence, the best procedure is to first of all remove rather less bone than is probably necessary to get the limb straight, and, after the limb has thus been loosened, it is quite easy to put the tendons and fascial structures on the stretch, and to divide any that require it. Firm extension is then made so as to stretch the soft structures, when, if necessary, more bone may be removed. It is, however, generally found that, after dividing the tight structures and employing steady traction, the displacement may be overcome without the removal of much bone. When the limb has been straightened, it is well to introduce a wire, a screw, or a peg, in order to keep the bones in close apposition.

It is important that this operation should not be done too early and that it should not be performed until the growth of the limb is nearly complete, as otherwise, considerable shortening and arrest of development may result. It is practically impossible to avoid encroaching upon the region of the epiphyseal line in any of these operations that involve taking out a wedge, and serious distortion of the limb from partial arrest of development may result.

(γ) *Cases of bony anchylosis where a movable joint is required.*—A typical example of this is the elbow joint, in which excellent movement may be obtained after excision, provided that the anchylosis has not lasted long enough to have led to complete atrophy of the muscles around the joint.

2. Fibrous anchylosis between the ends of the bones, and,

3. Fibrous adhesions inside or outside the capsule. Here fair movement may often be obtained without operation. When, however, there are fibrous adhesions between the ends of the bones, and the position is very faulty, it may be necessary to cut down upon and remove portions of the articular ends, but, with this exception, improvement can be obtained and almost complete restoration of function can often be got by breaking down the adhesions. The great mistake made in treating these cases is

to attempt to do too much at a time. If very extensive adhesions in a joint be broken down under an anæsthetic at one sitting, so that the limb can be moved in all directions, the result is generally an acute inflammation, which necessitates rest for so long that the adhesions reform, and no real advantage is gained. It is therefore necessary to proceed cautiously, and only to break up the adhesions piecemeal.

Massage and passive movement should first be employed, and it is of advantage to precede this by exposure of the limb to super-heated air in a Tallermann's or other similar apparatus (see p. 154). This apparently produces congestion of the part, so that the adhesions become softer and stretch more readily. With poor patients who cannot obtain a suitable apparatus, a somewhat similar result may be obtained by suspending the limb in a wire cage covered with a blanket and a mackintosh outside, and introducing beneath this the nozzle of a bronchitis kettle, and so steaming the joint freely, taking care that the steam does not play on the skin.

As soon as it is evident that no further progress is being made—which will generally be in a week or ten days—an anæsthetic should be administered and the adhesions broken up. At the first sitting very little must be done; just a few of the adhesions should be broken through, and then another ten days or so devoted to massage and passive movement. At the end of that time, a little more may be done, and so on, until finally the joint can be freely moved in all its normal directions. Any swelling resulting from the manipulation may be treated by fomentations for a day or two, but massage consisting of gentle rubbing at first, gradually becoming more active, should be carried out from the first.

An additional reason for breaking down these adhesions gradually, especially when anchylosis is accompanied with deformity, is that the structures outside the joint are contracted, and, were the limb forcibly stretched at once, vessels and nerves might be ruptured and extensive damage done. On the other hand, by the cautious and slow method here described, the shortened structures may be gradually softened and stretched, all danger avoided, and a good result obtained even where there is considerable deformity. In connection with these cases it must never be forgotten that trouble has frequently resulted from attempts to move tuberculous joints, and that if fibrous tissue be forcibly broken up, the tuberculous disease is apt to be reproduced. It is not at all uncommon to meet with old tuberculous joints, where the patient has been to a bone-setter and the disease has been lighted up afresh. In anchylosis after tuberculous disease, even when accompanied by deformity, it is usually best to allow the patient to grow up, and then to excise the joint, rather than to make an attempt to forcibly move it, even though the union only be fibrous.

4. Anchylosis due to the adhesion of muscles around the joint.—This may be met with in fractures, or when sequestra have been removed. It may be necessary here to detach the muscles or to divide them, but this condition has already been referred to (see Part III., p. 55).

SUB-SECTION II.—DISEASES OF INDIVIDUAL JOINTS.

CHAPTER XIX.

DISEASES OF THE HIP JOINT.

INFLAMMATORY AFFECTIONS.

SIMPLE ACUTE SYNOVITIS.—This is not at all common, but it occasionally follows a sprain or twist, and leads to pain and difficulty in movement. The affection is most frequent in children; in them it is very difficult to be sure that the synovitis is not the preliminary stage of tuberculous disease. The distension of the capsule with fluid is difficult to make out, owing to the depth of the joint from the surface, but on comparing the two groins there is generally some fulness apparent; a similar condition can also be made out behind the trochanter. The position assumed by the limb is one of slight abduction, flexion and outward rotation.

Treatment.—The chief essential is *rest*, and for the first few days the patient should be kept in bed: *fomentations* should be applied to the region of the joint if there be much pain. It is unnecessary to employ splints or any form of extension. When the pain has passed off, the joint should be moved, and, if there be any stiffness, passive movements and massage will soon put matters right. The patient may be allowed to walk about in a week or ten days.

In children, in whom it is impossible to be certain that the affection is not early tuberculous disease, it is a good rule to simply put the child to bed and see the case again in a week; should it be simple synovitis from a strain, the affection will be well on the way to recovery, whereas if it be commencing tuberculous disease the condition will not have improved and will probably be considerably worse.

INFECTIVE ARTHRITIS.—Acute or sub-acute inflammation of the hip, sometimes ending in suppuration, occurs in various infective diseases, such as typhoid fever, gonorrhœa, pyæmia, etc.

(a) **After typhoid fever.**—The hip is the joint most likely to be affected during recovery from typhoid fever. The affection is a sub acute arthritis, and the joint is distended with fluid which is usually turbid and may be purulent. Suppuration does not necessarily occur, but the ligaments become remarkably softened, and spontaneous dislocation is not infrequent: indeed the affection is not uncommonly brought under notice by the occurrence of dislocation.

Treatment.—On account of the tendency to dislocation, it is necessary to fix the limb in a suitable apparatus, and in some cases the Liston's long splint (see Part III., p. 111) is best. The patient must be placed upon a *water bed*, as otherwise bedsores will almost certainly result from the rigid confinement to one position. As a rule, no further local treatment is necessary, and the inflammation rapidly subsides as the patient convalesces. The splint should be kept on for three or four weeks, after which passive movement and massage are employed to prevent stiffness.

Arthrotomy.—When the inflammatory symptoms are more acute and there are signs of suppuration, the joint should be opened, the pus washed out, and a drainage tube introduced. This is best done through an incision similar to that employed for the anterior excision of the hip, namely, just in front of the anterior edge of the tensor vaginæ femoris. For a detailed description of the operation see p. 187. The muscles are separated until the capsule is reached, an incision is made into it, the pus evacuated, the joint washed out with a 1-8000 sublimate solution, and a drainage tube (size No. 18) introduced.

It is a somewhat remarkable fact that the destructive changes in a joint which is the subject of acute infective arthritis of this kind are not very marked, and, if effectual drainage be promptly employed and the limb immobilised in good position, there is but little destruction of the cartilage or inflammation of the articular ends of the bone: consequently the danger of anchylosis is not very great. When the discharge has become quite small in amount (not covering in 24 hours an area on the dressing greater than a shilling) the drainage tube should be removed and the wound allowed to heal, when passive movements and massage should be employed.

(b) **Gonorrhœal.**—The hip is not infrequently affected in cases of gonorrhœa, and in this connection it is important to remember the liability to anchylosis: passive movements must therefore be made from time to time during the course of the affection. These movements must however be carefully watched in order to see whether they increase the inflammation. No splint should be employed in gonorrhœal affections unless there be commencing deformity which requires rectification: the patient should be simply kept in bed.

The *after-treatment* consists mainly in avoiding anchylosis. It is most difficult to determine the best time for commencing passive movement in these cases: if it be begun too soon, the inflammation recurs, if postponed too long, anchylosis will result. The best plan is to move the

joint very gently after all signs of acute inflammation have subsided, which will be in about two or three weeks, and, if this gives rise to no swelling or pain, a little more should be done on the following day, and so on, until the full range of movement is recovered

(c) **Pyæmic.**—Acute septic arthritis of the hip is most frequently met with in connection with acute epiphysitis of the upper end of the femur. It may occur also in pyæmia, although there the destructive changes are not so marked. In acute epiphysitis the infection of the joint is a necessary consequence of the anatomical conditions of the part, and the symptoms are extremely grave and acute. The patient is usually suddenly seized with pain in the hip, rigors are common, and the typhoid condition rapidly supervenes; there is marked swelling about the joint, and intense pain on movement or pressure.

Treatment.—As soon as possible, an *incision* should be made into the joint; this is most conveniently done through the anterior incision already described (see p. 165). The joint is opened, the pus evacuated, the articular cavity flushed out with a warm 1-8000 sublimate solution and the condition of the neck of the femur examined. Should the disease there be extensive and the patient's condition grave, the best plan is to remove the head and neck of the bone at once, and counter-openings should be made for *drainage* through the posterior part of the capsule. This can readily be done by pushing a long stout pair of dressing forceps through the posterior part of the capsule from the anterior wound, and making them project in the buttock as close as possible to the trochanter. The skin is then incised over the tip of the forceps, which are pushed through, the blades expanded so as to enlarge the opening, and made to grasp the end of the drainage tube (size No. 18), which is pulled back into the joint as they are withdrawn.

When this has been done, the cavity left should be swabbed out with *undiluted carbolic acid*, and the application of this to the cut surfaces of the bone should be especially thorough. The one point of danger in removing the head of the bone is that the organisms (which are extremely virulent) may spread into the cut surface and set up an acute osteo-myelitis of the upper end of the femur; the saturation of the bone section with undiluted carbolic acid is therefore of extreme importance as a preventive.

Before the wound is closed, a large drainage tube (size No. 20) must be introduced into the joint from the front. The ordinary antiseptic dressings are applied, the patient put back to bed, the trunk fixed between sandbags and the arrangement shown in Part III., Fig 43, p. 117 is applied behind the knee to prevent rotation of the limb. In these cases it is also well to have a divided mattrass so as to avoid unnecessary movement.

Even with this thorough treatment, it is as a rule impossible to completely disinfect the whole of the wound, but if free drainage be employed,

the infection of the bone is usually comparatively slight. Cellular invasion of the superficial cancellous spaces takes place before the infection has time to spread, and this may prove an effectual barrier against extension of the disease. In some cases, however, it will be found that, although the patient's life is saved, the cut surface of the neck of the femur undergoes necrosis: the wound will then require opening up again for its removal when the necrosed fragment has separated, which will usually be in three or four months.

When the osteo-myelitis occurs, as it sometimes does, in the acetabulum, the results of treatment are not so satisfactory. The joint becomes distended with pus, and must be opened as just described. It will be necessary to remove the head of the bone to get proper access to the acetabulum, which should be gouged out and the diseased area removed as completely as possible. The whole thickness of the bottom of the acetabulum should be taken away, so as to make sure that any collection of pus on the inner wall of the pelvis is properly drained.

In all these acute cases every possible means must be taken to improve the general health. Quinine should be given in large doses (5 grains every four hours), and the other methods of general treatment described for acute septicæmia (see Part I., p. 210) and acute osteo-myelitis (see Part III p. 175) must be adopted.

CHRONIC SYNOVITIS.—Chronic synovitis is but rarely met with in the hip. The treatment must follow the lines laid down for the disease in general (see p. 105).

TUBERCULOUS DISEASE.

After the spine, the hip is the joint most frequently affected with tuberculosis. Hip disease is essentially an affection of childhood, more than half the cases occurring before ten years of age, and over 90 per cent. before puberty.

SEATS.—The disease may arise either in the bone or in the synovial membrane, probably oftener in the former than in the latter. When the disease commences *in the femur*, the primary focus is most frequently found at the lower part of the neck just external to the epiphyseal line. It may sometimes be met with further out towards the trochanter, or deeply in the substance of the neck, or, in some rare instances, in the epiphysis of the head itself. Tuberculous sequestra seem to be rather more frequent than soft caseating masses.

Primary disease *in the acetabulum* is also not uncommon, some authorities considering that it is quite as frequent as that in the femur, although this does not seem to us to be quite borne out by facts. When it commences in this situation its usual seat is the neighbourhood of the Y-cartilage; this structure may be destroyed, and mobility of the various constituents of the innominate bone may result.

COURSE.—When the disease commences in the bone it follows the course already fully described (see Part III., p. 196). Generally the tuberculous deposit establishes a communication with the joint, and leads to general infection of the synovial membrane; it may, however, reach the surface outside the synovial membrane and give rise to an abscess which does not communicate with the joint. This is most common with the primary deposits in the femur in the immediate neighbourhood of the trochanter. When the disease is in the acetabulum, the deposit not only infects the joint, but, owing to the thinness of the bone, it generally gives rise to thickening of the periosteum inside the pelvis, often followed by a chronic abscess.

Enlargement of the acetabulum.—Whether the case be one of primary bone or synovial disease, the history is much as follows. If the affection be left untreated, there is tonic spasm of the muscles surrounding the joint, which causes the head of the femur to press firmly against the upper and back part of the acetabulum. This leads to absorption of that part of the inflamed head of the femur and the acetabulum which are in contact, so that the latter cavity becomes considerably enlarged in the upward and backward direction. Fresh bone is, however, formed beyond the area of absorption, so that there is an imperfect new rim provided to the cavity. This enlargement goes on until the acetabulum loses its round shape and becomes so much elongated that the head of the bone is drawn up on the pelvis, although it still retains its connection with the acetabular cavity. This is the common cause of the condition usually spoken of clinically as "dislocation" in hip disease, and is not a true dislocation at all.

Dislocation.—True dislocation is of very rare occurrence in this affection. It may, however, happen, especially in the earlier stages, from destruction of the ligamentum teres and filling up of the acetabular cavity by new tissue. This pushes the head of the bone out of place, when some sudden movement brings about the displacement. The head of the bone, however, does not follow the course of the true traumatic dislocation; it simply slips upwards either backwards or forwards. Not infrequently it passes forwards beneath the anterior superior iliac spine. Sometimes the dislocation is only partial, the head of the bone being caught on the margin of the acetabulum, in which case a deep groove may be made on the head by the rim of the acetabular cavity.

Abscess.—Chronic abscess is very common; its most common seat is in front of the trochanter, close to the insertion of the tensor vaginæ femoris, and less frequently about the gluteal fold. Sometimes the abscess may point at the upper and inner part of the thigh close to the perineum, and in rare cases abscesses forming in front of the joint may burrow upwards beneath Poupart's ligament, occupy the iliac fossa, and give rise to one of the forms of pelvic abscess. This last method in which the abscess may spread should be remembered, because it is very common to assume that

these iliac abscesses have extended upwards from the pelvis, whereas, in a certain number of cases undoubtedly, the original focus of the disease is in front of the hip joint, and in some others it may be in the iliac glands.

Abscesses may also form in the pelvis in connection with primary acetabular disease, and thence they may spread upwards into the iliac or downwards into the ischio-rectal fossa, or they may find their way into the buttock through one of the sacro-sciatic notches.

CLINICAL STAGES.—It is very convenient from the point of view of treatment to divide tuberculous hip disease into four clinical stages, although in practice it is not always easy to distinguish where one stage ends and another commences. These four stages are as follows:

1. **The stage in which there is no enlargement of the acetabulum or absorption of the neck of the femur.**—There is here no shortening of the limb, which is slightly flexed, abducted and rotated outwards. The patient therefore tilts the pelvis down on the affected side in order to walk, and this causes apparent lengthening of the limb. The muscles of the thigh and buttock rapidly waste and their electrical reaction is somewhat impaired.

2. **Destruction of the cartilage and enlargement of the acetabular cavity without abscess.**—Here the limb is shortened to a degree dependent on the enlargement of the acetabulum and the absorption of the head and neck of the femur. There is considerable pain, with nocturnal starting pains. The flexion is increased and the limb is rotated inwards and somewhat adducted. The affected side of the pelvis is therefore raised on walking so that the shortening appears to be very marked; a certain amount of this is only apparent and is due to this pelvic obliquity. The real shortening varies from about a quarter of an inch to two inches. As the disease progresses, the muscles, especially the adductors, become shortened and offer considerable opposition to the restoration of the limb to its proper position. In this stage would be included the cases of true dislocation without suppuration.

3. **Suppuration is present.**—The changes in the joint and the position of the limb are those just mentioned. There is, in addition, an abscess or there may be sinuses resulting from its rupture. When suppuration occurs quite early in the disease, the position of the limb may be more nearly that of the first stage than of the second. The abscesses may or may not communicate with the joint; generally they do so, but in some cases the osseous deposit is so far out along the neck of the bone that the probe passes down to the sequestrum without entering the joint. A rectal examination should never be omitted when examining a case of hip disease for abscess, as the inner surface of the acetabulum can easily be palpated and its condition on the two sides compared; if there be a pelvic abscess due to acetabular disease, fulness can be quite easily made out.

4. **Disease that is retrogressive or has completely subsided, but has**

left deformity.—The deformity is generally that of the third stage, *i.e.* flexion, adduction, and inward rotation, but this of course may be much modified by treatment, etc.

PROGNOSIS.—Although of considerable gravity, hip disease is nevertheless often attended by recovery if suitable treatment be carefully carried out for a sufficient length of time. If however any good is to be done, it is imperative that the treatment be persisted in much longer than is generally the custom. A few weeks' or a few months' treatment is totally insufficient to ensure a child against recurrence of the symptoms when the treatment is abandoned, and two, three, and sometimes even six or seven years are required.

When the case is seen quite early and treatment is begun at once, recovery without shortening and with a considerable amount of mobility of the joint may ensue, but it must be borne in mind that movement can only be obtained if the joint be kept perfectly fixed during the treatment. Any attempt to ensure movement by means of passive motion only leads to the spread of the disease and increased stiffness when it subsides. Recovery also is by no means hopeless even when the case is complicated by abscess, a very considerable proportion recovering with satisfactory joints if careful aseptic treatment be adopted. In fact, where it is possible to keep the case aseptic from first to last, the only way in which the disease threatens life is from the occurrence of tubercle elsewhere, usually as lung disease or tuberculous meningitis.

It may be concluded that a case of hip-joint disease has completely recovered, and the treatment may be left off, when there is a total disappearance of the thickening in the neighbourhood of the joint, with a complete absence of pain and of rigidity of the muscles surrounding it.

TREATMENT.—This is partly general and partly local. The general treatment of tuberculous joint disease has already been referred to (see p. 114), and we shall therefore only describe the local treatment. This we shall divide up in accordance with the clinical stages already defined

1. Of the first stage.—The limb must be efficiently immobilised, and counter-irritation should be employed. Of these two methods *rest* is the more important, and should be enforced, at all events, not only by applying suitable apparatus, but by the maintenance of the horizontal position in bed. Whatever splint be employed, it is essential that the patient should not get up even on crutches, until all signs of acute mischief, namely pain and tenderness on pressure, have entirely disappeared, and the affection is well on the way to cure.

The first point of practical importance in determining the treatment for any given case in the early stage is to decide whether to employ rest and splints alone, or whether extension is also necessary. This will depend upon whether the disease is essentially synovial, or whether there is

a deposit in the bone leading to infection of the joint and destruction of the articular cartilages.

(a) **Primary bone disease.**—When there are osseous deposits infecting the joint, there will be thickening of the bone and spasm of the muscles around the joint. The spasm presses the inflamed surfaces together, promotes rapid absorption and shortening, and calls for the employment of *extension*. It should, however, be remembered that the object of extension is not to separate the bone ends—which would be impossible without using more weight than the patient could tolerate—but to overcome the tonic contraction of the muscles around the joint, and so to prevent the bones being forcibly pressed together; they thus get rest, and the inflammatory mischief subsides.

If, on the other hand, the disease be purely synovial, without any affection of the bone, there will be little or no muscular spasm, and extension will not be called for; indeed, it would actually do harm by stretching and irritating the already inflamed capsule, and thus would increase the inflammation.

When extension is employed in hip disease, the strapping should take its purchase from the thigh as well as from the leg; indeed, if much weight be required, it is well not to continue the plaster below the knee at all, so as to avoid pulling unduly upon the ligaments of the knee. In this first stage the extension should be made in the long axis of the body. The weight employed for extension will depend upon the age of the patient and the strength of the muscles. In a child, three pounds is very suitable to begin with, and may be increased or diminished according to circumstances; should it not relieve the pain and overcome the spasm, additional weight must of course be employed. If this relieves the pain, the case should be watched to see that pain does not recur after a time; any recurrent pain will be due to the weight being now too great for the muscles, and unduly stretching the ligaments. The indication is to slightly decrease the weight.

Another essential is to prevent rotation of the limb, and a very suitable apparatus for this purpose has been figured in connection with fractures of the femur (see Part III., p. 117). The trunk is kept steady by a folded sheet, in which sandbags are rolled up, passed across the thorax, but, should the patient be unruly and constantly try to sit up, it will be well to apply a Liston's long splint (see Part III., p. 111) to the *sound side*; if applied to the affected side, it would, of course, interfere with the extension. Counter-extension is provided for by raising the foot of the bed on blocks (see Fig. 37).

When the case is very acute, it is well to employ a mattrass divided into three parts; the narrow central part is beneath the pelvis and is again divided into two lateral halves, so that one-half of it can be removed for nursing purposes without disturbing the patient.

When the disease is very acute, and the pain is considerable, some

benefit may be obtained by employing *the actual cautery* (see Part I., p. 19), which should be applied at a white heat in front of and behind the trochanter. The sore resulting should be kept open by savin ointment for at least six weeks.

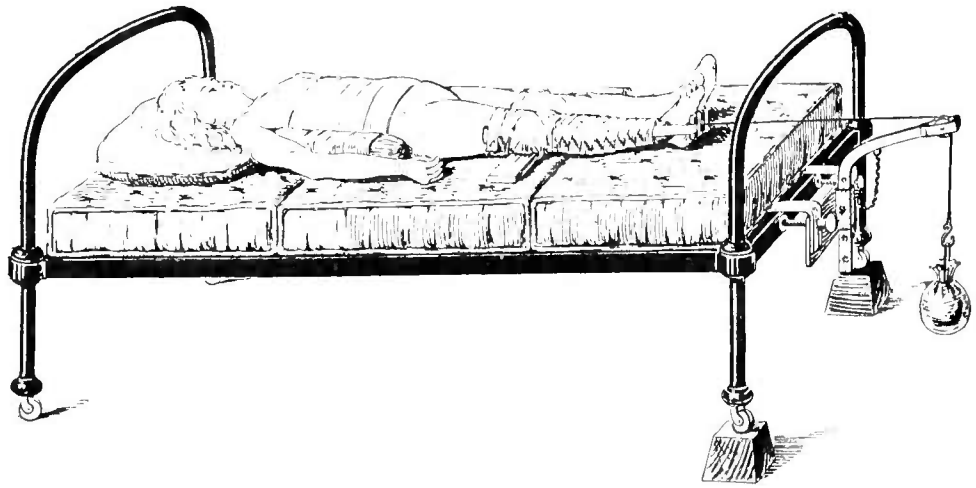


FIG. 37.—EXTENSION BY WEIGHT AND PULLEY FOR HIP DISEASE. The extension is made by the weight attached to the cord passing over the pulley fixed to the end of the bed. The limb is kept from rotating by means of the transverse bar of wood fixed behind the knee with plaster of Paris bandages. The trunk is kept horizontal by the sheet passed across the chest with a sandbag rolled up in each end. Counter-extension is made by raising the foot of the bed on blocks.

(b) **Primary synovial disease.**—When, on the other hand, the disease is synovial, extension is not called for in the early stages; the best treatment here is by means of a Thomas's hip splint.

Thomas's hip splint (see Fig. 38) consists of a long flat bar of malleable iron running down the back of the trunk and the affected extremity from the axilla to just above the ankle. It lies vertically against the trunk and is bent into a curve with the convexity backwards opposite the buttock, after which it is continued straight down behind the thigh and leg. The lower vertical portion is parallel to the upper, but lies on a plane somewhat anterior to it. The bar is twisted a little, so that it lies flat against the side of the trunk above, whilst it runs down the middle of the limb behind. In the ordinary Thomas's splint there are three cross-pieces attached to the vertical bar, and bent round to form wings on either side. The length of these wings is unequal on the two sides, the shorter ones being on the side corresponding to the affected limb. The upper wings encircle the thorax just below the axilla; the middle ones surround the lower part of the thigh; whilst the lowest encircle the upper part of the calf. The splint is secured to the trunk by a broad bandage and by special shoulder braces, whilst the lower portion is fixed by bandages between the lower wings; it is also generally well to add a stout pelvic band taking in the splint, or otherwise the pelvis may be moved to one side, and adduction or abduction may not be properly overcome.

Thomas's original directions for the application of this splint are as follows:—1. The initial act should be to place the machine so far posteriorly that it is just out of sight behind the buttock when the patient is lying horizontal. 2. The machine should be pushed upwards until the upper wings are close to the patient's axillæ. 3. An assistant should grasp the patient's leg, together with the lower part of the main stem, to hinder the machine from slipping downwards while the operator is manipulating, that is to say, twisting it so as to fit properly. 4. The

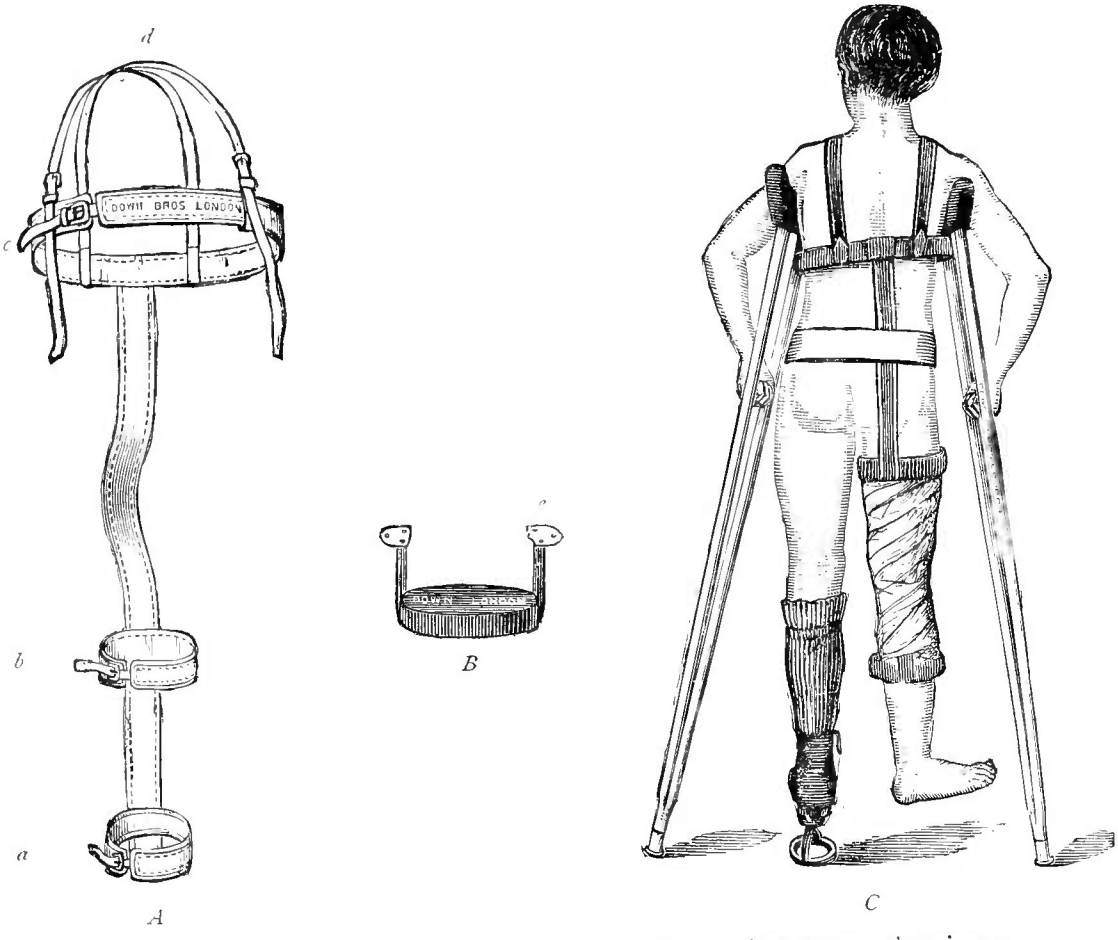


FIG. 38.—THOMAS'S HIP SPLINT. *A* shows the splint previous to use; the wings *a* surround the leg just below the knee, while those at *b* enclose the thigh well above it. The stout metal band *c* encircles the chest, and the splint is kept in place partly by bandages and partly by the braces *d*. *B* is the patten fastened to the boot on the sound side by the screw plates *e*. The apparatus is shown applied in *C*, with the patient walking on crutches.

surgeon should proceed first to closely fit the wings which grasp the sound side of the trunk, thigh and leg, and afterwards the outer wings are adjusted. 5. The shoulder braces are to be adjusted; afterwards the thigh and leg bandages. When flexion is present at the time that the splint is applied, no attempt should be made to draw the leg forcibly into the straight position. It should be allowed to remain in the position which is comfortable to the patient, and in the course of a few days the weight of the limb itself which is left unsupported behind the knee will gradually bring the leg straight.

Sometimes there is considerable pain for a day or two after the splint

has been applied; this is largely due to the weight of the limb, which is gradually producing extension at the hip joint. If the pain be excessive, two or three pads may be placed behind the knee so as to prevent the limb being brought down to the vertical; these are gradually diminished in thickness so as to allow the limb to come down by degrees, which it will then do without pain. The patient should be encouraged to persevere with the splint in spite of the pain, which should cease in a few days when the limb is got into good position.

A very serious fault frequently committed by instrument makers is to mould the splint to fit the body of the patient accurately whilst the

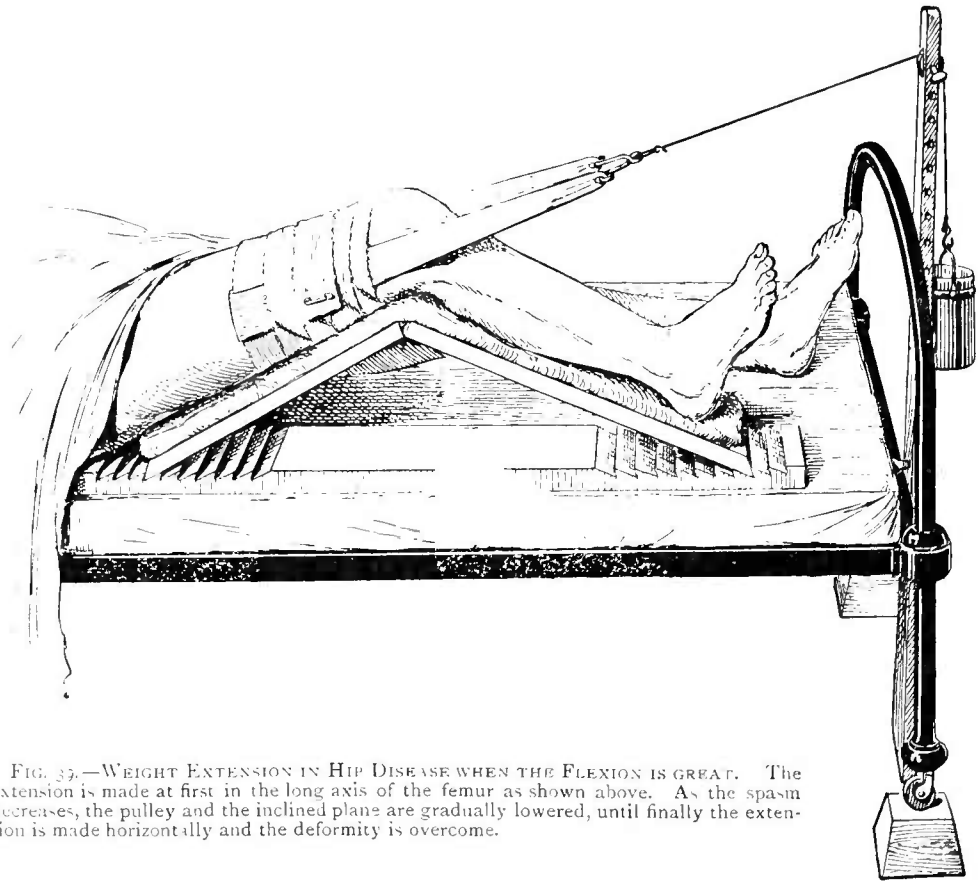


FIG. 39.—WEIGHT EXTENSION IN HIP DISEASE WHEN THE FLEXION IS GREAT. The extension is made at first in the long axis of the femur as shown above. As the spasm decreases, the pulley and the inclined plane are gradually lowered, until finally the extension is made horizontally and the deformity is overcome.

limb is in the position of deformity. Thus, it is curved forward in the loin to correspond to the amount of lordosis; below this comes the concavity for the buttock, and then it is bent forward again to correspond to the flexion of the leg. The result is that by no possibility can the flexion be overcome, as the apparatus fixes the limb in the faulty position. If a good result is to be obtained, it is absolutely essential to overcome the flexion, and, when a Thomas's splint alone is employed, this must be applied as he himself recommended; namely, in the form of a straight bar simply curved where it lies over the buttock, the other parts of the apparatus being absolutely vertical.

When the flexion is extreme, some extension must be made before applying Thomas's splint; this, however, must never be applied in the horizontal direction to a flexed limb as it would cause great pain, and might considerably increase the muscular spasm. It is quite easy to make extension in the direction that the limb has already assumed. When the flexion is considerable, the pulley over which extension is being made must be raised sufficiently for the cord passing from the limb to the

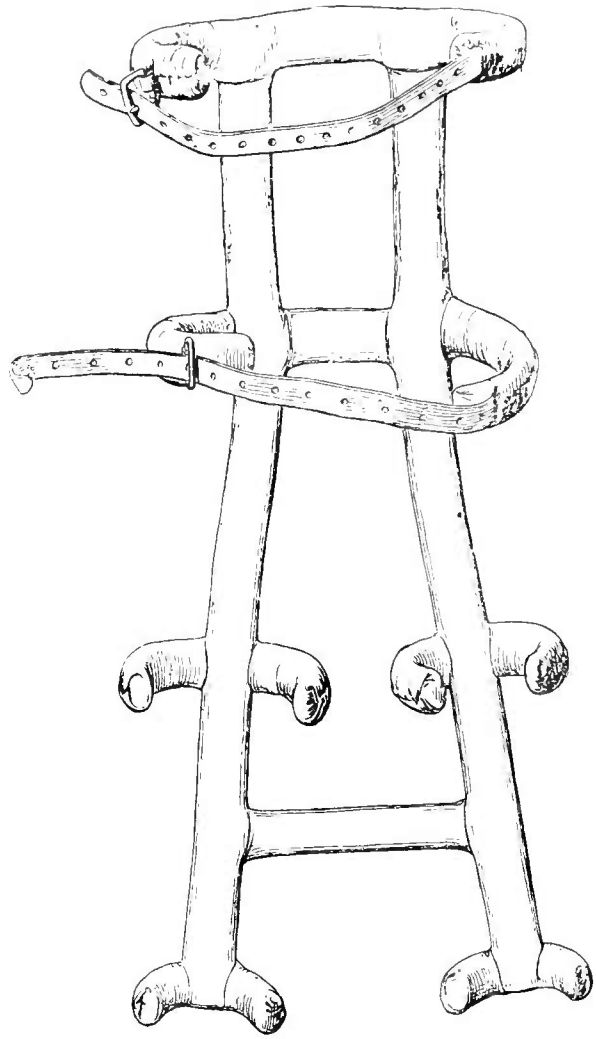


FIG. 40.—A DOUBLE THOMAS'S SPLINT FOR HIP DISEASE. The splint, which is made of malleable iron thickly padded with leather, is shown applied in the following Figure. The leg-pieces diverge, so as to abduct the lower extremities.

pulley, to run very much in the direction of the limb itself (see Fig. 39). In two or three days, the pulley may be lowered so as to diminish the amount of flexion slightly, and this can be continued as the limb comes down, until finally the horizontal position is reached.

When there is very marked adduction, or when the patient is a restless child, a single Thomas's splint is not sufficient, and it is better to employ *the double form* (see Fig. 40), which consists of a bar running up behind each buttock and leg, thence along each side of the spine, the two being connected by cross-pieces above and opposite the pelvis. The bars should diverge from each other, so that, when fixed to them, the

lower extremities are slightly abducted (see Fig. 41). Here also a pelvic band is absolutely essential to prevent the patient moving the pelvis laterally.

Another apparatus of very great value in these cases is *Phelps's box*, which will be more particularly referred to when we deal with the treatment of spinal caries. Phelps's box (see Fig. 42) is essentially a large trough diverging into two narrower troughs below for the lower extremities. In this the patient can be kept lying flatter and more comfortably than in the Thomas's splint, whilst adduction is readily prevented and extension

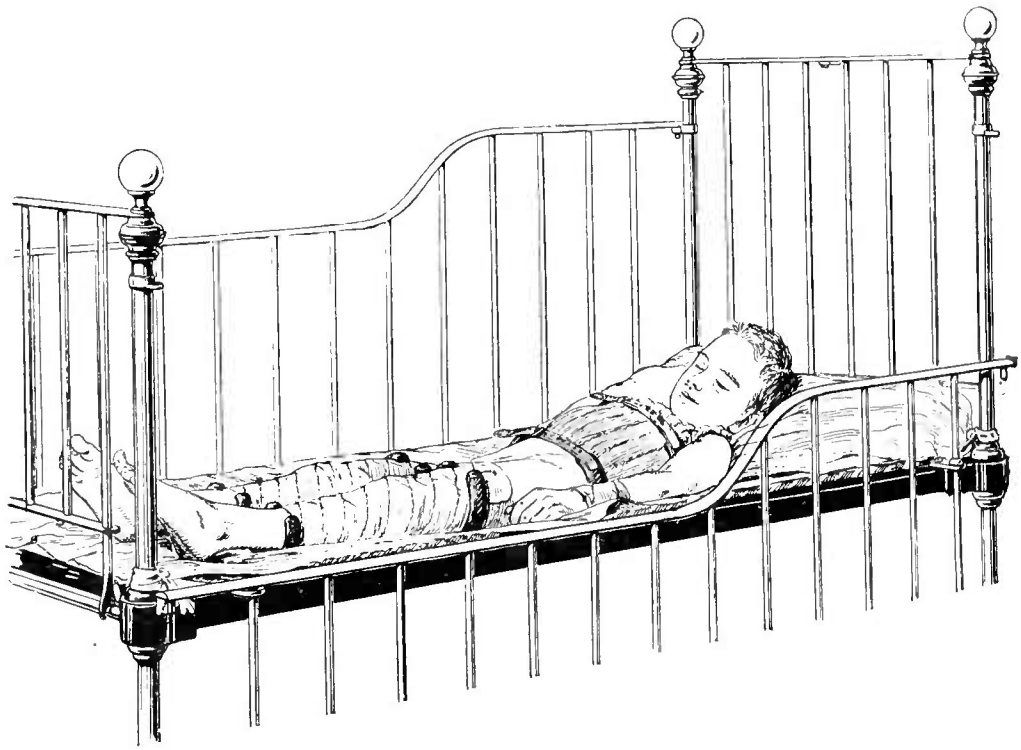


FIG. 41.—METHOD OF APPLICATION OF THE DOUBLE THOMAS'S SPLINT FOR HIP DISEASE. The limbs are fastened to the vertical bars with bandages and are encircled by the iron wings. Those surrounding the chest are fastened by buckles. There are no braces as in the single form of splint as of course the patient cannot walk.

can be obtained by elastic tubing attached to the foot-pieces of the splint below: the child can thus be carried about and wheeled out without disturbing him, or interfering with the extension (see Fig. 43). Another apparatus which is also useful and is very similar to the Phelps's box is *Bonnet's wire splint*, which is practically a wire tray made to fit the trunk and limbs, into which the patient is fastened so that he can be readily carried about without disturbing the joint.

Operative interference is rarely required in the first stage of the disease, but sometimes, when there is clearly a deposit in the neck of the femur, good results may be obtained by cutting down upon and removing it before the joint has become infected. The difficulty here is to make an exact diagnosis. Probably the neck of the bone and the great trochanter will

be markedly thickened without any pronounced symptoms such as pain or interference with movement. No thickening will be found inside the pelvis on a rectal examination, and practically none in the synovial membrane. It is probable that a skiagram will help considerably. Under these circumstances we have cut down and removed tuberculous deposits from the bone, and have thus succeeded in curing the disease without any infection of the joint. When the disease is evidently in the thickness of the neck of the femur, it may readily be got at by a vertical incision over the outer surface of the trochanter; when this is exposed, the shell of the bone is cut away with a gouge, and then the cancellous bone scraped out with a sharp spoon until the tuberculous deposit is reached. The wound is sewn up without a drainage tube, and the cavity in the neck fills with new tissue which undergoes ossification.

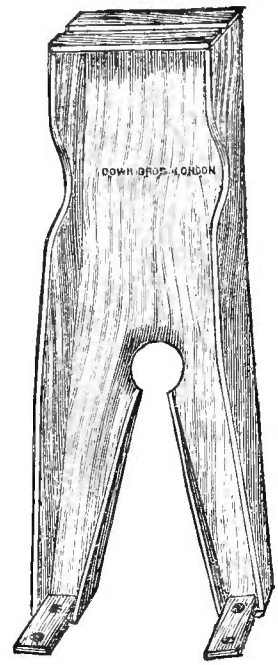


FIG. 42.—PHELPS'S BOX. The splint is here shown without the pads etc.; in the next Fig. it is shown in use. The holes in the foot-pieces and the slit in the upper end of the splint, through which extension and counter-extension can be made if desired, are seen here, as also the hollows in the sides of the box over which the child's arms can lie.

It is rarely necessary to perform any operation involving opening of the joint in this early stage of the disease; but sometimes, when the disease is rapidly progressing, and when it is evidently due to a deposit in the bone which has burst into the joint, the case may with advantage be treated by opening the joint and performing as complete an *arthrectomy* as possible. Unfortunately in the hip it is impossible to gain sufficiently free access to the joint to perform a really satisfactory arthrectomy; but if the original focus of the disease in the bone be removed and the anterior part of the capsule taken away—as can readily be done—and if the joint cavity be then filled up with iodoform and glycerine emulsion and stitched up, the disease will often be found to subside. The careful employment of the methods of after-treatment already referred to, carried out for a long period, may then effect a cure. For the steps of arthrectomy see p. 187.

2. Of the second stage.—It is in the second stage that *extension* is of special value, for absorption is going on and the acetabulum is becoming enlarged, so that, unless means be taken to control the muscular spasm, the shortening will increase in spite of the most careful fixation of the joint. It must also be remembered that flexion undergoes marked increase in this stage, whilst there is also adduction and rotation inwards. The essential points in the expectant treatment during this stage, therefore, are the prevention of further shortening, and the reduction of the three deformities just mentioned; suitable extension is usually able to do all this. When the extension is first put on, it should be in the line that the limb has already assumed; this overcomes the spasm of the muscles

readily, and in a few days the line of extension may be slightly altered so as to diminish the flexion and the adduction. The rotation can be overcome by means of the transverse piece of wood behind the knee, which has already been described (see Part III., p. 117). By gradually altering the position of the extension, the deformity can be quite overcome, until finally extension should be made with the joint in a position of distinct abduction. The best result that can be hoped for in these cases is recovery with a more or less complete anchylosis of the limb, and, should anchylosis occur with the limb parallel to the middle line, the shortening

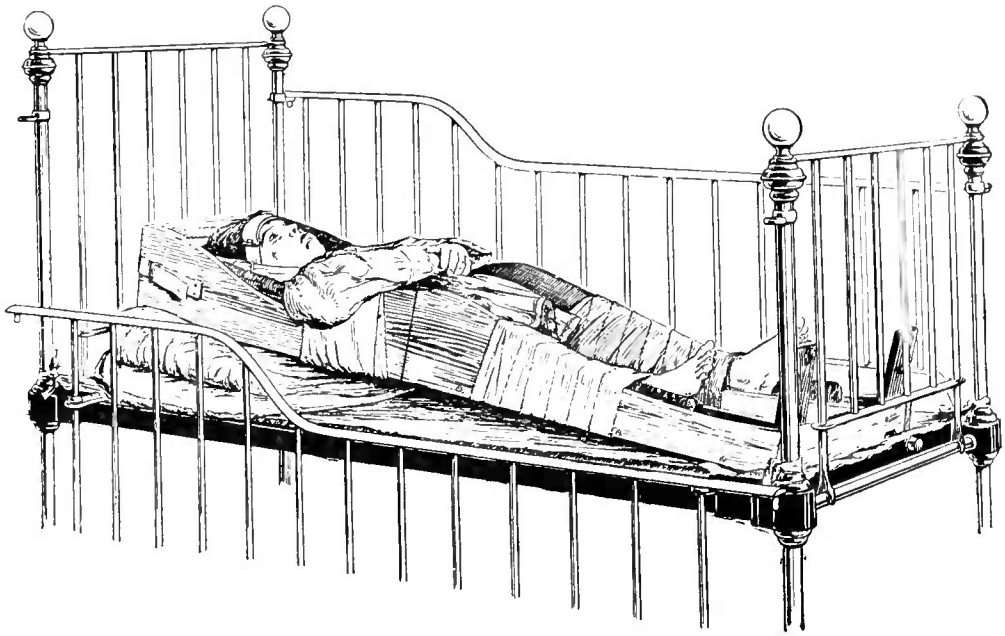


FIG. 43.—METHOD OF APPLICATION OF PHELPS'S BOX. The child lies upon suitable firm cushions made to fit the splint; other similar ones are inserted between the sides of the splint and the body. The legs are kept in their respective troughs by bandages, the thorax is encircled by a broad towel or folded sheet over the splint. The sketch above shows the box arranged for a case of spinal caries; extension is applied to the head, which is fastened to the end of the splint by a headstall, and the child's weight allowed to tell upon it by raising that end of the splint. For hip disease, if desired, extension can be made by combining weight and pulley extension of the lower limb with the above; the cord bearing the weight passes from the stirrup through holes in the foot of the splint.

will be considerable. If, however, the limb be abducted, the patient will have to tilt the pelvis towards that side when he desires to bring the sole of the foot flat upon the ground in walking, so that the apparent shortening becomes less than the real shortening, and thus the patient can get about with a thinner sole on the affected side than he otherwise could; this is a point of great importance.

It is seldom sufficient to allow the body weight to be the sole counter-extending force while the position of the limb is being thus rectified, since the patient is apt to wriggle across the bed and so defeat all attempts to remedy the adduction. Hence, a perineal band should be passed around the sound groin, and fastened to the head of the bed; as a further precautionary measure, heavy sandbags should be applied

along the trunk and should pass through the loop of the perineal band so as to anchor the patient firmly.

After the limb has been got into good position, and when the muscular spasm has subsided, a *Thomas's splint* may be fitted: the double form should always be employed, as the single one is quite ineffectual in obtaining sufficient abduction. The splint must be worn for a considerable time as otherwise muscular contraction will recur and the deformity will be reproduced. The apparatus should be worn for a year or two after the disease has come to a standstill. A great advantage of the double Thomas's splint is that the patient can be moved out-of-doors and can get the benefit of the fresh air. Until the disease has become entirely quiescent however it is not advisable to allow him to get about on crutches.

Sometimes the contraction of the adductors may be so marked that extension fails to get the limb into proper position, and it may be necessary to perform *tenotomy*: the adductors are divided close to their origin from the pubes. It is, however, very important that no force should be used to restore the limb to its proper position, as otherwise aggravation of the disease is almost certain to occur. Gentle steady traction will bring the limb out to a considerable extent, and then further abduction may be obtained in a short time by a suitable arrangement of the extension apparatus.

The question of operation often comes up for decision in the second stage of hip disease, the particular form being *excision of the hip*, with as complete a removal of the diseased structures around as possible. Some surgeons are strongly in favour of operation at this stage, even before suppuration has occurred, and they claim that, by an early and complete removal of the disease, the trouble is cut short and the danger of subsequent constitutional infection is avoided. Supposing this to be correct, the great objection to early excision is the imperfect functional result that is obtained. Even with a stiff hip—so long as it is in good position—the patient has a much firmer and more satisfactory limb than he would have were the joint excised. In the latter case, the trochanter moves up and down over the side of the pelvis, and there is a great want of stability, the gait resembling very closely that of congenital dislocation. The complete removal of the disease from the hip is, however, hardly possible, even after excision. It is particularly difficult to remove the posterior part of the synovial membrane, and the surgeon often has to content himself with scraping this after he has removed the head of the bone.

Moreover, it is by no means certain that early excision does avoid dissemination of the tubercle. Since it is practically impossible to get rid of the whole of the disease as satisfactorily as can be done in more accessible joints, such as the knee, and since scraping a tuberculous surface not only usually fails to eradicate the disease, but is apt to lead to the very accident which it is wished to avoid, namely dissemination of the tubercle, the operation must be regarded with suspicion. A considerable number

of cases are recorded in which tuberculous meningitis has followed so directly after an excision of the hip that there can hardly be any doubt that it was caused by the operative procedure. Local recurrence also is by no means necessarily avoided, because the exposed bone may become infected, since the disease has not been completely removed, and tuberculous osteitis or osteo-myelitis may set in. Hence we cannot agree that early excision is indicated either on the ground of a rapid cure of the disease or on that of avoiding dissemination of the tubercle, whilst the functional result is certainly not good. Finally, there is no doubt that there is very marked interference with the growth of the limb when excision is performed in very young children.

Notwithstanding all this, there are cases in which excision at this stage of the disease is the proper procedure. We should reserve it for the following cases:—1. Those in which the disease is progressing in spite of careful treatment on the lines just indicated; that is to say, those in which the tenderness does not subside, where the fulness in the groin increases, where the starting pains at night continue, and where there are other signs that the disease is progressing.

2. Those in which it is evident that there is primary acetabular disease in which recovery is evidently not taking place; this is shown particularly by thickening of the tissues on the inner surface of the acetabulum, which can be felt per rectum. In these cases, the head of the bone must be removed before sufficiently free access can be got to the acetabulum.

3. Those in which the head of the bone cannot be kept in place satisfactorily. It does not necessarily follow that excision need be performed here; the head of the bone may be exposed and the thickened synovial membrane removed, together with a large amount of the disease, when, after replacing the head of the bone, filling up the joint with an emulsion of iodoform and glycerine, and treating the patient on the lines already laid down, a cure may take place. (For the operation of excision, see p. 187.)

3. Of the third stage.—The great characteristic of this stage is the presence either of unopened abscesses or of sinuses resulting from the opening or rupture of them. The deformity is very similar to that already described in the previous stage. Treatment must vary according to whether (a) the abscess is unopened, or (b) sinuses are present.

(a) **When there is an unopened abscess.**—Operative treatment is necessary, because the cases in which a chronic abscess has become absorbed under rest alone are so rare that a cure cannot be reasonably looked for without it. The point for decision in the operative treatment is whether the abscess shall be merely opened and treated, or whether steps, such as excision of the joint, shall be taken to remove the primary disease. The answer to this will depend upon the circumstances of the individual case, and one of the points of greatest importance is whether the abscess originated within the pelvis, or whether its starting point is in the thigh. When the abscess is entirely outside the pelvis, and is therefore probably

connected with disease which is either primarily synovial or is situated in the neck of the femur, it is probably best, if the patient's condition be good and the limb be easily got into position, to treat the abscess alone and to defer the question of excision to a later period. If excision of the joint be done when a large abscess is present, the operation is prolonged and difficult, because, were the abscess simply opened and the joint excised, much disease would be left behind, and there would be great risk of infection of the bone section. On the other hand, removal of the abscess wall in combination with excision of the joint entails a prolonged operation with much loss of blood and great shock, and patients have died under these circumstances. Hence, we believe that in most cases it is best in the first instance to treat the abscess alone, and not to interfere with the actual joint disease for the time being at any rate.

Treatment of the abscess alone.—The treatment of chronic abscess has already been fully described in Part I., p. 248. It consists essentially of complete removal of the abscess wall if possible; if not, as much of the wall as is accessible is removed, and the remainder treated by thorough scraping; failing either of these methods, scraping alone is employed, followed by washing out of the abscess and injection of iodoform and

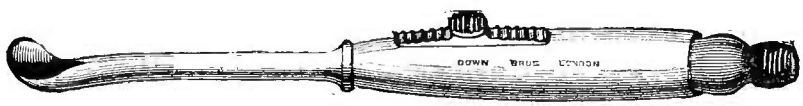


FIG 44.—BARKER'S FLUSHING GOUGE. The instrument is hollowed and is connected by india rubber tubing with a reservoir of lotion, the flow of which is regulated by the sliding button seen on the upper surface of the figure.

glycerine emulsion. In these hip abscesses the first plan is not feasible. The abscess goes down to the synovial membrane or the bone, and as a rule it is quite impossible to dissect it out. The second method, however, can generally be employed. It is done by making a very free incision over the abscess, which should not be opened until as much of its wall as possible has been isolated; the abscess is then opened and the isolated portion of the wall is clipped away, and then, by means of Barker's flushing spoon (see Fig. 44), the abscess cavity is thoroughly cleared. The addition of flushing to the use of the sharp spoon, which is due to Mr. Barker, is a great safeguard against the risks of general infection which accompany scraping alone. As the material is scraped away, the rush of fluid through the instrument washes it out of the wound at once, and it is not therefore likely to be carried into the circulation.

After the abscess has been scraped out, about an ounce of the 10 per cent. emulsion of iodoform and glycerine is injected into the cavity, the wound stitched up without a drainage tube and antiseptic dressings applied. The whole essence of the treatment depends upon strict asepsis; should the wound become septic, good results cannot be expected from treatment of the abscess alone.

In many cases the wound heals by first intention and the abscess is cured. In some, a certain amount of serum may collect, in which case, if there be distinct fluctuation, it is well to evacuate it by introducing sinus forceps between the lips of the wound and squeezing the fluid out; closure of the abscess cavity then gradually takes place. In some, a second or even a third scraping may be necessary, but in the great majority of cases the abscess heals—unless there be a sequestrum at the bottom of the cavity—and the case falls into the second stage, of which the treatment has already been described (see p. 177).

Sequestrotomy.—Should a sequestrum be felt when the abscess is opened and scraped, or should a cheesy deposit in the bone be easily reached, it ought to be removed; but any further attempt to clear out the joint is, we think, unnecessary at this stage and to be avoided. When the abscess heals, or when a sinus forms in spite of more than one scraping, the question of excision will arise, and if this be considered necessary on account of extension of the disease, or on account of indications mentioned on p. 180, it will be found that the operation is now neither so extensive nor so formidable as if it had been carried out before the abscess was got rid of.

Excision.—When the abscess originates within the pelvis it is a clear indication that the acetabulum is diseased; this is usually due to a primary osseous deposit in it, although sometimes it may be secondary. Under these circumstances excision of the head of the bone is advisable because it allows free access to the acetabulum and good drainage if necessary. The abscess is first treated by making a small incision into it at some point easy of access—generally about the anterior superior iliac spine when the abscess has penetrated into the iliac fossa—and is scraped out as thoroughly as possible, iodoform and glycerine injected and the wound stitched up. Excision of the head of the femur should then be performed through an anterior incision, and when the head of the bone has been removed, special attention must be directed to the acetabulum so as to remove from it any osseous deposit, and to establish a communication with the interior of the pelvis by gouging or scraping away the bone until a perforation has been made. The steps of the operation and the after-treatment are similar to those described on p. 187.

(b) **When there are septic sinuses.**—When septic sinuses are present, the conditions are altogether different, and in most cases excision is advisable. When the position of the limb is good, and the patient's general health is satisfactory, and when there are only one or two sinuses, an attempt may be made by proper fixation of the limb and the establishment of good drainage to bring about a cure of the disease. The patient should be put under an anæsthetic, the external opening of the sinuses enlarged and their track thoroughly scraped. It is well also to apply undiluted carbolic acid to the whole length of the sinus before finishing the operation. If two or more sinuses can be made to communicate, a large drainage tube should

be passed through from one opening to the other; where this cannot be done, a large drainage tube must be introduced into each sinus, reaching down as far as possible. Antiseptic dressings should be applied, because it is just possible that the treatment may not have completely destroyed the septic organisms, and in any case it is better to avoid the entrance of more.

The after-treatment of the case will consist of complete fixation of the joint and careful dressing of the sinuses. The best method of fixing the joint is to apply a plaster of Paris spica in which suitable openings are left for dressing the sinuses; the spica should extend up over the lower ribs. It should be strengthened both in front and behind the hip, either by strips of metal incorporated in the bandage or by strands of tow thoroughly impregnated with plaster. Below, it should reach to the upper part of the calf, so as to fix the knee joint as well as the hip, and it should be applied with the limb in a position of abduction. When the sinuses are situated so that it is difficult to apply the bandage without covering them in, metal bars bent outwards opposite the wound may be incorporated with the bandage so as to provide a firm splint, and at the same time to give sufficient interruption in it to allow proper access to the wound.

The drainage tubes should not be removed for at least a week, as otherwise there may be some difficulty in re-introducing them. When two sinuses have been made to communicate, and a tube has been passed through from one to the other, a long loop of silk should be inserted into each end of the tube, and then, when it is desired to wash the latter, it will be easy to re-introduce it, because one end can be pulled upon until a considerable amount of the tube has been withdrawn; this portion can be washed with a 1-2000 sublimate solution, and, by traction upon the second loop, the other end of tube can be made to project, until the whole tube has been thoroughly washed, when traction on the first loop will pull the tube into position again. After cleansing the tube it is well to dust it with iodoform before it is put back into position. We do not consider that these tubes should be syringed out with any antiseptic; the only result of this is to irritate the wound without doing any good. After about three weeks, the tube may be cut in two and shortened, so that the outer end of each lies flush with the skin, whilst the deeper one goes to the bottom of the cavity. As healing takes place from the bottom, the tubes will be gradually pushed out and must be cut down. When a very large tube has been used at first, a somewhat smaller one may be substituted after a time.

When a tube has been passed into each sinus they should not be disturbed for about a week. Each tube may then be withdrawn, cleaned, powdered with iodoform and replaced. In all cases the tubes should be kept in as long as possible, and, when it is found that the large tube will not go down to the bottom of the sinus, one of smaller calibre must be

substituted for it. It is well to substitute a fresh tube every few days, as granulation tissue grows through the holes in it and blocks its lumen unless fresh tubes be used; in the fresh tube the holes will be in a different position, and the difficulty is thus easily avoided.

In a certain number of cases, but unfortunately in only a few, the sinuses may heal and the disease may be cured when the patient is under good hygienic conditions and carefully treated; but when there are a number of sinuses, and when sepsis is marked, the attempt as a rule ends in failure, and it will be necessary to excise the joint. In other cases where the disease is evidently active, and it is obvious that the patient cannot be placed under good hygienic conditions, it is well to excise the joint at once.

Before proceeding to excision, the sinuses should be thoroughly scraped out and sponged with pure carbolic acid, so as to render the wound as aseptic as possible before the excision is performed. After excision the cavity left should also be thoroughly sponged out with undiluted carbolic acid (for the operation of excision, see p. 187).

4. Of the fourth stage.—In this we include those cases in which recovery has either taken place or is progressing satisfactorily, but where the limb is in bad position; the aim of the treatment is therefore mainly to remedy the deformity. The usual deformities met with are flexion, adduction and rotation inwards. When flexion is marked, the patient is either unable to put the foot to the ground, or can only do so by producing very extreme lordosis. When the adduction is marked, it is necessary to tilt the pelvis before the leg can be brought parallel with its fellow, and this produces marked scoliosis, whilst the practical shortening of the limb is greatly increased. For these reasons it is necessary to do something to remedy the deformities.

In the cases where there is still a certain amount of movement in the joint, the deformity may be overcome by dividing any contracted bands or tendons, particularly the adductors, and by the very careful employment of a certain amount of force to stretch the adhesions, and then finally following this up by extension, employed as directed on p. 177, until the limb is in the position of abduction with the rotation and flexion corrected. The reason for preferring the abducted position has already been given (see p. 178). A certain amount of scoliosis must, of course, result from this abducted position, but, if the patient be strong, it will not go beyond that necessary to compensate for the shortening, and even without abduction a certain amount of scoliosis is almost inevitable.

In the majority of cases, however, the anchylosis is so firm that the deformity cannot be overcome by these means alone, and would require for its rectification a force that would be almost certain to light up the disease afresh. Various operative measures must therefore be considered, the principal being excision of the joint, removal of a wedge of bone from

the region of the trochanter so as to enable the limb to come straight, or simple division of the femur below the trochanters. Of these plans the most satisfactory in the majority of cases are the two last. Excision of the joint is not to be recommended for the reasons already given (see p. 179). Sometimes however it may be called for when the deformity is very marked, as it may be impossible to get the limb straight by other measures; when excision is done, prolonged after-treatment is necessary in order to get a stable joint.

When the deformity can be remedied by the removal of a wedge of bone of reasonable size, this should certainly be done. It is probably best to take the bone from somewhere about the junction of the neck with the trochanter; this leaves a large surface for union, and is in quite an accessible region (see Fig. 45). The shape and the size of the wedge will depend upon the exact nature of the deformity. If it be mainly adduction, its base must be directed outwards and upwards; if there be marked outward rotation its base must be forwards, and so on.

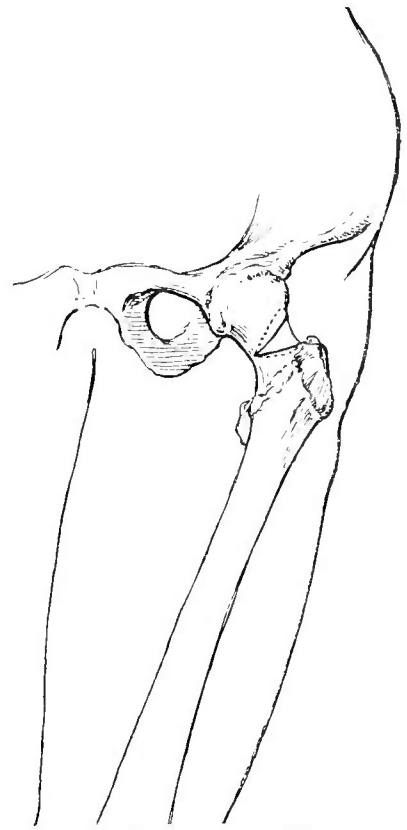
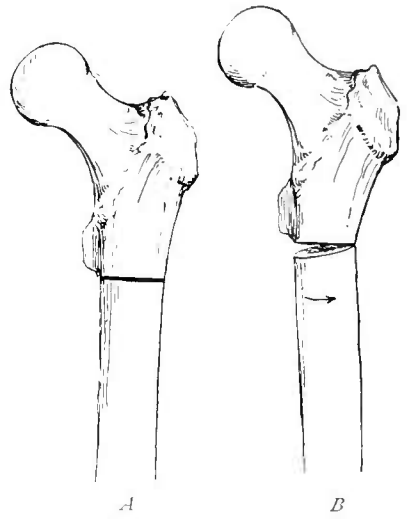


FIG. 45.—EXCISION OF A WEDGE FROM THE NECK OF THE FEMUR IN OLD HIP DISEASE. The wedge, which is excised through the incision seen in Fig. 27, is made with its base upwards and outwards for the deformity here shown, viz., flexion, adduction and inward rotation. The wedge also requires to be made wider behind than in front, as shown by the dotted lines.

The neck of the bone is reached by an incision very closely resembling that for the anterior operation for excision of the hip (see Fig. 27). It commences just below the anterior superior iliac spine, and runs downwards and outwards, along the anterior edge of the tensor vaginæ femoris; it should be four or five inches in length. The incision is deepened, the muscles are pulled aside, and the junction of the neck of the femur with the trochanter is exposed, no structures of importance being divided. The wedge is best shaped by means of a chisel and hammer, as if a saw be employed it is apt to lacerate the muscles or even the skin, in the upper part of the incision, whilst the amount of bone to be removed can be more accurately gauged if a chisel and hammer be used. When the limb is brought into position it will generally be found that the adductors at least require division, and the adductor longus may be divided by a tenotomy knife close to its origin from the pubes; any other tense bands should also be similarly treated.

After removal of the bone it is best to try to obtain bony union, although some surgeons prefer a false joint. Others again simply divide the bone below the trochanters (see Fig. 46), but this is not nearly such a satisfactory

method. After the limb has been got into position, an extension of three or four pounds should be employed in the direction which it is desired that the limb should finally occupy. Besides this, the arrangement described on p. 171 for preventing rotation should also be employed. A Liston's long splint should be fastened to the sound side, so as to prevent the patient from sitting up, and the divided mattrass, already described (see p. 171), should be employed.



A *B*

FIG. 46.—SUB-TROCHANTERIC OSTEOTOMY OF THE FEMUR FOR OLD HIP DISEASE. The simple linear division of the bone at right angles to its long axis is seen in *A*. *B* shows the gap produced when the deformity is corrected; the arrow indicates that the shaft of the bone requires to be rotated on its long axis to correct the inward rotation.

The patient should be kept in this position until union has occurred, which will generally be in about six weeks, after which he may be fitted with a Thomas's splint bent to correspond to the amount of abduction present; he may then get about on crutches. In about three months from this time he may be provided with a high boot on the affected side and allowed to walk without crutches.

When the deformity is very great, and when it is evidently impossible to remedy it by taking out a wedge, and particularly when the disease is still progressing, excision of the joint will probably provide a better result. This excision should be by the anterior method (see p. 187), and, after it has been performed, the adductors should be divided and the limb placed in proper position; the subsequent treatment is identical with that described (see p. 189). Here, however, the patient should not be allowed to bear any weight upon the limb for at least a year after the operation. Many surgeons allow the patient to walk after about six weeks, but this only stretches the fibrous union in the deeper part of the wound, so that the upper end of the bone slides about freely when the patient bears weight upon the limb; the consequence is that the gait very closely resembles that of congenital dislocation. On the other hand, if the limb be kept fixed in a properly applied Thomas's splint for a prolonged period, the fibrous union becomes very firm and there is no undue mobility. The chief objection urged against this prolonged treatment is the risk of producing anchylosis; even should this happen, the result will be quite satisfactory, and a very strong limb will result; but in most cases it can be entirely obviated by employing passive movement once or twice a week, carried out, however, only through a limited range, because there should be no desire to obtain free movement.

At this stage of the disease cases are sometimes met with in which

both hip joints have been affected, and the adduction has caused the legs to cross one another, and to produce the so-called "scissor-leg" deformity. This is a most distressing condition, and something must be done to remedy it. We believe that the best treatment is to excise the joint on one side so as to get a movable joint, and thus to enable the patient to sit down, whilst on the other side a wedge should be removed so as to insure a firm support. If both the joints be excised, the patient is in a condition very similar to that of congenital dislocation of both hips, and will probably have most serious locomotive troubles, whereas if one leg be firm and in good position and the joint on the other side be excised, the ultimate result will probably be very satisfactory.

EXCISION OF THE HIP.—This operation is practically confined to cases of tuberculous disease, and the indications for its performance have already been given. In all these cases excision must of course be combined with free removal of the diseased synovial membrane; in fact there is no real distinction between excision and arthrectomy, unless the latter term be reserved for the rare cases in which the head of the bone is not removed (see p. 180).

Methods.—Excision may be performed in various ways, of which we may mention three: by an anterior, an external, or a posterior incision. Each of these has its own special merits and may be adopted under different circumstances.

(1) By an anterior incision.—The anterior incision is the one in common use, and is the most satisfactory method *for children*. It is especially adapted for cases of medium severity in which the disease does not extend far out along the neck of the femur. The incision commences just below the anterior superior iliac spine, and runs downwards and slightly inwards for about four inches, so as to open up the interval between the tensor vaginæ femoris externally and the sartorius internally (see Fig. 47). After the skin and deep fascia have been divided, the septum between the tensor and the sartorius comes into view, and these muscles are separated and pulled well apart by large retractors; the cellular tissue lying between the deeper muscles is then divided, in doing which a fairly large branch of the external circumflex artery is usually cut across. As the incision is deepened, the capsule of the joint is reached and is opened. The neck of the bone is then divided in the line of the external wound with a fine saw (see Fig. 48), and the head of the bone is seized with lion forceps; it can usually be removed without any difficulty owing to the enlargement of the acetabulum and the destruction of the ligamentum teres.

This brings the surgeon to the most important part of the operation, namely the identification and removal of the diseased synovial membrane. In order to do this, the wound is fully retracted, the outer surface of the capsule is defined at the point where it has been incised, and the

tissues in front of it are separated by the finger and a suitable blunt dissector, and raised from it until the margin of the acetabulum is reached. The anterior part of the capsule is freed in this manner as far as possible upwards and downwards, when it may be clipped away almost entirely. When the soft parts are fully retracted, this gives a good view of the interior of the joint, and the acetabulum can be dealt with. The remains of the ligamentum teres are cleared out, and if there be any destruction of the cartilage covering the acetabulum or any tuberculous deposit in the bone, the whole surface of the acetabular cavity should be thoroughly scraped with a Barker's flushing gouge (see Fig. 44).

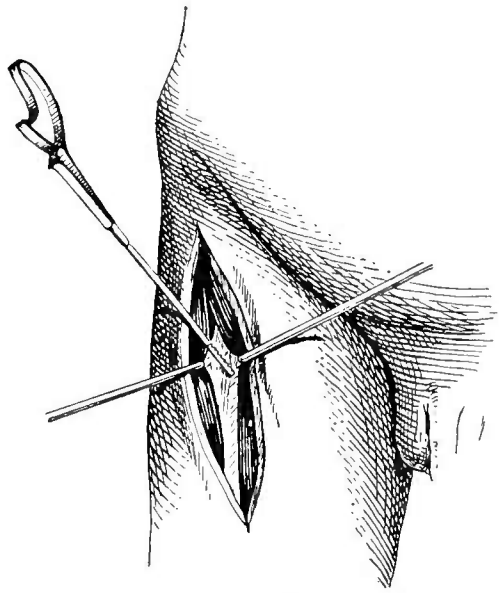


FIG. 47.—EXCISION OF THE HIP BY AN ANTERIOR INCISION. The interval between the Tensor vaginæ femoris externally, and the Sartorius internally is opened up and the neck of the femur directly exposed. The figure shows how the saw is applied to divide the neck of the bone *in situ*.

The next, and perhaps the most difficult, part of the operation consists in defining and removing the posterior portion of the capsule. If the patient be standing the operation well and be in good condition, by far the best way of doing

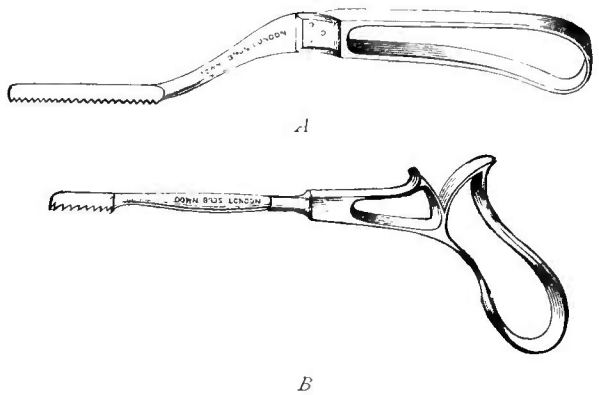


FIG. 48.—SAWS FOR DIVISION OF THE FEMUR. *A* is the form most useful for subtrochanteric division, while *B* is more suited for division of the neck of the femur, where the width of the bone to be divided is less. Both forms should be blunt-ended, cross-cut, and very stout, so as to ensure rapid cutting and to minimise the chance of breaking the saw *in situ*.

this is to make an incision behind the trochanter extending upwards and backwards from its posterior border in the direction of the fibres of the gluteus maximus muscle, which, when exposed, are separated by the handle of the knife; the dissection is then carried gradually downwards until the posterior portion of the capsule is reached. This

may now be separated from the structures behind it by means of one finger introduced through the posterior wound aided by another introduced through the anterior incision as a guide, and a considerable portion of the capsule at any rate may thus be clipped away. It is, however, practically impossible to remove the entire structure, and the portion remaining must be cut away with curved scissors and systematically scraped with a sharp flushing gouge (see Fig. 44) through which a weak sublimate solution (1-6000), is kept running.

After the bleeding has been arrested, the posterior wound is first sutured accurately and then about an ounce of the iodoform and glycerine emulsion (see p. 120) is introduced through the anterior incision, and the wound stitched up entirely without any drainage. The limb is brought into proper position, which will be one of slight abduction. The tendons of the adductors may if necessary be divided by a tenotomy knife close to their origin from the pubes.

When, after making the anterior incision and removing the head of the bone and the anterior portion of the capsule, the patient's condition is such as to contra-indicate the risk of the additional shock entailed by the posterior incision, the surgeon must confine himself to removing as much of the posterior part of the capsule as possible through the anterior wound by means of scissors and a sharp flushing gouge. This, however, is a far inferior method to the one described, and should only be adopted when circumstances forbid the employment of the other method.

After-treatment.—When the patient is put back to bed, extension should be employed, a weight of about three or four pounds being used for a child, the limb being in the abducted position, and rotation prevented by means of the apparatus behind the knee shown in Fig. 37. A Liston's long splint should also be applied to the sound side from the axilla to beyond the toes, so as to prevent any flexion of the hip joint. The patient should be laid upon a mattrass divided into three parts, so that the central portion can be removed for nursing purposes without necessitating any disturbance.

The extension and fixation of the limb should be kept up for about six weeks; at the end of that time a Thomas's hip splint (see p. 172) may be employed. This should be bent well outwards opposite the joint so as to keep the limb in the abducted position; the splint should be provided with a pelvic band. In quite young children, who are very difficult to keep quiet, either a double Thomas's splint (see p. 175) or a Phelps's box (see p. 176) will be better than the single splint. Contrary to the common recommendation, we very strongly advise that the patient should not be allowed to walk or to bear any weight on the limb for several months—at least six or eight after the operation. If this be done, the consolidation of the structures in the neighbourhood of the joint will give a much firmer joint than is otherwise obtainable. It is very seldom that anything like bony anchylosis occurs, but if a movable joint be desired, this may

be assured by performing passive movement of the hip through a limited range twice a week after the wound has healed. The patient need not be kept in bed after six weeks or so; he may be allowed to get about on crutches with a high boot on the sound foot so as to avoid any risk of the affected foot being put to the ground.

(2) By an external incision.—*When the disease extends far out along the neck of the femur*, and especially when there are several sinuses, a freer and better opening may be obtained by an incision over the outer surface of the trochanter, commencing about two inches above its upper border and running vertically downwards for four or five inches (see Fig. 49). The knife should be carried through the glutei muscles directly down to the bone, and the trochanter itself is cut into. This structure is usually still cartilaginous in young subjects, and the epiphyseal portion may be divided into two halves with the knife. These retain their muscular connections above and are still connected with the periosteum of the femur below. They are then pulled aside, and access is at once gained to the neck of the femur. In adults, or in those in whom ossification in the trochanter has taken place, a portion of this structure may be split off on each side with a chisel, leaving it attached to the muscles above and the periosteum below; in this way the neck of the bone is exposed.

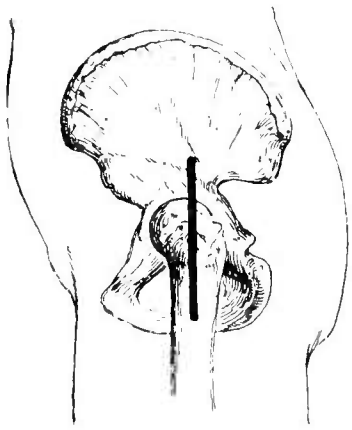


FIG. 49.—EXCISION OF THE HIP BY AN EXTERNAL INCISION. The limb should be somewhat flexed and rotated inwards.

The neck of the femur is sawn through with an Adams' osteotomy saw (see Fig. 48), outside the limit of the disease—usually on a level with the trochanter—the saw being directed obliquely downwards and forwards. The head and neck of the bone are then seized with lion forceps and gradually extracted. In these cases the removal of the head and neck of the bone in one piece is very difficult if the ligamentum teres be intact, but, when the latter structure is destroyed, there is no particular difficulty. The manœuvre is much aided by freely incising the capsular ligament, when the admission of air into the joint facilitates the removal of the head. Should it be difficult to take the latter away in one piece, there is no objection to chiselling it out of the acetabulum piecemeal.

The subsequent steps are similar to those recommended for the anterior operation. In this method there is much better access to the posterior part of the capsule, so that a second incision is unnecessary.

(3) By a posterior incision.—*In very bad cases, especially in adults, or when there is dislocation of the head of the bone on to the dorsum ilii*, a curved incision passing behind the trochanter is very useful and pro-

vides excellent drainage. The patient is rolled over on to the sound side, the thigh is semiflexed and rotated a little inwards, and an incision is made commencing about an inch and a half above the centre of the top of the trochanter and passing downwards and forwards, until it reaches the junction of the base of the trochanter and the shaft of the bone (see Fig. 50). As this is deepened, the glutei muscles are cut through in the line of their

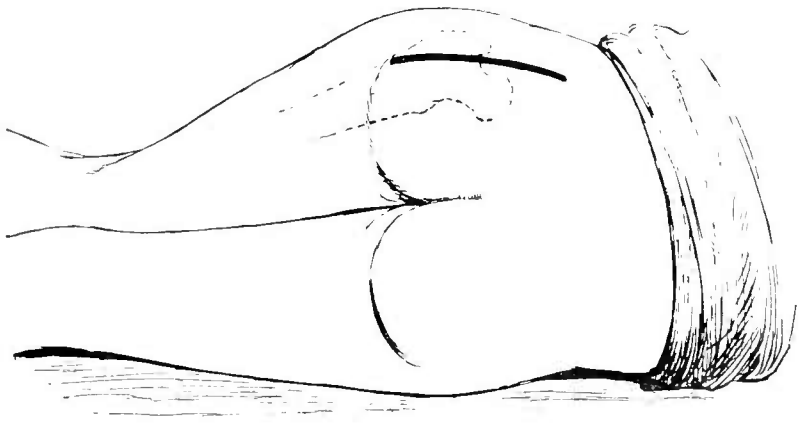


FIG. 50.—EXCISION OF THE HIP BY A POSTERIOR INCISION. The patient lies upon the sound side with the affected joint flexed and rotated inwards.

fibres and the posterior surface of the neck of the bone is easily exposed by dividing the muscles attached to the great trochanter. The saw is now applied to the bone just above the trochanter and the head and neck removed.

By this operation the whole of the interior of the joint is very freely exposed and can be accurately examined. The thorough removal of the disease is perhaps more easy by this method than by any other. It is, however, open to the serious objection that the glutei are considerably damaged and the functional result is therefore not likely to be so good; it gives, however, excellent drainage and should be employed by preference in cases where numerous septic sinuses are present.

These sinuses should be dissected out or scraped, and undiluted carbolic acid applied to them; finally the whole wound should be thoroughly sponged with the same substance before the sutures are introduced. When there is widespread sepsis and a number of sinuses, it is well to leave the wound open and to pack it with cyanide gauze impregnated with iodoform until granulation has far advanced. The packing should be renewed daily for about three weeks, after which time the wound may generally be allowed to close.

When excision is employed in the fourth stage of the disease (see p. 184), where the disease has been cured and the operation is only done for the deformity, mere removal of the head of the bone is all that is necessary; the removal of the capsule is not called for as the disease has disappeared. The object of the operation in these cases is simply to get rid of the head of the bone so as to obtain a movable joint. Here the anterior incision is the best, and after the neck is sawn through, the

head of the bone must be chiselled out of the acetabular cavity; it is impossible to pull it out after division of the neck on account of the bony anchylosis. The after-treatment in all these cases is the same (see p. 189).

RHEUMATOID ARTHRITIS.

This is one of the commonest diseases of the hip in old subjects. The joint is one of the most frequent seats of non-articular rheumatoid arthritis, and probably the condition known as *malum coxæ senile*, in which there are marked atrophic changes in the cartilage and bone, and which so frequently follows injury in old people, is merely a mild form of this disease. The affection in the hip is accompanied by much greater pain than in other joints, and this does not necessarily accompany movement, but may be very marked while the patient is lying in bed; it is, however, generally increased on movement.

There is usually considerable fixation of the joint, which is somewhat flexed, adducted and rotated inwards. The head of the femur undergoes softening and absorption, and the angle it forms with the neck is considerably altered, so that it may be at right angles, or even at a somewhat acute angle. This gives shortening of the limb, which is not due to enlargement of the acetabulum or to dislocation, but to absorption and the altered position of the head and neck of the bone. The trochanter will therefore be often considerably above Nélaton's line in advanced cases. There is a marked tendency to the formation of osteophytes around the hip, and the patient may suffer from severe pain in addition to that attributable to the trouble in the joint; the pain arises from pressure upon the sciatic nerve by these osteophytic outgrowths, or from adhesion of the nerve to the capsule.

Treatment.—This has been fully discussed on page 151, and there is little further to be said. It may, however, be occasionally necessary to consider the question of operation in cases in which the sciatic or obturator nerves are pressed upon by osteophytes, or have become adherent to the capsule of the joint. Under these circumstances it may be advisable to cut down and either free the nerve or remove the osteophytic growths which press upon it. The operations for exposing these nerves have already been described (see Part II., p. 273). The nerves after being freed, should be stretched, any osteophytic outgrowths being defined, and as much as necessary removed. Great improvement frequently follows the operation.

The surgeon may sometimes be tempted to excise the joint; the procedure, however, is not to be recommended. The operation is difficult on account of the displacement of the neck and the presence of osteophytes around it, so that it is accompanied by considerable shock, which may be fatal to an old subject. Besides this, the results are extremely

unsatisfactory, as the limitation of movement and the pain are likely to recur owing to the formation of fresh osteophytes, whilst the joint resulting is very imperfect.

CHARCOT'S DISEASE.

The hip is frequently the seat of Charcot's disease, and in this situation atrophic changes only are found as a rule. There is rapid atrophy of the head and neck of the bone, with destruction of the joint, and early dislocation.

Treatment.—The treatment is mainly directed to fixing the joint and enabling the patient to get about. In the earlier stages of the affection he should, if possible, be taken off his feet entirely, and confined either to bed or to a couch; at the same time, matters should be so arranged that he is able to get out in the air, and for this purpose he may be wheeled out sitting in a bath chair. At a later period, when the acuter symptoms have subsided, a Thomas's hip splint may be employed, and the patient allowed to get about on crutches. In younger subjects in whom there is some attempt at formation of fresh bone about the joint, a Thomas's knee splint may be useful; and, after prolonged rest, it may be permissible for them to walk with the aid of a stick, after being fitted with a high boot. They should be kept off their feet, however, for at least three years.

HYSTERICAL HIP-JOINT DISEASE.

Hysterical joint disease is very common in the hip and is generally marked by muscular contraction and the assumption of vicious attitudes. The trouble often occurs after some injury, and is distinguished from true hip-joint disease by the diffuseness of the pain and its superficial character. There is an entire absence of any sign of true disease of the joint particularly thickening over the front and back of the joint. In the early stages also, the limb can be moved without any difficulty under an anæsthetic, and no grating can be felt.

Treatment.—The treatment of these cases has been fully discussed (see p. 145), and little more need be added here. In the later stages, when true shortening of the muscles has occurred, it may be necessary to perform tenotomy, after which the limb must be kept extended by extension apparatus or fixed with splints. The muscles that usually require division are the adductors, which are readily divided over the inner side of the thigh, just below their origin from the ramus of the pubes; the tensor vaginæ femoris may require division, which may be done subcutaneously over the contracted bands. Sometimes the rectus may have to be divided, and it is then best to make an incision between the inner border of the tensor vaginæ femoris and the sartorius, close

beneath the anterior superior spine of the ilium, and then, separating these muscles, to define the tendon of the rectus and divide it.

LOOSE BODIES.

Loose bodies have been found in the hip and, if the diagnosis be made, the joint is opened by an anterior incision and the body extracted. Sometimes the loose body may be in the posterior part of the joint when it will be advisable to make a posterior incision as well. This is done through an incision parallel with the fibres of the gluteus maximus muscle, commencing an inch below the tip of the trochanter and running upwards and backwards for two or three inches; the fibres of the gluteus are then separated and the soft tissues dissected through until the capsule is reached.

CHAPTER XX.

DISEASES OF THE KNEE JOINT.

The knee is so commonly affected by one of the various diseases already described that what has been already said as to their treatment will apply to this joint without much modification, and we need here only go into certain special points.

ACUTE SYNOVITIS.

This is one of the commonest affections of the knee, and generally occurs after sprains; it is sometimes a result of simple exposure. It may also be associated with rheumatism, although the true rheumatic inflammation of joints affects the fibrous capsule rather than the synovial membrane.

SYMPTOMS.—The symptoms vary with the acuteness of the inflammation, but they consist essentially of effusion of fluid into the joint, and pain which is increased on flexing or extending the limb. The joint usually assumes the semi-flexed position, the fluid effused is coagulable, the synovial membrane is congested and infiltrated with cells, and, in the more acute cases, its surface may be covered with a layer of fibrin; when this occurs, adhesion between the two opposing surfaces may take place. This adhesion is at first fibrinous, but, if the part be kept at rest, organisation may occur later on and give rise to true fibrous adhesions which may be so extensive as to lead to complete obliteration of that portion of the joint cavity. Adhesions of course only occur after the effusion has become absorbed or has been removed; as long as fluid is present, the synovial cavity is distended and its surfaces are separated.

TREATMENT.—This largely depends upon the acuteness of the inflammation and the character of the effusion. When much fibrin is poured out and the inflammation is acute, there is great probability of adhesions forming afterwards, and the treatment must be mainly directed to their prevention. In slighter cases—as after slight sprains—there is

little tendency to adhesion, and the trouble will subside almost spontaneously. We have already spoken of the treatment of sprains and the synovitis accompanying them (see p. 77), and we need not therefore refer further to these cases.

When, however, the inflammatory attack is very acute, the indications are, firstly to subdue the inflammation as rapidly as possible, and secondly to prevent adhesions forming in the joint afterwards. *Rest and elevation of the limb* are the first essentials. The patient should be confined to bed, with the limb upon a suitable splint and somewhat elevated. The knee should be kept as straight as it can be got without pain; it will generally be necessary to allow some flexion, as the fully extended position is almost intolerable if there be much distension. The best apparatus is a MacIntyre's splint slightly bent at the knee, and suitably padded, or a trough of Gooch's splinting, in which the limb is fixed, with an extra amount of padding behind the knee, which can be gradually reduced as the swelling subsides, until finally the limb is brought perfectly straight.

Amongst local applications, *fomentations* are probably most satisfactory; they may be applied as follows, without removing the splint and without wetting the padding. After the splint has been padded, but before it is put on, a broad piece of mackintosh is placed over the padding in the popliteal space, sufficiently long to fold around the limb, and reaching from about the middle of the thigh to the middle of the leg. The limb is now placed upon the splint, which is fastened on by means of straps or bandages, leaving the knee uncovered; the edges of the mackintosh are then turned aside, the fomentations laid in place over the front of the knee and the mackintosh folded over them. A large mass of wool is then put on over all and secured by a bandage. Hot fomentations are on the whole better and more soothing than ice-bags or the evaporating lotions so commonly employed. They should be changed as soon as they get cold—about every 2 or 3 hours.

When the inflammation is very acute, it is a good plan to apply half a dozen *leeches* around the patella and over the supra-patellar pouch before employing the fomentations. Under this treatment the attack will soon subside, and the fluid will be almost absorbed in a week or ten days; it will then be necessary to deal with the adhesions which occur, most frequently in the supra-patellar pouch. As soon therefore as the acute symptoms have subsided—that is to say, in about ten days after the commencement of the attack—gentle massage and passive movement should be begun; the patella should be moved freely in all directions, and the knee gently flexed. Unless these manœuvres be followed by an increase of the effusion, a little more may be done the following day, and the massage may be also more vigorous. This treatment should be continued for three or four days, when, in the absence of any bad symptom, the patient may be allowed to walk, at first wearing a firm

starch and cotton wool bandage (see p. 120), and later without any apparatus at all.

The common mistake made in treating acute synovitis of the knee is to keep the limb too long upon a splint. It is not at all unusual to find the limb kept up for six or eight weeks without any attempt at passive movement, and this allows the formation of firm fibrous adhesions which must be broken down under an anæsthetic before the joint can be freely moved. The reason that the limb is confined for so long is that the patient often suffers pain on attempting movement and so the limb is kept up to allow this to disappear; this pain is really due to a stretching of the young adhesions, and quickly passes off as they are stretched or torn through. Hence the mere occurrence of pain should not deter the surgeon from employing early passive movement, the chief symptom that must be regarded as an indication for relaxation of vigorous treatment being recurrence of the effusion.

When the limb has been kept stiff for too long and adhesions have formed, massage and passive movement may be tried for a short time, but as a rule these are not very effectual in the knee and it will be necessary to break the adhesions down forcibly. In doing this the rules recommended for the treatment of adhesions (see p. 162) should be strictly followed, and no attempt should be made to break down the whole of the adhesions at the first sitting; unless the procedure be very gradual, considerable pain and recurrence of the effusion will be caused, and time is actually saved by proceeding slowly. The treatment of the case at this stage is in fact that suitable for anchylosis, and the directions already given for that condition should be followed.

CHRONIC SYNOVITIS.

This condition is of very frequent occurrence and may either follow an injury or may appear without any obvious cause. Sometimes the effusion is extreme, when the case is spoken of as "hydrops articuli," the capsule being enormously distended with fluid and constituting a very serious condition, not only on account of the disability of the limb, but because of the liability to deformity from stretching of the ligaments. The particular deformity most likely to occur is either a lateral divergence or an external rotation of the leg upon the thigh.

TREATMENT.—What has already been said relative to the treatment of chronic synovitis in general applies closely to that condition in the knee (see p. 105): indeed what has been said in that connection is meant to apply mainly to the knee, and we need not therefore go into the matter here.

PAPILLARY SYNOVITIS.

In speaking of the diseases of joints in general we referred to a condition marked by the occurrence of papillary outgrowths from the synovial membrane due to hypertrophy of the synovial fringes; these are generally most numerous in the neighbourhood of the cartilages, but may sometimes cover the entire synovial membrane, and may or may not be associated with rheumatoid changes in the bones (see p. 107). The condition affects various joints, but is most frequently found in the knee where it gives rise to very acute symptoms. The long villous fringes float about in the joint, keep up considerable chronic synovitis with effusion, and frequently become nipped between the articular ends, so that the patient gets sudden pain and locking of the joint with exacerbation of the general symptoms. The condition is quite unaffected by baths, massage, and other measures usually employed for rheumatoid arthritis, and it may be well therefore to deal here in detail with its management, as in the knee the disease frequently calls for vigorous treatment.

TREATMENT.—As far as our experience goes there are only two methods of treatment that offer any prospect of success. The first of these is to remove the affected portions of the synovial membrane, and the other is to inject irritating fluids into the joint with the object of fixing these freely movable villous tufts by causing adhesions.

Irritant injections.—Injection of irritating fluids into the joint is by no means certain in its action. It is done by making a small vertical incision about an inch to the inner side of the patella through the skin and subcutaneous tissues. When all bleeding has been arrested, this is carried through the capsule and the synovial membrane, the edges of which are seized by catch forceps and held apart, while a stream of warm 1-2000 sublimate solution is flushed through the joint by means of a sterilised catheter attached by india-rubber tubing to a glass funnel and pushed into the articular cavity. After the joint has been well flushed out, the catheter is withdrawn, the fluid left in the joint, and the incision in the capsule closed by a fine catgut suture; the skin wound is then stitched up without a drainage tube. The limb is put on a suitable splint (see p. 196) until the resulting synovitis has subsided.

The operation may have to be repeated more than once before the desired effect is produced. Should the first injection fail, a more irritating solution—such as the 1-20 carbolic acid—may be resorted to. We should only be inclined to recommend this method when the symptoms seem to point to a general affection of the synovial membrane rather than to the presence of one or two localised villous growths.

Excision of the hypertrophied synovial membrane—The most certain method is to remove the hypertrophied synovial membrane, and, when the affection is limited to one or two patches, the result is most satisfactory; it is only necessary to remove the portion actually affected, after which

persistent massage and passive movement will entirely restore the functions of the joint. When, however, the entire synovial membrane is involved and requires removal, the mobility of the joint is likely to be considerably impaired. In some cases, however, even this is preferable to the great pain and complete disability from which the patient suffers, and we should strongly recommend that this method be employed when a fair trial of the preceding method has failed to cure these cases of general synovial hypertrophy. The steps of the operation have been already given (see p. 109).

ACUTE SUPPURATIVE ARTHRITIS.

Acute suppurative arthritis is not uncommon in the knee, and, when occurring as the result of a wound in the neighbourhood or from acute epiphysitis, complete destruction of the joint may take place without any great risk to the patient's life. The condition may also occur during pyæmia, but curiously enough the destruction of the joint is often very slight, whereas the risk to life is of course very great; it is not uncommon to find that the few patients who recover do so with a fairly movable joint.

TREATMENT.—This has already been fully gone into, and directions given for opening and draining the knee joint (see p. 95). It is always well to attempt to save the limb, and amputation should therefore not be resorted to unless the case does not come under notice until the conditions are so bad that it is obviously hopeless to attempt to retain the limb, or unless the symptoms do not decidedly abate within three days from the establishment of efficient drainage.

If, in spite of free incision and drainage, the serious symptoms continue and amputation is called for, this should be done through the lower third of the thigh. The medulla must be carefully examined for signs of osteo-myelitis. Should this be found, a second amputation should be performed higher up. Excision has been practised for this condition, but it is not at all satisfactory. It opens up the cancellous ends of the bones and exposes them to infection, and therefore acute osteo-myelitis not infrequently results and the case terminates fatally. In our opinion the choice of procedure lies between free drainage with irrigation and amputation.

When the disease is not due to pyæmia and occurs without a wound, the epiphyses of the femur and the tibia and also the patella should be carefully examined for signs of acute osteo-myelitis; should this disease be present the medulla must be thoroughly opened up and any dead bone or collections of pus evacuated.

GONORRHŒAL ARTHRITIS.

This condition has already been fully discussed (see p. 98) and, as the knee is the joint in which the trouble most frequently occurs, the remarks

made there are particularly applicable to this joint and need not be repeated. It is important to bear in mind the great tendency to stiffness met with after gonorrhœal inflammation, and therefore, as soon as the acute symptoms have passed off, passive movement must be begun (see p. 102).

SYPHILITIC AFFECTIONS.

The knee is the joint most frequently affected both in the secondary and tertiary stages. What has already been said with regard to the treatment of the various forms of syphilis of joints (see p. 138) may be taken as applying to the particular joint under notice.

TUBERCULOUS DISEASE.

This affection, which is more common in adults than in children, may commence either in the synovial membrane or the bone, probably more frequently in the latter. As age advances, the proportion of primary bone cases with sequestra as compared with soft caseating deposits increases very markedly. The osseous deposits especially affect the epiphyses of the tibia or the femur; sometimes, though rarely, they occur in the shaft of the bone outside the epiphyseal line, but this is more common in the tibia than in the femur—in which the internal condyle is the most common seat of the primary deposit. The patella is but rarely affected primarily.

Nothing need be said about the course of the disease, as this has already been fully dealt with in speaking of tuberculous joint disease, in general (see Chap. XIII.).

PATHOLOGICAL CHANGES.—The treatment is influenced to a certain extent by the particular form of disease present, and we may therefore describe the following:—

(a) Localised tuberculous deposits.—Here the disease has not infected all the structures of the joint. The deposits may occur either in the bone or the synovial membrane; in the latter they may give rise either to a localised thickening of the synovial capsule or to one or more pedunculated outgrowths from the synovial membrane hanging into the joint cavity. These deposits are unfortunately comparatively rarely seen, because the patient does not usually seek advice until the disease has spread over the joint, but they are of great importance because removal of the affected area may cure the disease and save the joint.

The localised deposits in the synovial membrane, more particularly the pedunculated forms, occur especially in the supra-patellar pouch, and may be felt there as masses which can be readily moved about and which may be confounded with loose bodies in the joint. They differ however from the latter in that the swelling is usually larger, and thickening of the synovial membrane can generally be made out in its immediate neighbourhood. These localised thickenings of synovial membrane, apart

from pedunculated outgrowths, may of course begin anywhere, but are perhaps most commonly met with at the lateral and lower parts of the joint in front and in the immediate neighbourhood of the semilunar cartilages, especially the internal one. For this latter reason some authors have assumed that the disease begins in the semilunar cartilages and have therefore given the name of "meniscitis" to it. It is probable however that the disease really commences in the synovial membrane where it is attached to the cartilage.

The localised osseous deposits accessible to treatment occur most frequently in the internal condyle of the femur. Sometimes there is an enlargement of the upper end of the tibia which may be reached without opening the joint, but there is usually such a short distance between the deposit and the articular cavity that this is unfortunately very rarely possible.

(b) Diffuse infiltration.—This is the more common form of the disease, at any rate when it occurs in the synovial membrane, and is not at all infrequently associated with tuberculous deposits in the bone. We may divide diffuse infiltration into five clinical stages, namely, (1) where the affection is confined to the synovial membrane; (2) where it has spread from the latter to the bone, or *vice versâ*; that is to say, when both synovial membrane and bone are diseased; (3) when the disease is accompanied by unopened abscesses or by sinuses; (4) the stage of recovery; and (5) complete recovery with deformity.

In the first stage the synovial membrane is thickened throughout, but the thickening may be greater at one spot than at another; the result is a general elastic swelling of the knee accompanied by signs of inflammation. This thickening is more readily made out at the point of reflection of the synovial membrane on to the femur in the supra-patellar pouch, where its edge will be found to be especially thick and to roll away under the finger; there is no enlargement of the bone and usually but little pain. Movement may be possible, but there is generally some restriction and usually more or less flexion; the thigh muscles, especially the anterior ones, waste very rapidly.

In the second stage the disease has spread from the synovial membrane to the ligaments, the cartilages and the articular surfaces, and the condition may result from extension from primary synovial disease or by sudden rupture of an osseous deposit into the joint. Under the latter circumstances the symptoms are generally very acute and were formerly described under the name of "ulceration of cartilage." The symptoms are in marked contrast to those of the first stage. There is much pain on movement or on pressing the ends of the bones together because of the articular osteitis. The ligaments are unduly loose and the joint can be moved laterally, whilst there is tonic spasm of the hamstring muscles, so that the joint becomes flexed; as the disease progresses, the ligaments are destroyed and allow the limb to be pulled backwards and rotated outwards. The degree of thickening of the synovial membrane at this stage depends upon the

acuteness of the disease and on whether or not there was primary disease of the synovial membrane; in the latter case the enlargement of the joint is very marked, but when the synovial disease is secondary to rupture of an osseous deposit the thickening may be comparatively slight and there may be a considerable amount of fluid in the joint.

In the third stage abscesses form and may or may not burst externally and lead to sinuses. The abscesses often form in the most superficial portions of the synovial membrane and may then find their way externally without opening into the joint. It does not necessarily follow that a probe can be passed into the joint through a sinus in connection with knee joint disease, and the greatest care must always be used in probing these sinuses not to use force, or else a communication with the joint, which otherwise would not have existed, may be established. In other cases, however, the abscess communicates both with the joint and the exterior, whilst in others again the suppuration begins within the joint and finally perforates the capsule and the skin over it.

In this stage there is increased synovial thickening; there is also severe pain with starting pains at night, whilst the laxity of the joint increases, and flexion and rotation outwards are more marked. As the flexion goes on, the tibia becomes drawn up behind the femur, so that the limb cannot be brought straight even under an anæsthetic.

In the fourth stage recovery is taking place, and a considerable amount of anchylosis will be met with, which may be fibrous or bony, according to the amount of destruction that has taken place in the articular cartilages and the bones; generally it is fibrous or only partly bony. Restoration of movement seldom occurs to any marked degree unless recovery takes place quite in the early stages of a primary synovial disease. When recovery occurs in the second or third stages there will be anchylosis, due partly to adhesions between the opposed surfaces of the joint and partly to shortening and thickening of the ligaments and obliteration of the synovial capsule.

In the fifth stage the symptoms have entirely subsided but, either because there has been no treatment or because it has been inefficient, deformity has resulted; the knee is flexed up to or beyond a right angle, with rotation outwards of the leg and drawing up of the head of the tibia behind the femur, so that it is impossible to bring the leg straight; indeed if this be done forcibly, true dislocation backwards will actually be produced.

TREATMENT.—It will perhaps be best if we divide the treatment first of all into that suitable for tuberculous deposits in the bone and synovial membrane and that appropriate for general tuberculous disease of the joint. The treatment of the latter form will again be subdivided according to the clinical stages at which it is met.

(a) **Of localised deposits, either synovial or osseous.**—Whenever these deposits can be recognised, their early removal is of course indicated.

Unfortunately this can rarely be the case, but where it is feasible the disease may be cut short, and it is always well to bear this possibility in mind when examining a case of tuberculous disease of the joint.

Synovial masses.—Localised pedunculated masses have been more than once removed with great success. All that is necessary is to make a free incision over the mass and, after having arrested the bleeding, to incise the fibrous capsule, which should then be separated from the synovial membrane without opening the latter, after which the synovial membrane should be snipped through well outside the pedicle of the mass, and the pedunculated body with a little of the healthy synovial membrane in its vicinity thus cleanly removed. The joint should be flushed out freely with a 1-8000 sublimate solution to wash out any tuberculous material detached during the operation which would infect the joint if left behind. The capsule and the external wound are then sutured in the ordinary manner (see p. 227).

After-treatment.—If there be any suspicion of commencing infection of the synovial membrane as a whole, a useful addition to the above procedure is to introduce about half an ounce of the 10% emulsion of iodoform and glycerine (see p. 120) into the joint cavity after squeezing out the fluid used for irrigation. The limb should be kept at rest for at least six or eight weeks after the operation, the splint being removed from time to time and passive movement carried out twice a week from a very early period, so as to prevent adhesion of the cut surfaces of the synovial membrane to adjacent parts. The passive movement should, however, never be carried beyond this, and the patient must be content to risk a certain amount of stiffness, as it is impossible to be certain that the whole of the disease has been removed; movement would of course aggravate any disease left behind. After six or eight weeks, the patient may be allowed to go about as usual if there be no thickening of the joint left. Any adhesions that have formed will then gradually stretch or may subsequently be broken down. Should there be any thickening in the vicinity of the wound, however, treatment appropriate to the first stage of the general affection of the joint must be adopted (see p. 205).

Osseous deposits.—The treatment of tuberculous deposits in the bone is much more hopeful, especially if the deposit be situated in the internal condyle of the femur, provided always that the diagnosis can be made. This is often arrived at by finding a distinct enlargement of the condyle, the patient meanwhile complaining of a dull, deep-seated, aching pain in the bone, and limping on walking. Otherwise there is but little discomfort and very slight swelling of the synovial membrane or marked interference with the movements of the joint. There may be some tenderness on percussion over the bone.

Under these circumstances, and especially if the patient has a marked tuberculous history, a primary osseous deposit should be suspected, and an operation undertaken for its removal. Even should the diagnosis be wrong, the only other conditions likely to be confounded with a tuberculous

deposit, namely a chronic inflammatory condition of the condyle or the presence of a tumour in it, render the operation justifiable, as in the former case the gouging of the bone appropriate for the removal of a sequestrum is the best treatment for the chronic inflammation, whilst in the latter case it reveals the presence of a tumour for which early and effective treatment may be undertaken. Hence there need be no hesitation about operating even if it be impossible to make an exact diagnosis, and, should the case be one of tuberculous deposit, the result may be very brilliant.

In operating in these cases, particularly on the internal condyle, the limits of the synovial membrane must be borne in mind. This structure extends more than halfway over the inner surface of the condyle, and therefore, if an incision were made over the latter just along the edge of the articular cartilage, the synovial cavity would inevitably be opened and, should a tuberculous deposit or tumour be present, the knee joint would probably be infected from it. It is imperative therefore to expose the extreme upper limit of the condyle, which can be done by a curved incision with its convexity upwards at the junction of the condyle with the shaft (see Fig. 51). This skin flap is turned down and a vertical incision is made through the muscular fibres rather towards the back of the condyle. When these have been separated with a rugine, the soft parts, and with them the capsule of the joint, are stripped downwards and the surface of the bone is exposed, and may be gouged in a direction obliquely from above downwards and outwards without any danger of wounding the synovial membrane. The removal of the shell of compact bone should be very free so as to enable complete access to be gained to the interior. In a child there will be a risk of injuring the epiphyseal cartilage by making the incision as high as this, and therefore it is important not to remove much bone until the epiphyseal cartilage has been defined; it can then easily be avoided.

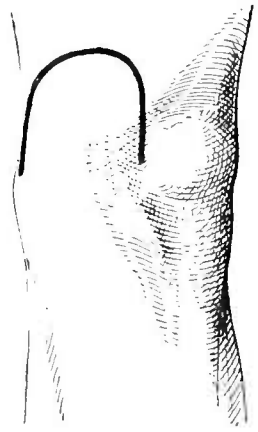


FIG. 51. — INCISION FOR EXPOSING A TUBERCULOUS DEPOSIT IN THE INTERNAL CONDYLE OF THE FEMUR.

After the compact tissue has been removed, a strong sharp spoon is generally sufficient to scoop out the cancellous tissue. Inspection will show whether the bone thus removed be inflamed or not; if so, the scooping should be carried on until the epiphysis has been partly cleared out, so as to make sure of finding the tuberculous deposit if it be present. The deposit must be thoroughly cleared out along with a layer of bone forming the wall surrounding it.

The bleeding is then arrested by pressure, and it is well to insert into the cavity a piece of sponge saturated with undiluted carbolic acid and leave it in position for five minutes, so as to allow the acid to come into contact with the whole of the wall. Care must be taken in pushing in

the sponge that the acid does not flow over the skin. After the sponge is removed, the cavity in the bone is filled up with a 10% emulsion of iodoform and glycerine, and the skin wound is stitched up without a drainage tube.

After-treatment.—The limb is put on a back splint in the extended position and laid upon a pillow. The dressing need not be changed for ten days unless much discharge comes through; by that time the wound will usually be healed, the stitches can be taken out and active and passive movement practised. After six or eight weeks, the patient can be allowed to get about if no sign of joint disease has appeared. This operation must be done under the strictest antiseptic precautions, as otherwise serious inflammation of the bone may occur, which would rapidly communicate with the joint and lead to most disastrous consequences.

When osseous deposits occur elsewhere, as in the head of the tibia, or the external condyle of the femur, they are not nearly so easy to deal with, and we ourselves have never had to do with such a case. In the head of the tibia particularly, it seems to us that it would be most dangerous to scoop away indefinitely seeing how close the epiphyseal cartilage lies to the joint; unless the deposit were extra-epiphyseal, the attempt would probably end either in destruction of the epiphyseal cartilage or in the establishment of a communication between the deposit and the joint, or in both. Under such circumstances it would probably be better to resort for a time to expectant treatment.

(b) **Of general tuberculous disease.**—It will be most convenient to describe separately the treatment of each of the clinical stages in which the case may be met with.

(1) **Treatment of the first stage.**—When the synovial thickening is not very marked, and there is no great pain or interference with movement, the disease is seen under the most favourable conditions; indeed, so slight are the symptoms that their seriousness is often overlooked, and the patient allowed to get about and move the joint freely, with the idea of retaining movement when the disease is recovered from. Parents also are often most averse to proper fixation of the joint under these circumstances. It must never be forgotten, however, that the chances of securing a good result are best at this stage; if a cure can be obtained, it is probable that a certain amount of movement will also be retained—much more than if movement be permitted and the disease thus allowed to progress.

Expectant.—The great indication in the local treatment at this period is the employment of *absolute physiological rest.* The patient must be confined to bed in the horizontal position, with the leg elevated and the joint fixed by some suitable apparatus. Well-moulded, closely-fitting leather, poroplastic or Croft's *splints* (see Part III., p. 14) are the best. It is most essential that the patient should be recumbent until improvement is well advanced, because any attempt to move about on crutches or even

to sit up in bed is accompanied by contraction of the thigh muscles, and this keeps up a state of unrest in the joint. In a child the recumbent position may be enforced by placing a sheet across the trunk and rolling up heavy sand-bags in either end of it.

If, after about two months of this treatment, the condition be improving or at any rate not extending, the limb may be put up in an immovable apparatus; it is well not to use this in the early stage for fear of abscesses occurring beneath the splint. The best arrangement is to put the limb up in a silicate or plaster of Paris bandage from the toes to the groin. A bandage of boracic lint is first applied round the limb, and outside

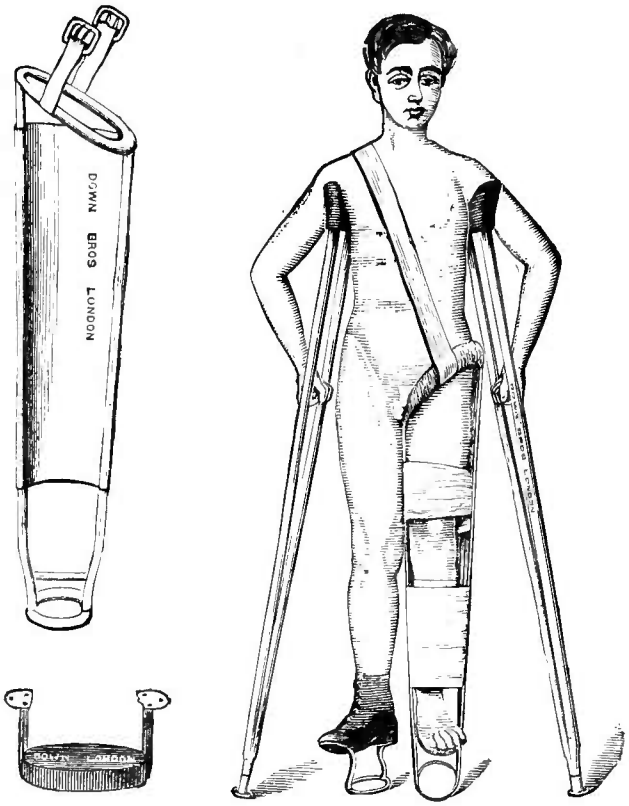


FIG. 52.—THOMAS'S KNEE SPLINT. As the weight of the body is borne on the oval ring which supports the pelvis, no pressure is allowed to fall upon the knee. The left hand figure is a sketch of the splint, and patten for the sound limb, before application.

this two or three layers of firm woven bandage soaked in a solution of silicate of potash are applied. The silicate bandage is much lighter than the plaster of Paris, and for the present purpose is equally efficient; whenever available, it should be used in preference to the plaster.

If the patient be allowed to get about, the limb, enclosed in the silicate bandage, may be placed in a *Thomas's knee splint* (see Fig. 52). It is customary to use Thomas's knee splint alone for this purpose, but it does not seem to us that the leg is sufficiently fixed unless some form of immobilising bandage be employed, as the splint does not grasp the leg well and considerable mobility is possible. The combination of the two

methods is very useful, as the Thomas's splint overcomes a common difficulty—viz., that the silicate bandage does not usually get a satisfactory hold upon the upper part of the thigh, and is therefore hardly sufficient by itself.

Thomas's knee splint consists of a groin ring, lateral rods running down the inner and outer sides of the limb, attached at the bottom to the boot, and three broad leather bands behind to support the limb. The groin ring is of an ovoid shape, the narrowest part being on the outer side, and the inner part, which rests on the tuber ischii, being thickly padded. This ring lies obliquely in the fold of the groin, the inner vertical rod being attached to it at an angle of 120°, the angle at the outer side varying with the shape of the limb. Thomas employed two splints—one for the recumbent position and one for rest in bed. In the case of the bed splint the lateral rods are attached at the longest diameters of the ovoid ring. In the walking splint the inner rod is attached further back. At the lower end, the foot is enclosed in a boot which is cut away in a **V**-shaped manner at the back part and the lateral rods are bent at right angles and passed into holes in the heel. The posterior leather bands are three in number: one about the middle of the thigh, one behind the knee, and one behind the lower part of the leg. The splint is fixed to the leg by two broad straps passing in front, one above and one below the knee. If flexion be present, these straps are employed to overcome it. If there be a tendency to knock-knee, the thigh is pulled outwards by a band attached to the outer rod, while the inner rod is bent inwards so as not to press on the internal condyle.

A point of some importance at this stage is whether the patient should be allowed to get about on crutches wearing the splint, or whether he should be merely wheeled about in the recumbent position until the disease is more advanced towards recovery. In our opinion the latter course is preferable. The dependent position certainly interferes with the circulation in the limb and must therefore interfere with its nutrition, although, in view of Bier's method of treatment by producing passive congestion (see p. 122), this cannot have very great weight. Nevertheless the joint will be kept more perfectly at rest and the circulation in it will be better if the patient be kept recumbent. It is only in cases of pure synovial disease that permission to walk on crutches should be granted; when the bone is affected the patient ought to be kept recumbent.

When the patient is allowed to walk, Thomas's knee splint is by far the best apparatus; no pressure is borne on the joint, the weight of the body is transmitted through the tuber ischii, which rests upon the upper ring of the splint, and the patient may thus bear weight directly upon the affected side without any undue pressure upon the joint. If walking be allowed when only the silicate apparatus is worn, there is constant pressure of the tibia upon the femur, which is bad for the chances of recovery.

Pressure is often of considerable value at this stage of the treatment

and is best employed in combination with counter-irritation, as is obtained by strapping the limb with Scott's dressing. The latter, which is the compound mercurial ointment, spread fairly thickly upon lint, is cut into strips and applied around the joint. Outside this, ordinary strapping is applied smoothly and firmly so as to compress the joint. An even more satisfactory method is to spread the ointment on chamois leather, which is then cut into strips and applied in an imbricated fashion as already described (see p. 119). The limb is then fixed upon a suitable splint and the patient kept at rest as before. The Scott's dressing requires changing at least once a week, as otherwise the skin may become excoriated; should this happen, the dressing must be abandoned, and pressure by means of a cotton wool and starch bandage (see p. 120) substituted for it.

Counter-irritation by blistering is often employed in this stage, but it does not seem to be of any special benefit and may actually do harm by increasing the congestion. In pure synovial disease *extension* is of course entirely unnecessary; indeed it would be hurtful in most cases, as has already been pointed out in connection with disease of the hip. It is only likely to be of benefit at this stage when flexion has occurred and extension is therefore required to bring the limb straight mechanically; three or four pounds are usually sufficient for this purpose. When the flexion is slight, it is usually found that, after the application of a Thomas's splint, the weight of the limb alone gradually brings the knee straight, so that it is very seldom that extension will be called for.

Should the synovial thickening remain unaffected or actually increase in spite of physiological rest, good hygienic conditions and pressure, some more active measures will be required; of these perhaps the best is *injection of iodoform and glycerine emulsion* into the joint. This should be prepared and used as directed on p. 120. The injection gives rise to a certain amount of swelling and perhaps slight pain for a few hours afterwards, both of which gradually pass off; the injection may be repeated about once a week. In some cases we have found very marked improvement follow this treatment; in others the method fails and the disease progresses in spite of it, when more vigorous measures still will have to be adopted. Another plan used in the early stage is *Bier's congestive method.* This has already been described (see p. 122) and may be advantageously combined with the iodoform injections.

Operative.—The question of early operative interference will arise in this stage of the disease, and will be largely influenced by the patient's age. The object of operating at this period is to remove the diseased synovial membrane before it has had time to spread to the cartilage and destroy it, and in children the disease can often be cut short by an arthrectomy when the methods already recommended have failed to arrest its progress. In adults, on the other hand, arthrectomy is unsatisfactory and should seldom be employed. Excision is too severe an operation at this stage unless other lesions be present.

Other operations have sometimes been performed in this stage with benefit; one of these is arthrotomy or simple free incision into the joint designed to relieve tension and allow the chronic inflammation to subside. Another is an incomplete arthrectomy; that is to say, removal of a large portion but not the whole of the affected synovial membrane. As regards efficacy, arthrotomy cannot be compared to arthrectomy, as it is quite uncertain in its results, whereas arthrectomy, if satisfactorily performed, cuts short the disease effectually. In adults, however, when the disease is progressing and excision does not seem desirable, the intermediate course of performing arthrotomy and perhaps combining with it the removal of the supra-patellar pouch of synovial membrane may be adopted.

Arthrectomy.—By an arthrectomy we understand complete removal of the whole of the diseased tissues without removing healthy structures and without taking away bone upon set lines as is done in excision. It is most important to bear in mind that the diseased structures should be removed by clean cutting and not by scraping, which is a most unsatisfactory procedure. The tubercles in the synovial membrane are generally embedded in firm fibrous tissue and are not readily scraped away, and scraping is therefore only a partial arthrectomy; to be effectual the operation must be performed by the knife.

A large number of different incisions have been recommended, but the one we advise as giving the best access to the joint is a somewhat H-shaped one, consisting of a vertical incision on each side of the patella connected by a transverse one across the centre of that bone. The vertical incisions should reach from the upper limit of the supra-patellar pouch well on to the anterior surface of the tibia, and should be from an inch to an inch and a half away from the edges of the patella. These are deepened until the tendon of the quadriceps extensor is exposed, division of which displays the fibrous capsule of the joint covered by fat and loose cellular tissue.

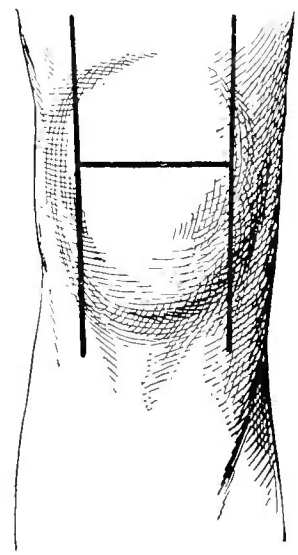


FIG. 53.—INCISIONS FOR ARTHRECTOMY OF THE KNEE. The longitudinal incision should be very free. The transverse one joining them across the centre of the patella is not always necessary.

The next step is to carefully divide the fibrous capsule, taking care not to cut into the synovial membrane. The handle of the knife or a blunt dissector is introduced between the two structures, and they are separated from one another, first of all in the supra-patellar region. Should however the disease be very advanced and the capsule obviously implicated in parts, it is best to take away this structure as well. The separation of the synovial membrane from the capsule is effected first between the two incisions, so that the finger can be introduced from one incision to the other between the two structures. This separation is continued upwards until

the reflection of the synovial membrane is reached, and downwards as far as the margin of the patella; it should also be continued inwards and outwards from the lateral incisions so as to clear the supra-patellar pouch on each side: finally the structures are separated downwards over the condyles as far as possible, and also behind the ligamentum patellæ. In this way the whole anterior part of the synovial membrane is separated from the capsule. The supra-patellar pouch of synovial membrane is pulled down and its posterior surface separated from the femur; this is best done with the finger. The separation is carried down to the point of attachment of the synovial membrane to the articular cartilage.

The soft parts are now well retracted and the synovial membrane is cut through with scissors, first at its attachment, all round the articular surface of the patella; this allows the finger to be introduced into the joint, and further facilitates the pulling downwards of the supra-patellar pouch and its separation from the front of the femur. When this has been done, the membrane is detached from the articular surface of the femur all round as far as can be reached, and from the head of the tibia below. The division is carried as far backwards as possible on either side beneath the lateral ligaments, and then the whole of the anterior portion of the synovial membrane can be lifted out. The line of attachment of the synovial membrane to the patella, the femur and the tibia, should have a slice of cartilage shaved off with the knife, so as to insure the whole of the synovial membrane being removed.

The next step is to wash out the joint with a 1-8000 sublimate solution. This removes all flakes of tuberculous material before dividing the patella and so avoids infection of the cut surface of the bone. When this has been done, the transverse incision over the patella is deepened and the bone sawn across, when the cut surfaces are immediately covered with a piece of gauze soaking in a 1-2000 sublimate solution, and the two flaps thus made are thrown upwards and downwards. Each half of the cartilage covering the patella is carefully examined and, if it shows any appearance of being affected, a thin layer is shaved off.

The knee is now fully flexed, and the semilunar cartilages are removed with the knife, all the synovial membrane around the articular edges being most carefully pared away. The condition of the crucial ligaments and the structures in the intercondyloid notch is then examined. At this stage of the disease it will generally be found that the ligaments are intact, although they are often covered with pulpy synovial membrane, which can not infrequently be stripped off without detaching them. Great care must be taken to remove every portion of synovial membrane from the intercondyloid notch.

The synovial membrane at the side of the joint should next be attacked, and in most cases it will be necessary to divide the lateral ligaments, after having effected separation between them and the synovial

membrane with some suitable blunt instrument. When this is done, the whole of the lateral portion of the synovial membrane on each side can be removed entire by pulling the soft tissues first to one side and then to the other and detaching the synovial membrane from the articular edges of the femur and the tibia.

The last point is the question of how to deal with the posterior part of the synovial membrane. In many cases this can be removed without dividing the crucial ligaments, which it is of the highest importance to leave intact, if it be desired to obtain a movable joint afterwards. It is possible with care to gradually effect the separation of the synovial membrane from the capsule backwards into the popliteal space by means of the finger and a blunt instrument, and to separate it from the important structures there, when, on fully flexing the knee, the finger can be passed across from side to side and upwards and downwards throughout the whole extent of the synovial membrane. When this has been done, all that remains is to detach the structure from its insertion into the articular cartilage. The popliteal artery can always be felt pulsating behind the finger and forms a useful guide in the manipulations.

The articular surfaces must now be carefully examined, and wherever there is any greyness, roughness, or undue vascularity of the cartilage, its surface should be shaved off with a sharp knife and any pits in it carefully cut out; if there be a hole in the cartilage leading down to the bone, this should be scooped out, first with a knife and afterwards with a sharp spoon or suitable gouge.

The bleeding is finally arrested and the divided ligaments sutured. If the crucial ligaments have been divided, as they will generally have to be —it is best to divide them about their centre—they should be united by one or two catgut stitches; the lateral ligaments should be similarly treated. A hole is drilled in each half of the patella, through which a silver wire is passed to unite the two fragments; this is exactly similar to the operation for fracture of the patella (see Part III., p. 136). The wound is now sewn up without any drainage, antiseptic dressings are applied, and the limb placed upon a suitable splint.

If possible, the operation should be carried out without using a tourniquet. It is far easier to distinguish the exact limits of the tuberculous tissue when the surface bleeds freely, and, as a matter of fact, there is probably more blood lost when a tourniquet is used than when the operation is done without it, whilst the healing of the wound is certainly better. After the tourniquet is removed, there is considerable capillary oozing, which may not be satisfactorily arrested by ligature; the result of this is that, after the wound is sewn up, there is bleeding into the joint and healing is materially impaired. When no tourniquet is employed there is no vascular paralysis, and, while the vessels bleed freely when divided, they can at once be clamped and tied, and therefore when the operation is finished the surface is practically dry. Further than this,

the pulsation of the popliteal artery is a valuable guide in separating the posterior part of the capsule.

The best *splint* for these cases is a trough of Gooch's splinting. This should be cut to the length of the leg as already described (see Part III., p. 11), and covered with a folded sheet over which is a large piece of mackintosh. Upon the mackintosh is placed a thick sheet of salicylic wool, whilst superficial to this, opposite the region that the knee will occupy, is laid a series of broad strips of cyanide gauze overlapping each other well—much as in a many-tailed bandage—so that, when the limb is laid flat upon the splint, these strips can be folded up one after the other around the knee. When this is done, suitable pads are carefully inserted and the splint fastened on. The apparatus is then placed upon a pillow so as to raise the limb slightly.

After-treatment.—As a rule there is no need to disturb the limb for dressing. It may be left in the splint for six weeks, when the stitches are removed and a water-glass or some similar immovable apparatus is applied. In most cases, especially when the crucial and lateral ligaments have been divided, it is best not to try to obtain a movable joint; if movement be aimed at after arthrectomy at this early stage, union of the ligaments and shortening of the capsule do not occur satisfactorily, and there is a marked tendency for the knee to become flexed. In fact, the great difficulty is this tendency to flexion after operation, so that in a large number of cases it is advisable that the patient should wear a splint —either a Thomas's splint or an iron running down the back of the thigh and leg—for months or even years afterwards. There is no doubt that the tendency to flexion is greater after arthrectomy than after excision, though in young subjects even the latter operation may be followed by the same trouble.

The results of a complete arthrectomy when carried out comparatively early in pure synovial disease are extremely satisfactory. The wound heals and there is no further trouble beyond the tendency to flexion just mentioned; the disease is thus markedly cut short and the patient quickly restored to health. In adults, however, arthrectomy does not, as a rule, seem to be such a satisfactory operation. It is generally necessary to divide the crucial and lateral ligaments and the result is bad, because, if a movable joint be desired, the probabilities are that it will be very unstable, whilst on the other hand, if the joint be stiff, the anchylosis is merely due to fibrous adhesions which are not very strong and may cause a good deal of pain by stretching. In adults, therefore, excision is preferable in most cases because firm bony union can be obtained. We should, however, prefer to continue expectant treatment at this stage of the disease in adults, unless there were very special reasons for early operation. These reasons may be that time is a matter of great importance, and the patient, being the bread-winner of the family, cannot afford to lie up and abstain from work for two or three years as is often necessary, even at

the shortest computation, when expectant treatment is employed. Again, the patient may be the subject of tuberculous disease elsewhere, and the confinement necessary for the proper carrying out of the expectant treatment will be injurious to this; in both these cases, therefore, early excision is indicated. When, however, the patient can afford the time, and when he is otherwise perfectly healthy, expectant treatment should be employed.

(2) **Treatment of the second stage.**—Here the affection is no longer confined to the synovial membrane, but is attacking the cartilages and the bone, and consequently there are symptoms produced by the articular osteitis. This stage of the disease may also come on suddenly from rupture of osseous deposits into the joint. Its characteristic features are great increase in the pain, and fixation of the joint from muscular contraction. There is also intense pain on the slightest movement, and starting pains at night.

The treatment in this stage may be either expectant or operative; the former does not, however, offer the same prospects of success as in the preceding stage. Nevertheless it is advisable to make a trial of it for six weeks or two months, when, if no improvement follows, operative measures may be resorted to.

Expectant treatment.—Extension as a rule is required to overcome the pressure of the bony surfaces and to control the starting pains at night. The weight employed will depend upon the relief obtained; in children three or four pounds may be used to begin with and may be increased if necessary; in adults from six to eight pounds are generally called for at first, and this may also have to be increased. With extension it is necessary to combine absolute rest upon a splint, whilst injections of iodoform emulsion and the internal administration of guaiacol (see p. 115) are very useful.

Operative treatment.—In most cases, however, operative treatment will be called for. *In children this should be an arthrectomy*, performed as described above; in this stage special care must be taken in inspecting the bones, so to avoid overlooking a primary osseous deposit, and to make sure of removing the whole of the affected surface. Should the cartilage be much destroyed and pitted, it is well not only to remove the whole of it, but also to shave off a thin layer of the bone beneath. This may be done by a knife, and not more than a quarter of an inch in depth need be taken. Under no circumstances should the ends of the bones be scraped, as this is very likely to force tuberculous tissue into the cancellous spaces and so to facilitate the spread of the disease. The after-treatment is the same as that already described (see p. 212).

When the disease has reached this stage in adults, it is almost useless to hope for recovery without operation. As a matter of fact the results from *excision in adults* are so extremely good and are obtained so quickly and with such little risk that there seems no valid reason why excision

should not be practised immediately it is evident that the ends of the bones are attacked. The best that can be hoped for from expectant treatment is a stiff joint, and this will often require years of rest, while the patient will never be secure against a recurrence of the disease; the anchylosis which then results is generally fibrous and is likely to give rise to pain and to be injured by some wrench or twist. On the other hand, a successful excision removes the disease, cures the patient within a very short time, and leaves him with an absolutely firm limb, without any risk of recurrence and without liability to sprains and strains.

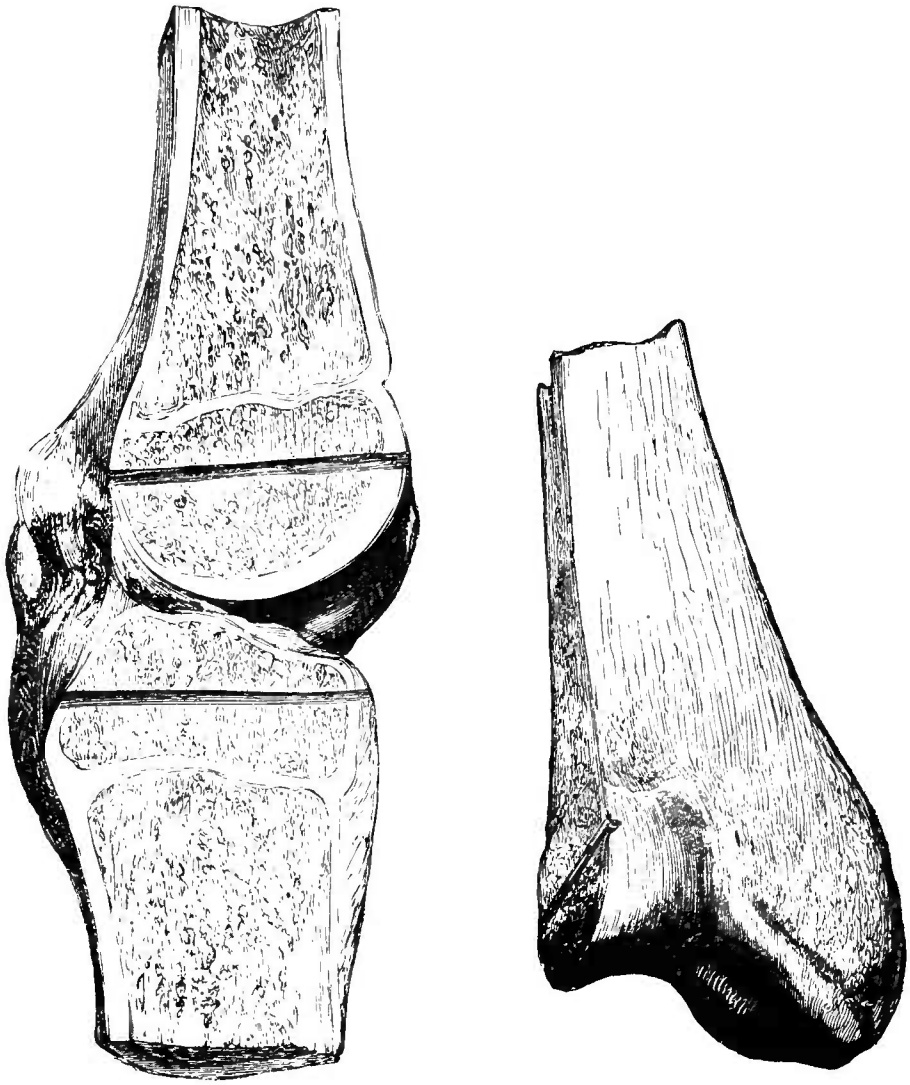


FIG. 54.—RELATION OF THE EPIPHYSEAL CARTILAGE TO THE BONE SECTION IN EXCISION OF THE KNEE. The left-hand figure is a lateral view, showing the epiphyseal cartilage as a white line and the saw-cut as a dark one. The other figure is a front view of the same femur, and illustrates the relation of the bone section to the edge of the articular cartilage in front. It will be seen how easy it is to encroach unduly upon the line of growth when sawing the bone. *(Holmes's System of Surgery.)*

The above remarks, of course, apply only to adults; in children excision should be avoided because of the interference with growth that is almost sure to occur (see Fig. 54). Even when special care is taken to saw the bones

on the distal side of the epiphyseal cartilage the latter is apt to undergo premature ossification so that growth in the bone ceases. On the other hand, the simple paring of the surface recommended in arthrectomy quite avoids this risk. The chief objection to excision is that, as it is performed nowadays, the operation takes a long time and is accompanied by considerable shock and loss of blood; hence the operation is not to be undertaken lightly in weakly patients, in those suffering from tuberculous disease elsewhere—particularly in the lung—or in those who have renal mischief. For the majority of these patients the choice must lie between continuance of the expectant treatment and amputation. When, however, the patient is vigorous and able to stand the operation, it seems much more reasonable to resort to it when the disease has arrived at this stage than to continue the expectant treatment indefinitely.

Excision.—The remarks already made as to the tourniquet apply to excision as much as to arthrectomy, and its use should therefore be avoided wherever possible.

The best incision is a curved one with the convexity downwards, commencing over the centre of the lateral aspect of the joint, running down to below the tubercle of the tibia, and then curving upwards to a corresponding point on the opposite side (see Fig. 55). The flap thus marked out is turned well up so as to expose the whole of the capsule of the joint.

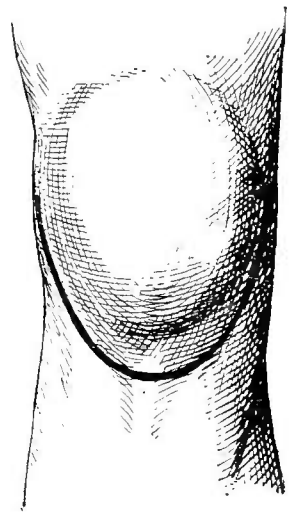


FIG. 55. — INCISION FOR EXCISION OF THE KNEE. The lowest point of the incision should reach a little below the tubercle of the tibia.

The first question that arises is as to whether or not the patella should be removed. In most cases it is well to take it away, and the only real objection to this is that the divided extensor may contract adhesions to the lower end of the femur rather than to the tibia, and there will not then be such good leverage as if the patella were left; this defect can easily be remedied by peeling off the periosteum from the anterior surface of the patella, and thus shelling the bone, as it were, out of the quadriceps tendon instead of dividing the latter transversely above the bone. The best way to do this is to have the skin flap held well out of the way, and to make a vertical median incision through the quadriceps from the top of the supra-patellar pouch down to the tubercle of the tibia. This incision is very carefully deepened above until the muscular fibres are cut through, when the handle of the knife can be sunk between the muscle and the capsule and the two structures separated from one another. The periosteum over the patella is then turned off to either side with a raspatory, and the ligamentum patellæ is split longitudinally.

The muscle is now raised from the capsule of the joint on each side until the whole of the supra-patellar pouch and its lateral prolongations have

been thoroughly exposed. The steps of this procedure are identical with that for arthrectomy (see p. 209). The margin of the quadriceps tendon is defined below, and then the supra-patellar pouch and the whole of the anterior portion of the synovial membrane, including the patella with the fatty pads below it, are clipped cleanly away. The knee is fully flexed, the lateral ligaments are divided, and the synovial membrane over each side of the joint is removed. After the crucial ligaments have been divided and the knee fully flexed, the end of the femur can be protruded through the vertical slit in the extensor tendon and its articular surface removed. In doing this the limb is held absolutely horizontal, and the saw is applied vertically at the upper limit of the articular cartilage on the front of the femur. The line of bone section should be at right angles to the long axis of the limb and not to that of the femur. As the posterior surface of the femur is reached, care must be taken to see that the structures in the popliteal space are stripped well up out of the way of harm, and are protected if necessary by a suitable spatula.

When the end of the femur has been removed, the posterior part of the capsule is easily separated and removed, much in the manner described for arthrectomy (see p. 211), and the head of the tibia is then protruded through the wound and its articular surface sawn off. In doing this the knee must be flexed, the foot being placed flat upon the table so that the leg is vertical; the saw is applied at right angles to the long axis of the tibia, and about half an inch of the upper end is removed.

The wound is now thoroughly examined to see that none of the capsule is left behind. Any portions of articular cartilage remaining are carefully clipped away, any projecting edges are removed with bone pliers, and the cut surfaces of bone are examined to see whether there be any tuberculous deposits in them; these if present must be thoroughly scooped out, together with a portion of the healthy bone around.

The bleeding is now arrested and the wound stitched up, but before doing so it is well to wire the femur to the tibia; this is not absolutely essential, but it keeps the limb in position while the dressings are being applied, and it serves to prevent any antero-posterior dislocation of the bone surfaces. It must be remembered that the divided surface of the tibia is much broader than that of the femur, and if, therefore, the anterior margins of the two bones be brought into apposition, the posterior surface of the tibia will project markedly into the popliteal space, and when the limb is placed upon the splint, pressure may be exerted upon the popliteal artery, and gangrene of the limb may result. The posterior margins of the bones should therefore be accurately adapted, and it is with the view of securing this that fixation of the bones is advisable. Some trouble may, however, be caused from the extreme softness of the bone, which allows the wires or pegs to cut through considerably, and therefore great care must be taken to keep the limb in proper position after the wire has been introduced.

As a rule it is well to introduce a drainage tube at the outer edge of the incision, the rest of which is sewn up by a continuous suture: the limb is placed upon a Gooch's splint, prepared in the way recommended for arthrectomy (see p. 212).

After-treatment.—When a drainage tube has been used, the dressing must be changed in three days, when the tube may be removed. When changing the dressing it is well to have a fresh splint prepared in a similar manner to the original one. The splint is then opened and the front of the knee dressed; while this is being done, an assistant must fix the thigh to prevent starting of the limb, while another similarly fixes the leg. It is well, in fact, at the first dressing to keep the limb in firm contact with the splint by opening one side at a time whilst the limb is pressed against the other, and one side is washed and dressed at a time. The splint is elevated, the inclined plane or pillow upon which it is resting is removed, and then the splint is opened. One assistant grasps the thigh and another the leg, whilst the surgeon grasps the limb on either side of the knee; the splint is then allowed to drop away from the limb, the posterior part of which is thoroughly washed with a 1-20 carbolic acid solution, and afterwards with a 1-2000 sublimate. The fresh splint, with the dressing already arranged, is put in place beneath the limb and gradually raised until the surgeon and the assistants can remove their hands and leave the limb lying upon the fresh splint. The strips of gauze are then wrapped around the knee and the dressing, and the splint is bandaged on.

It is well at this dressing to impregnate the outside bandage with a starch solution, so as to prevent it stretching and to insure that the apparatus will keep firm for six weeks or so, at the end of which time it may be taken off, the stitches removed, and the limb put up in plaster of Paris or some similar immovable apparatus.

In three months after the operation union is usually firm enough for the patient to get about without any apparatus. Massage may be required for two or three weeks afterwards to restore the circulation and improve the nutrition of the muscles.

(3) **Treatment of the third stage.**—Here, in addition to the destructive changes in the synovial membrane, the cartilage and the bones, there are either unopened abscesses or sinuses—usually septic—which have resulted from abscesses bursting. The treatment will vary to some extent according as there are unopened abscesses or septic sinuses, and also according to whether the patient is a child or an adult.

When there are unopened abscesses in children.—The treatment here will depend largely upon the general condition of the joint, particularly the extent of the disease, and upon whether there is more than one abscess. When the abscess is single and the joint condition is not very advanced, the treatment should first be directed to the cure of the abscess. We have already discussed the treatment of chronic abscess (see Part I.,

p. 248), and have pointed out the three lines of treatment that may be adopted, viz.:—(1) excision of the abscess wall; (2) incision of the abscess with removal of as much of the wall as possible; and (3) incision and scraping of the abscess, irrigation, and injection of iodoform emulsion with subsequent suture of the wound. One of the first two methods may generally be adopted in the knee joint, the choice depending upon the size and situation of the abscess. When this is small and over one side of the joint—for example over the inner condyle—it may be quite possible to dissect out the abscess entire. In most cases, however, it is only possible to remove portions of the wall by clean cutting; the rest must be dealt with by scraping or otherwise.

Treatment of the abscess.—A free incision should be made over the abscess, and its wall isolated from the surrounding tissues as completely as possible before it is opened; it will soon be seen whether it be possible to dissect out the wall entire or whether only a portion can be removed; in the former case the dissection is proceeded with until the abscess is removed: in the latter, as much of the wall exposed is clipped away as can be done without excessive opening up of the parts. The cavity is then thoroughly washed out with a stream of 1-4000 sublimate solution run through a Barker's flushing spoon, and the portion of the wall remaining is scraped. If a free opening be made at first, the whole interior of the abscess can be seen and the wall systematically scraped. The deeper parts of the abscess must be examined both by inspection and with a probe, for it must be remembered that these abscesses may originate either in the synovial membrane or in connection with an osseous deposit reaching the surface outside the joint; in the latter case the probe will in all probability pass through a hole in the outer shell of the bone into the interior of the deposit. If this be the case, the compact tissue should be gouged or chiselled away and the deposit thoroughly scooped out, along with a portion of the healthy bone around it. When the abscess is connected with the synovial membrane and does not open into the joint, it is as well not to establish a communication with the articular cavity.

The wound must next be thoroughly sponged out, and as much iodoform emulsion (see p. 120) as possible is left in; the skin is sutured, pressure is applied to bring the walls of the abscess together, and the limb is put up on a suitable splint. The wound should heal by first intention. Should serum collect in the cavity, it must be let out and the cavity again scraped. Even though there be disease in the joint, the majority of these abscesses will heal satisfactorily after two or three scrapings; the surgeon can then decide whether further operative treatment for the joint disease is necessary or whether expectant treatment should be persisted in. The decision will depend largely upon the condition of the joint; should this be similar to that described in the latter part of the second stage, an arthrectomy should be done after the abscess has entirely or almost entirely healed.

When there are unopened abscesses in adults.—Treatment will be largely influenced by the general condition of the patient as well as by the local condition of the joint. Should the abscesses be numerous or large, should the joint be unduly movable,—indicating marked destruction of the ligaments,—and should the patient be suffering great pain, much emaciated and with phthisis or tuberculosis elsewhere, amputation at the junction of the lower with the middle third of the femur is the best procedure in the majority of cases. In cutting the flaps care should be taken not to open the abscess and thus soil the wound with tuberculous material. When, on the other hand, the patient is vigorous, the abscess single and the disorganisation of the joint and the pain not very great, the case may be treated much in the manner just described. If the disease be still progressive, excision of the joint may be performed when the abscess has healed or has much diminished in size.

We are strongly of opinion that both in adults and in children it is well to separate the treatment of the abscess from the performance of arthrectomy or excision, because the pus is very likely to infect the cut surfaces of the bone and to lead to a fresh outbreak of the tuberculous disease. An additional argument in favour of this is that the removal of the abscess simultaneously with the performance of the excision or the arthrectomy makes the operation much longer and more severe.

When septic sinuses are present.—The state of affairs is here much more serious. In children undoubtedly these sinuses will sometimes heal if the limb be thoroughly immobilised and the patient placed under good hygienic conditions: at the same time, this is rare and the case is very apt apt to go downhill, especially if there be much pain. Operative interference is therefore called for.

In children.—Amputation through the thigh in a child should always be avoided if possible, because very little growth occurs in the stump, so that, when adult life is reached, the limb is practically valueless.

Arthrectomy in most cases gives a very satisfactory result, but it must be remembered that the case is complicated by sepsis and special care will have to be taken to eradicate this. At the commencement of the operation therefore, after the skin has been thoroughly purified, the sinuses should be carefully scraped, and a piece of sponge immersed in undiluted carbolic acid should be introduced into each sinus and left there. Each sinus should then be included in an elliptical incision and dissected out throughout its whole extent. Should the sinuses lie in the line of the ordinary incision they will of course be removed during the deepening of the wound. The operation is performed as already described (see p. 209). After the synovial membrane has been removed, it is well to sponge the entire wound over with undiluted carbolic acid, which is allowed to act for five or ten minutes and then washed away with a 1-2000 sublimate solution. No symptoms of carbolic acid poisoning need be feared. In most cases it is well to insert a drainage tube, but, when there have been

only one or two sinuses and the septic condition is not marked, the wound may be stitched up without one.

In adults.— In adults the choice lies between excision and amputation. When the patient is strong and well-to-do, *excision* is probably best. The same care must be taken in disinfecting the sinuses and removing them, as has already been mentioned in the case of children; it is well also to treat the wound with undiluted carbolic acid (*vide supra*).

When the general condition is bad, however, *amputation* through the lower third of the thigh is the best treatment; the patient recovers at once, there is much less shock, and little fear of recurrence.

(4) **Treatment of the fourth stage.**—When recovery is taking place with anchylosis of the joint in a faulty position, the treatment consists

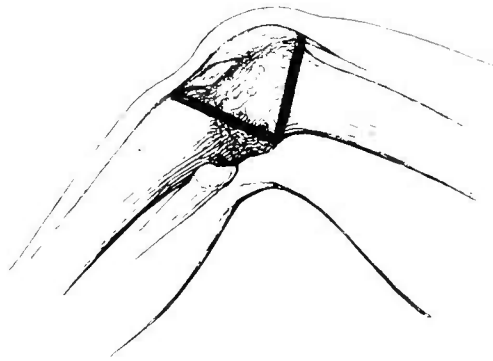


FIG. 56.—CUNEIFORM EXCISION OF THE KNEE FOR ANCHYLOSIS WITH DEFORMITY. The thick lines show where the bone will require to be divided in order to get the limb straight. From this it is obvious that the region of the epiphyseal line must necessarily be encroached upon.

essentially in rectifying the deformity. If the union be fibrous and comparatively slight, *continued extension* may succeed in bringing the limb straight; but this is rarely successful, because the adhesions in the joint are generally accompanied by marked shrinking of the posterior ligaments or shortening of the muscles around the joint. If extension is to be employed, it is well in most cases to perform tenotomy of these structures before it is used; the extension should be very gentle, as otherwise the disease may be lighted up again. The straightening of the limb may be facilitated by stretching under an anæsthetic, but this must be extremely gentle and practised by slow degrees at intervals of a week or ten days.

In a child.—In children where there is only fibrous anchylosis, and where disease is still present and extension fails to get the limb into proper position, *arthrectomy* should be done. This allows free access to the various ligaments about the joint, which can be divided, when the limb is easily brought straight. When no active disease is present, the limb cannot be brought straight by extension, but the best treatment is to allow the child to get about, to have the limb well massaged, and then, when growth is nearly complete—at from sixteen to eighteen years of age—the case can be treated as though the patient were an adult (*vide infra*).

In an adult.—In an adult, however, in whom the union is firm and bony, the best treatment is to *remove a wedge* from the region of the knee, so planned that the limb will come straight (see Fig. 56). The bones should be wired together afterwards and put up on a straight splint. This form of treatment should be limited to adults, because in children the epiphysis would certainly be interfered with and arrest of growth would ensue.

RHEUMATOID ARTHRITIS.

This is very common in the knee. The characteristic deformities are flexion and outward rotation, and there is sometimes a certain amount of genu valgum. The symptoms have already been described (see p. 149).

TREATMENT.—There is very little to add to what has already been said as to the treatment of this disease in general (see p. 151).

Operative interference, such as gouging or drilling the condyles of the femur for excessive pain, or removal of osteophytes in the rare instances in which they interfere mechanically with the movements of the limb, may be called for.

In speaking of the general treatment of osteo-arthritis, we referred to the question of excision of joints in the non-articular form of the disease. This procedure is more particularly suited for the joints of the upper extremity; when the knee is affected, it is of more doubtful value, mainly because of the risk of the other knee becoming affected later. When one knee is stiff, extra strain is thrown upon the opposite side, and it is not uncommon after excision for rheumatoid arthritis to find that the disease appears in other joints subjected to extra strain. How far this should contra-indicate the performance of excision of the knee must be judged of by the circumstances of each individual case. When the patient suffers greatly, and the other joints are free from any sign of the disease, it is probably better to be relieved of pain and to take the risk of the disease developing elsewhere. This risk may to some extent be avoided if the possibility of it be remembered and the patient instructed to lead a more or less invalid life, and on no account to over-strain the other joints; under these circumstances it is quite possible to escape any further development of the disease. The result of the operation will therefore be to make the patient much more comfortable.

CHARCOT'S DISEASE.

The knee is a joint frequently affected by this disease, the general principles for the treatment of which have already been laid down (see p. 141). The special points with regard to the knee are to aim at obtaining as much consolidation of the joint as possible, and, as that form of Charcot's disease accompanied by osteophytic outgrowth is not un-

common in this situation, it is possible sometimes to get sufficient rigidity to enable the patient to get about. With the view of preventing deformity, a Thomas's knee splint (see Fig. 52) is the best apparatus at first; at a later stage, when consolidation is advancing, a good apparatus is one similar to that employed after operation for genu valgum in adults, namely, an outside iron running down the outer side of the limb, socketed below into the heel of the boot, and fixed to the pelvis by a suitable band; to this the limb is firmly bandaged. In most cases it is also advisable to have a second rod descending from the pelvic girdle along the back of the limb so as to give extra support. This apparatus must be worn for the rest of the patient's life.

HYSTERICAL CONDITIONS.

These must be treated similarly to hysterical joint disease elsewhere (see p. 145). When true contracture occurs, it may be necessary to divide the hamstring tendons. The majority of these may be divided subcutaneously where they are most prominent, but the biceps tendon should be divided through an open incision; if the operation be done subcutaneously, the external popliteal nerve runs a risk of being divided also.

HÆMOPHILIA.

Effusion of blood into the knee from this cause is not at all uncommon, the joint swelling up suddenly and becoming distended with blood after a slight injury or without any injury at all.

Treatment.—The limb should be placed at rest on a splint in the elevated position, the patient being recumbent, and an ice-bag or evaporating lotions (see Part I., p. 8) should be applied. The general treatment of hæmophilia is unsatisfactory, but it is well to administer chloride of calcium in one-grain pills in the hope of increasing the coagulability of the blood. Massage and aspiration should be avoided on account of the risk of increasing the bleeding. When the effusion has disappeared, passive movement must be very cautiously resorted to.

INTERNAL DERANGEMENTS OF THE KNEE JOINT.

The knee is especially liable to the various forms of disability formerly classed under the term, "internal derangements of the knee joint." These may be subdivided into two main groups: (1) Actual loose bodies—the so-called loose cartilages—and (2) Injuries to the semilunar cartilages, villous fringes in the joint (see p. 107), or detachment of the ligamenta alaria.

LOOSE CARTILAGES.—These are very common, and their symptoms have already been described (see p. 158). The patient very frequently

identifies the loose body slipping about in the joint, but whether this be so or not, the symptoms will easily lead to the identification of the condition, and the only treatment possible is to remove the body. At the same time it is extremely unsatisfactory to open a joint like the knee, in which there are so many recesses, however certain one may be that a loose body is present, unless it can actually be fixed. It is quite easy for the loose cartilage to slip away into some recess and to escape detection even after the joint has been freely opened. In all these cases therefore it is well to delay the operation until the patient can feel the loose body, and can retain it in position until the surgeon can remove it.

Hence, when a patient has characteristic symptoms of a loose body in the joint, and has made up his mind to an operation, the limb should be shaved, disinfected, and kept ready for operation by a gauze dressing over it, and the patient should be directed to try and find the loose body from time to time. Should he succeed in doing so, it will usually be met with on one side of the supra-patellar pouch, and he should then try to fix it in position, and let the surgeon know that it has been found. While the patient is being placed under the anæsthetic, the loose body must be fixed, as otherwise it is very liable to slip away during the slight movements preliminary to the operation. It is well, therefore, after disinfecting the skin to thrust a needle through it and to transfix the body; failing this, an assistant should be told off to steady it with his fingers.

The loose body is extracted by making an incision directly over it, arresting all the hæmorrhage from the superficial structures before the capsule is divided, and then opening the latter freely and removing the body as already described (see p. 160). When the body has been merely fixed by an assistant's fingers previous to operation, it is well to thrust a stout needle into it before the skin incision is made, as otherwise it is extremely liable to slip away when the capsule is opened, as the assistant's fingers must necessarily be removed then.

Should the body escape into the joint notwithstanding these precautions, or should it be deemed advisable to open the articulation without previously fixing it, and should the introduction of the finger through the opening fail to detect it, it may often be brought into reach by freely flushing the joint with a 1-8000 sublimate solution. After the loose body has been removed, all bleeding is arrested, the capsule is sutured with fine catgut and the external wound is sewn up.

In former days this operation was a very dangerous one, and all sorts of expedients were resorted to in order to avoid opening the joint directly. Nowadays with perfect asepsis there is no risk at all.

PAPILLARY SYNOVITIS.—The second form of internal derangement of the joint has already been fully described (see p. 107).

DETACHMENT OF THE LIGAMENTA ALARIA.—We have had several examples of this condition under our notice. One or both of the ligamenta alaria may be torn away from their attachments to the

intercondyloid notch and hang into the joint, where they may be caught between the ends of the bones, and give rise to all the symptoms of a loose cartilage. The possibility of this should always be borne in mind when the patient has symptoms of a loose cartilage, but is unable to find one; under these circumstances it is of course justifiable to open the joint for purposes of examination.

Treatment.—The best incision for opening the joint is a curved one around the inner edge of the patella with its convexity backwards; the horns of the incision should reach the middle line above and below the bone, and the limit of the convexity should be about two inches from its inner margin. The flap thus marked out is turned forwards, all bleeding in the superficial parts arrested and the capsule divided sufficiently to permit of proper inspection of the joint cavity. The patella and the ligamentum patellæ are pulled well forwards, the synovial membrane examined to see if any villous outgrowths are present, and the finger is pushed into the recesses of the joint, particularly above the patella, to see if there be any loose body; finally, the ligamenta alaria are examined to see if they are detached. Should they be loose, the free ends will probably be thickened from the constant irritation, and they should be cut off close to the fatty pad and removed. The wound is then closed in the usual manner (*vide supra*). The after-treatment is the same as in the preceding cases. The patient does perfectly well without one or both of these ligaments.

INJURY TO THE SEMILUNAR CARTILAGES.—This is perhaps the commonest form of internal derangement of the knee joint. One or both cartilages may be injured, the one usually affected being the internal. The accident follows some sudden strain, more particularly a twist of the leg upon the thigh, the internal semilunar cartilage being damaged by violent external rotation, whilst the external is injured by violent internal rotation. The accident most commonly occurs whilst playing football or lawn tennis, or whilst doing anything in which the leg is planted firmly upon the ground whilst the body is twisted violently round upon it.

The lesions in the cartilage are various: sometimes it is split longitudinally; sometimes it is completely divided transversely; in other cases it is torn from its connection with the tibia whilst remaining attached at its two ends; sometimes one of the attachments to the spine of the tibia is torn through and the free end curls up in the intercondyloid notch and gets nipped between the ends of the bones; in other cases again there may be practically complete detachment of the entire cartilage. The exact lesion present cannot be clearly made out before the joint is opened. The symptoms are very apt to recur on any very slight injury, such as knocking the toe against a stone, rotating the foot, or some equally trivial movement.

Treatment.—It is well to differentiate between the treatment of this

condition according as the case is seen after the first injury or as it is one in which there are frequently recurring attacks.

(a) **Of a first attack.**—The first point here is to *replace the cartilage* if it be displaced. If the limb be in the semiflexed and "locked" position, re-position is readily accomplished by completely flexing the joint to disengage the cartilage, and then, while keeping up pressure over the latter, suddenly extending the limb and rotating the foot somewhat inwards if the internal cartilage has been damaged, and somewhat outwards if the lesion be in the external.

After having thus replaced the cartilage, *the limb should be immobilised* in order to allow the cartilage to contract adhesions and to become fixed in its normal position. Opinions differ as to the exact method to be employed, some surgeons preferring to employ massage and to simply strap the joint, on the ground that adhesions within the joint are thus avoided, and that at the same time the muscles do not lose power; it is very seldom however that anything like satisfactory recovery follows this method. In our opinion it is necessary after a severe injury of this kind to employ complete fixation of the limb for at least two months. Any adhesions in the joint which follow such prolonged rest can be readily overcome by massage and passive movement, while, unless the limb be thoroughly fixed for at least this period, the cartilage can hardly be expected to unite satisfactorily. The best plan is to place the limb in a trough of Gooch's splinting or in a MacIntyre's splint, bent to a suitable angle and somewhat elevated on a pillow until the effusion which follows the injury has subsided. The limb should be kept as straight as the patient can conveniently bear, and care should be taken to rotate the foot well inwards. After the swelling has subsided, the limb should be put up in some suitably moulded apparatus; this may be either leather, poroplastic material, or plaster of Paris (see Part III., p. 12).

In about eight weeks the limb may be taken down, and massage and passive movement employed. If there be any marked adhesions, the use of the radiant heat apparatus or super-heated steam, etc. (see p. 155), before the passive movement, is of value. Massage should be applied to the thigh muscles in particular, and is of primary importance, especially in elderly subjects, on account of the wasting from non-use that otherwise occurs. If allowed to occur, this wasting is very slowly recovered from, and in old people, therefore, it is well to begin the massage about a week or so after the injury, the casing being removed from time to time for the purpose. When this is done, however, care must be taken to keep the knee joint extended and immovable.

In a good many cases the trouble does not recur when this treatment is carried out, but it is well to prohibit the patient from joining in such games as football or tennis, even though no symptoms recur, as they are very apt to bring about a reappearance of the trouble. He should also be instructed not to walk too much, and above all to avoid rotation of

the leg upon the thigh; when the internal condyle has been dislocated, he should walk with the toes turned in and *vice versâ* in the case of the external.

(b) **Of recurrent cases.**—When the patient suffers from repeated attacks, it is out of the question to expect union of the torn cartilage, and a choice must be made between palliative or radical treatment.

Palliative treatment.—The main reliance must here be placed upon massage applied mainly to the thigh muscles so as to strengthen them and enable them to fix the joint well; in addition, a special apparatus is often used to prevent inward displacement of the leg, and the patient is instructed to avoid rotating the limb when walking. The result obtained is, however, very imperfect, and we would strongly recommend that operative measures should be employed in all cases where the patient will consent.

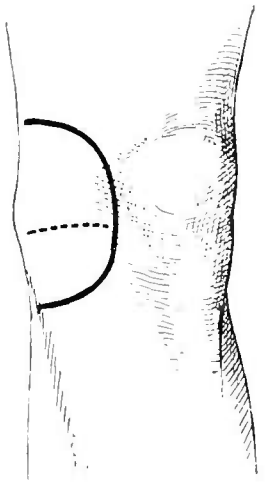


FIG. 57.—INCISION FOR THE REMOVAL OF THE INTERNAL SEMILUNAR CARTILAGE. The thick line indicates the incision in the skin, the dotted one that through the capsule. If preferred, the operation may be done by means of a flap in the reverse direction, *i.e.* with its convexity backwards, the horns of the incision reaching from the centre of the inner border of the ligamentum patellæ to a point above the centre of the bone. The incision in the capsule is sometimes made somewhat convex forwards and downwards. The one shown above is perhaps the most suitable on the whole.

Operative treatment.—The exact form of operative procedure to be adopted will depend largely upon the condition found when the joint is opened, and varies from partial or complete removal of the cartilage to merely stitching it back into place.

In order to obtain proper access to the cartilage it is best to make a curved incision over the inner side of the knee with its convexity forwards (see Fig. 57). The flap is dissected up and all bleeding is arrested before the capsule is divided; this is done by an incision running just above the border of the inner tuberosity. The joint can then easily be inspected, especially if the limb be flexed. The condition of the cartilage is examined, and, if it be wholly or partially detached, it is well to remove it altogether; this can best be done by slipping a fine pair of blunt-pointed scissors into the joint along the cartilage and dividing it as far back as possible. The loose end is then dragged forward and the anterior extremity similarly severed. It is remarkable how little trouble patients have after its removal; indeed they do not seem to feel the loss of it at all.

When the cartilage is merely split and a portion only is loose, the latter may be removed and the remainder left. When the entire circumference of the cartilage is detached from its connections but the extremities still remain attached, a cure may be effected by stitching the cartilage back in position; this should be done with the knee fully flexed and the stitches, which should be of catgut, must be made to take a firm hold of the cartilage on the one hand, and of the capsule of the joint and the peri-

osteum over the head of the tibia on the other. A sufficient number of stitches must be put in to fix the cartilage firmly. The limb is now gradually straightened, while a careful watch is kept upon the cartilage, as it is during extension that the greatest strain is put upon the stitches. Should these tear through, the cartilage had better be removed.

After the cartilage has been dealt with, all blood is removed from the joint by irrigation. We are in the habit of irrigating the articulation from time to time during the operation with a warm 1-8000 sublimate solution. The capsule is next accurately stitched up with fine catgut and the skin incision is sutured without any drainage tube. The limb is put upon a suitable splint in the straight position, elevated upon a pillow, and kept there for about ten days.

After-treatment.—When the cartilage has been removed wholly or in part, passive movement and massage may be commenced at the end of the first week in order to avoid adhesions; when, however, the cartilage has been stitched back into position, it is well to keep the limb rigidly fixed for at least four weeks, so as to give time for adhesion to occur. It will require the greatest care to avoid detaching the cartilage when passive movements and massage are afterwards employed to restore the mobility of the joint.

CHAPTER XXI.

DISEASES OF THE ANKLE AND TARSUS.

VERY little need be said concerning the non-tuberculous affections of these joints; their treatment has already been fully described in speaking of the diseases in general, and only a few words concerning the special forms of apparatus, etc., will be necessary.

ACUTE ARTHRITIS.

VARIETIES.—This may be either suppurative—when it is most commonly either of pyæmic origin or is secondary to osteo-myelitis—or it may be non-suppurative—when it either results from an injury such as a sprain, or is associated with some general disease such as rheumatism, gout, or gonorrhœa; the latter affection is extremely common in the ankle and tarsus, where it is one of the commonest causes of acute flat-foot.

The most common seat of acute osteo-myelitis occurring about the foot is the os calcis, but fortunately the disease here generally gives rise to an abscess which finds its way externally rather than into the neighbouring joints. It usually takes the form of acute epiphysitis, so that the principal focus of disease is situated in the immediate neighbourhood of the posterior epiphyseal line, and necrosis may occur in that situation. Sometimes the calcaneo-astragaloid or calcaneo-cuboid articulation may become affected; there is then generally necrosis of the entire os calcis.

TREATMENT.—This will vary considerably according to whether—(*a*) there is no suppuration in the joint, (*b*) there is suppuration, or (*c*) there is also acute osteo-myelitis of the os calcis.

When there is no suppuration in the ankle-joint.—Absolute rest of the joint should be provided. It is important to remember that there is a constant tendency to pointing of the toes when the ankle joint is fixed, and this must be carefully avoided, as it would inevitably cause difficulty in restoring the foot to its proper position. It can easily be guarded against by seeing that the foot is kept strictly at right angles to

the leg when the splint is applied. Perhaps the best splints for the purpose are Croft's lateral plaster of Paris splints (see Part III., p. 14).

There is a great tendency to the formation of adhesions after all acute inflammations about the ankle, and therefore after the subsidence of the acute symptoms no time must be lost in employing massage and passive movements to break up the young adhesions.

When there is suppuration in the joint.—This will be shown by increasing distension of the joint, great pain and severe febrile symptoms. It sometimes suffices to make incisions on either side of the extensor tendons over the front of the joint, but as a rule it is well to provide additional drainage through openings on either side of the tendo Achillis. It is a point of great importance to avoid wounding the tendon sheaths about the ankle, as otherwise a disastrous suppurative teno-synovitis may be set up. When efficient drainage has been provided, the case is treated on the lines already laid down for suppuration of joints (see p. 87). Care must be taken to keep the foot at right angles to the leg.

The after-treatment will be similar to that just described.

When there is also acute epiphysitis of the os calcis.—The risk of the inflammation spreading to the tarsal joints is an additional reason for early operation in cases of acute osteo-myelitis of the os calcis. Besides treatment directed to the joint (*vide supra*), means must be taken to cure the bone disease.

When the disease is limited to the bone.—The bone should be exposed by a curved incision with its convexity backwards either over the inner or outer aspect of the heel, the periosteum incised, the compact bone chiselled through and the interior gouged freely out so as to afford exit for the pus. This treatment is the best and most efficient when the disease is seen in the early stages and is limited to the bone.

When the disease involves neighbouring joints.—When, however, the disease has spread to the neighbouring joints, particularly the calcaneo-cuboid, it is best to amputate. If the tarsal joints only be effected, this as a rule should be done through the lower third of the leg, as it is particularly difficult to perform a Syme's operation without infecting the flaps. In some rare cases, when the osteo-myelitis occurs in the anterior part of the bone, there will not be the same risk of infection, and a Syme's amputation may be done.

When the disease implicates the ankle joint and, in spite of free drainage and constant irrigation, the symptoms do not abate in two days, amputation below the knee is called for.

CHRONIC SYNOVITIS.

This is of comparatively rare occurrence in the ankle, and its causes, symptoms, and treatment are similar to those already described for the disease in general (see p. 105); when occurring in the ankle joint it does not offer any points of special interest.

RHEUMATOID ARTHRITIS.

This affection has already been fully described (see p. 147). It is not infrequent in the ankle, and the pain may be so great as to completely incapacitate the patient from walking.

The question of excision of the astragalus may have to be considered here. The decision will depend upon whether the ankle is the only joint affected or whether several are attacked. Should the disease be confined to one ankle it is quite justifiable to relieve the patient's pain and enable him to get about by removal of the bone (for the operation see p. 72).

CHARCOT'S DISEASE.

The ankle is not infrequently affected by this disease, and, from the amount of pressure to which it is subjected, usually undergoes great disorganisation.

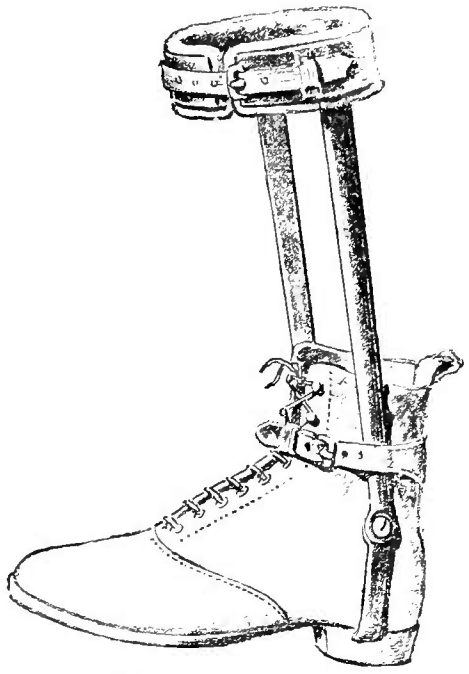


FIG. 58.—BOOT FOR USE IN CHARCOT'S DISEASE OF THE ANKLE JOINT. The band to which the leg irons are fastened should encircle the limb on a level with the tubercle of the tibia.

While the active destructive stage is going on, the patient should be confined to a couch or allowed merely to go about on crutches with the affected limb supported by a sling from the neck. In some months a certain amount of consolidation may occur, when it will be possible to allow the patient to walk wearing a suitable firm boot (see Fig. 58), provided with lateral irons and a hinge at the ankle joint, so as to allow the ordinary movements of the joint without the possibility of lateral bending.

When the ankle is the only joint affected and the patient is completely crippled, amputation either at or above the ankle joint is quite justifiable if it will enable the patient to do his work better.

SYPHILITIC AFFECTIONS.

Syphilitic disease of the tarsal bones is not at all uncommon, and the various forms of joint syphilis already referred to (see Chap. XIV.) may be met with in the ankle, although more seldom than in the knee.

Thickenings of the tarsal bones are not uncommon in hereditary syphilis; these are due to periostitis and may lead to considerable interference with

the movements of the joint. The treatment offers no points of difference from that already described (see p. 140).

TUBERCULOUS DISEASE.

Tuberculous disease of the ankle, the tarsus, and metatarsus are relatively more common during adolescence than at any other period. The parts most frequently affected are those upon which most strain is thrown in the transmission of the weight of the body, namely the ankle joint itself, the astragalus (more particularly the head), the os calcis, and the base of the first metatarsal.

As in other joints, the disease may be primary either in the synovial membrane or in the bone; in the ankle it is more often primary in the synovial membrane, whilst in the tarsus it is more common in the bone. Of the tarsal bones, the os calcis is most frequently affected; next in order comes the first metatarsal, then the astragalus, and finally the scaphoid and internal cuneiform. It is important to note that in tuberculous disease of the tarsus nearly all the bones are usually the seat of rarefying osteitis and are consequently much softer than usual, although the disease may be confined to one bone or to one part of the articulation.

TUBERCULOUS DISEASE OF THE ANKLE JOINT.

In cases of *primary synovial disease*, the principal swelling is over the front of the ankle, on either side of the tendons; there is also generally some swelling on either side of the tendo Achillis. As the disease advances, enlargement is noticed below the malleoli.

When the disease is *primary in the bone* its most frequent seat is in the astragalus; after this come the malleoli, particularly the inner one, and when the malleoli are affected there is also enlargement of the bone in addition to the other joint symptoms.

When the astragalus is primarily affected the enlargement cannot be made out in the early stages, and it is often difficult to diagnose the disease before the ankle joint has become involved. In some cases the deposit is in the substance of the bone and makes its way to the surface outside the joint, but in the majority the deposit occurs beneath the cartilage and very soon opens either into the ankle or the astragalo-scaphoid joint.

Course.—If the disease be left untreated, a condition of talipes equinus is produced from pointing of the toes, while the ligaments become softened in the later stages and allow lateral deviation of the foot, particularly to the outer side. When abscesses occur, they are usually on the antero-lateral aspects of the joint. A very common complication is tuberculous disease of the tendon sheaths of the extensors and those passing behind the internal malleolus.

Treatment.—As in the case of other joints, we may distinguish various

stages of the disease from the point of view of treatment. These are:—1. Primary osseous deposits. 2. Synovial thickening. 3. Joint disease complicated by abscesses or sinuses. 4. Recovery with deformity.

(1) **Primary osseous deposits.**—If these can be diagnosed and are accessible they should be removed at once, when the joint may be saved. Should the deposit be in the base of either malleolus, it is quite readily reached through an incision directly over the enlarged bone, and the deposit can easily be scooped out with a sharp spoon. Unless there be marked signs of synovial disease present, it is well to be content with the removal of the bone deposit, and to treat the joint trouble by the expectant measures which will be immediately described for the treatment of the first stage of the synovial form of the disease (*vide infra*).

When the deposit occurs in the astragalus, that bone must be removed in order to obtain a cure. Unfortunately these cases are seldom diagnosed until the synovial membrane of the ankle is widely involved, when an arthrectomy of the ankle joint should be combined with removal of the astragalus (see p. 233).

(2) **Synovial thickening.**—When the disease in the ankle is either primarily synovial or the bone deposit has been removed and the synovial affection is left, the case should be treated first on lines similar to that recommended for other joints, the first essential being rest in the recumbent position, combined with fixation of the joint. Most cases of disease of the ankle joint result in anchylosis if they get well, and therefore the limb must be kept in the position in which it will be most useful afterwards; this will be at or slightly beyond a right angle to the leg. The thing to avoid is pointing of the toes, as it is most essential to comfort in walking that the heel should reach the ground and support the weight; when the toes are pointed, the whole weight is thrown on the heads of the metatarsals. Care must also be taken to see that there is no lateral deviation of the foot.

The best arrangement is to fix the limb in Croft's lateral splints extending from the knee to the roots of the toes (see Part III., p. 14). It is well to apply an ordinary back splint with a foot-piece at right angles outside the plaster splints until they have thoroughly dried. The patient should be kept recumbent in bed or upon a sofa, with the limb slightly elevated, until the disease is well advanced towards cure; afterwards he may be allowed to get about on crutches, the best arrangement being to fit him with a peg-leg so that the weight is supported upon the knee instead of the ankle. He may then get about with the aid of a crutch or a stick.

In addition, the other methods for the treatment of tuberculous joints may be employed, such as the injection of iodoform emulsion, which is very readily carried out from the front of the joint, particularly in front of the internal malleolus; or if this fails, the use of firm pressure by Scott's dressing, either alone or combined with a starch and cotton wool bandage (see p. 119).

In children, however, unless rapid improvement follows these methods,

arthrectomy should be done comparatively early. Tuberculous disease of the ankle has not the same tendency to recovery as in other joints, and moreover is frequently associated with tuberculous meningitis or phthisis. Another point of importance is that the functional result after recovery without operation is not so good as when arthrectomy has been performed, and hence we do not advise that expectant treatment be persevered with unless steady improvement be taking place. This is the exact contrary to what we have advised for joints such as the hip, and is mainly dependent on the functional result after arthrectomy.

Arthrectomy.—Arthrectomy of the ankle joint may be performed in various ways, but either temporary resection of the malleoli or removal of the astragalus is absolutely essential for free access to the posterior part of the joint; some surgeons prefer one, some the other procedure. Our own opinion is that the best result, both from the point of view of complete removal of the disease and the functional result afterwards, is obtained by combining excision of the astragalus with the arthrectomy. The division of the malleoli does not seem to us to be so satisfactory, as the difficulty

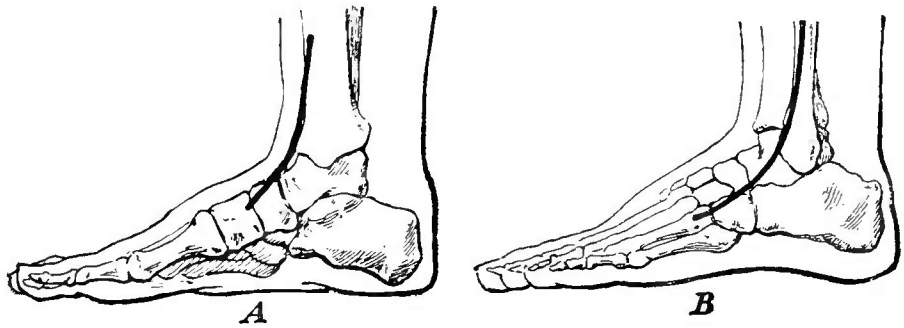


FIG. 59.—INCISIONS FOR ARTHRECTOMY OR EXCISION OF THE ANKLE. *A* is the inner, *B* the outer incision.

of obtaining access to the back of the joint is not entirely overcome, and, moreover, the area of cartilage and bone which has to be examined, and from which disease may have to be removed, is much greater and is not so accessible; any disease left behind is apt to infect the cut surfaces of the malleoli, whilst their union afterwards may not be quite accurate and deformity may consequently occur. Further than this, the astragalus is very commonly the primary seat of disease, and small sub-cartilaginous deposits may be overlooked; and lastly, division of the malleoli in young children may interfere with the epiphyseal line. On the other hand, removal of the astragalus gives most admirable access to the whole of the joint, and by removing it the surgeon can make quite sure of taking away all the diseased synovial membrane and at the same time removing any deposits in the bone. The functional result is perfect, a freely movable joint being practically always obtained. We shall, therefore, only describe this method.

Many incisions have been employed. We generally use a longitudinal incision in front of each malleolus, extending from about two inches above the joint to the centre of the lateral aspects of the foot (see Fig. 59).

The inner incision commences just over the anterior border of the tibia, runs down in front of the internal malleolus and curves somewhat inwards on the foot towards the internal cuneiform bone. On the outer side, the incision runs from the front of the fibula, in front of the external malleolus, forwards on to the foot, curving slightly to about the base of the fourth metatarsal. The incisions are deepened until the capsule of the ankle is exposed. The soft parts are carefully raised from the front of the joint with a periosteum detacher, which is gradually insinuated from one wound to the other, between the capsule and the parts over it. Then, by pushing the periosteum detacher forcibly upwards and downwards, the whole bridge of soft parts, containing the tendons and the anterior tibial vessels and nerves, can be lifted up so as to expose the entire anterior portion of the capsule from its connection with the tibia above to the astragalus below.

The soft parts are then similarly separated from the capsule backwards from each incision, and the structures are raised from the malleoli. The entire anterior and antero-lateral areas of the capsule are thus separated from the structures over them, and the attachments of the former to the lower end of the tibia, the malleoli, and the tarsus may be cut through with a knife or scissors, and the whole synovial membrane gradually removed in one piece, the edges of the articular cartilage being shaved away with a knife. The interior of the joint is thus exposed and its condition can be examined.

The lateral ligaments are now divided, and the next step in the operation is to remove the astragalus. The inner incision is fully retracted, the astragalo-scaphoid articulation is defined and its ligaments divided. The lateral connections of the astragalus with the os calcis are severed, when it is easy, by everting the foot and pushing up the astragalus, to insinuate the knife beneath the bone and to divide the calcaneo-astragaloid ligament. The astragalus is now only held at its posterior part by the sheath of the flexor longus hallucis which runs in its groove; this is cleared and the astragalus is removed.

The interior of the joint can now be thoroughly inspected. The remains of the synovial membrane over the lateral and posterior aspects of the joint are gradually detached from the tissues superficial to them with a blunt dissector and the finger, and are divided at their attachment to the tibia and fibula. The tendon of the flexor longus hallucis gives rise to some difficulty, but by pulling the foot downwards from the leg it can easily be seen and avoided.

When the entire synovial membrane has thus been removed, the lower ends of the bones should be examined; these may be protruded through either wound and can be methodically examined and anything suspicious removed (see Fig. 60). In any case, the edge of the cartilage to which the synovial membrane was attached should be shaved off cleanly all round with a knife. Any soft or loose portions of cartilage should be

removed, and the surface of the bone beneath gouged. Should there be any pits or depressions in the cartilage, they should be enlarged and bone deposits beneath them looked for.

After the joint has thus been cleared out, the parts are replaced, the joint cavity is filled with iodoform and glycerine and the wound stitched up without a drainage tube. The usual cyanide dressings are applied, with which may be incorporated perforated block-tin or wire netting splints (see p. 73); outside these a large mass of wool is put on.

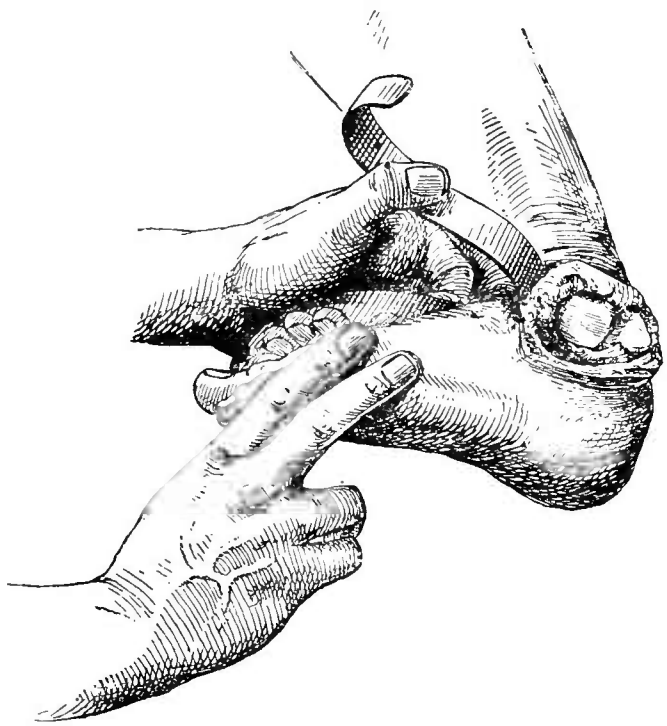


FIG. 60.—METHOD OF EXPOSING THE ENDS OF THE TIBIA AND FIBULA IN ARTHRECTOMY OF THE ANKLE. When the astragalus has been removed, the ends of the bones can readily be protruded through either of the lateral incisions.

After-treatment.—The dressings should be changed in a fortnight, when the wound should be healed, and the stitches may be removed. The limb may now be put up in plaster of Paris, taking care to keep the foot strictly in its normal position. The plaster casing should be maintained for about six weeks, when it should be renewed. The patient should not be allowed to walk until six or eight months have elapsed from the time of the operation.

Results.—The chief trouble after arthrectomy of the ankle is the tendency to lateral deviation of the foot—more particularly inversion—and this must be carefully guarded against by the use of apparatus until the parts have become quite firm. Afterwards the patient must wear a suitable boot designed to prevent lateral displacement (see Fig. 32). There is no fear of the mobility of the limb becoming impaired, even though the joint be kept in plaster for as long as six months, because the os calcis does not unite firmly to the tibia and a very excellent movable joint results.

In adults, this method of arthrectomy, combined with removal of the astragalus, is a better operation than the ordinary excision, because it gives a good movable joint, whereas the latter leaves the articulation stiff: nothing impedes locomotion more than a stiff ankle.

Excision.—In performing a set excision, the joint may be exposed in the manner just described and, after the ends of the bones have been cleared, the tibia and fibula are sawn across just above the level of the articulation with a narrow saw introduced across the front of the joint; the cartilaginous surface of the astralagus should also be removed. Bony anchylosis is certain to occur after this operation, and special care must therefore be taken that it occurs with the foot in good position. For this reason we do not recommend the operation of excision of the ankle joint under any circumstances whatever; indeed we are of opinion that if arthrectomy of the joint combined with removal of the astralagus be out of the question, amputation will probably leave the patient with a more useful limb.

(3) **When abscesses or sinuses are present.**—Here the treatment must be operative, and should consist of arthrectomy at the very least; arthrectomy will be best in children, whilst in adults amputation will be most often called for.

When there is a large abscess, it is well to wash it out and inject it with iodoform and glycerine in the first instance (see p. 120) and wait for the diminution or cure of the abscess before proceeding to arthrectomy; otherwise extra large incisions will be required, and it is very likely that tuberculous material will be left behind. The arthrectomy may be performed as soon as the abscess has healed or has diminished to a small size.

The presence of sinuses does not necessarily contra-indicate arthrectomy, as they may be scraped out and sponged with undiluted carbolic acid before proceeding to the operation, and may then be included in the incisions and dissected out entirely. The steps of the operation are exactly similar to those already described, but it is well before sewing up the wound to sponge it out freely with undiluted carbolic acid, after which a drainage tube should be inserted. The best position for drainage is on the inner side of the tendo Achillis, and the incision may be made by thrusting a pair of forceps through the back of the joint, making it project beneath the skin just at the inner border of the tendo Achillis and cutting down upon it in that situation; the forceps are then pushed through, the blades expanded, and a drainage tube of suitable size seized and pulled back into the joint. Drainage is necessary here because the wound is septic, and suppuration may of course occur in it, whilst the carbolic acid with which the wound is swabbed leads to so much effusion that it is well to allow of its escape for the first few days. If there be no suppuration in five or six days, the drainage tube may be left out.

When amputation is called for in disease of the ankle joint, the favourite form used to be Syme's (see Part III., p. 276), and no doubt this yields a most excellent stump. It is however extremely difficult to do the operation without leaving some of the diseased synovial membrane behind, and it is very common to find recurrence after this amputation. This is sometimes in the soft parts, and often in the bone, and calls for a further amputation. We are therefore of opinion that Syme's amputation should be limited to those cases in which the disease is not extensive. If it be done in cases complicated by sinuses, the surgeon must remember that all the sinuses must be removed, and that a very accurate removal of the synovial membrane and the bone must be made. There is a great risk that, with flaps that are so slightly vascular and so thin, injury may be done which may lead to sloughing. As a rule, we are inclined to believe that in bad cases it is best to amputate rather below the seat of election in the leg (see Part III., p. 282) instead of doing a Syme's amputation.

(4) **Recovery with deformity.**—The deformity generally takes the form of pointed toes, and the treatment will depend upon whether or not there is bony anchylosis; if bony anchylosis be present, the proper treatment is excision of the astragalus, whereby the position of the foot is at once rectified and a movable joint is obtained.

Forcible movements.—On the other hand, if bony anchylosis be not present, it may be possible, by dividing the tendo Achillis and the shortened posterior ligaments of the joint, and by the subsequent use of gentle massage and passive movement, to obtain a rectification of the position. It is important to remember, however, that the disease is not really cured, and therefore any violent wrenching may light it up afresh. At the same time, after the lapse of two or three years without any symptoms of disease, and when there is a certain amount of mobility retained in the ankle, an attempt may be made to restore the mobility of the joint on the lines already indicated (see p. 162), but no violent breaking down of the adhesions should be carried out.

Excision of the astragalus.—We believe, however, that on the whole the removal of the astragalus will yield the best results in these cases. In doing this it must be remembered that, should firm bony anchylosis be present, the removal of the astragalus is a very difficult matter, and can only be done by chiselling it out piecemeal. Tenotomy of the tendo Achillis may also be called for.

TUBERCULOUS DISEASE OF THE TARSUS.

As we have already said, tuberculous disease is most common in the os calcis, the astragalus, and the base of the first metatarsal. In the os calcis the disease usually remains limited for a time to the bone. If the deposit be near its upper surface, the calcaneo-astragaloid articulation alone may be affected. When the deposit is in the base of the first metatarsal, an

abscess may form outside the bone without infection of any of the tarsal joints in the neighbourhood. On the other hand, however, it is not uncommon to find extensive disease of the tarsus starting from this situation. Disease of the astragalus rarely remains limited to that bone, as it readily affects the ankle or the astragalo-scaphoid joints. In the latter event, the disease spreads rapidly over the whole of the tarsus. When the disease commences in one of the other tarsal bones the entire tarsus readily becomes involved.

In considering the treatment of tarsal disease, we distinguish two main classes of cases: (1) those in which the disease is confined to a single bone of the tarsus; and (2) those in which all the tarsal joints are involved.

Disease of the Individual Bones of the Tarsus.

DISEASE OF THE OS CALCIS.—The osseous deposit here may be either soft and caseous or it may be a sequestrum. There is generally dull pain in the heel and enlargement of the bone, with fulness later on about the calcaneo-astragaloid joint; sometimes, however, the deposit makes its way through the shell of the bone to one side—most commonly the outer—and gives rise to an external abscess.

Treatment.—This will depend upon the stage at which the disease has arrived. When there is no external abscess and no distinct evidence of disease of the calcaneo-astragaloid joint, palliative measures may be employed for a time: these will consist of immobilisation of the foot in plaster of Paris, and the usual hygienic measures suitable for tuberculous joint disease in general (see p. 114).

Operative measures.—It is best, however, to advise early operative interference, as it should be borne in mind that the essential lesion is an osseous deposit. The position of the incision will be determined largely by the situation of the primary deposit; this is generally indicated by thickening of the bone, which points to the conclusion that the deposit is nearest to the surface at that spot. When the entire bone is uniformly thickened, it is best to cut down over its upper part near the calcaneo-astragaloid articulation.

When there is no abscess.—Should there be no definite indication, the most convenient access can be gained from the inner side of the bone, over which a curved incision should be made with its convexity upwards. This incision is gradually deepened, care being taken not to divide the plantar vessels and nerves; the incision should not go far enough forward to endanger them. The flap is dissected downwards so as to expose the inner surface of the bone, which after exposure is chiselled away until the compact tissue is removed, when the osseous deposit is often reached at once; if not, the cancellous tissue is cleared out, especially towards the upper and back part of the bone, with a sharp flushing spoon. If cheesy material be exposed, the scraping should be continued until healthy bone

is reached everywhere, after which the cavity may be filled up with iodoform emulsion, and the wound stitched up without a drainage tube. Should serum accumulate in the cavity, it can be allowed to escape quite easily by inserting a pair of dressing forceps through the wound, but this is usually unnecessary, and healing is quite satisfactory. Blood-clot forms in the cavity and subsequently becomes organised.

After-treatment.—After the operation, the foot should be encased in a large mass of dressing and enveloped in wool firmly bandaged on; it should be fixed in position by means of suitable lateral splints. When the wound has healed and the parts are quite sound, a large mass of wool should be put around the ankle and fixed on firmly with a silicate bandage, so as to exercise a certain amount of compression. The patient should not be allowed to hang the foot down for at least eight weeks after the operation, as otherwise the vitality of the organising blood-clot within the bone will be endangered. Should a sinus form and fail to heal, the scraping may be repeated after a time; the second operation will often succeed in curing the disease.

When an abscess or sinuses are present.—*When there is an abscess* over the bone, this should if possible be dissected out or at any rate cleared out as thoroughly as possible, and the bone deposit removed as described above.

When septic sinuses are present leading into the interior of the bone, they may be treated in a similar manner: the sinus is swabbed out with undiluted carbolic acid, included in the incision and entirely removed. The interior of the bone is then gouged out and similarly sponged with the undiluted acid. It is well afterwards to stuff the cavity and leave it open. The flap may be stitched into position later on when the cavity is granulating well, a small drainage tube being placed at the posterior angle of the incision so as to allow the discharge to escape.

Excision of the os calcis.—In other cases, however, it may be necessary to excise the os calcis altogether. This will be called for when the disease has lasted for a long time, when it has resisted the operations just described, when several sinuses are present or when there is evidence of infection of neighbouring joints, such as the calcaneo-astragaloid or calcaneo-cuboid.

Various incisions have been employed for removal of the os calcis. The one we are accustomed to use commences a finger's-breadth above the sole just behind the base of the fifth metatarsal, and is carried horizontally backwards around the heel and along the inner side of the bone for an inch and a half (see Fig. 61); it must not be carried too far forward, for fear of damaging the vessels and other structures below the internal malleolus. The incision should go through the skin and fascia only at first. It is sometimes useful to add a vertical incision to the horizontal one just in front of and parallel to the outer border of the tendo Achillis for about two inches. By this means three flaps are formed which are dissected off the bone, care being taken to avoid the peronei tendons behind the external malleolus.

As soon as these have been defined, the incision is carried down to the bone throughout the rest of its extent, and the soft structures are peeled off with a periosteum detacher. The tendo Achillis is divided just at its point of attachment to the bone, or the periosteum with the tendon attached to it may be peeled off so as to allow it to retain its connection with the flaps; this of course can only be done when the posterior part of the bone is free from disease.

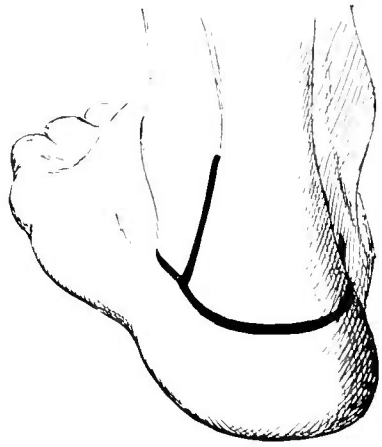


FIG. 61.—INCISION FOR EXCISION OF THE OS CALCIS. The incision should run a full finger's breadth above the sole. The vertical incision along the outer border of the tendo Achillis is only occasionally required.

If the flaps be well retracted, the greater part of the bone can now be cleared and the whole of the upper surface exposed as far as the calcaneo-astragaloid articulation. The only parts of the bone not well exposed are the calcaneo-cuboid joint and the sustentaculum tali. The middle fasciculus of the external lateral ligament of the ankle is next divided, when, by pressing the bone downwards and inwards, the articulation between it and the astragalus is seen, and the calcaneo-astragaloid ligament can be divided. The calcaneo-cuboid joint is exposed by dissecting the structures forward at the anterior end of the outer incision, and the ligaments are divided by keeping the knife close to the bone.

The portion of the bone that gives most trouble is the sustentaculum tali; in freeing it, the greatest care must be taken to keep the edge of the knife well against the bone and to employ the periosteum detacher as much as possible, so as to avoid damage to the important structures in its immediate neighbourhood. As a rule, after dividing the connections between the astragalus and the os calcis and opening the calcaneo-cuboid articulation, it is possible to gradually expose the structures retaining the bone by using the latter as a lever, and then to turn them off the sustentaculum tali without damage. The tendon of the tibialis posticus must be carefully raised from its groove with a raspatory.

After the bone has been removed and the bleeding arrested, the wound must be examined for diseased synovial membrane in the neighbourhood of the calcaneo-astragaloid or the calcaneo-cuboid joints, and any found must be removed. Sometimes the cartilage on the under surface of the astragalus is diseased, and if so, it must be removed and with it a thin layer of the lower surface of the bone. Any sinuses present must be excised, if possible, or at any rate carefully scraped and sponged with undiluted carbolic acid.

As a rule it is best to stitch the wound up after inserting a drainage tube at the most dependent spot. It is always advisable to employ drainage in these cases, because a large cavity is left in which serum is otherwise

certain to collect and to interfere with union, while, should septic sinuses be present, suppuration is of course very apt to occur.

After-treatment.—After the wound has been stitched up and the usual dressings applied, it is well to employ an anterior splint so as to avoid pressure upon the tissues over the heel. The bandage is sufficient to keep the surfaces fairly well in contact, and any additional pressure, such as would result from allowing the heel to rest upon a splint, might lead to sloughing of the flaps. The best arrangement, perhaps, is an anterior suspension splint (see Fig. 62). A flat bar of malleable iron is moulded to the leg from the tubercle of the tibia to well beyond the toes, the

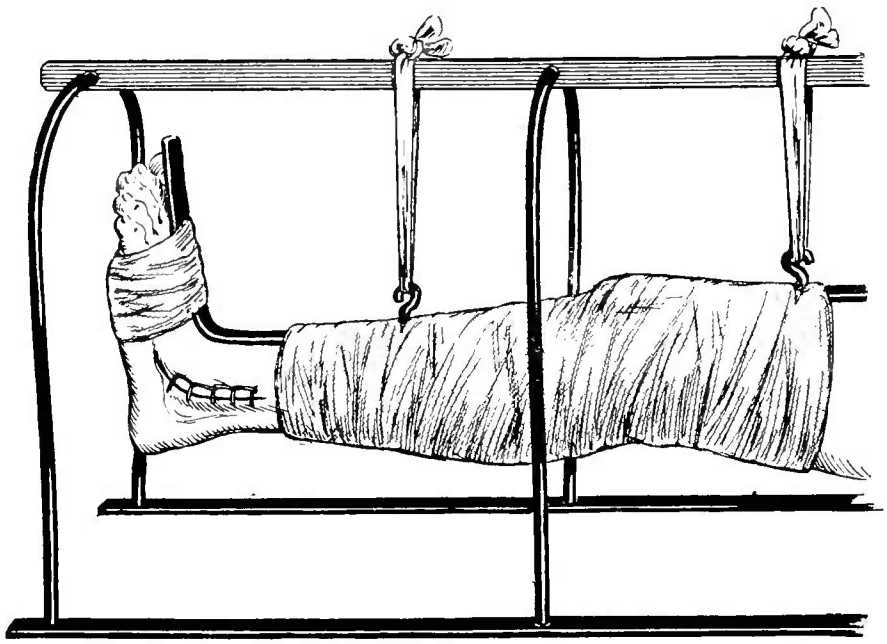


FIG. 62.—ANTERIOR SUSPENSION BAR APPLIED AFTER ARTHRECTOMY OF THE ANKLE. The wound is shown exposed without any dressings. The splint is fixed to the limb by plaster of Paris bandages and suspended from a cradle. This gives sufficient fixation to the joint and at the same time allows dressings to be properly applied. It is a very useful splint for excision of the os calcis.

foot meanwhile being kept at a right angle. The iron is fixed to the leg and the anterior part of the foot by a waterglass or plaster of Paris bandage, the region of the heel being left free for dressings. The bar is furnished with hooks by which it may be suspended from a cradle. The drainage tube should be kept in for about ten days, and, when the wound has healed, the limb should be put up in plaster of Paris, with the foot strictly at right angles. The patient should not be allowed to walk or to hang the limb down for two or three months after the operation.

Results.—The results of this operation are extremely satisfactory; patients are able to walk with comfort and without limping by merely placing a small pad of felt, wool, or india-rubber inside the boot, to supply the deficiency left by the removal of the os calcis. As a matter of fact, a considerable amount of new tissue, sometimes actual bone, forms, and the depression of the heel is not nearly so great as one would expect after removal of so large a bone. In most cases a pad about

half an inch thick will be amply sufficient to compensate for the loss. The result is equally good in adults and in children.

DISEASE OF THE BASE OF THE FIRST METATARSAL.—The disease usually begins in the interior of the base of the bone and may gradually find its way outwards either to the inner and anterior aspect of the bone, or it may open into the articulation between it and the internal cuneiform, or attack the synovial membrane of that joint.

Treatment.—*When the disease remains limited to the interior of the bone*, the best treatment is to excise the base of the bone, cutting it through well beyond the tuberculous focus. In this way the disease is cured at once and the risk of infection of the tarsal joints, which is always present if palliative treatment be adopted, is avoided. The functional result is excellent, as the bone remaining does not get materially drawn up, and dense fibrous tissue forms in the vacant space, replacing it quite satisfactorily. If the deposit has not reached the surface, a considerable amount of the periosteum may be turned back during the operation and new bone will then be formed.

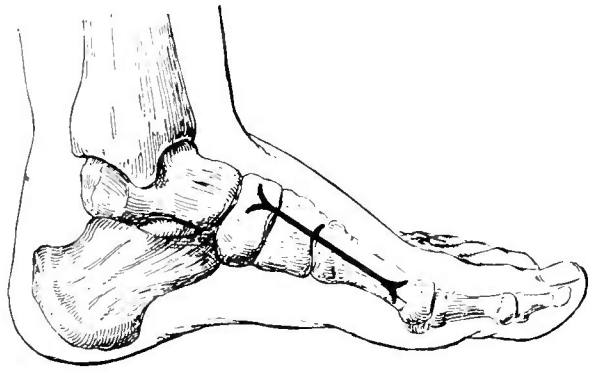


FIG. 63.—INCISION FOR REMOVAL OF A TUBERCULOUS DEPOSIT IN THE BASE OF THE FIRST METATARSAL. The bifurcation at each end of the incision is to facilitate the turning back of the edges of the incision.

The operation is easily done through an incision in the long axis of the bone, a little to the inner side of the extensor tendon; this should extend down to about the centre of the bone, below and well over the internal cuneiform above (see Fig. 63). The periosteum and soft tissues are detached as far as possible: the anterior and internal ligaments connecting it with the internal cuneiform are divided, the bone partially sawn across beyond the expanded portion, and the division completed with cutting pliers. The divided end of the bone is then seized and pulled inwards, when the outer ligaments between it and the cuneiform and also the connections between the first and second metatarsals are divided.

After the bone has been removed, the cut surfaces must be examined to see if they are healthy, and any diseased synovial membrane about the internal cuneiform should be carefully removed. When a healthy surface is everywhere obtained, the wound is stitched up without a

drainage tube and the ordinary dressings are applied. The wound fills with clot which organises and heals rapidly, and after two or three months the patient may be allowed to walk. In the meanwhile, the foot should be encased in plaster of Paris as soon as the wound has healed, care being taken to see that the affected metatarsal bone is parallel to its fellows.

When the tarsal joints have become affected from extension of the disease to the synovial membrane, the treatment, if the case be seen sufficiently early, should be removal of the proximal end of the bone and excision of as much of the synovial membrane as possible. If the infection of the synovial membrane has not extended very far, this will suffice to cure the affection and stop that generalised form of tarsal disease (see p. 244) which is so very grave.

DISEASE OF OTHER TARSAL BONES.—Besides the bones already considered, the astragalus, the cuboid, the scaphoid, and the internal cuneiform are not uncommonly attacked. We need say nothing here concerning tuberculous disease of the astragalus: that has already been fully dealt with in connection with tuberculous disease of the ankle, of which it is frequently the primary cause (see p. 231).

When the patient is young and there is evidence of disease limited to one part of the tarsus and involving one of these bones, operative treatment is far preferable to the expectant method—which of course consists essentially in putting the foot up in plaster or Scott's dressing, injecting iodoform emulsion and applying suitable splints, etc. (see p. 116) In these cases, however, the disease almost inevitably spreads over the whole of the tarsal synovial membrane and is very grave. It is particularly resistant to expectant treatment and is very commonly associated with internal tuberculosis; therefore, no time should be wasted when the disease is limited to one bone or to one portion of the tarsus.

The removal of individual tarsal bones does not really affect the usefulness of the foot at all. The scaphoid, the cuboid, or the internal cuneiform may be removed, and after a year or two it will be difficult to see that any important structure has been taken away. We would therefore strongly advise that, in all cases where there is undoubtedly disease limited to a portion of the tarsus, a partial tarsectomy should be performed; even though the bones themselves be not involved, the removal of a bone such as the internal cuneiform gives better access to the diseased synovial membrane, does not damage the foot and assists recovery to a remarkable extent.

Excision.—*The internal cuneiform* may be removed by a longitudinal incision made directly over its inner aspect, and carried down to the bone; the soft parts are dissected up, and the ligaments divided upon the dorsal and inner aspects. The bone is then seized with forceps, the toes forcibly pulled outwards and the ligaments on the outer and posterior aspect are divided with a long narrow knife, when, by twisting the bone, the plantar

ligaments can also be cut and the bone removed. *The scaphoid* is removed by a similar incision directly over the bone, extending well above and below its limits so as to facilitate good retraction of the parts.

The removal of individual bones in this manner is far superior to the operation formerly done, which generally consisted in the removal of a wedge of the tarsus without respect to its articulations. Excision of individual bones does not open up the cancellous tissue of other bones not yet involved in the disease; there is therefore no risk of re-infection and, as we have said, the functional result is extremely good, in fact much better than when the bones are merely sawn across.

After-treatment.—After the affected bone has been removed, the wound should be stitched up without a drainage tube unless sinuses have been present; before this is done, a little iodoform emulsion should be left in. Healing should take place by first intention, after which the foot may be put up in a waterglass or plaster of Paris bandage. The patient is not allowed to walk for two or three months.

Diffuse Disease of the Tarsus.

It is perhaps most common to find the patient when he first presents himself for treatment suffering from diffuse disease of the tarsus involving the whole of the large synovial membrane.

Treatment.—Removal of individual bones will not meet the requirements of these cases. In the first instance, expectant treatment, consisting of rest, the injection of iodoform, pressure, etc. (see p. 116), may be attempted for a short time, but it must be remembered that this form of disease is very grave and is likely to be followed by internal complications; expectant treatment must therefore not be persisted in too long.

The choice of operative procedures lies between partial tarsectomy, complete tarsectomy by some operation such as Mikulicz's, or amputation, and the choice will be influenced by the virulence of the disease, the general condition of the patient, and the presence or absence of tuberculosis elsewhere.

Partial tarsectomy.—When the disease is limited to the bones and joints in front of the transverse tarsal articulations, the best procedure is to remove the affected bones in one mass, namely a partial tarsectomy. This is best done by lateral incisions which preserve the tendons, vessels and nerves, and are not much more troublesome than the transverse incisions recommended by some surgeons which involve division and subsequent suture of the tendons. Two long incisions are made, one on each side of the foot just above the sole, extending on the inner side from the front of the sustentaculum tali to the centre of the first metatarsal, and on the outer side from just below and in front of the external malleolus to the centre of the fifth metatarsal (see Fig. 64). These incisions should be carried down to the bones at once. The tibialis anticus and the peroneus

longus tendons may be divided, as they must inevitably be separated from their points of attachment during the operation.

All the tissues down to the bone are now raised from the front of the foot in a manner similar to that described for arthrectomy of the ankle (see p. 234), so that the fingers can be made to meet through the two incisions. The structures on the plantar surface should similarly be separated from the tarsus, and, in doing this, care must be taken to remember the arch formed by the tarsal bones. In this way the whole of the soft structures are separated from the bony skeleton of the foot through the

FIG. 64.—INCISIONS FOR PARTIAL TARSECTOMY FOR TUBERCULOUS DISEASE OF THE TARSUS. *A* is the incision on the inner, *B* that on the outer side. By varying the length of the incisions, as much or as little of the tarsus as may be desired can be removed.

whole extent of the incisions, leaving the entire synovial membrane intact and in connection with the joints. This is quite easy to do on the dorsum of the foot, as the surgeon is easily able to see what he is doing, but it is more difficult in the sole.

The next step is to apply a long narrow saw transversely across the bases of the metatarsal bones, about an inch below the level of the base of the first metatarsal, and to divide them. The saw is then applied transversely across the tarsus opposite the neck of the astragalus and divides it and the corresponding portion of the os calcis. Whilst this is being done, the soft parts must be protected and held out of the way by suitably bent copper spatulæ. After the bone has been divided, a few touches of the knife allow the whole bony mass, together with the synovial membrane and other diseased structures, to be taken away in one mass without infecting the wound. Some surgeons wire the metatarsal bones, or at any rate the first and the fifth, to the astragalus and os calcis; this however is not really necessary.

After-treatment.—The wound is now stitched up and a drainage tube is inserted if there be much oozing. The limb should be placed upon a back splint with a foot-piece at right angles, when the weight of the toes

will keep the metatarsal bones in contact with the os calcis and astragalus. In arranging the padding, particular care must be taken to get the foot into proper position and to keep the bones in contact. As healing takes place, the muscles contract and the tendons, which at first are much too long, get gradually pulled up and finally act very well. One of the chief reasons given for doing this operation through an incision across the dorsum of the foot is that, apart from the ease with which the operation can be done, this method allows the tendons to be shortened afterwards when they are re-united; this however we have found to be quite unnecessary. Even were the muscles not to contract afterwards it would not much matter, as there is no longer any transverse tarsal joint and their action is not so material.

Results.—The result of the operation is to shorten the foot very markedly, as the divided surfaces of the metatarsal bones are brought up into contact with the cut surfaces of the astragalus and os calcis. The functional result however is very good when healing has taken place, and, as the ankle joint is preserved, a much better result is got than could be obtained by amputation.

A similar operation can in some cases be performed even when sinuses are present if care be taken to treat them as has already been recommended (see p. 239). When, however, there are numerous sinuses or when abscesses are present, and the patient is an adult, amputation is much the better practice, and this should take the form of a Syme's amputation.

Complete tarsectomy.—In some cases however, particularly when sinuses are present about the heel, and the disease does not extend further forward than the tarsal bones, the operation known as *Mikulicz's operation* may be practised. This operation consists essentially in dividing the bones of the foot through the bases of the metatarsal bones, and sawing the bones of the leg immediately above the ankle, and removing the whole of the structures between these two limits—in other words it is a complete tarsectomy. The operation is really only applicable to adults, it is not so good as Syme's amputation when that can be practised, and it is not much better than amputation through the leg. The result of the operation is that the metatarsus is brought into the same straight line with the bones of the leg to which it should unite by bone, so that the patient walks upon the ends of the metatarsal bones. This makes the limb slightly longer than it should be, but it must be admitted that in some instances a very excellent functional result has been obtained. Although this operation is, strictly speaking, a complete tarsectomy, *i.e.* the entire tarsus is removed, yet in practice it is frequently modified to adapt it for use in cases of posterior tarsal disease—it is then only a partial tarsectomy. We shall describe the modified operation first.

The patient is turned over on the side, and an incision is carried transversely across the sole of the foot from the tubercle of the scaphoid to just behind the tuberosity of the fifth metatarsal, dividing all the structures

down to the bones. The toes are bent forcibly downwards, and from each end of this incision the knife is carried upwards on each side to the corresponding malleolus, and the upper ends of these two incisions are joined by a transverse cut across the posterior surface of the leg down to the bone (see Fig. 65). The foot is now fully flexed and the ankle joint opened from behind, when the soft parts are gradually peeled off from the front of the capsule of the ankle joint, the astragalus and the os calcis as far down as the anterior surfaces of the scaphoid and cuboid.

The bones are then sawn across with a narrow-bladed saw through the lower transverse plantar incision and the whole of the posterior portion of the tarsus is thus removed. The lower ends of the tibia and fibula are then cleared and sawn just above the malleoli, leaving the front half of the foot connected with the leg by the broad bridge of tissues consisting

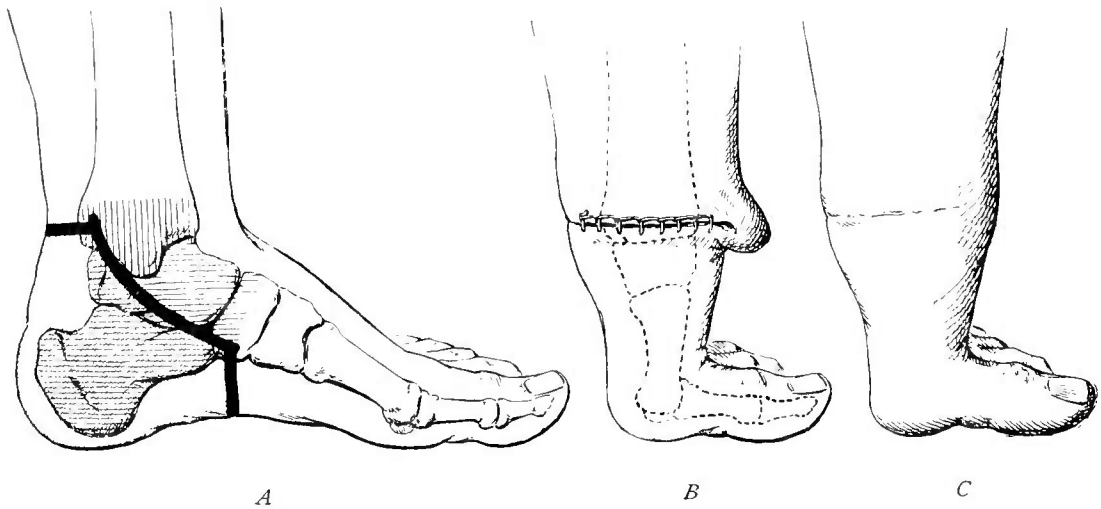


FIG. 65.—MIKULICZ'S OPERATION.

A. The thick line indicates the cutaneous incision which is exactly similar on the outer side of the foot. The shaded portion indicates the amount both of the bony structures and the soft tissues usually removed. Sometimes the bone section is made as far forward as the bases of the metatarsals.

B. The appearance of the limb immediately after operation. The prominent tissues on the front of the dorsum are well shown.

C. The final result of the operation. As will be readily understood, the limb is easy to fit a boot to.

The operation only merits the appellation of "complete tarsectomy" bestowed upon it in the text when the more extensive bone removal is practised, *i.e.* from the malleoli to the bases of the metatarsals.

of the skin of the dorsum of the foot containing the extensor tendons, vessels and nerves. This operation may be modified when the disease extends further down along the tarsus by dissecting the soft parts off the front of the foot as far down as the bases of the metatarsal bones, across which the bone section is made instead of across the scaphoid and cuboid as above described.

After the bleeding has been stopped, the anterior portion of the foot is brought into the same straight line as the leg, and is united to the tibia and fibula with silver wire. The limb is then put up on a straight posterior splint, great care being taken to keep the bone surfaces in proper position. The lower end of the splint should be provided with a

small rectangular foot-piece against which the toes are pressed forwards so that they are at a right angle with the metatarsus.

The question of the treatment of the posterior tibial nerve, which is usually divided in this operation, is of some importance. It is divided above and below in the incisions. When the operation is completed, the cut ends should be sought for and united if possible; it is, however, not a matter of vital importance if this cannot be done. Rose dissects the nerve out beforehand and takes care to leave it intact.

Amputation through the leg.—There still remains another group of cases, those namely in which the disease has implicated the ankle joint. Here operative procedures are called for, and in most cases amputation is the best practice. This should generally be done through the lower third of the leg, as it is seldom possible to perform a Syme's amputation satisfactorily under these conditions without running the risk of re-infecting the stump.

CHAPTER XXII.

DISEASES OF THE SHOULDER JOINT.

INFLAMMATORY AFFECTIONS.

ACUTE AND CHRONIC SYNOVITIS with effusion are comparatively rare in the shoulder, and the condition may be readily overlooked if the distension of the capsule be only slight; when it is considerable, the swelling is most marked beneath the anterior edge of the deltoid, and the upper arm is slightly abducted and somewhat internally rotated; fluctuation may sometimes be felt in the axilla.

These forms of serous synovitis are mainly produced by injuries such as twists or dislocations: in the latter case the distension is first due to blood, and subsequently to serous effusion.

The treatment of this condition follows lines similar to those already described for acute and chronic synovitis (see Chap. XII.), and presents no points of special interest.

ACUTE SUPPURATION occurs as a result of penetrating wounds or as a complication of acute epiphysitis of the upper end of the humerus; in the latter affection the joint is very readily affected.

The treatment is identical with that for similar affections elsewhere (see p. 94).

TUBERCULOUS DISEASE.

Tuberculous disease of the shoulder is not uncommon and is mainly met with in adult life, being most frequent between the ages of twenty and thirty. As in the other joints, the disease may be primary in the synovial membrane or the bone, more commonly the latter.

The primary osseous deposits occur most frequently in the great tuberosity of the humerus, and much less commonly about the neck of the scapula. In some cases the acromion process may be the primary seat of the mischief, but when this bone is affected it is usually secondary to

tuberculous disease of the deltoid bursa. When the deposit reaches the surface of the bone, it is not uncommon for the deltoid bursa to be distended and to give rise to a soft fluctuating swelling beneath that muscle often containing rice-like bodies, which manifest themselves by their peculiar creaking sensation on manipulation.

In the early stages of the disease there is increased fulness about the shoulder, with thickening to be felt in the axilla, and some considerable limitation of movement of the arm, which is kept slightly abducted and rotated inwards. In the later stages there is very marked pain on movement, the arm being kept rigidly applied to the side and considerably rotated inwards, whilst abscesses form and point in front of or behind the deltoid. It is not uncommon to find an abscess travelling along the bicipital groove and coming to the surface beneath the skin about the centre of the front of the arm. In other cases it may open into the axilla, and sometimes about the lower limit of the posterior border of the deltoid.

TREATMENT.—The same general rules must guide the surgeon in the treatment of tuberculous shoulder joint disease as in the case of tuberculous joint disease elsewhere. There are, however, certain points special to this joint which may be remarked upon here.

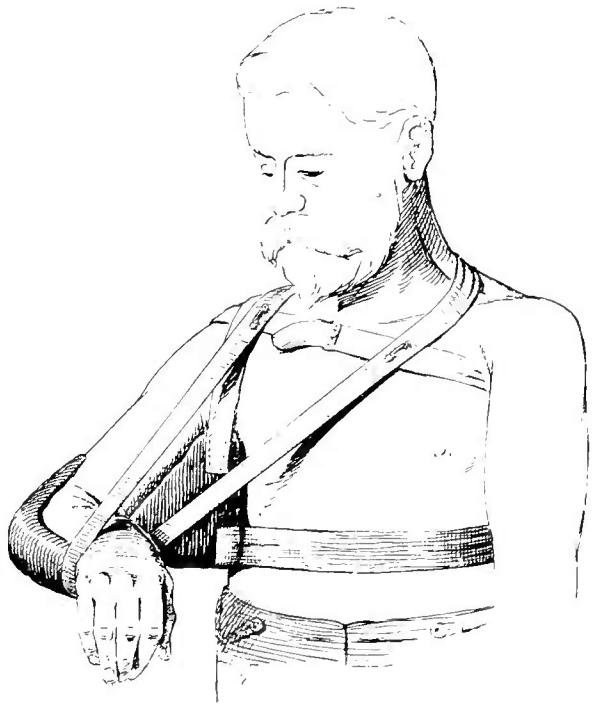


FIG. 66.—APPARATUS FOR USE IN TUBERCULOUS DISEASE OF THE SHOULDER. The wedge-shaped cushion is fixed in position by the straps shown in the figure. The apparatus is fully described in the text.

(a) **Expectant.**—The first point of importance is the advisability of employing expectant methods. It must be remembered that recovery from the disease in this situation is followed by stiffness of the joint,

which is a great disability to the patient. Moreover, unless special care be taken to prevent it, stiffness will occur with the arm in such a position that the limb is rendered very useless; that is to say, it is rotated inwards and firmly applied to the side. If expectant treatment is to be employed, the limb should be abducted to about 45° and kept midway between extreme inward and outward rotation, that is to say with the fore-arm looking almost directly forward. Abduction can be secured by a large wedge-shaped pad in the axilla with the base downwards (see Fig. 66), whilst the fore-arm should be flexed to a right angle. The elbow may be

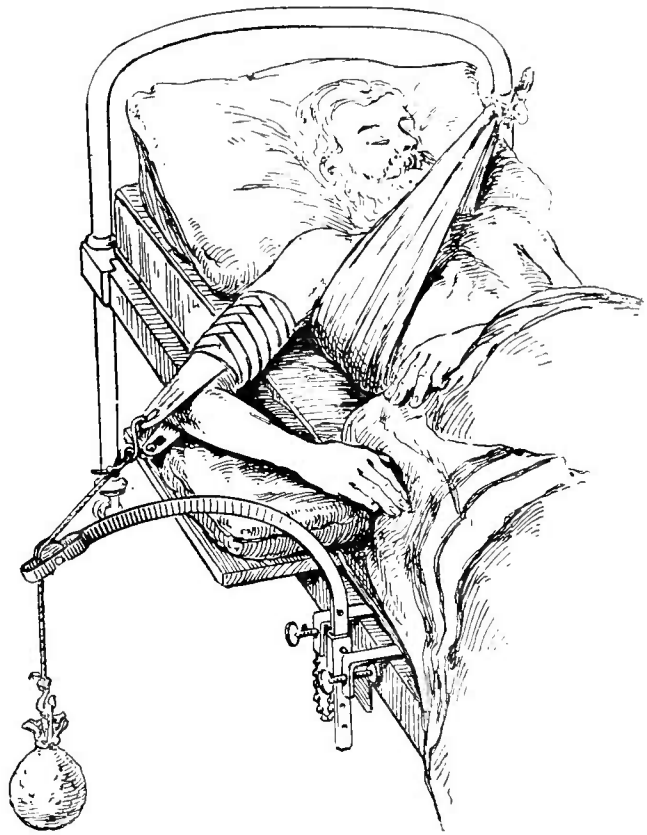


FIG. 67.—WEIGHT EXTENSION APPLIED FOR TUBERCULOUS SHOULDER JOINT DISEASE. The extension is made with the arm in the abducted position. In the figure above, however, the arm is rotated too much inwards. Care should be taken, by using a thick wedge cushion, with its base beneath the hand, to prop up the fore-arm almost into the vertical position. It then corresponds to the position of the limb seen in the preceding figure.

fixed by a plaster of Paris casing or a moulded guttapercha or other splint; if desired, the shoulder itself may be left uncovered so that local applications, such as blisters or the actual cautery, may be made to it.

Among the local applications the best is the *actual cautery*. When there is much deep-seated pain, as is commonly the case in the primary bone deposits, the cautery will often relieve it to a very marked extent. The flat cautery should be used (see Part I, p. 19) over the front and back of the joint.

Extension has also been used in cases marked by very severe starting pains at night. If this is to be employed, the patient should be confined to bed, the trunk fixed with sandbags, counter-extension made by

a broad bandage passed around the thorax, and a weight applied by means of a stirrup fixed upon the upper arm, which is kept in the position recommended above (see Fig. 67). Extension is, however, not to be recommended, as in most cases in which the pain is so great as to call for it, the disease will be so extensive that operative interference is advisable.

(b) **Operative.**—When there are abscesses in connection with the joint, the question of operation becomes more urgent. Here, as in the case of other joints, it is best to treat the abscess first, so as to cure or reduce it in size (see p. 134). The same remark applies to disease of the deltoid bursa.

We have not laid much stress upon the expectant methods, because we are strongly of opinion that early excision is of pre-eminent value in tuberculous disease of the shoulder. As the disease is essentially one of adult life, the question of excision will arise more frequently than in the other joints. In children, it is true, we should advise that operative interference be delayed as long as possible, as arthrectomy of the shoulder is neither an easy nor a satisfactory operation; but in adults, in whom the growth of the limb has ceased, excision is almost the first thing to be thought of in cases of well-established disease. By it the progress of the disease is cut short, and the patient is given a movable arm which, though weaker than its fellow, is still greatly superior to an anchylosed joint, especially when the limb is in bad position.

There is a further reason for advocating excision, in that shoulder joint disease is very frequently associated with or followed by disease of the lungs; the exact connection between the two is difficult to understand, but it certainly is a clinical fact that a large number of patients suffering from this affection suffer also from phthisis, and, in a very considerable proportion, the latter affection only occurs after the joint disease has lasted for some time. Hence excision, which secures a useful movable joint with a short convalescence, eradication of the entire disease, and diminished danger of deposit of tubercle elsewhere, is distinctly preferable to expectant methods, which will demand a long time, leave the patient subject to risks of infection elsewhere, and at the best give a stiff joint which is of comparatively little value.

Excision of the shoulder joint.—We recommend the following method. The patient should lie upon the back with a firm pillow or sandbag beneath the affected shoulder, which is drawn well to the side of the table. The surgeon stands on the outer side of the joint and makes an incision about four inches in length, commencing just external to the tip of the coracoid process, and extending downwards and outwards parallel to the anterior border of the deltoid, dividing skin and fascia only (see Fig. 68). The arm should be slightly abducted and rotated outwards as the incision is made. The knife cuts almost directly down upon the thickened capsule at the upper part of the incision, while the tendon

of the biceps must be looked out for below, and will readily come into view if the arm be slightly rotated outwards.

The biceps tendon should be carefully freed from its sheath, and pulled aside if it be healthy; if, however, the disease extends down the bicipital groove it must be carefully dissected out. The finger is then passed beneath the deltoid, which is raised from the muscles beneath and pulled forcibly outwards. Should the deltoid bursa be affected, its remains must be carefully dissected out, whilst the arm is fully abducted and the under surface of the muscle rendered accessible by everting it. The front part of the capsule is defined and isolated from the structures in front of it, and the portion thus separated may be clipped away with scissors. The arm is now carried backwards so as to hang over the table, and pushed up so as to protrude the head of the bone (see Fig. 69), when the muscles attached to the tuberosities must be partially or entirely divided. In most cases enough bone can be removed without complete division of the rotators, as a bone section about the level of the anatomical neck or just below it usually suffices. If, however, there be a deposit in the greater tuberosity, that structure must

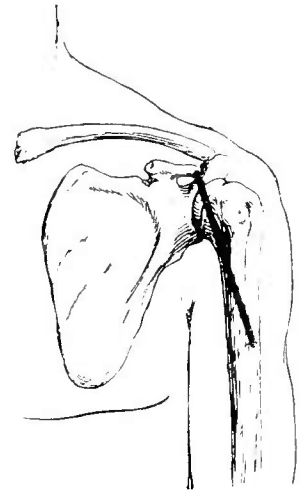


FIG. 68.—INCISION FOR EXCISION OF THE SHOULDER.

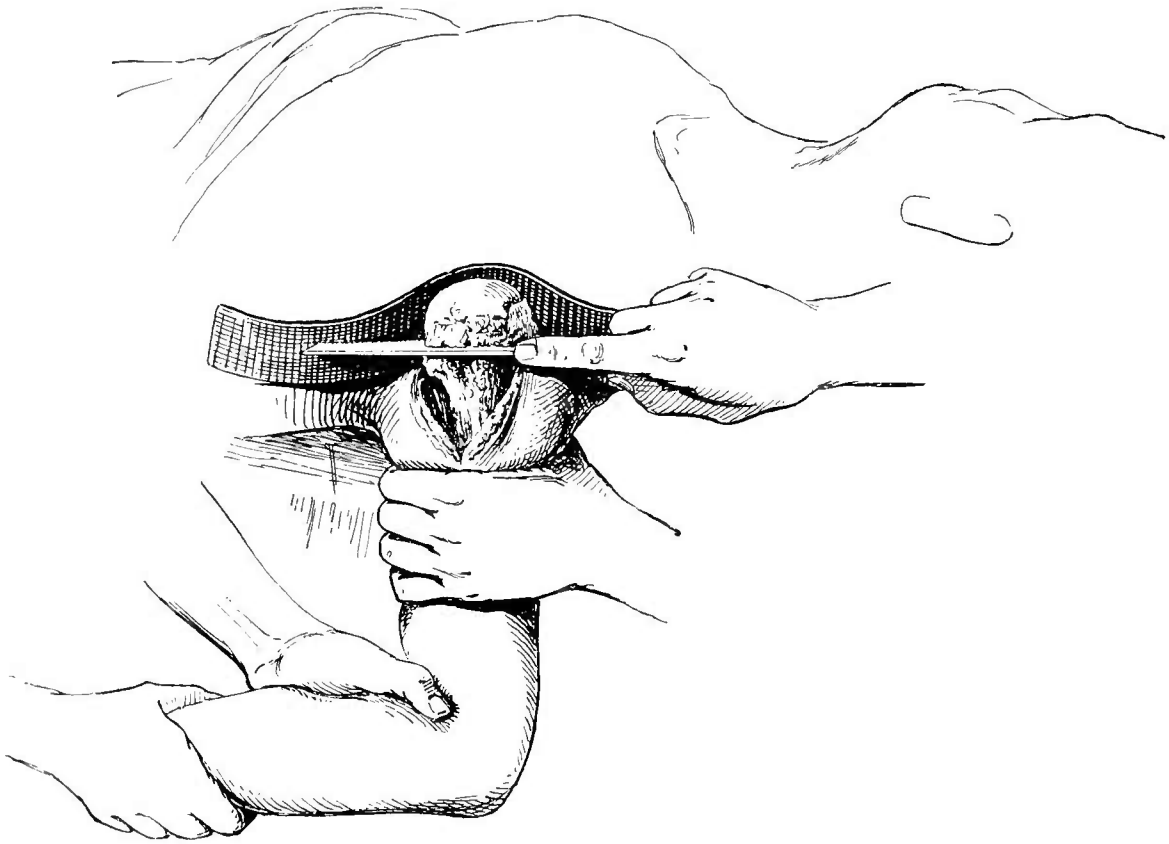


FIG. 69.—REMOVAL OF THE HEAD OF THE HUMERUS IN EXCISION OF THE SHOULDER. The assistant holds the humerus almost vertical and at the same time pushes the head upwards and outwards. The soft parts are protected by a flexible copper spatula suitably bent, and the saw is applied as shown above.

either be removed also, or at any rate its interior must be carefully gouged out.

After the head of the bone has been removed, the glenoid cavity is examined and is sawn off if diseased, the amount of bone removed depending on the extent of the disease present; should there be no obvious affection of it, the cartilaginous surface is merely shaved off with a knife. The remains of the capsule at the posterior part of the joint must now be clipped away with scissors, and the joint cavity, after being examined to see that all tuberculous material has been removed, may be closed.

When there is already actual anchylosis of the joint, the head of the bone may be removed *in situ* at the level of the anatomical neck with a chisel of suitable breadth, the soft parts on the inner and posterior aspects of the joint being protected from damage by a flexible copper spatula which is pushed in around the head of the bone. A second bone section is then made through the glenoid cavity, and the portion of bone thus detached is removed with lion forceps.

In excising the shoulder it is very important to remove as little of the bone as possible, because it is necessary to leave the attachment of the rotators intact if this can be safely done; this permits rotation of the arm, whereas after the old operation, in which the rotators were completely cut across and the bone was sawn on a level with the surgical neck, the resulting limb was very useless, rotation being especially imperfect.

When the wound has been stitched up, it is advisable to insert a drainage tube at the lower angle for a few days, as a considerable cavity is left which may become distended with blood and serum; the tube may generally be taken out in three days. After the usual gauze dressings have been applied, a large wedge-shaped pad is placed in the axilla so as to prevent displacement inwards of the upper end of the bone. It is well also to place a firm pad over the front of the joint, because the upper end of the bone is apt also to be drawn forwards. The wedge-shaped pad should be carried down as far as the elbow, and the fore-arm should be supported in a wrist-sling. The hand should not be bound to the side, but should be put up with the fore-arm looking directly forward, in the position recommended for the expectant treatment (see Fig. 66).

After-treatment.—As soon as the wound has healed, the arm may be fixed in proper position by a starch or waterglass bandage, and, after two weeks more, passive movement may be begun; the period at which this passive movement should be employed depends largely upon the amount of bone removed; if the whole of the upper end of the bone has been removed and the rotators divided, as was done in the old operation, the elbow should be supported and the arm fixed for four or five weeks, as otherwise a very lax joint is likely to result; if, on the other hand, the operation we have described is sufficient, passive movement should be begun after a fortnight. Special attention must be paid to preserving rotation, which is the movement most likely to be lost: abduction should

also be carefully attended to. The axillary pad and the wrist-sling should be continued for six or eight weeks.

Results.—The results of the operation are very satisfactory on the whole; all the arm movements, with the exception of a certain amount of rotation, may be readily performed, but it is seldom that abduction can be carried as far as, and certainly not beyond, a right angle. If however the patient can abduct the limb nearly to a right angle he is generally very well satisfied.

RHEUMATOID ARTHRITIS.

The shoulder joint is frequently affected by this disease, when, as in the hip, the affection is often mon-articular, or at the most only affects two or three joints. The affection in the shoulder is often spoken of as *malum senile*, just as in the case of the hip joint affection. In the shoulder the disease is marked by extremely severe pain, which occurs quite in the early stages and is generally accompanied by very marked limitation of movement, the arm being kept to the side and only abducted and rotated with great pain and difficulty. Associated with this is rapid atrophy of the deltoid, so that the head of the humerus can easily be felt, and the osteophytes, which are very common in this situation, can be made out. The tendon of the biceps is also apt to be affected and indeed may be actually destroyed; short of this, its sheath is occupied by villous masses which correspond in all respects to the villous condition of the synovial membrane of joints and interferes with the movements of the tendon.

Treatment.—The treatment must be carried out on the same lines as for the disease elsewhere (see p. 149); the only point that we need deal with here is the question of *excision*. As a means of relieving the pain there is no doubt that excision has great advantages, and therefore, if the patient be in good condition, and if the pain be intolerable, it may be justifiable for that reason. In the way of a functional result, too much, however, must not be expected. The movement of the limb afterwards is very imperfect, partly on account of the atrophy of the deltoid which accompanies the disease, and partly on account of the limitation of movement which follows all excisions of this joint. In connection with this it must be remembered that the atrophy of the deltoid spoken of above is hardly ever recovered from, and therefore the functional result in any case is not likely to be good.

It is, however, quite justifiable to excise the joint for the relief of the excessive pain, and in doing so it is advisable to confine the removal of bone to the head, leaving the greater part of the tuberosities untouched. This can usually be done by means of a chisel without dividing the otator muscles of the shoulder more than partially. If at the same time the surface of the glenoid cavity be removed, and after the operation the arm be kept at rest, with the elbow well away from the side and fixed by a wedge-shaped pad in the axilla, anchylosis by firm fibrous or

even bony union may occur and may give the patient a very useful limb, the movement of the shoulder-joint being replaced by the increased mobility of the scapula. This is a very much better plan than a free removal of the head of the bone, and an attempt to obtain a movable joint when the atrophy of the deltoid is very marked.

CHARCOT'S DISEASE.

The shoulder is a not infrequent seat of this affection, and is likewise fairly frequently affected with that form of the disease connected with syringo-myelia. The treatment offers no points of special importance, and has already been described in connection with the disease in general (see p. 141).

CHAPTER XXIII.

DISEASES OF THE ELBOW JOINT.

INFLAMMATION OF THE BURSA BENEATH THE BICEPS TENDON.

An affection of some importance is inflammation of the bursa between the tendon of the biceps and the tubercle of the radius. This bursa lies very deep and it is seldom that it gives rise to any definite swelling, even when it is markedly distended; the symptoms are therefore often very vague and the diagnosis consequently difficult. When the bursa is much distended it is apt to be mistaken for a solid tumour. A characteristic point in the diagnosis is the occurrence of pain when the elbow is bent with the fore-arm fully supinated, whereas there is little or no pain when the limb is pronated. This arises from the fact that in the former case the biceps action alone is called into play, whilst in the latter the brachialis anticus is the most important agent. There is also special tenderness on pressure just over the bicipital tuberosity, and the pain is increased by rolling the biceps tendon laterally over the bursa, and by alternate pronation and supination.

Treatment.—The treatment consists of rest on a rectangular splint which throws the biceps out of action. After a short time devoted to this method, moderate elastic compression and massage are of considerable value, but in persistent cases it may be necessary to aspirate the bursa, following this up by elastic pressure with cotton wool and a bandage.

ACUTE SUPPURATION.

This affection usually occurs after septic penetrating wounds of the joint, and disorganisation of the articulation with all its accompanying risks soon follows.

Treatment.—The joint should be opened freely by incisions on either side of the olecranon, with drainage from the front, followed, if the case be acute, by continuous irrigation (see p. 88).

When the condition is very acute, amputation through the upper arm may be required, and, when this is done, the state of the medulla must be carefully examined, for osteo-myelitis is not uncommon.

Should the acuteness of the symptoms subside under incision and drainage, it is well to excise the joint after a short time, seeing that a stiff elbow will otherwise be obtained, whereas excision gives a most excellent functional result. Moreover, septic wounds of the elbow are excessively slow in healing.

ACUTE AND CHRONIC SYNOVITIS.

Distension of the elbow joint shows itself by a fluctuating swelling on either side of the olecranon, which is increased on flexion. The movements of the joint are considerably interfered with, flexion particularly being diminished and causing considerable pain. The position assumed by the limb when the joint is distended is one of slight flexion which ultimately increases up to about a right angle.

Treatment.—The first point in the treatment is to immobilise the joint and subsequently to employ compression; if there be much pain, an ice bag or evaporating lotions may be applied first. The elbow should be put up at a right angle, with the fore-arm midway between pronation and supination. The various methods of treatment for these affections have already been fully described (see Chap. XII.).

RHEUMATOID ARTHRITIS.

This joint is often affected and the lesions are usually well marked. The condition not infrequently follows fractures into the joint, such as those of the olecranon or the condyles of the humerus. Osteophytic outgrowths are usually well marked and a villous condition of the synovial membrane is not uncommon, particularly between the olecranon and the condyles.

Treatment.—The treatment of the affection has already been fully dealt with (see p. 151), and presents no points of special importance.

LOOSE CARTILAGES.

After the knee, the elbow is perhaps the most common seat of these bodies. They give rise to the usual symptoms and are most commonly met with in the olecranon fossa.

Treatment.—When an operation is decided upon, it is best to make an incision upon one side of the olecranon, preferably the outer, extending from the top of the olecranon fossa down to the head of the radius. All bleeding in the superficial structures is arrested and the capsule is incised, when the finger is introduced into the joint, the olecranon fossa explored, and the loose body removed.

CHARCOT'S DISEASE.

The elbow is a common seat of this affection, the treatment of which has been already described (see p. 141). The special point of importance in the elbow joint is to provide the patient with a splint which will give a certain amount of firmness to the joint while permitting flexion and extension. This may be used after the stage of acute swelling has subsided, and should take the form of a leather case for the upper arm and another for the fore-arm, the two being connected at the elbow by jointed lateral steel rods.

TUBERCULOUS DISEASE.

This affection generally occurs in early adult life, about the age of sixteen; only about 33% of cases begin before ten years of age. As with tuberculous joint disease elsewhere, the primary deposit may be in the synovial membrane—when it is most frequent in the radio-ulnar articulation,—or in the bone—when it is generally either in the olecranon or the external condyle of the humerus. It would appear that primary bone disease is more common than the primary synovial form. Owing to the superficial nature of the elbow joint, it is sometimes possible to define the osseous deposits before the joint has become involved, and this is particularly the case when the deposit is in the olecranon.

The disease runs the same course here as elsewhere. The swelling in the joint is most marked on each side of and above the olecranon; the elbow is flexed and the fore-arm pronated. Abscesses when present are most common about the posterior and outer aspects of the joint.

Treatment.—The treatment of tuberculous disease of the elbow joint may be divided, like the treatment of tuberculous joint disease elsewhere, into expectant and operative treatment.

(a) **Expectant.**—The joint is put up with the fore-arm flexed either to or slightly beyond a right angle, and with the hand midway between pronation and supination, as this is probably the most useful position for the limb should the joint become stiff. A very good method of fixing the joint is to envelope the elbow in a large mass of cotton wool and then to apply a bandage impregnated with a solution of silicate of potash firmly over it. The bandage should extend from the wrist—or in bad cases from the knuckles—up to the shoulder, and the fore arm should be carried in a sling; the fingers should always be left free and the patient encouraged to move them.

Results.—The result of expectant treatment is always a stiff elbow, except in some cases of pure synovial disease, which may recover pretty rapidly with a movable joint. In children, expectant treatment may be persevered with for a considerable time, but in adults we are of opinion that in most cases it is a mere waste of time to employ it for a prolonged period, as a better result on the whole is to be obtained by

excision. The elbow joint is the joint of all others in which operative treatment yields a most satisfactory result, because a successful operation should result in a perfectly movable joint. We therefore strongly recommend that this treatment should be adopted before abscesses or sinuses occur, as soon, that is to say, as it is evident that the disease is not coming to a standstill under expectant treatment.

(b) **Operative.**—*In children* the operation will be arthrectomy, whilst in adults it will be excision. Arthrectomy in children is an extremely satisfactory operation which generally leaves a certain amount of movement, although the restoration of function is not complete. In adults excision removes the disease thoroughly and at the same time leaves a movable joint, and, if proper care be taken in the after-treatment, the resulting joint is practically perfectly useful in something like 70 or 80% of the cases.

Arthrectomy of the elbow.—This operation is best performed through two long lateral incisions, one on either side of the joint. On the inner

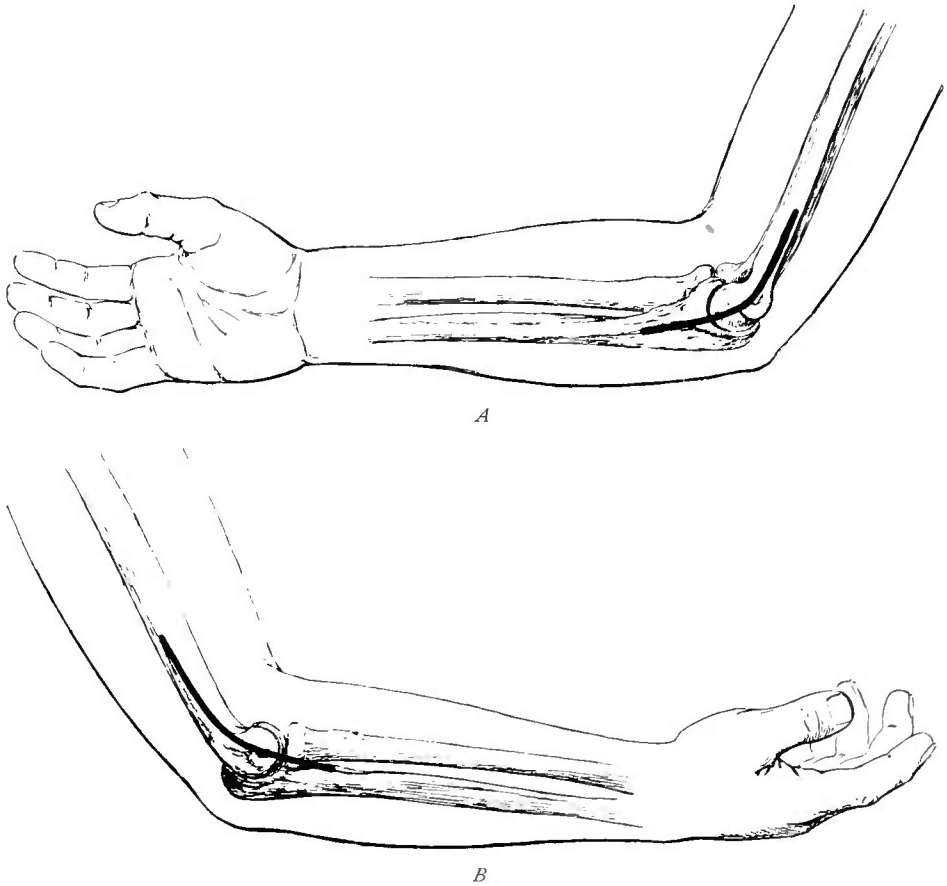


FIG. 70.—INCISIONS FOR ARTHRECTOMY OF THE ELBOW JOINT. These are also those recommended for use in excision. *A* is the incision on the inner, *B* that on the outer side.

side, the incision should reach from just below the point at which the ulnar nerve pierces the internal intermuscular septum downwards to about two or three inches below the level of the joint. On the outer side, the incision may extend slightly higher up the arm, but must not reach as low down

on the fore-arm for fear of injuring the posterior interosseous nerve just opposite the neck of the radius. It is well to make the incisions as free as possible because plenty of room is required to enable the surgeon to see clearly what he is doing.

The incisions are carried down to the condyles of the humerus, and the removal of the synovial membrane from the back of the joint is proceeded with. The capsule can usually be readily defined especially upon the outer side, and the skin and subcutaneous tissues are raised from it by the handle of the knife or a blunt dissector. The whole of the capsule over the radio-ulnar and the radio-humeral articulations is thus gradually separated as far as the edge of the olecranon. The triceps is also raised from the capsule as far as the middle line of the joint, when a similar procedure is adopted on the inner side, care being taken to raise the ulnar nerve from its groove behind the internal condyle along with the soft parts and not to injure it. The fingers can then be made to meet across between the triceps and the capsule, and thus the whole of the upper part of the synovial membrane is easily separated and can be divided by a knife just at its reflection on to the bone and peeled carefully downwards; it is also divided on each side in the line of the incisions, and is cut away below at its attachments to the olecranon and to the radius and ulna.

The entire posterior portion of the synovial membrane is thus removed, and the next step is to deal with the anterior portion. In order to do this satisfactorily it is generally advisable to partially detach the tendinous origins of the muscles from the condyles of the humerus, beginning over the outer one. The periosteum is incised and stripped forwards, together with the muscles arising from it, with a periosteum detacher; these structures are pulled forcibly forwards, an assistant holds the limb flexed to a right angle, and the anterior surface of the capsule is defined and separated by a blunt dissector and the fingers. Special care must be taken not to damage the posterior interosseous nerve in the lower part of the incision.

The structures on the inner side are then dealt with in a similar manner, the periosteum and the tendinous origins of the muscles being separated from the internal epi-condyle and the capsule defined and separated from them. The finger can soon be made to pass across from one incision to the other between the capsule and the superficial structures, amongst which will be the brachial artery. By passing the finger across from one incision to the other and by stripping the soft parts upwards and downwards the entire front portion of the capsule can be separated and may be cut across at its attachment to the bones and removed whole. The lateral ligaments are divided in doing this, and the ends of the bones can then be easily protruded through the wound; the olecranon is first pushed through whichever incision it can be made to project from more easily—generally the outer—and the synovial membrane of the radio-ulnar articulation is

completely removed. The orbicular ligament will also require careful inspection for it is often diseased.

After all the synovial membrane has been removed from its attachment to the bone, and after any portions of cartilage or bone that are affected have been shaved off with a knife or freely gouged out, the humerus is protruded through one of the wounds—generally the inner—and examined (see Fig. 71). Special attention must be paid to the olecranon and coronoid fossæ, and the articular surface must be treated in a manner similar to that adopted for the bones of the fore-arm.

After the disease has been thoroughly removed, the bones are replaced, the wounds stitched up without a drainage tube, the usual antiseptic dressings applied and the limb placed upon an internal angular splint.

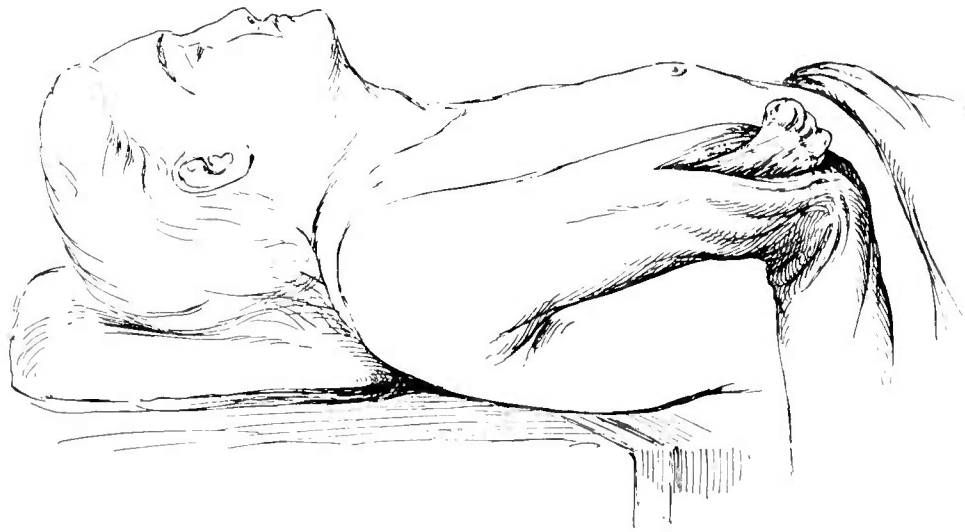


FIG. 71.—METHOD OF PROTRUDING THE ARTICULAR ENDS IN ARTHRECTOMY OF THE ELBOW. If the lateral incisions shown in the preceding figure be long enough, it is quite easy to protrude the end of the humerus, as shown above, after dividing the ligaments. The fore-arm may if necessary be deflected laterally to a very acute angle. The upper ends of the radius and ulna may be protruded in a similar manner through either of the lateral incisions.

Should septic sinuses be present they must be treated by excision if possible, or at any rate by thorough scraping (see p. 135); the articular surfaces should then be sponged over with undiluted carbolic acid, and a drainage tube inserted when the wound is sewn up; when no sinuses are present drainage is seldom if ever necessary.

After-treatment.—The splints should be retained for three or four weeks, after which the arm should be kept in a sling for another two or three weeks and the patient encouraged to move it freely. There is no particular advantage in performing passive movement; in a child, the arm will be constantly used and the result will be as good by leaving the case to nature as by trying to force it with passive movement. The only form of passive movement that is really desirable is rotation of the hand, and this may be practised diligently both actively and passively.

As a rule the restriction of movement afterwards is quite slight and the arm is perfectly firm and movable, but in the cases in which the disease has been very advanced, anchylosis may occur; this can if necessary be remedied by excision when adult life is reached.

In adults excision is the better operation. Arthrectomy does not give such good results as far as the mobility and usefulness of the joint are concerned, nor is it so easy to get rid of the disease by its means: in fact the mobility after arthrectomy in adults is not nearly so great as after excision. The question of early excision in elbow joint disease depends upon the condition of the patient, his willingness to undergo an operation, and also to a considerable extent upon his occupation. It must be remembered that a stiff elbow without any removal of bone will no doubt be stronger than the movable elbow obtained after excision, and in some occupations it is more important for the patient to have a strong arm which is stiff than a movable one which is weak; hence, before deciding upon operating, it is important to consult the patient himself as to the relative value of movement and strength in his work. In the majority of cases, however, both as a time-saving method and as giving greater utility, excision will be preferred.

Excision of the elbow.—Various incisions have been recommended, the older operations through a vertical or an **H**-shaped incision possessing the drawback that it is difficult to properly remove the synovial membranes through them. After employing various methods, the conclusion we have come to is that the best incisions for the operation are similar to those just recommended for arthrectomy; in fact we are firmly of opinion that excision of the elbow is best performed by removing the synovial membrane in a manner precisely similar to that described for arthrectomy, and, in fact, performing the operation in the two cases in an identical fashion up to the point of protruding the bone ends (see p. 260).

When the bone ends are protruded, the periosteum over the olecranon should be peeled off with a raspatory, leaving the triceps still attached to it; the olecranon process and the articular surface of the ulna are then removed by a saw applied just below the level of the coronoid process. The head of the radius is next nipped off by bone forceps, after which the humerus is protruded through the wound and sawn off at the level of the condyles. This leaves the upper part of the olecranon fossa behind, and this should be thoroughly scooped out so as to remove all the cartilage.

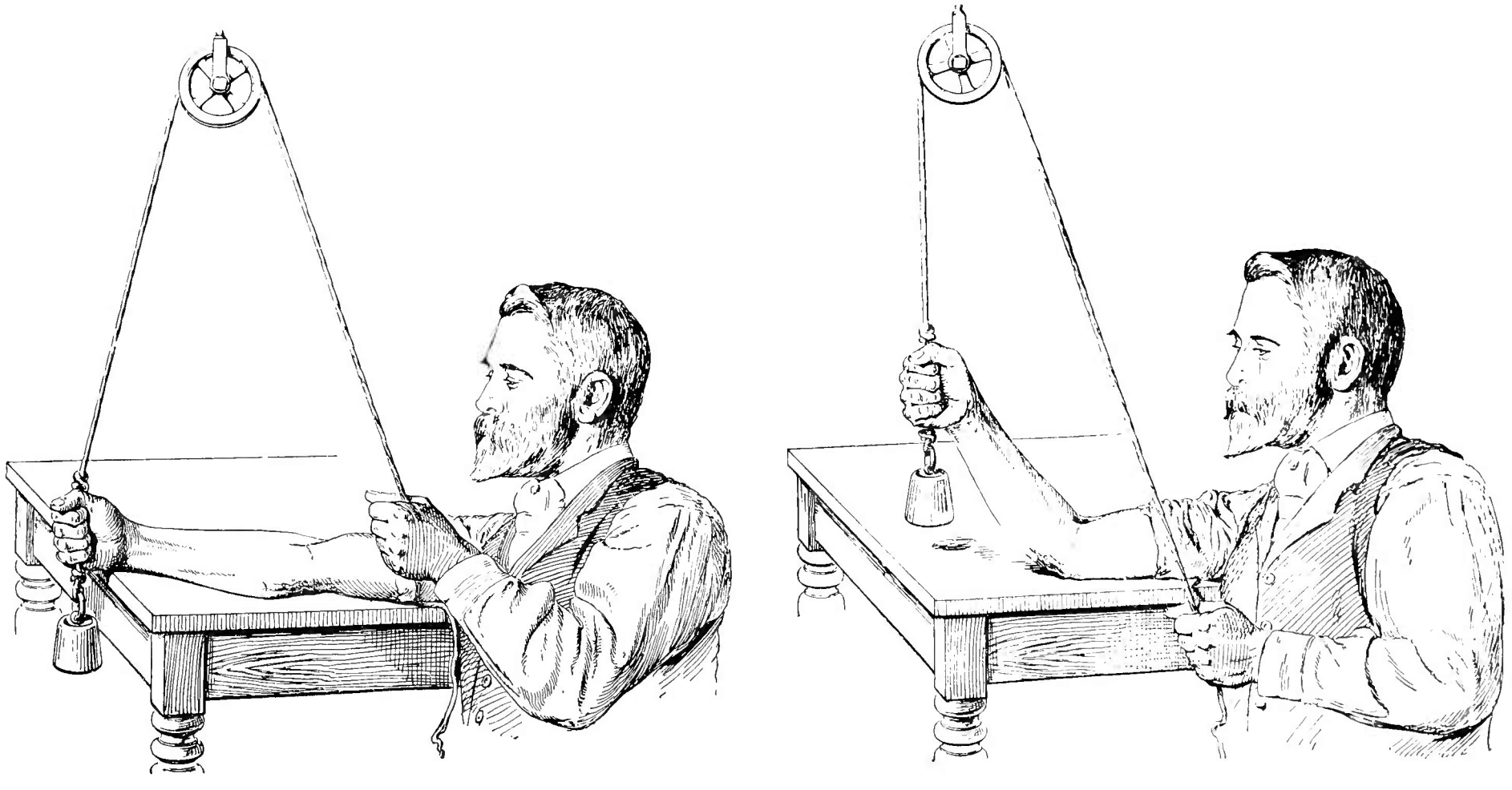
The incision may now be stitched up, and the limb fixed upon an internal angular splint. If no sinuses were present before operation, a drainage tube is unnecessary; when they have been present, the wound should be swabbed out with undiluted carbolic acid and drainage tubes inserted. If a drainage tube be employed, it should be left in until it is certain that no suppuration will occur, which will be in three or four days.

After-treatment.—Pronation and supination should be practised passively

every day from the first. At the end of a fortnight the stitches may be taken out and the arm removed from the splint, while gentle flexion and extension are practised daily: in the intervals between the movements the splint should be re-applied and kept on for about four weeks after the operation. Except when a very large amount of bone has had to be removed and there is therefore much looseness of the joint, the splint may be abandoned after four weeks, the arm carried in a sling, and passive movement still more vigorously employed. This is the critical period in the history of the case, as about this time stiffness tends to increase very rapidly, and therefore active movement should be encouraged. A good apparatus designed to enable the patient to practise passive movement for himself may be made by carrying a rope, to one end of which a weight is attached, round an overhead pulley. The patient grasps the free end of the rope with the sound hand, and seizes the other end a little above the weight with the hand on the affected side. All that is necessary is to pull upon the rope with the sound hand; this flexes the fore-arm, and, when the pull is relaxed, the weight extends the limb (see Fig. 72); this should be done for from half an hour to an hour at a time twice or three times daily.

In carrying out the after-treatment, two conditions must be carefully guarded against: on the one hand, the limb must not be allowed to get stiff, on the other, a flail-joint must not be permitted. It is at this period, about a month after the operation, that the surgeon is best able to judge what is likely to happen. When the case is going on well, there will be some slight difficulty in obtaining complete flexion and extension, although movement should be pretty good; if, on the other hand, the joint be quite loose and complete extension can be got without difficulty, a flail joint is to be feared, and it is then best to put the arm up in plaster of Paris or waterglass for three or four weeks without attempting any further passive movement. It will then be seen whether the joint is still loose or whether sufficient contraction has occurred to require passive movement. There is seldom any difficulty in preserving pronation and supination.

When, in spite of this, it is found that the joint is too lax, it is well to apply an apparatus consisting of two pieces, one of which grasps the upper arm and the other the fore-arm, the two being connected by a metal band over each side of the elbow jointed to permit of flexion and extension. This apparatus prevents lateral mobility, and, if worn for some months, it is quite possible that a joint which was at first very lax may finally be quite satisfactory.



A *B*

FIG. 72.—APPARATUS FOR PROMOTING FLEXION AND EXTENSION OF THE ELBOW AFTER EXCISION. *A*. The arm is laid flat upon a table and the weight is grasped as shown in the figure, while the rope is pulled upon by the other hand. This raises the hand to the position shown in *B* and so makes flexion. When the pull upon the cord is relaxed, the weight carries the hand back and so makes extension.

By arranging the arm so that the elbow is immediately beneath the pulley, the flexion can be carried to its full extent by inclining the hand to the radial side after the fore-arm has been raised to the vertical. The weight that the hand grasps then flexes the elbow as far as it will go; the pull on the rope by the other hand is meanwhile relaxed.

CHAPTER XXIV

DISEASES OF THE WRIST AND HAND.

DISEASES OF THE WRIST.

ACUTE INFLAMMATION.

The carpal and radio-carpal joints are comparatively seldom attacked by acute inflammation, but penetrating wounds may occur and may lead to dangerous suppuration in the irregular synovial cavity, with all the severe general symptoms already described (see Chap. XI.). Twists and sprains may lead to a sub-acute form of synovitis, sometimes associated with hæmorrhage into the carpal articulations. The wrist joint is also one of the commonest seats of acute and gonorrhœal rheumatism.

In acute and sub-acute inflammations of the wrist, the chief swelling is not so marked in the joint itself as in the tissues around it, especially the tendon sheaths which lie over the dorsal surface and which may become inflamed and distended, and give rise to very marked enlargement.

Treatment.—In all cases of synovitis of the wrist the proper treatment is to fix the joint on a palmar splint arranged so as to throw the carpus and metacarpus backwards; this splint will be more fully described in speaking of tuberculous disease of the joint (see p. 268). In the acute stage also, the application of cold is of considerable value. When the synovitis has followed a sprain, the fixation should not be continued for more than three or four days, as otherwise adhesions may form in the joint and the tendon sheaths in its neighbourhood.

Massage should be practised after the second day and should be followed by the use of hot douches and pressure (see p. 93). In all cases, whether the joint be fixed upon a splint or pressure be employed, the fingers should be left free and constantly moved passively and actively. Should there be any difficulty in this, faradisation to the muscles acting upon the fingers may be employed daily.

The treatment of other forms of acute inflammation, as well as that of gouty and rheumatoid arthritis, has already been fully described, and presents no points of special importance.

CHRONIC INFLAMMATION.

There is a form of chronic inflammation of the wrist in young people which leads to marked deformity and which is not generally recognised. No marked destructive changes take place in the joint, and the affection is often overlooked entirely until the onset of a sub-luxation of the carpus, which is pulled forwards on the radio-ulnar arch. If this condition last for any length of time, the articular surfaces become altered so that the radio-ulnar surface becomes oblique and the carpus cannot be got back into its normal position.

This affection is frequently associated with certain trades, and is often met with in washerwomen and those who have much manual labour and in whom the wrist is carried beyond its normal range of movement. In other cases the affection occurs chiefly in the radio-ulnar joint, the ligaments becoming relaxed and the styloid process of the ulna projecting markedly backwards, while the carpus projects somewhat forwards on the ulnar side. This is particularly the case in boxers, cricketers, and tennis players.

The result of this condition is pain about the ulnar side of the wrist, which is relieved for a time by rest and is finally associated with a marked prominence of the ulnar styloid process. If the causes producing the affection continue, there may be actual arrest of growth in the lower end of the ulna or even wasting and permanent disability of the joint.

Treatment.—In the early stages of the disease the causes producing it should be removed and an attempt made to prevent further strain on the weak parts by proper fixation of the joint. The patient will often state that the pain is relieved by applying a firm bandage around the wrist, and many sufferers from this condition, when they wish to follow the occupation which induces the pain, find great relief from wearing a leather or elastic wristlet so as to control its movements. In most cases, change of occupation, together with the use of a wristlet, is all that is necessary; the latter should be continued for many months.

TUBERCULOUS DISEASE.

This wrist, like the shoulder, is chiefly affected by tuberculous disease in adult life. As is the case with the shoulder, disease of this joint is not of very common occurrence and is frequently accompanied by phthisis.

The disease may begin either primarily in the synovial membrane or as a deposit in one of the bones; probably it is more often primary in the synovial membrane. When it commences in the bone, the deposit is generally in the lower end of the radius or in the base of one of the metacarpal bones, generally the second.

In the early stage of the disease there is considerable swelling over the back of the hand, and from quite an early period there is marked lateral

mobility of the wrist, as ascertained by fixing the fore-arm with one hand and moving the carpus laterally upon it with the other: this is due to softening of the lateral ligaments and is a most characteristic symptom of a tuberculous wrist.

As the disease progresses, there is a marked tendency to dislocation forwards of the carpus, and the affection is accompanied by great pain and rigidity about the joint. The patient cannot hold up the hand without support, and the wrist joint is fixed in the slightly flexed position with the fingers widely outspread. Adhesions may form in the tendon sheaths and tuberculous disease of these structures is not uncommon. Abscesses and sinuses are most frequently met with over the dorsal aspect of the wrist.

Treatment.—Here again the treatment is divided into expectant and operative.

(a) **Expectant.**—In putting the limb upon a splint it must be remembered that there is a very great tendency to stiffness of the fingers from adhesion of the tendons; moreover, if put upon a straight

FIG. 73.—LISTER'S WRIST SPLINT. This splint, which is generally used for excisions of the wrist, is most useful in any inflammatory condition of that joint. The cork pad *a* extends the metacarpus and carpus upon the fore-arm, and is only of sufficient width to support the four inner metacarpals. That of the thumb hangs down beside the splint, which is allowed for by raising the latter upon the block *b*. There is a lateral piece *c* to keep the fore-arm and hand in the same straight line.

splint, the wrist will become stiff with the metacarpals in a line with the bones of the fore-arm or even slightly flexed. With the joint anchylosed in this position, it is almost impossible to shut the fingers into the palm, even though there be no adhesions in the tendons about the joint. In order to flex the fingers properly, it is necessary for the metacarpus to form an obtuse angle with the back of the fore-arm; this is a point of the highest importance and one very commonly neglected, the whole limb being usually put up upon a straight anterior splint.

The best *splint* for disease of the wrist joint is that introduced by Lord Lister for the after-treatment of excision of the wrist. This takes the form of an anterior flat splint of wood, to the lower end of which is glued a piece of cork forming an inclined plane with its apex upwards, upon which the metacarpus rests (see Fig. 73). The cork ends abruptly opposite the knuckles so as to allow the fingers to be flexed. This splint maintains the metacarpus in its proper position and can be easily prevented from slipping down by carrying two or three turns of bandage from above the elbow over the lower end of the splint.

Another very important point, which is often neglected and which greatly

affects the after-utility of the hand, is that the thumb is commonly allowed to lie upon the same level as the rest of the hand and usually in close contact with it. If the thumb becomes stiff in this position, all power of opposition is lost even though movement be retained in the fingers, and Lord Lister has pointed out, with special reference to excision, the importance of making the splint sufficiently narrow to allow the thumb to drop: indeed any splint employed for wrist-joint disease should be cut away opposite the ball of the thumb, and the latter should be allowed to hang down at the side of the splint whilst the metacarpus is supported as just described. The result of these precautions is that, during the treatment, the fingers and thumb can be kept moved, and, even if a certain amount of stiffness should occur, the power of grasp in the thumb will be retained.

The splint should reach as high as the elbow and may be fixed on by plaster of Paris or waterglass. The arm should be carried in a sling during the day, and at night should be laid upon a pillow or upon an inclined plane, and it is well to provide the splint with a wooden support on the under surface so as to raise it when it lies upon an inclined plane or a pillow, so that the thumb is allowed to hang down: otherwise the pressure of the inclined plane will push the thumb up. The fingers should be freely moved passively and actively every day. The apparatus is readjusted whenever necessary, and, so long as the disease improves, there is no doubt that the best result is obtained without operation.

(b) **Operative.**— If the disease be progressive, and there be internal tuberculosis, some form of operative procedure must be adopted, the choice lying between excision or amputation.

Excision is only suited for cases occurring in comparatively young adults who are healthy and strong, and in whom there is no sign of tuberculosis elsewhere: when the patient is feeble and old, when there is tuberculous mischief in the lungs, when the local mischief has spread to the tendon sheaths or when there are abscesses and sinuses, amputation is the best practice.

Excision of the wrist joint.—The operation introduced by Lord Lister is perhaps the one that offers the greatest advantages. It is a very complicated procedure and in any given case may require modification according to circumstances, but it is far preferable to the so-called sub-periosteal resection of the bones carried out by some of the French surgeons, in which tuberculous mischief is very apt to be left behind.

Before commencing the operation, the fingers must be thoroughly moved so as to break down any adhesions present, because after the operation this cannot be done nearly so readily. The operation is admirably described by Mr. Jacobson in *The Operations of Surgery*, third edition, page 38, from which the following description is taken:

"The radial incision is planned so as to avoid the radial artery and also the tendons of the extensor secundi internodii and indicis. It commences above at the middle of the dorsal aspect of the radius on a

level with the styloid process. Thence it is at first directed towards the inner side of the metacarpo-phalangeal joint of the thumb, running parallel in this course to the extensor secundi internodii; but, on reaching the line of the radial border of the second metacarpal bone, it is carried downwards longitudinally for half its length, the radial artery being thus avoided, as it lies a little further out. These directions will be found to serve, however

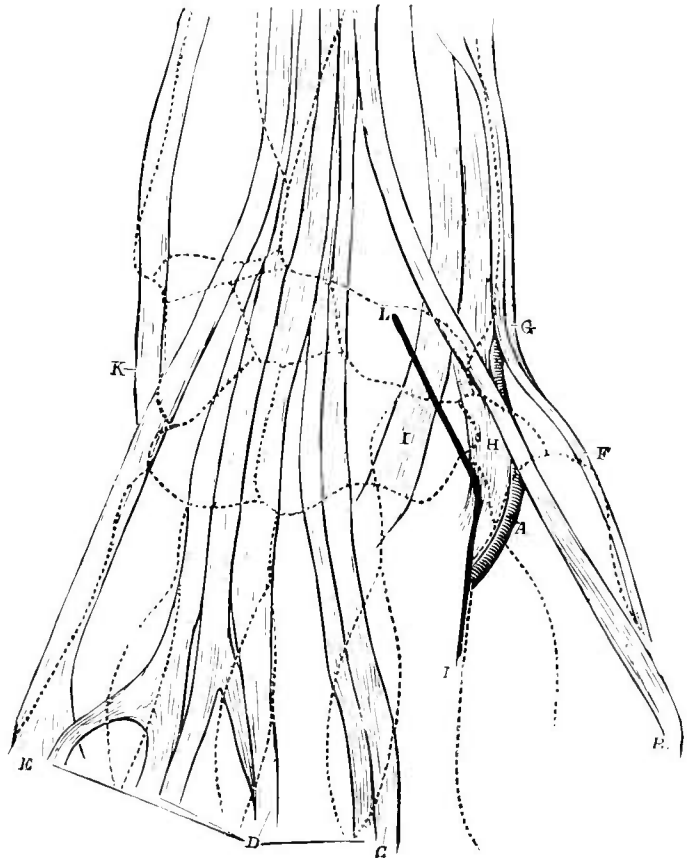


FIG. 74.—LISTER'S EXCISION OF THE WRIST. *The arrangement of the tendons on the back of the wrist.*

L L. The radial (dorsal) incision. The ulnar incision, being on the front of the wrist, is not shown.
A. The radial artery.
B. The tendon of the extensor secundi internodii pollicis.
C. The tendon of the extensor indicis.
D. The extensor communis digitorum tendons.
E. The tendon of the extensor minimi digiti.
F. The tendon of the extensor primi internodii pollicis.
G. The tendon of the extensor ossis metacarpi pollicis.
H and *I*. The tendons of the extensores carpi radialis longior et brevior.
K. The tendon of the extensor carpi ulnaris. (*Holmes's System of Surgery.*)

much the parts may be obscured by inflammatory thickening. The tendon of the extensor carpi radialis longior is next detached with the knife, guided by the thumb nail, and raised, together with that of the extensor brevoir, also cut, while the extensor secundi internodii, with the radial artery, is thrust somewhat outwards. The next step is the separation of the trapezium from the rest of the carpus by cutting forceps applied in a line with the longitudinal part of the incision, great care being taken of the radial

artery. The removal of the trapezium is left till the rest of the carpus has been taken away, when it can be dissected out without much difficulty, whereas its intimate relations with the artery and the neighbouring parts would cause much trouble at an earlier stage. The hand being bent back to relax the extensors, the ulnar incision should next be made very free by entering the knife at least two inches above the end of the ulna immediately anterior to the bone, and carrying it down between the bone and the flexor carpi ulnaris, and on in a straight line as far as the middle of the fifth metacarpal bone at its palmar aspect. The dorsal lip of the incision is then raised, and the tendon of the extensor carpi ulnaris cut at its insertion, and its tendon dissected up from its groove in the ulna, care being taken not to isolate it from the integuments, which would endanger its vitality. The finger extensors are then separated from the carpus, and the dorsal and internal lateral ligaments of the wrist joint divided, but the connections of the tendons with the radius are purposely left undisturbed. Attention is now directed to the palmar side of the incision. The anterior surface of the ulna is cleared by cutting towards the bone so as to avoid the artery and nerve, the articulation of the pistiform bone opened, if that has not been already done in making the incision, and the flexor tendons separated from the carpus, the hand being depressed to relax them. While this is being done, the knife is arrested by the unciform process, which is clipped through at its base with pliers. Care is taken to avoid carrying the knife farther down the hand than the bases of the metacarpal bones, for this, besides inflicting unnecessary injury, would involve risk of cutting the deep palmar arch. The anterior ligament of the wrist joint is also divided, after which the junction between carpus and metacarpus is severed with cutting-pliers, and the carpus is extracted from the ulnar incision with sequestrum forceps, any ligamentous connections being touched with the knife. The hand being now forcibly everted, the articular ends of the radius and ulna will protrude at the ulnar incision. If they appear sound, or very superficially affected, the articular surfaces only are removed. The ulna is divided obliquely with a small saw, so as to take away the cartilage-covered rounded part over which the radius sweeps, while the base of the styloid process is retained. The ulna and radius are thus left of the same length, which greatly promotes the symmetry and steadiness of the hand, the angular interval between the bones being soon filled up with fresh ossific deposit. A thin slice is then sawn off the radius parallel with the articular surface. For this it is scarcely necessary to disturb the tendons in their grooves on the back, and thus the extensor secundi internodii may never appear at all. This may seem a refinement, but the freedom with which the thumb and fingers can be extended, even within a day or two of the operation, when this point is attended to, shows that it is important. The articular facet on the ulnar side of the bone is then clipped away with the forceps applied longitudinally.

"If the bones prove to be deeply carious, the pliers or gouge must be used with the greatest freedom. The metacarpal bones are next dealt with on the same principle, each being closely investigated, the second and third being most readily reached from the radial, the fourth and fifth from the ulnar, side. If they seem sound, the articular surfaces only are clipped off, the lateral facets being removed by longitudinal application of the pliers.

"The trapezium is next seized with forceps and dissected out without cutting the tendon of the flexor carpi radialis, which is firmly bound down in the groove on the palmar aspect, the knife being also kept close to the bone so as to avoid the radial. The thumb being then pushed up by an assistant, the articular end of the metacarpal bone is removed. Though this articulates by a separate joint, it may be affected, and the symmetry of the hand is promoted by reducing it to the same level as the other metacarpals.

"Lastly, the articular surface of the pisiform is clipped off, the rest being left if sound, as it gives insertion to the flexor carpi ulnaris and attachment to the anterior annular ligament. But if there is any suspicion as to its unsoundness, it should be dissected out altogether, and the same applies to the process of the unciform.

"The only tendons divided are the extensors of the carpus, for the flexor carpi radialis is inserted into the second metacarpal below its base, and so escapes. Only one or two small vessels require ligature. Free drainage must be given. The hand and fore-arm are put up on the well-known splint of Sir J. Lister, with the cork support for the hand, which helps to secure the principal objects in the after-treatment—viz., frequent movements of the fingers—while the wrist is kept fixed during consolidation.

"Passive movement of the fingers is begun on the second day, whether the inflammation has subsided or not, and continued daily. Each joint should be flexed and extended to the fullest extent possible in health, the metacarpal bone being held quite steady to avoid disturbing the wrist. By this means the suppleness gained by breaking down the adhesions under chloroform is maintained.

"Pronation and supination, flexion and extension, abduction and adduction, must be gradually encouraged as the new wrist acquires firmness. When the hand has acquired sufficient strength, freer play for the fingers should be allowed by cutting off all the splint beyond the knuckles. Even after the hand is healed, a leather support should be worn for some time, accurately moulded to the front of the limb, reaching from the middle of the fore-arm to the knuckles, and sufficiently turned up at the ulnar side. This is retained *in situ* by lacing over the back of the fore-arm.'

The results of this operation vary very much, and on the whole are perhaps not entirely satisfactory. A splint must be employed for a very considerable time—from three to six months—and there is a tendency for the hand to fall into a position of adduction, and also for the base

of the first metacarpal bone to be drawn inwards against the rest of the metacarpus. In very bad cases the whole hand becomes rigid and useless. In some cases, however, a very satisfactory result is obtained.

Amputation.—Amputation is best done as close above the wrist as possible, and by means of the modified circular method already described (see Part III., p. 256).

DISEASES OF THE PHALANGEAL JOINTS.

SPRAINS.—Sprains of the fingers may be followed by considerable trouble unless great care be taken in the treatment. There is often partial or entire rupture of the lateral ligaments of the articulation, with pain in the joint, localised tenderness over the insertion of one of the ligaments, swelling and interference with movement. This condition may be very obstinate even in healthy patients, while, in those who are predisposed to rheumatoid arthritis or tuberculous disease, it may be the starting point of these affections.

Treatment.—The affected member should be immobilised, and pressure employed. The best plan is to apply Scott's dressing spread on lint around the joint, and then to fix this on firmly with rubber strapping; outside this a palmar splint of block-tin is applied. The splint should have a broad portion fitting the palm and reaching down to the metacarpo-phalangeal joints and as high up as the wrist; it is cut away opposite the thenar eminence so as to allow movement of the thumb. From the palmar portion a trough extends down for the reception of the affected finger. This splint should be kept on for ten days or a fortnight, after which passive movement and massage should be diligently employed.

SYNOVITIS.—*Acute synovitis* may be the result of injury, and as a rule soon passes off. The chief trouble lies in the adhesions which are left behind. *Chronic synovitis* with effusion, corresponding to the hydrops articuli of the larger joints, is, however, of rare occurrence; when it does occur, it is most frequently associated with the presence of loose bodies in the joint, which, in the case of the fingers, usually follows actual detachment of portions of cartilage or bone from violent dislocations or twists of the joint.

The treatment of these conditions is similar to that already described for other joints (see p. 93), and presents nothing of importance.

GOUTY ARTHRITIS.—This is one of the commonest diseases of the phalangeal joints, and is associated with the deposit of chalkstones in the neighbourhood of the articulation, accompanied by some difficulty in complete extension. The urates are deposited not only around the joint, but actually in the cartilages, leading to an alteration in shape, and accounting for the difficulty in movement.

Treatment.—The essential point is the general treatment for gout—regulation of the diet, diminution in the amount of nitrogenous food, and the employment of suitable drugs and mineral waters such as lithia and

Contrexéville water, to increase the excretion of uric acid and urea. Gouty arthritis, however, practically comes under the care of the physician, and further details as to treatment should be sought in medical text-books.

RHEUMATOID ARTHRITIS.—This is very common, and all the joints of all the fingers may be involved. It may be associated with a similar condition in the larger joints. There is usually great deformity, the fingers being deflected towards the ulnar side, and the joints much enlarged from the outgrowth of fresh bone around the articular surfaces, by which the movements of the fingers are much hampered; the joints are usually somewhat flexed. The condition is generally associated with considerable pain and marked exacerbations.

Treatment.—This is very disappointing, as the disease is obstinate and generally ends in more or less crippling, in spite of any treatment that may be adopted. In the early stage the usual remedies already described for rheumatoid arthritis (see p. 151) should be had recourse to.

In all elderly subjects, and especially those predisposed to rheumatoid arthritis, it is of the highest practical importance to remember that fixation of the fingers or joints of the upper extremity after injuries such as sprains, fractures, or dislocations is very apt to be followed by this form of disease. Hence the greatest care must be taken, whenever a fracture occurs in the arm, fore-arm, or hand, to leave the fingers free and to encourage active and passive movement from the very first, if it be possible to do so without interfering with the union. Even when splints must be applied to the fingers, they should be taken off daily, and the joints exercised and moved, so as to prevent adhesions and to hinder the onset of this crippling disease. These remarks apply perhaps more particularly to Colles's fracture than to any other, as it is frequently followed by rheumatoid arthritis in the wrist and fingers if the undue immobilisation, which is so commonly practised, be persisted in.

TUBERCULOUS DISEASE.—Tuberculous phalangeal joint disease is comparatively rare. The deposit much more frequently occurs in the shaft of the bone, as a tuberculous osteo-myelitis, which has already been described (see Part III., p. 197). Nevertheless, primary tuberculous arthritis may occur, or tuberculous osteo-myelitis may spread into and invade the joint.

Treatment.—The treatment is the same as for tuberculous joint disease elsewhere. The parts are kept at rest with the fingers slightly bent, and this is best effected by putting the hand and affected finger into a silicate bandage and leaving the other fingers free to move. It is important to remember that it is not sufficient to fix the finger alone; the hand must also be fixed, and, when the case is one of infection of a metacarpo-phalangeal joint, the fixation should extend to the wrist joint also, as otherwise the flexor and extensor tendons keep up a certain amount of movement.

When the disease is progressing in spite of treatment, operative measures

must be considered, and either excision or amputation may be performed. In some cases excision of the ends of the bones gives a very good result, and leaves a certain amount of movement and a useful finger: but it is rarely that it can be employed, because in this affection the trouble is very apt to spread to the tendon sheaths as they pass over the joint, and excision of the articulation will therefore fail to cure the disease. Hence, when there is disease of the sheath or the neighbouring bone as well as an affection of the joint, or when abscesses are present, amputation is the better practice, the seat of the amputation being dependent, of course, upon the joint affected.

SYPHILITIC DACTYLITIS.—This is an affection that is not very uncommon in the fingers. It has been fully described and its treatment discussed (see p. 140), and therefore nothing further need be said about it here.

DIVISION II.

THE SURGICAL AFFECTIONS OF THE SPINE.

CHAPTER XXV

INJURIES OF THE SPINE.

Injuries of the spine are of common occurrence and vary in gravity according to the severity of the violence producing them.

CAUSES.—The most common cause is sudden extreme flexion of the spinal column, the injury being therefore due to indirect violence. The less severe lesions may sometimes result from very powerful muscular action. Common examples of these injuries are seen in hunting or bicycle accidents, in which the patient falls upon the head or upper extremities, and the spine is forcibly doubled up. Damage may also be caused by sudden twisting or over-extension of the spine, as contrasted with over-flexion; an example of this is a fall across a bar. Direct violence, particularly direct blows upon the back which drive the upper part of the spine forward, while the lower remains stationary, is also an important cause; as an example may be cited the case of a man digging in a pit and struck by a fall of earth or stones upon the upper part of the spine. Other causes of spinal injury are jars and concussions, such as are seen in railway accidents and falls upon the back, the feet, or the buttocks.

RESULTS.—The results of these injuries vary in degree according to their severity, to the position of the patient at the time of the accident and to the strength of the muscles and ligaments concerned.

(1) The mildest form of injury is a *sprain* of the spinal muscles and ligaments, resulting in severe cases in a rupture of muscles and ligaments; these lesions usually follow violent flexion or rotation of the spine.

(2) In more severe forms of injury, the ligaments within the spinal canal are torn, and hæmorrhage results, the latter sometimes even without rupture

of the ligaments. Hæmorrhage occurs either outside the dura mater or within it—a condition known as *hæmato-rachis*.

(3) As the result of severe injuries or jars, with or without rupture of ligaments or muscles, the condition known as *concussion* may arise; here there is more or less complete but temporary loss of function of the spinal cord.

(4) Apart from hæmorrhage into the spinal meninges, bleeding may in some cases of severe injury occur in the substance of the cord itself—the condition known as *hæmato-myelia*. According to Thorburn, this is practically limited to the cord in the lower cervical region.

(5) Lastly, as the result of the more severe forms of violence we may have *dislocation* of the spine, which may occur in the cervical region or, more usually, a *fracture-dislocation* occurring most frequently in the lower cervical and in the dorso-lumbar regions.

SPRAINS.

Sprains of the spinal column are usually associated with some partial rupture of ligaments or tearing of the tendinous insertions of the spinal muscles. In very severe injuries, the ligamenta subflava may actually be torn, when the gravity of the case is increased, since hæmato-rachis then results. These injuries are much more common in the lumbar region than elsewhere, and next in frequency comes the cervical region, this distribution being due to the fact that these portions of the spine are the most mobile, and are therefore most likely to suffer injury.

Symptoms.—The symptoms vary much in severity. In the mildest cases there is only slight pain at the time of the accident, whilst the most severe are often difficult to diagnose from actual fractures of the spine. Even when the pain is but slight at the time of the injury, considerable pain over the affected area generally follows in the course of from twelve to twenty-four hours; there is also tenderness on pressure, and the patient often experiences agonising pain on attempting to move the spine or the limbs, so that the back is kept absolutely rigid, and, unless the examination be conducted carefully, a condition of paraplegia may be diagnosed. Extravasation of blood may also be present if the lesion be extensive. Usually there are no nerve symptoms unless intra-spinal hæmorrhage be also present.

These injuries are of great practical importance because, unless treatment be prompt and sufficiently prolonged, the patient is liable to great, or even permanent, disability from the supervention of chronic inflammation of the damaged tissues; when such a condition is established it may be very difficult to get rid of it. In some cases also, especially in children, sprains of the spine may be the starting-point of tuberculous disease.

Treatment.—This may be divided into the treatment suitable for cases seen immediately after the injury, and that best adapted to those in which

a considerable time has elapsed and previous treatment has been either very inefficient or absent.

(a) **In recent cases.**—Here immediate and absolute rest in the horizontal position should be enforced for at any rate a few days, the patient being confined to bed in the most comfortable position, which is usually upon the back, and the pain being relieved by the application of fomentations to the seat of injury; usually some narcotic, such as chloral or bromide of potassium, will also be required for the first night or two. In injuries about the lumbar spine the urine should be examined for blood, as it is not uncommon to find that the kidney is contused; if this be the case, special treatment for the arrest of the bleeding, if excessive, or for the maintenance of a gentle diuretic action, will be called for. Rest however must not be prolonged too long, otherwise, as in sprains elsewhere, the condition may become chronic; massage should therefore be begun almost from the very first. For the first four or five days it should consist of gentle rubbing in the upward direction, and, if the injury be severe, it should be performed without turning the patient over. It should be practised for a quarter of an hour or twenty minutes at a time, at first once, and later on twice, daily. After the first week it should be more vigorous and employed for a longer time, and it is well then to combine the massage with the use of some stimulating liniment, such as liniment. terebinth. acet., or the following:

℞	Menthol,	ʒss.
	Lin. belladonnæ,	aa ʒss.
	Lin. camph. co.,	

The trouble will usually subside in the course of two or three weeks under this treatment, but it is well not to permit active movements until the case is practically well, as otherwise the condition may become chronic.

(b) **In long-standing cases.**—When the patient is not seen until some time after the accident and the symptoms continue, the condition has become one of chronic inflammation of the damaged structures, and the essential symptoms are great pain on any attempt to move the spine.

The treatment must be mainly that for chronic inflammation, of which *counter-irritation* is the most valuable. If the pain be comparatively slight, large blisters should be placed on either side of the spine and parallel to it over the affected area; this may be repeated once a week. When the pain is extensive and deep-seated, the actual cautery may be of value, and for this purpose the flat cautery (see Part I., p. 19) is usually better suited than Corrigan's cautery. The patient is placed under gas, and the cautery, heated to a white heat, is rapidly passed three times over the skin on each side of the vertebral column. The separation of the sloughs is hastened by the application of boracic fomentations (see Part I., p. 48), and, when these have separated, savin ointment, either alone or diluted to half or quarter strength and with the addition of cocaine, should be applied

to prevent the sore healing too rapidly; the patient must of course be kept in bed.

When the counter-irritation has subdued the pain almost completely, *massage*, increasing gradually in duration and frequency, should be commenced. In addition to massage, *douching* the spine alternately with hot and cold water is very useful. These chronic troubles are not infrequently associated with a rheumatic or a gouty tendency, and, under these circumstances, a sojourn at Bath, Buxton or some similar watering-place is very beneficial.

HÆMATO-RACHIS.

Hæmato-rachis or hæmorrhage into the membranes of the spinal cord may follow rupture of the ligamenta subflava, caused by very violent twists or blows, or it may result from a severe blow on the back or a fall without rupture of ligaments. The blood is usually extravasated between the dura mater and the bones, but sometimes the extravasation may occur within the dura mater.

Symptoms.—The condition resulting is similar to meningeal hæmorrhage in the brain; in the early stage there are symptoms of irritation, followed, as the amount of blood increases, by definite pressure symptoms. As the clot has greater room in the spinal canal, the pressure symptoms are not nearly so frequent as the irritative symptoms. Hæmato-rachis may be suspected when there is severe pain both at the seat of the injury and along the distribution of the nerves arising from the corresponding area of the cord, and also when there are irritative symptoms, as shown by muscular cramps due to irritation of the motor nerve roots. As the hæmorrhage increases, paralysis, either complete or partial, follows.

Treatment.—The patient should always be put to bed at once, and kept perfectly quiet in the prone position. Ice should be applied to the spine, and ergot—in doses of one drachm of the liquid extract every three hours for three doses by mouth—or ergotinine, in subcutaneous injections of $\frac{1}{5}$ gr. similarly repeated, may be administered, so as to check the bleeding promptly. A smart purge—calomel, gr. v.—should also be given, and, as in all spinal injuries, the condition of the bladder should be ascertained, so as to avoid retention of urine. Should the symptoms show no improvement under this treatment, and more especially should pressure symptoms in the shape of commencing paraplegia supervene, it is well to treat the case similarly to one of cerebral meningeal hæmorrhage by laying open the spinal canal and evacuating the clot. This is done by the operation of laminectomy, the steps of which will be described immediately (see p. 288). As a rule the clot is outside the dura mater and is thus easily evacuated; should it not be found there, the dura mater must be opened and any clot beneath it removed.

CONCUSSION OF THE SPINE.

By the term concussion of the spine is really meant a condition in which there is a molecular disturbance of the nerve cells, leading

to temporary loss of function without any actual organic lesion. Whether such a state of matters is possible has been much debated, and it is true that in the majority of cases of supposed concussion, whether cerebral or spinal, minute lesions, chiefly in the form of capillary hæmorrhages, have been discovered. A certain number of cases do however occur in which no lesion can be detected but in which no other known cause of paraplegia can be found. The affection is usually caused by a severe blow on the back or by a fall from a height upon the feet, buttocks, or back.

Symptoms.—There is usually more or less complete loss of movement and sensation, especially in the legs, immediately after the accident; there may sometimes be weakness of the arms as well. There may also be incontinence of urine and constipation. The symptoms usually pass off in a few hours, but they may last a few days; when there is no actual organic lesion, recovery practically always occurs. Should there be defective recovery, such as permanent weakness affecting some single muscle or group of muscles, it is probable that there has been some actual lesion, such as hæmorrhage into the cord.

Treatment.—Nothing is necessary beyond keeping the patient in bed and employing a spinal ice-bag and ergot (see p. 279) in the early stage, if there be any reason to suspect increasing hæmorrhage. The condition of the bladder must be ascertained and the diet should be non-stimulating and should consist mainly of milk.

"Railway spine."—In connection with concussion we may refer to the condition known as "railway spine." This is usually a condition of sprain of the muscles and fasciæ which has been neglected and has become chronic, but some cases, in which degenerative changes subsequently occur, are probably due to hæmorrhage into the cord or into the membranes. Others again are hysterical conditions following the general nervous upset.

The condition is one of great interest, partly from the difficulty in arriving at an accurate estimate of the damage sustained, and partly from the obstacles that are so often thrown in the way of treatment. The mere fact that the injury has been met with upon the railway, and that compensation may therefore possibly be claimed, doubtless often has a tendency both to discount the gravity of the case in the eyes of the surgeon and to increase it in those of the patient. It frequently requires not only a good knowledge of surgery, but also a keen insight into character to arrive at a just conclusion.

Treatment.—There are often difficulties in carrying this out successfully. In the first place complete rest and quietude are called for immediately after the accident, with rest from all mental work. This, however, it is often most difficult to secure, and, from the circumstances of the case, business worries, interviews and correspondence regarding compensation, etc., are very difficult to exclude; this alone is sufficient to account for

the fact that in many cases the obscurer nerve symptoms—which may be absolutely genuine in character—do not develop until some little time after the injury. Conversely, improvement may be proportionately rapid after the worry and fatigue attendant on the question of compensation are finally disposed of.

After a short time devoted to rest and quiet, the treatment must be directed to the absorption of any effusion about the spine and to the early restoration of its functions. Practically the treatment resolves itself into that suitable for sprains of the spine (*vide supra*). It is a point of the highest practical importance in these cases to get the patient up and about as soon as the local condition of the spine will allow. Unduly prolonged rest only serves to accentuate the various vague spinal, muscular and nerve pains from which the patient suffers, while the mental condition becomes proportionately bad. In the more markedly hysterical cases nothing will succeed but some form of the Weir Mitchell treatment (see p. 145); in the less severe ones, an entire change of scene and surroundings, such as a sea-voyage or the like, may be sufficient.

HÆMORRHAGE INTO THE CORD OR HÆMATO-MYELIA.

This condition must be considered in connection with spinal concussion, because the injuries which lead to the one are very apt to produce the other, while the two conditions are very often combined. The presence of punctiform hæmorrhages in the substance of the cord has been already alluded to above, but the condition specially referred to here is marked by more extensive hæmorrhage, which gives rise to a definite clot in the grey matter of the spinal cord. This condition usually follows acute flexion of the spine, and, according to Thorburn, is practically confined to the region of the fourth, fifth, or sixth cervical vertebræ.

Symptoms.—When the lesion is marked, there may at first be complete paraplegia; this is subsequently recovered from to a certain extent in the lower limbs, in which only some slight weakness may be left. The severe symptoms are practically confined to the upper extremities, and are often followed by permanent loss of power, and wasting in some of the muscles. When the hæmorrhage is less, the symptoms are confined to the arms from the first; this distinguishes these cases from those of spinal concussion, in which the symptoms are most marked in the lower parts of the legs and in which the arms are comparatively slightly affected. After partial recovery, the paralysis may begin to extend as the result of myelitis. Unless the hæmorrhage be severe and be followed by myelitis, there is usually partial recovery.

Treatment.—This consists simply of rest in bed, ice to the back, injections of ergotinine (see p. 279), and the use of purgatives. It is hardly to be expected that an operation for removal of the intra-medullary clot can be of any practical service.

DISLOCATION AND FRACTURE-DISLOCATION.

The severe injuries already mentioned (see p. 276) may also produce dislocation of the spine—or more commonly fracture-dislocation.

DISLOCATION.—Dislocation of the spine is practically confined to the cervical region. In it the articular processes become displaced from one another on one side or both, usually the latter, and the intervertebral disc and the common ligaments are also lacerated. The upper part of the spine is practically always displaced forward. Accompanying the dislocation are degrees of paralysis varying according to the injury inflicted upon the cord, and there is also pressure upon the nerves passing through the intervertebral foramina. True dislocation of the spine is very rare and hardly calls for special mention. Owing to the smallness of the bodies and the large size of the spinal canal in the cervical region, the damage to the cord is not usually so extensive as when the injury occurs lower down, so that in some cases marked benefit may result from the reduction of the dislocation.

Reduction.—The attempt to reduce these cervical dislocations should in the first place be made without operation by placing the patient under an anæsthetic, making extension by grasping the occiput with the one hand and the chin with the other, while counter-extension is made by fixing the shoulders and trunk. The extension must be made in the upward and backward direction, and in some cases the dislocation is reduced with a sudden jerk or snap; it is not uncommon however for reduction to be followed by sudden cessation of breathing which necessitates recourse to artificial respiration for a few minutes.

If it be found that the dislocation cannot be readily reduced, operation is advisable. The surgeon must expose the seat of dislocation and divide any structures that interfere with reduction; these are most likely to be the superior articular processes of the vertebra below the seat of dislocation. If the articular processes have to be removed, it is well to drill the transverse and spinous processes above and below the dislocation and to wire them together so as to prevent subsequent displacement.

The wound is closed and, after the dressing has been applied, it is well to apply a moulded poroplastic splint which takes purchase from the shoulders, and embraces the neck, the chin and the occiput; if necessary, this may be strengthened by suitable pieces of metal; the whole head is thus fixed, and the risk of fresh displacement avoided.

FRACTURE-DISLOCATION.—This injury is a combination of fracture and dislocation, and may result either from direct or indirect violence; the latter is the commoner, the spine being forcibly bent. Fracture by direct violence is rare, but it may be caused by severe kicks, blows or the passage of heavy structures across the spine, and it is most frequent in adult labouring-men as the result of a fall from a height. The spine may be fractured in any portion of its length, and any of the constituent parts of the vertebræ affected may be broken. It is most common

to find the line of fracture running obliquely from above downwards and forwards through the body of the vertebra, the upper part of the spine being carried forwards, and the posterior edge of the lower portion of the vertebra forming a sharp projection over which the cord is stretched and bruised. Accompanying the fracture there may be dislocation of the articular processes from one another, and it is well to bear this in mind in attempts at reduction, because they may form the obstacle to the replacement of the fracture. Fracture-dislocation occurs most commonly in the lower cervical and the dorso-lumbar regions.

The spinous processes and the laminæ may also be fractured independently of the body, either from violent flexion of the spine or, more usually, from direct violence.

The gravity of a case of fractured spine depends upon the damage done to the spinal cord, which in its turn depends upon the amount of displacement that has occurred. The cord is always acutely flexed over the projecting lower part of the body of the fractured vertebra, and if the flexion be great, the cord may be most severely damaged; in some cases it is so pulped up that its structure is unrecognisable and it is merely represented by a tube of dura mater containing a mass of blood-clot and disintegrated nerve elements. It is important from the point of view of the efficacy of operation to remember that the lesion of the cord is generally caused, not by continued pressure, but by sudden contusion at the time of the injury, so that the chances of doing good by reducing the fracture-dislocation or by removing bone pressing on the cord are really very slight indeed.

Symptoms.—Fractures of the spine are accompanied by a series of symptoms due to the damage that the cord has sustained, which vary in nature and severity with the situation of the fracture and the amount of the damage. The only symptoms directly due to the fracture are the deformity and the mobility, crepitus, etc., common to other fractures. As regards the deformity it is practically only noticeable in cases of fracture of the body with dislocation forwards, and the degree existing when the case is seen is not any measure of the amount which has existed, or of the damage done to the spinal cord, for it is not at all uncommon for the deformity to disappear, or at any rate to become distinctly less, when the patient is laid flat upon his back. This disappearance of the deformity does not however necessarily relieve the nervous symptoms at all, as they are caused by the damage done to the cord at the time of the accident, which is practically irreparable.

In cases of fracture of the spinal arch the deformity is seldom particularly noticeable, but in some cases crepitus and mobility can be made out by lateral pressure on the spines. In fractures of the bodies, on the other hand, mobility and crepitus are usually absent.

There is generally more or less complete paralysis of motion and sensation in the parts supplied by the nerves coming off from the cord at or below

the seat of injury. This varies with the amount of damage done to the cord, but, if not complete, the motor paralysis is generally more marked than the sensory. It is however rare to find only a partial injury except in fracture of the spines or the laminæ, in which the pressure may be on one side of the cord or in which a spicule of bone may have been broken off from one part of the spinal column. Above the area of complete sensory paralysis there is generally a zone of hyperæsthesia due to irritation of the nerves in the neighbourhood of the fracture. The reflexes are abolished at the time of the accident but may recur later on; their return generally indicates a partial lesion of the cord.

Certain special symptoms accompany fractures of the spine, of which the following may be mentioned:

1. *Urinary disorders.*—These are met with in all fractures above the lower lumbar region. When the fracture is in the dorso-lumbar region there is generally incontinence of urine; when it is higher up, retention with overflow. After a time, in spite of the greatest care, the bladder becomes the seat of a low form of cystitis, the urine is filled with thick, ropy muco-pus and later on the inflammation spreads upwards and leads to pyelo-nephritis. There is generally very considerable priapism, often painless, but sometimes causing considerable inconvenience.

2. *Alimentary troubles.*—When the fracture is in the lower dorsal region there is often considerable interference with the sympathetic nervous system leading to intestinal disturbances, such as vomiting, tympanites and constipation. This condition is aggravated by the paralysis of the abdominal muscles.

3. *Respiratory troubles.*—Fracture in the upper dorsal region entails paralysis of the intercostal muscles, and when it is in the lower cervical region all the accessory muscles of respiration are paralysed as well as the intercostals, and respiration is carried on by the diaphragm alone. In fracture above the third cervical vertebra death is usually immediate from paralysis of the phrenic as well as the other respiratory nerves. As a result of the interference with the muscles of respiration in these fractures in the dorsal and lower cervical regions, there is a great tendency to imperfect expansion and aëration of the lungs, leading to congestion of the bases followed by hypostatic pneumonia, which is a frequent cause of death.

4. *Nerve troubles.*—There are other changes common to all fractures of the spine. For example, the circulation is affected, the pulse being markedly irregular and often very rapid, whilst vascular disturbances, such as flushing, etc., are frequent. The temperature, at first at any rate, is usually subnormal. Trophic changes are met with in the paralysed parts, the most important being the occurrence of acute bedsore which appears on any part subject to pressure, more especially over the sacrum. The slightest pressure may lead to rapidly spreading gangrene of the skin, the pressure of one knee against the other being sufficient in some cases.

These bedsores are often fatal from septic infection. Cutaneous rashes, bullæ, etc., are also frequently met with.

Prognosis.—The prognosis varies according to the region of the spine that is the seat of fracture and according as the fracture affects the spinous processes and laminæ or the bodies of the vertebræ. *When the fracture is in the neural arches* the symptoms are mainly due to depression of the fragments, and the compression they cause does not necessarily give rise to much permanent damage to the spinal cord. Indeed, if means be taken to relieve the pressure, the patient may recover partially or even entirely. When the cauda equina is alone pressed upon, as it is in fractures in the lower lumbar region, the recovery following removal of the pressure is usually complete.

In fracture of the bodies of the vertebræ the prognosis is much more grave on account of the immediate and often irreparable damage done to the cord—a damage that can seldom be remedied by any attempts to relieve pressure. The prognosis is most favourable *in fractures of the lumbar spine* and is worst in those about the upper dorsal and cervical regions. In fractures of the lumbar spine, even though there be permanent paralysis of motion and sensation in the parts below, along with the attendant trophic changes, the patient does not as a rule suffer from any severe symptoms except perhaps incontinence of urine, and if this condition be carefully attended to, years may elapse before he dies. In fact, the cause of death is usually either sepsis in connection with acute bedsore or a similar condition in the urinary organs, both of which can, to a certain extent at any rate, be guarded against.

When however the fracture is in the dorsal region, the mortality is greatly increased. Here the urinary troubles are much more severe and, in spite of the greatest care, it is hardly possible to stave off for any great length of time the occurrence of pyelo-nephritis. The patient is moreover constantly exposed to the risk of dangerous hypostatic congestion of the lungs from the want of proper aëration of the bases owing to the paralysis of the abdominal and lower intercostal muscles; this risk not uncommonly increases as time goes on, because some secondary myelitis generally occurs above the injury to the cord, and thus leads to extension of the trouble upwards and a further diminution in the nerve supply.

When the fracture is in the cervical region death almost invariably results within a few days, or weeks at the utmost, chiefly owing to the respiratory embarrassment due to the paralysis, and the resulting imperfect aëration of the lungs.

Treatment of the fracture.—In considering the treatment, we have to distinguish between fractures of the bodies and those of the neural arches.

1. **Fracture of the bodies of the vertebræ.**—In taking charge of these cases it is very important to remember the grave damage which has probably already been done to the cord, and the serious risk of increasing this by incautious movements. It is not permissible in examining these

cases to turn the patient over or to raise him, so as to find deformity or other symptoms of fracture, because displacement is very readily thus produced and might immensely aggravate the damage already present. The symptoms of fracture of the spine are always sufficiently clear to render such a course as unnecessary as it is dangerous.

Removal.—It sometimes falls to the lot of the surgeon to be called to a case of fractured spine while the patient is still lying on the spot at which he received the injury; he then becomes responsible for the patient's removal, which must be done with the utmost care and with the aid of intelligent assistants. The patient should be laid flat upon the ground or floor, without anything beneath his head, and all attempts at movement must be restrained until a suitable stretcher or litter is ready for him. This should be firm and unyielding, a shutter or door being as useful as anything if a regular stretcher cannot be found; indeed in any case it is a good plan to slip a narrow shutter or a wide plank of suitable length beneath the patient and to lift him on to the stretcher on this. A board of this kind can be readily slipped between the patient and the floor without raising him more than an inch or so, and it prevents him from sinking down in the stretcher and thus increasing the deformity. In raising the patient it is very important to remember that a certain amount of extension should be made. At least four assistants are required, two of whom take the lower extremities while the other two grasp the thorax in cases of fracture of the dorso-lumbar region or the head in fractures higher up; in the latter case two more are required to support the trunk. As the patient is raised from the ground the assistants make extension. The surgeon at the same time places his hand beneath the spine and tries to keep it as horizontal as possible. The board or shutter is then rapidly slipped beneath the patient immediately there is room for it, and upon this he can be lifted and carried home; or the entire apparatus may be placed upon a stretcher. It is well if possible to encircle the patient and the stretcher in a sheet, or to bandage the arms to the sides so as to prevent all movement. The stretcher should in all cases be carried by hand so as to prevent the jolting which wheeled carriages entail, and, as is well known, the stretcher bearers at the two ends should not walk in step.

When the patient reaches his home or the hospital he should not be disturbed until every preparation has been made for securing permanent immobilisation. He may be temporarily left upon the stretcher, hot-water bottles and hot blankets being piled around him, and stimulants administered if necessary to lessen the shock while preparations are being made to reduce and immobilise the fracture. The initial shock, although sometimes severe, is in the majority of cases surprisingly slight. It must be remembered that, as the lower extremities are anæsthetic, extra care must be taken that the hot bottles do not come into contact with the skin, as otherwise extensive and intractible burns are certain to result; the bottles should be applied outside the blanket.

Reduction.—Before proceeding to reduce and immobilise the fracture. the patient's bed should be prepared for his reception; fracture-boards should be placed upon the bed-frame and upon them is laid a horse-hair mattrass, consisting of three parts, the central one (*i.e.* that beneath the sacrum) being again subdivided vertically into two lateral halves; each of the segments should have a separate sheet. A water-bed is not advisable at this stage. In some cases the fracture spontaneously reduces itself when the spine is in the horizontal position; in others, however, the deformity persists and it is well to attempt reduction. For fractures in the cervical region when the deformity is persistent, operative procedures may be necessary; these have already been referred to in connection with simple dislocation (see p. 282) and consist essentially in the removal of any obstacle to reduction such as the upper articular processes of the vertebra below the fracture. In fractures below the cervical region, however, reduction must usually be effected by manipulation, and on the whole it is best to employ an anæsthetic, particularly in muscular or highly sensitive patients. Anæsthesia must be very gradual and the greatest care must be taken to see that the patient does not struggle during the initial stages. When the patient is fully anæsthetised, extension must be employed with the greatest caution by from four to six assistants (see p. 286). The extension should be gradual and equable and should be made without lifting the patient from the horizontal position. The surgeon meanwhile observes the result on the fracture and helps to manipulate the bones into position.

Immobilisation.—When reduction has been effected, an attempt must be made to fix the fracture, either by the application of a plaster of Paris jacket or by the use of extension and counter-extension with weights and pulleys. In muscular subjects it is well to employ both methods in combination, at first at any rate. The weight employed varies with the muscularity of the patient; usually from six to eight pounds must be used for each leg. Counter-extension is perhaps best effected by fastening a broad bandage around the chest and fixing it to the head of the bed. The greatest care must however be taken in employing extension lest sloughing of the skin occur from the defective trophic condition; the apparatus must be frequently examined to see that this does not happen.

It is well to employ a plaster of Paris jacket in addition to extension; this is especially useful in fractures of the lower dorsal region. A large sheet of boracic lint is first slipped around the body to keep the plaster from contact with the skin, and then a large many-tailed bandage of two thicknesses of house flannel impregnated with plaster, as for Croft's splints (see Part III., p. 14), is rapidly slipped beneath the patient and the ends brought round the trunk in the usual way. Extra plaster may be rubbed over the bandage and thus the fracture may be fixed without unnecessary disturbance.

When the fracture is higher up in the dorsal region, a retentive apparatus of this kind is of extremely doubtful utility because of its

tendency to interfere with the respiration, which is already very much embarrassed by the paralysis of the respiratory muscles. The good that can be done by immobilisation is small in comparison with the risk that is thus run.

When there is no marked deformity, it is sufficient to place the patient flat upon the back in bed with the head low and the knees flexed over a pillow to relax the psoas muscles.

The advisability of attempting to remove the pressure on the cord by operation in fracture of the vertebral bodies has been much debated; in our opinion it is of very doubtful value indeed. Indeed, in the majority of cases in which the displacement is marked and where there is therefore no doubt that the cord has been irremediably damaged, operation is not only useless but adds very considerably to the immediate risks. The only cases in which laminectomy seems advisable or even justifiable are those in which the damage to the cord appears to be incomplete,—that is to say, the paralysis is partial and, judging from its gradual increase and the irritative symptoms accompanying it at first, is probably due rather to pressure by blood-clot than by the bony fragments; under these circumstances it is well to perform laminectomy at once. In other cases again, where the paralysis, although complete in the first instance, shows signs of improvement, it is also advisable to perform laminectomy with the view of removing any source of pressure still present. Except under these circumstances however, the operation does not seem advisable for fractures through the bodies, except possibly in the case of the cervical spine. The operation of laminectomy will be described immediately (*vide infra*).

2. **Fracture of the spinous processes and laminæ.**—This condition is much more hopeful, because the cord is seldom pulped up by the depressed bone. Any paralysis present is usually due to direct pressure of the bone or to pressure of blood effused between the cord and the bone. It is very important to recognise this condition, because the prognosis is good if treatment be carried out early.

The only method likely to be efficacious is removal of the pressure on the cord; in other words operation must be the first thing to be thought of. When the depressed bone is removed or the blood-clot cleared out, it is not uncommon for complete recovery to take place, unless the cord has been badly lacerated at the time of the injury. The operation is known as laminectomy: and although in its later stages the procedure varies in different cases, the operation is the same in all cases up to the removal of the laminæ. We shall therefore describe the main operation and the various modifications of it suitable for the different cases that may be met with.

Laminectomy.—The operation consists essentially in the removal of the laminæ in order to gain access to the spinal canal; a variety of procedures may be called for when this has been done.

Incision.—The skin incision must be very free, since the laminæ lie deep down, and the parts must be widely retracted before they can be satisfactorily exposed; when, for example, the laminæ of two or three vertebræ are to be removed, the incision should at any rate reach from a couple of spines higher up to a couple of spines lower down than the area to be operated upon. Some surgeons employ a median incision, while others use a curved one; the latter has the advantage, here as elsewhere, that it removes the scar from the line of the spinous processes, but in cases in which the exact situation and extent of the lesion are not known, the vertical incision is to be preferred because it can be enlarged when necessary. Some surgeons make the curved flap with its convexity either upwards or downwards, while others make it with its convexity to one side; it seems on the whole that this lateral flap is really the best. The convexity of the curve extends to one side as far as the outer edge of the spinal muscles and crosses the middle line both at the upper and lower ends (see Fig. 75).

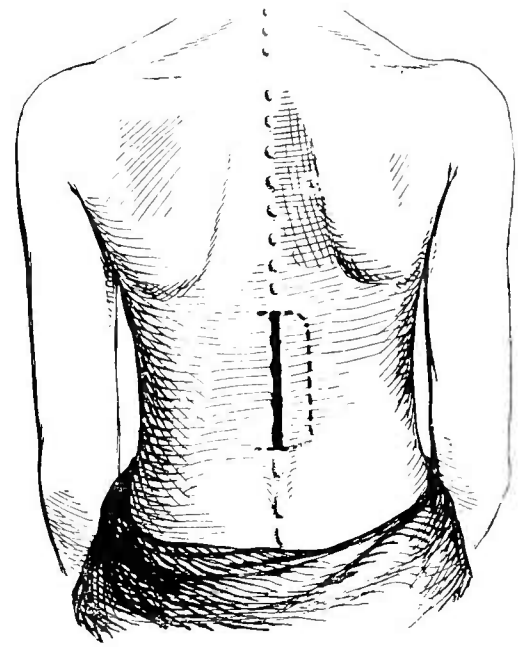


FIG. 75.—INCISIONS FOR LAMINECTOMY. The merits of the two forms are discussed in the text.

Retraction of the muscles.—The next point is the separation of the muscles from the spinous processes and the laminæ. This should be effected as rapidly as possible because considerable oozing takes place, and is best arrested by pressure as soon as the separation is complete. The muscles are divided at their attachment to the spinous processes and are then rapidly stripped off with a curved raspatory. If the bleeding be excessive, a sponge wrung out of hot lotion (about 110° to 120° F.) should be packed into the vertebral groove on one side while the muscles on the opposite side are being separated, and in a very short time the bleeding stops. The muscles must be freely detached not only from the spines but from the laminæ as far out as the transverse processes on both sides: they are pulled firmly aside by large flat retractors.

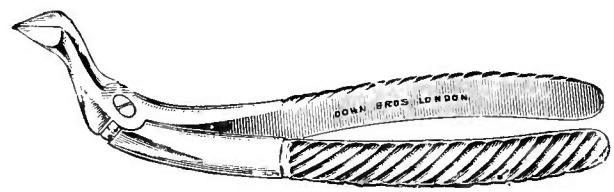


FIG. 76.—LAMINECTOMY PLIERS.

Removal of the spinous processes.—When the neural arches have been thoroughly cleared, the spinous processes are removed. This is done by nipping through their bases with a pair of angular cutting pliers (see Fig. 76); it is generally well to remove the spinous process both of the vertebra

above and that below the ones to be operated upon, in order to gain proper access to the laminæ.

Removal of the laminæ.—The spinal canal is now opened by removing the laminæ. Here there is a choice between two procedures: in the one the laminæ are completely removed; in the other, they are detached, lifted up upon a hinge and subsequently replaced in position. In cases of fracture the laminæ must be removed; in other cases the alternative procedure

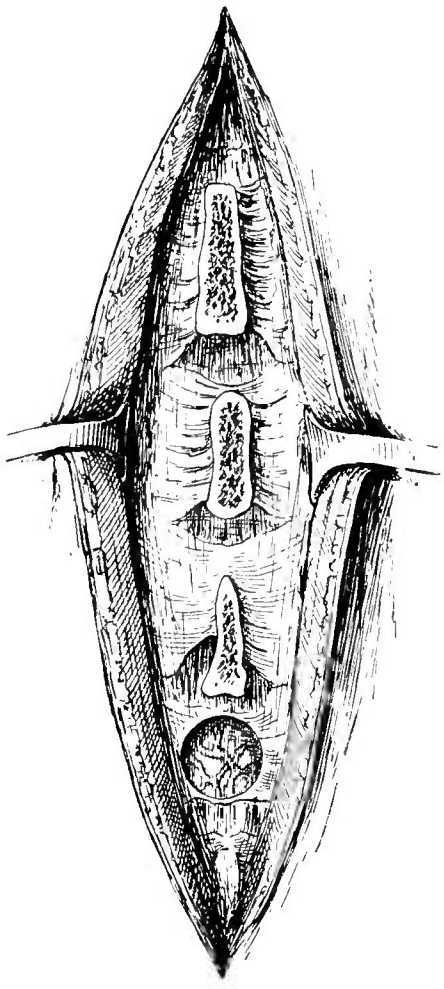


FIG. 77.—REMOVAL OF THE LAMINÆ IN LAMINECTOMY. The spinous processes have been clipped off with the pliers, and the opening into the spinal canal is made by means of the trephine hole seen on the lowermost neural arch. The opening is then easily enlarged, until the entire lamina is removed.

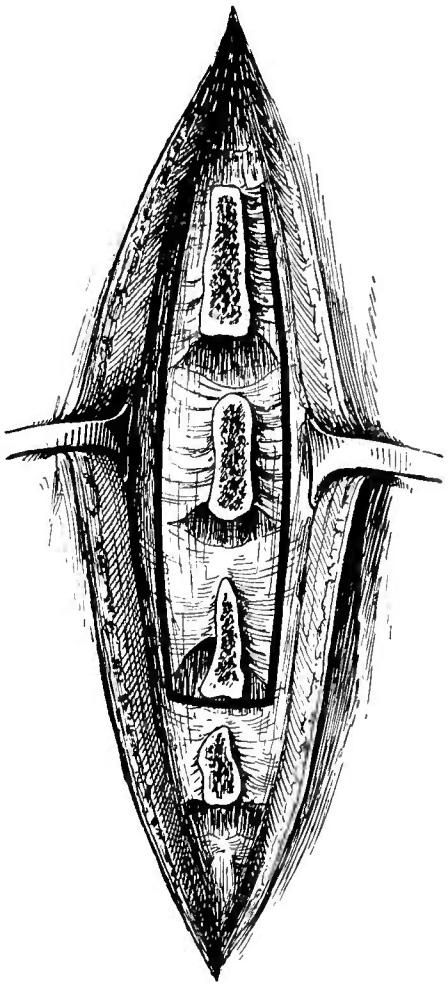


FIG. 78.—METHOD OF RETAINING THE LAMINÆ IN LAMINECTOMY. The thick black lines show (semi-diagrammatically) the incisions necessary to turn up the block of three laminæ. The incisions through the bones are made partly with a Hey's saw and partly with a chisel, while the ligaments are divided with probe-pointed scissors.

may be adopted. The great difficulty in either case is the removal of the first laminæ because it is essential to avoid injuring the cord in the process; it may be done in various ways. If the laminæ are to be completely removed, it is simplest to apply a small trephine ($\frac{3}{8}$ inch crown) over the root of the spinous process (see Fig. 77) and remove a circle of bone; then, working laterally with a pair of cutting pliers on each side, the whole lamina can be

cut away. Perhaps, however, the most common plan is to apply a Hey's saw close to the junction of the lamina with the pedicle on each side and to saw it partially through, when, either with a chisel or with cutting pliers, the lamina is divided completely. When the first lamina has been removed, it is easy to insinuate the blade of the cutting pliers beneath the next above it, and so to divide it. When the laminæ are to be removed, they are lifted out as divided; when they are to be left, the ligaments uniting the lowest lamina divided to the one below it are divided transversely, and all the divided laminæ are lifted up as one mass upon a hinge which is formed by the ligaments uniting the uppermost of the divided laminæ to the one immediately above it (see Fig. 78). This procedure brings into view the dura mater which is covered by fat and a plexus of veins. It can now be easily ascertained whether there is effusion of blood outside the dura mater or whether a spicule of bone is pressing upon the cord.

The further procedure depends upon what is found when the laminæ have been removed. In cases of fracture of the neural arch, the operation is practically complete at this stage: the depressed bone is removed, any rough spicules are clipped away and any blood-clot pressing upon the cord is removed; it is seldom necessary to open the dura mater. In cases of fracture of the body, attempts have been made, after having opened the canal, to chisel away the projecting portion of the body, but this has practically always failed and cannot be recommended.

Should it be deemed advisable to open the dura mater—which is not always necessary—this is best done by a vertical incision, care being taken to arrest the bleeding from the veins first. The chief reason for opening the dura mater is to remove blood-clot pressing on the spinal cord. After opening the dura mater great care should be taken to prevent the escape of the cerebro-spinal fluid in any quantity. It is well therefore to keep the head hanging down, in order to allow the cerebro-spinal fluid to collect in the skull, and, as soon as the inspection of the cord is satisfactorily accomplished, the dura mater should be closely stitched up with a fine catgut suture. And in the after-treatment it is well to keep the patient on his face, with the head down and the foot of the bed elevated, for some days in order to prevent excessive leakage of cerebro-spinal fluid.

After-treatment.—A large mass of dressing is put on after the wound has been sewn up without a drainage tube, and a large moulded shield of poroplastic material or plaster of Paris is fitted to the back and sides of the trunk to ensure immobility. If the dura mater has been opened, the precautions mentioned in the last paragraph must be adopted. Unless the dressing becomes soaked with discharge, it need not be changed for ten days, when the stitches are taken out.

Treatment of complications.—Perhaps the most important point in these cases is the avoidance of complications and their treatment when they arise. Death in cases of fracture of the spine is almost invariably due to one of these. The most important are cystitis and bedsores.

It will nearly always be necessary to have recourse to the systematic use of the catheter. Sometimes however there is true *incontinence*, the urine being voided as soon as it reaches the bladder, and catheterisation is therefore unnecessary, but nevertheless the surgeon must do his best to avoid septic decomposition of the urine. With this view suitable glass urine-bottles should be provided, which must be changed at least every two or three hours and sterilised by boiling before use. In the male, the glans penis should be disinfected several times a day by washing with 1-2000 sublimate solution, and subsequently enveloping it in gauze dipped in 1-4000 sublimate solution.

When *retention*—the common condition—is present, regular catheterisation is called for, and hence the risks of cystitis are much increased. The softest of instruments, of which the best is Jaques' red rubber catheter, should be employed, and this must be scrupulously sterilised. The best plan is to allow it to lie in plain water for about half an hour after use and then to remove all mucus from the interior by forcibly syringing water through it. It is then sterilised, either by boiling for a quarter of an hour, or by immersion in a 1-20 carbolic solution until it is required for use; the rubber is not spoilt either by boiling or by immersion in carbolic lotion. Previous to use, the carbolic acid should be removed by syringing a little boracic lotion through the instrument, which should be anointed with eucalyptus oil and vaseline squeezed on to it from a collapsible tube and not got from the ordinary ointment pot. The advantages of this are obvious; nothing is more calculated to introduce septic material than dipping the catheter point into an ointment jar which has probably been similarly used scores of times previously. The meatus should be washed with 1-2000 sublimate solution immediately before the catheter is introduced, the fossa navicularis being cleansed with a small pledget of wool. After the urine has been drawn off, care should be taken to prevent the introduction of air into the bladder by pinching the catheter as it is withdrawn, and in the interval between the catheterisations the glans penis should be disinfected and enveloped in gauze (*vide supra*).

Cystitis.—In spite of the greatest care however cystitis frequently supervenes, particularly when the fracture is in the neighbourhood of the urinary centre in the cord. The principal reliance must be placed upon washing out the bladder with antiseptic lotions, of which the best are sanitas, or boro-glyceride (1 in 20), dilute Condy's fluid, boracic lotion, etc.; while internally salol may be given in ten-grain doses, either alone or in combination with a similar amount of boracic acid. When the urine is strongly alkaline and contains large quantities of thick ropy pus, a good lotion is one containing five grains of sulphate of quinine and ten minims of dilute sulphuric acid to the ounce of water, or a weak solution of nitrate of silver in distilled water (a quarter to half a grain to the ounce). If there be hæmaturia, the administration of turpentine (℥ x.-xx.) or balsam of copaiba (℥ xx.-xxx.) may be useful; terebine

(℥ v.-xv.) may also be advantageously employed on account of its action both on the kidneys and the lungs. Generally however, in spite of the most careful treatment, the case goes from bad to worse and the patient eventually dies of suppurative nephritis.

Bedsores.—The prevention of bedsores is always most difficult and sometimes is almost impossible. Every care should be taken to see that there is no undue pressure at any point; even the knees must not be allowed to rest against one another without the intervention of a suitable pillow or pad. The various precautions recommended against bedsore (see Part I., p. 66) must be scrupulously adopted, and above all the skin must not be allowed to become soiled or wet. It is almost essential to employ a divided mattrass in the early stages, so that the central portion can be pulled out to allow of the introduction of a bed-pan or applications to the skin of the back. Two to three weeks later, when the fracture is beginning to consolidate, a water-bed should be substituted for this. The empty water-bed is slipped under the patient beneath the sheet, and is readily filled through a funnel or an ordinary douche-can provided with enough indiarubber tubing to allow it to be well raised.

The food must be concentrated and easily digestible; it should consist of strong soups, milk and beef-tea. The state of the bowels must be carefully attended to, as constipation is the rule. The breathing must be facilitated as much as possible, and symptoms of commencing congestion of the lungs should be watched for keenly and treated immediately they arise. Carbonate of ammonia (gr. v.-x.) and diffusible stimulants, such as alcohol, ether, etc., must be had recourse to, but if pneumonia develops, the prognosis is practically hopeless, as the patient is unable to clear the lungs owing to the embarrassment resulting from the paralysis of the abdominal and other respiratory muscles.

After-treatment.—When recovery is taking place, the patient must be kept in the horizontal position for at least two months, at the end of which time he may be fitted with a well-moulded poroplastic or plaster of Paris jacket and be allowed to get about on crutches if the paralysis remaining be only slight. As a rule however the patient remains bed-ridden throughout the rest of his existence, the sitting position being the utmost that he is able to assume. The condition of the urine usually varies considerably at different times, and treatment may be required for the various trophic nerve lesions that are apt to follow on the fracture.

WOUNDS OF THE SPINE.

STABS.—Penetrating wounds of the spine are very uncommon except in military surgery, but they are occasionally met with as the result of stabs, or falls upon sharp-pointed instruments. The symptoms and the severity of the accident vary of course with the amount of damage done to the spinal cord, but in all cases in which the spinal canal is penetrated

the accident is one of considerable gravity owing to the risk of septic spinal meningitis.

Treatment.—The treatment of these wounds must be conducted on the same lines as those for penetrating wounds elsewhere. If the opening in the skin be small, made with a clean instrument, and seen at once, it will probably suffice in most cases to disinfect the skin and the orifice of the wound and to apply an antiseptic dressing, much as for a punctured wound of a joint (see p. 82). When, however, symptoms of hæmorrhage appear, it will be necessary to perform laminectomy, arrest the hæmorrhage and remove the clot.

BULLET WOUNDS.—The chief penetrating wounds of the spine are however bullet wounds, and almost any injury may be caused by them. Perhaps the most common form is a bullet imbedded in the body of the vertebra; the question of the treatment then becomes a serious matter. In other cases the bullet may fracture the neural arches and cause compression of the cord, just as in a simple fracture; or again, it may perforate the spinal canal and divide the cord.

Treatment.—*When the laminæ are injured* immediate operation is required to remove the fractured bone pressing on the cord, to clean up the wound and to arrest any hæmorrhage. *When however there are signs of division of the cord* the case is very different. The symptoms may be due either to actual division of the cord by the bullet, but more often they are due to the bullet perforating the body of the vertebra and driving backwards portions of bone which either completely crush the cord or press on it and partially destroy it.

The treatment here is practically that for fractured spine, but laminectomy is required more often. In two or three instances laminectomy has been performed and the broken-up fragments of bone in front of the cord removed with fairly satisfactory results. In other cases however the cord has been found irretrievably damaged, when of course the operation is useless. There is no definite indication as to which of these injuries is present, unless it be the more partial character of the lesions after fracture than after complete division of the cord. Considering however the absolutely fatal nature of the injury, it seems to us that in the majority of cases it is well to perform laminectomy as early as possible with the view of ascertaining what the condition is; if the symptoms be found to result from pressure of portions of the body, it will fully justify the operation, whereas if the cord be found irretrievably damaged, no benefit will result, and the end of the case will be the same as if no operation had been performed.

CHAPTER XXVI.

SPINA BIFIDA.

DEFINITION.—By the term Spina Bifida is meant a condition in which there is a cleft in the posterior wall of the spinal canal due to imperfect development and want of union of the neural arch. This defect is usually accompanied by a protrusion of the spinal membranes through the gap with or without some of the constituents of the cord. The gap may affect one or several vertebræ and is most common in the lumbar or lumbo-sacral region, although it may occur in almost any part of the spine.

VARIETIES.—There are several varieties of this deformity.

1. **Spina bifida occulta.**—Here there is simply a defect in the laminæ without any protrusion of the meninges or prominence of the skin. In association with this condition there is usually a growth of hair on the skin over the defect which is often marked by a distinct dimple. Although there is no protrusion there may be various paralytic conditions present, such as talipes, paraplegia, want of control over the sphincters, etc.

The usual forms of the affection are accompanied by well-marked protrusion of the meninges which form a sac communicating with the interior of the spinal canal. The following are the chief forms met with:

2. **Meningocele.**—Here only the membranes of the cord project through the gap, and there are therefore no nerve elements in the tumour thus formed.

3. **Meningo-myelocele.**—This is the most common variety, and in it there is protrusion both of the meninges and of various nerve elements. When the spina bifida occurs low down, the cauda equina may be spread over the interior of the sac and adherent to it. When somewhat higher up, the spinal cord itself may run along the vertical median line of the tumour behind, and from it the nerves may run along the inner surface of the sac wall to the intervertebral foramina, or they may pass directly across the cavity.

4 **Syringo-myelocele.**—This is a rare condition in which the central canal of the cord is dilated, and a portion of the spinal cord is therefore spread out over the interior of the sac.

5. **Myelocele.**—Not only is the bony framework deficient here, but the skin also is wanting and there is a communication between the interior of the spinal canal and the exterior. This of course leads to a free discharge of the cerebro-spinal fluid and the death of the patient usually occurs in a very few days.

CLINICAL CHARACTERS.—From the point of view of treatment the following characters are important:

(a) **The size of the tumour,** which may range from a small rounded swelling the size of a walnut to a large ovoid sac occupying the area of several vertebræ.

(b) **The size of the defect in the laminæ.**—This may vary from a small opening barely large enough to admit a finger, up to a wide furrow occupying a considerable portion of the spinal column. There is however no constant ratio between the size of the tumour and the defect in the bones.

(c) **The coverings of the tumour.**—The swelling is sometimes covered by normal skin; more commonly it is only surrounded by normal skin for about the lower half. Above that the wall is thin, membranous and translucent, the skin being either very imperfectly developed or entirely absent, and its place being taken by a papery membrane. The area uncovered by skin is frequently ulcerating, and there are sometimes sloughs or even perforations through which the cerebro-spinal fluid escapes freely.

(d) **The contents of the sac.**—A point of the very highest importance is whether nerve elements are present in, or adherent to, the wall of the sac. When they are absent, the tumour is freely translucent in all directions; when present, however, they throw a shadow on trans-illumination, and their distribution and character may often be made out very distinctly, especially when the covering of the sac is membranous. Too much reliance however must not be placed on the absence of a shadow as indicating absence of nerve elements, for in some cases no satisfactory shadow is cast although the nerve elements are present. The presence of nerve elements in the sac is also often denoted by an umbilicus in the centre of the tumour or by a vertical median furrow corresponding to the attachment of the cord to the sac wall.

(e) **Malformations and paralyses.**—In the great majority of cases other congenital malformations co-exist, the most common being talipes calcaneus, and nervous disturbances, such as want of control over the sphincters, loss of sensation and motion in the lower extremities, etc. Trophic ulcerations are naturally common in connection with these paralyses, and hydrocephalus is either a frequent accompaniment of the disease or not uncommonly follows attempts at a cure. These deficiencies of innervation are also met with in spina bifida occulta.

Very few of the subjects of spina bifida reach adult life. Death usually occurs in the early weeks of life from marasmus, convulsions, septic troubles consequent upon the ulceration and rupture of the thin

membranous sac, or subsequently from hydrocephalus. The few who reach maturity are generally patients in whom the tumour is covered with healthy skin and contains no nerve elements.

TREATMENT.—The treatment of spina bifida resolves itself into palliative and radical treatment.

(a) **Palliative treatment.**—The first important question that presents itself to the surgeon is whether operative means should be resorted to or whether he will be content with palliative measures. These latter are called for in all cases where operation is refused, where the child is obviously so feeble that surgical interference is not warranted, where the opening into the spinal canal is very extensive, or where the covering of the tumour consists entirely of healthy skin and there is very considerable probability that the child may grow up; here operation is not urgently called for and is best delayed until the child is older. Operation would also be delayed when ulceration is present, so as to give time for the ulcer to heal, provided there be no imminent danger of perforation.

Shields.—The first essential in the palliative treatment is to protect the tumour from all possibility of injury by an accurately fitting shield, which should be moulded directly to a cast of the swelling. This shield may be made of various materials; among the most satisfactory are aluminium or celluloid, which should be perforated with holes so as to allow the perspiration to evaporate. These shields may be fixed on by strapping around the margin so as to prevent them shifting laterally, and by a broad abdominal belt fastened in front. Poroplastic felt also makes a very good shield; it allows the escape of perspiration and is cheap, but if the tumour be large, it will require strengthening to prevent it from being dented on pressure. This is easily done by fastening two strips of light steel at right angles to each other over the exterior of the shield. Beneath the shield should be placed a piece of boracic lint, and, if ulceration be present, this lint should be coated with quarter-strength boracic ointment and the part dressed night and morning. Great care must of course be taken to prevent soiling of the region of the tumour, especially when it is situated low down.

(b) **Operative Measures.**—The only operative measures that promise any reasonable hope of success are injections of Morton's fluid and excision of the sac. Such procedures as ligature of the sac, galvano-puncture, the introduction of setons, etc., are bad, on account of the septic infection which practically always follows and because of the injury frequently done to the nervous contents of the sac.

(a) **Injection of Morton's fluid.**—The plan of injecting these tumours has been practised for many years, but it was not followed by any real benefit until Dr. Morton suggested his combination of iodine with glycerine with which such greatly improved results have been obtained; indeed in a considerable number of cases a cure has followed. Morton's fluid consists of ten grains of iodine and half a drachm of iodide of potassium

to the ounce of glycerine. The object of the iodine is to cause sufficient irritation to lead to thickening of the sac wall and its ultimate contraction and obliteration, while the glycerine prevents unduly rapid diffusion of the solution, thus ensuring a more concentrated action of the drug and a diminished risk of spinal meningitis. The iodide of potassium is merely employed as a solvent of the iodine.

In performing the injection, several points must be attended to. In the first place it is most important that the needle, which should be sufficiently large to allow the fluid to flow readily through it, should be introduced through normal skin on one side of the base of the tumour; care must also be taken to avoid any spot where there is puckering or depression of the sac wall indicating the attachment of nerve elements. The needle alone is introduced first and, if the sac be tense, a small quantity, not more than a third of its contents, may be drawn off; when there is no marked tension, it is unnecessary to draw off any of the fluid. The syringe is now fitted to the needle, and a quantity of Morton's fluid, varying from fifteen drops to a drachm, according to the size of the tumour, is slowly injected. As the needle is withdrawn, the puncture is pinched up and finally closed with a small collodion dressing.

After-treatment.—After the injection the child should be kept on its face or its side for a few hours until the puncture is sealed, so as to avoid the escape of cerebro-spinal fluid. In the course of a few hours however, the child is turned over and kept lying on its back for some days. The tumour should be protected from friction and pressure by cotton wool or a moulded shield. The first effect of the injection is irritation, pain, and swelling of the sac; if benefit follows, the sac will become thickened, the fluctuation less evident and the translucency diminished. It is usually necessary to repeat the injections several times before a complete cure is obtained; this may be done at intervals of about a fortnight.

Cases suitable for injection.—Children who have been cured of spina bifida in this way, or indeed after excision, not infrequently become the subjects of fatal hydrocephalus. Hence it is never advisable to inject a spina bifida so long as the child is doing well and the sac is not threatening to burst; moreover, the older the child the better it stands the injection. We should say that the only cases really suited for Morton's injection were those of simple meningocele in very young children in which the tumour was rapidly increasing, and also those cases of ulcerating spina bifida where excision was out of the question and perforation was imminent.

(b) **Excision.**—By the excision of a spina bifida we understand an operation in which the redundant meningeal structures and skin are removed, the nerve elements, if present, separated from the sac wall and replaced in the vertebral canal, and the skin and meninges carefully sutured over the defect. In the hands of many surgeons this operation is taking the place of all other procedures for tumours that are increasing in size, and it is preferred by most authorities to injections with Morton's fluid. Of

late years the operation has been still further developed by the introduction of attempts to restore the bony roof of the spinal canal, so as to prevent on the one hand the possibility of recurrence and on the other the risk of injury to the cord from injuries later in life.

This operation is suited for a considerable number of cases, but strict asepsis is absolutely essential for its success. This is by no means an easy matter to obtain when the tumour is in the lumbo-sacral region, especially when the child is only a few days or weeks old. Failure to obtain asepsis means an inevitably fatal result from septic spinal meningitis. In some of these operations also there must be considerable shock, especially when the nerve elements have to be dissected out. In fact, when we consider the age of the patient, the situation of the tumour, the consequent liability to septic infection and the magnitude of the operation, it is a very severe procedure; the mortality is undoubtedly large, and therefore the operation should not be resorted to except when it is absolutely necessary.

Cases suitable for excision.—From the point of view of suitability for excision we may divide the cases into the three following groups:

1. *Cases in which the sac is covered by normal skin and does not contain nerve elements.*—Unless the tumour be large and increasing, these cases may

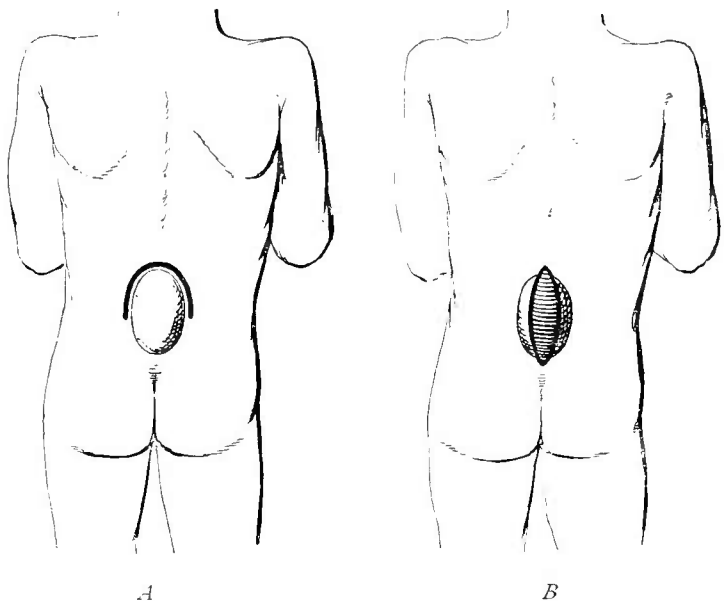


FIG. 79.—INCISIONS FOR EXCISION OF A SPINA BIFIDA. *A* shows the flap method that may be used when stout healthy skin covers the tumour. The incision may be made with its convexity to one side if the shape or size of the tumour demands it.
B. The incision in common use. This goes through the sound skin around the sides and base of the tumour, and encloses the thin membranous portion, which is removed.

as a rule be left alone, or at most may be treated by means of Morton's injections. When an operation is considered necessary because of the continued increase in the size of the tumour and the gradual thinning of the skin, the following is the procedure. The skin is rendered aseptic, and scrupulous precautions are taken against shock both before and during the operation (see

Part I., p. 139). The child should lie on a hot-water pillow, the extremities should be wrapped up in cotton wool and the operation performed as rapidly as possible. When the skin over the tumour is thick and has a plentiful supply of subcutaneous tissue, a curved incision may be made round the upper edge of the tumour and a horse-shoe-shaped flap turned down. In most cases however the skin over the centre of the tumour is so thinned that it would hardly live if treated in this way and therefore elliptical incisions enclosing and removing a considerable portion of the skin over the prominence of the swelling have usually to be employed (see Fig. 79). All the tissues down to the sac itself should be taken up in the skin-flap; when the sac is exposed, it is often easy to peel off the skin and subcutaneous tissues from it with the handle of the knife.

The sac is now pricked and the cerebro-spinal fluid allowed to flow out gradually, the child's head and shoulders being kept dependent so as to avoid too sudden an escape of the fluid. The next point is to ascertain whether nerve elements are present in the sac. The opening is gradually and carefully enlarged, and the inner surface of the sac inspected both by touch and sight. The redundant portion of the sac is now excised and the remainder of its wall sutured over the gap. In excising the redundant portion of the sac, the incision should be made to one side, so that the deep line of sutures will not correspond with the sutures in the skin which fall more or less in the middle line (see Fig. 80). The skin-flap is then laid down, and united by a continuous suture, the ordinary antiseptic dressings are applied and the child kept on its face, with the head somewhat dependent until healing is complete.

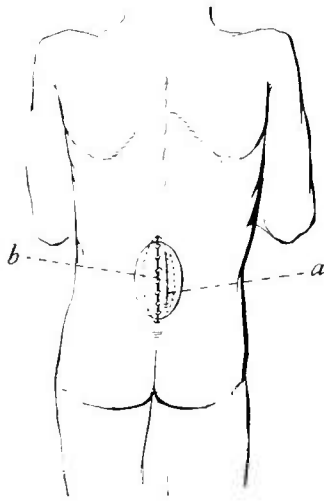


FIG. 80.—THE FLAP METHOD OF EXCISING A SPINA BIFIDA. The incision is that shown in *B* of the preceding figure. When this skin incision is sewn up it forms a median cicatrix *b*. By making the elliptical incision in the sac wall a little to one side, the line of suture is made not to correspond with that of the skin—as is shown in *a*.

When the defect in the neural arches is very wide and the coverings of the tumour are almost entirely membranous, it may be impossible to make the flaps meet in the middle line. It will then be necessary either to undermine the skin for some distance around and bring the edges together with stitches of relaxation (see Part I., p. 155), or else to do a plastic operation and turn in a skin-flap from below.

The after-treatment practically consists in taking care to avoid septic infection. The dressings should be fixed on with collodion or strapping instead of with bandages, and each dressing should be small in quantity and renewed at least twice daily, especially when the affection is in the lower sacral region and where consequently there is great risk of soiling of the wound.

Osteoplastic procedures.—Whenever possible, an attempt should be made to repair the defect in the bone; in newly-born children such a procedure is of course out of the question because in them it is essential that the operation should be performed as quickly as possible. At a later date however, when the child can bear a more prolonged operation, the operation is of considerable value. When there are portions of the laminæ remaining on each side, attempts have been made to close in the opening by dividing the attachment of the laminæ to the articular processes and pedicles of the vertebræ with a chisel, thus allowing the fragments to be pulled inwards over the sutured sac wall.

In another method, which has been carried out in the sacral region, the soft tissues are peeled off the side of the sacrum for some little distance and then a thin layer of the bone with the periosteum attached to it is chiselled up on each side and left attached at the edge of the defect. This plate of bone is then bent over and laid over the gap. It has been suggested that a similar procedure might be carried out in the dorsal region by raising a portion of bone and periosteum from the ribs. This is left attached at its inner end, while the outer is pushed through a slit in the spinal muscles and brought over the canal; this however is only a suggestion and we cannot say whether it would work in practice.

Success has however been obtained in several instances by bone-grafting, the bones employed being either the scapula or the skull bones of rabbits. The scapula, divested of its muscles, forms a very satisfactory plate between the skin and the sac, and has succeeded in more than one instance. The exact methods of grafting bones from animals, including the preparation of the animal and so forth, have already been described in Part III., p. 178. When an animal is not available, small portions of decalcified bone may be placed over the surface beneath the skin, but as a rule, beyond leading to a little extra thickening in the scar, this does not give rise to any actual bone development.

2. *Cases in which the sac is partly membranous and contains nerve elements.*—In these cases the operation differs from the above in several important particulars. The centre of the sac is usually covered by membrane, and any attempt at a flap is out of the question. Hence the thin portion of the sac should be enclosed by an elliptical incision; the further steps for the isolation of the sac are the same as in the preceding group of cases. The next point is to open the sac and separate the nerve structures; for this purpose a small incision is first made, and through it the cavity is inspected and the distribution of the nerves noted. The incision is then enlarged until the sac is laid freely open, and it is an important point to remember not to make this incision in the middle line. There are two objects in avoiding the middle line; in the first place the cord if present will escape damage, and in the second place the line of suture of the sac will not correspond to that of the skin.

The next step, that of dissecting out the nerves and returning them into the spinal canal, may be quite easy or it may be a matter of great difficulty. When the nerves simply pass across the cavity of the sac on their road to the intervertebral foramina there is no particular difficulty in isolating them: when however they are intimately adherent to the sac wall, which itself is thin and membranous, or when the cord is flattened out and adherent to the sac, the difficulties are very great, and considerable time may be required for the operation. The various structures must be most carefully identified and separated, and, if the nerves cannot be dissected quite free from the sac wall, the latter must be left adherent and returned with the nerves into the canal. The subsequent steps of the operation are similar to those just described. It is particularly in these cases that the difficulty in bringing the skin-flaps together at the end of the operation that has just been alluded to is most likely to be met with.

3. *Cases complicated by ulceration of the sac wall.*—This is a complication of the very gravest nature; on the one hand, it demands early operation, as otherwise rupture of the sac and fatal septic meningitis are certain, while, on the other hand, it minimises the surgeon's chance of obtaining a good result owing to the difficulty of securing asepsis. In all cases in which nerve elements are present in the sac and are adherent to the wall beneath the area of ulceration the matter is quite hopeless, because the ulcerated surface must be removed and the chances of carrying infection inwards are enormous. If the imminence of perforation of the sac demands that something must be done, it will be best to have recourse to Morton's injections (see p 297).

When matters are not so hopeless and operation is called for, disinfection of the ulcerated surface must be effected with undiluted carbolic acid, which should be thoroughly rubbed into the whole of the ulcerating surface, while the skin around is disinfected in the usual manner. The elliptical incision must of course go quite wide of the septic area, and if there be difficulty in getting the skin to meet afterwards—as usually happens—the skin around may be undermined or flaps may be made to enable the edges to come together without any great tension (*vide supra*).

Treatment suitable for the individual forms.—A few words may be said as to the applicability of these methods to the varieties of the affection already mentioned:

1. *Meningocele.*—As there are no nerve elements in the sac and the tumour is generally covered by sound skin, this is the most favourable condition. When the opening into the spinal canal is small, Morton's injections are best: when it is large, the operation should be delayed as long as is consistent with safety, the child wearing a shield in the meantime. If, as the child grows, the tumour tends to enlarge, excision and an attempt at osteoplastic repair should be employed.

2. *Meningo-myelocele and syringo-myelocele.*—Should the skin be sound all over the tumour, excision, with isolation and return of the nerve elements

is best. In all cases where operation is required on account of increase in the size of the tumour or a tendency to ulceration over the sac, etc., excision is the best procedure ; when the tumour is ulcerating, excision is absolutely essential if it can be done ; if not, Morton's injections may be had recourse to.

3. *Myelocele.*—Here there is nothing to be done except to purify the parts thoroughly and apply an antiseptic dressing.

CHAPTER XXVII.

KYPHOSIS; SCOLIOSIS.

UNDER this heading are included the forms of spinal curvature which are not due to disease of the vertebræ, in contra-distinction to the disease known as angular curvature or Pott's disease, which is due to a tuberculous affection.

Two forms of functional curvature of the spine are met with in practice. The first of these is known as kyphosis, or general curvature of the spine, and although it may in time lead to the second more serious form known as scoliosis, it is, as a rule, transient in nature and easy to treat. We shall therefore deal with this first.

KYPHOSIS.

In infancy.—This is usually associated with considerable muscular weakness, and also with rickets. As a rule it is merely temporary, and disappears as the child grows stronger. In bad cases, however, especially in those with extensive rickets, the curvature may not disappear, and, as ossification takes place, the child will be round-backed and stooping. The condition, if persistent, is also very likely to become the starting-point of the other and more serious form of curvature of the spine, namely scoliosis, and therefore always requires treatment.

A child who is the subject of kyphosis has a constant tendency to sprawl upon the back, and is unable to voluntarily assume the sitting posture. When the child is sat up, the trunk is bunched forward and the spine is strongly bowed backwards, so that the chin often nearly touches the knees. The entire spine is bent forwards into one large C-like curve. There is no want of mobility of the spine, and usually little or no tenderness on pressure. Except in very advanced cases the curvature entirely disappears when the child is laid flat on the back upon a hard level surface. There is no lateral bending of the spine except when the kyphosis has persisted for a considerable time.

In adult life.—Kyphosis is uncommon later in life, but may be met with at all ages. In the adult it is generally due to the habitual adoption of a faulty position, such for instance as that assumed by some bicyclists. At a more advanced age the condition may result from senile degeneration: the spinal muscles lose their tone, and the vertebral column becomes bowed forwards in consequence. This is of course a part of general debility, and calls for no special treatment.

Kyphosis may also complicate various general diseases, of which the most typical are osteo-arthritis and osteo-malacia. It also commonly occurs in the rare disease known as osteitis deformans, and is present in some forms of paralysis, in which it is due to atrophy of the erectors of the spine.

TREATMENT.—*In infants* this is very simple. It is of the first importance that strict instructions should be given for the child always to be carried in the horizontal position, and never to be sat up in the nurse's arms. Any assumption of the upright position will favour the bending forward of the head, which, in a weakly subject, will lead to bowing of the spine and this condition of kyphosis. With an intelligent nurse and in the children of the well-to-do it is easy to have this order properly carried out, and no apparatus of any kind need be employed. In hospital patients, however, where the infant may be nursed by a number of people and is often neglected, it is well to insist that the child shall be carried about on some form of basket-lid or tray, upon which it lies always in a horizontal position. Suitable wickerwork trays, appropriately padded, have been designed for the purpose, and are very suitable and inexpensive. Where this cannot be afforded, a basket-lid or an ironing-board padded with a folded blanket answers the purpose perfectly well.

In children who are approaching the end of the first year of life, and are therefore beginning to sit up and crawl about, the maintenance of the horizontal position is not quite so easy as in young infants; in them it is well, while enjoining the maintenance of the horizontal position as much as possible, to apply some light spinal support which will mechanically prevent the bending forwards of the vertebral column. For this purpose we are in the habit of moulding a sheet of guttapercha, leather, or poroplastic felt of appropriate size over the sides and back of the thorax, and fixing it above and below by bands of webbing passing across the front of the shoulders and the upper parts of the thighs, steadying the whole by a firm bandage. The child is thus provided with a light but stiff support which will counteract any tendency of the spine to assume the bent position. The child may be allowed to sit up and crawl about with comparative freedom wearing this apparatus.

The general health must receive careful attention. If rickets be present, the measures appropriate for that affection (see Part III., p. 207) must be adopted. Cod-liver oil and iron administered internally are of consider-

able benefit, and to these may be added the local treatment of the back muscles by suitable massage. The spinal muscles should be rubbed night and morning for from five to ten minutes at a time, either with olive oil or with sea-water.

The kyphosis of adult life resulting from faulty positions does not call for any particular treatment beyond that dictated by common-sense, such as attention to posture, which if necessary must involve the giving up of the particular occupation that induces the curvature. This should be combined with massage and suitable gymnastic exercises designed to extend the spine and to strengthen the erector muscles. These will be described immediately in connection with scoliosis (see p. 319).

The treatment of the kyphosis which occurs as a complication of various other diseases, such as osteo-arthritis, osteo-malacia, and osteitis deformans, calls for little or no remark. The treatment must be that of the primary disease of which the spinal deformity is a mere episode and not one which, as a rule, gives rise to any discomfort.

SCOLIOSIS.

By this term is understood a lateral deviation of the spine, accompanied by a certain amount of rotation of the individual vertebræ upon their vertical axes; this latter occurrence is essential for the production of true scoliosis, for it is possible to have a lateral deviation of the spine without any rotation of the vertebræ—when the case is strictly one of lateral curvature rather than of true scoliosis. The two terms should be kept quite distinct, but at the same time it must be remembered that many cases of true scoliosis commence as a simple lateral deviation of the spinal column, and the rotation of the vertebræ only takes place at a later period; this is particularly the case when the spinal muscles are weak. Simple lateral curvature, if treated sufficiently early, does not necessarily give rise to true scoliosis.

CAUSES.—We shall not attempt to go at length into the mechanics of this condition, but various experiments seem to prove that the most essential factor in the production of scoliosis is the transmission of the weight of the upper part of the body through the vertebral column, which, by the enfeeblement of its various muscles, or by the habitual maintenance of a faulty position, has allowed a lateral deviation to occur. The constant pressure thus produced will inevitably produce rotation of the vertebræ on account of the conformation of the constituent parts of the curved spine and their articulations.

The condition is strongly predisposed to by any cause of general debility, particularly rickets and anæmia, and is greatly favoured by over-fatigue and the constant assumption of faulty attitudes. The latter, by causing a deviation of the spinal column, places the spinal muscles on one side at a mechanical disadvantage compared with their fellows on the

opposite side, and, if a faulty position be habitually assumed, the muscles that are at a mechanical advantage will keep up or even accentuate the curvature, and will eventually produce the rotation of the vertebræ already spoken of. This rotation always takes place in one direction; the bodies of the vertebræ are rotated outwards towards the convexity of the curve, whilst the spinous and other processes are rotated inwards towards the side of the concavity, *i.e.* towards the middle line of the body.

It will perhaps help to make the matter clear from the point of view of treatment, if we classify cases of lateral curvature according to their causes into four main groups:

1. Cases due to inequality in length of the supports of the spine.—This group is of the highest importance, and embraces various causes, many of which are constantly met with in practice. Unless the base of the support of the spine (*i.e.* the sacrum) be horizontal, a certain amount of curvature must necessarily result. However slight the obliquity may be, it is sufficient to prove the starting-point of a severe scoliosis in susceptible subjects. In strong healthy persons, on the other hand, this obliquity may be easily corrected, and may pass practically unnoticed. Among the commonest of this group of causes is obliquity of the pelvis, resulting from an inequality in length of the two lower limbs. This may occur as the result of hip disease, of congenital dislocation of the hip, or of the arrest of development which follows infantile paralysis. In weakly subjects scoliosis is not at all an uncommon complication of bad genu valgum and even of flat foot. The primary curve in this group is usually in the lumbar or lower dorsal region.

2. Cases produced by inequality in the weight borne on the two sides of the spine.—Common examples of this are seen in nursemaids who carry children habitually upon one arm, labourers carrying hods, pails or heavy weights always on the same side, cases where amputation of one arm at the shoulder joint has been performed in young subjects, etc. It is of course not necessary that scoliosis should be produced in every case in which unequal weights are carried on the two sides; as long as the subject is perfectly strong and vigorous, and the weight carried is not out of proportion to the strength of the muscles, the latter are able to maintain their tone, and to keep the spine erect when the position of rest is assumed. When however the muscular system is weak or the weight is excessive, and particularly when it is carried for long periods at a time, scoliosis is apt to result.

3. Cases due primarily to weakness of the spinal muscles, aided by the habitual assumption of a faulty position.—This cause is responsible for a very large number of cases of scoliosis. As long as the patient is in good health, the muscles upon the two sides of the spine act together to keep that structure erect, but in certain subjects, and especially at certain periods of life, muscular weakness occurs, and the muscles are no longer equal to their task of keeping the spine in its normal position for

any length of time. This is most commonly seen in girls from the age of twelve to seventeen—a period which coincides largely with the onset of menstruation, and the abandonment of the free and vigorous life and exercises of childhood. It is a period often marked by a predilection for sedentary habits, the semi-recumbent position, confinement to heated rooms and the keeping of late hours, together with the assumption of tight-fitting garments which hinder the free play of the muscles so essential to the proper development of the trunk. The condition is still further aggravated if anæmia be present; fatigue is then produced by any slight muscular exertion, which in the subjects we are speaking of still further encourages an avoidance of active exercise and a recourse to faulty attitudes.

One of the strongest factors in bringing about scoliosis is over-fatigue, either from too long continued standing, sitting, or walking. Nursemaids, typewriters, school children continuously engaged in reading, writing, or piano-playing, which involve the habitual assumption of a faulty position of the spine, may all develop scoliosis, should the general health be such as to cause enfeeblement of the muscles. A similar result occurs in girls who are in the habit of riding on horseback for periods long enough to cause fatigue to the muscles of the back, and to lead to a faulty position of the spine. This is the explanation of the fact that rapidly growing girls who are at all weakly are generally recommended, if they practise horse-riding, to ride on opposite sides of the horse on alternate days, so as to exercise equally the erector muscles on the two sides. A similar condition is produced in children if they are always carried on the same arm, whereas if they be carried first upon one arm and then upon the other, the results, both to the nurse and to the child, are not likely to be injurious.

4. Cases in which the deformity is secondary to other affections of the spine or thorax.—Here the curvature of the spine is mechanical, and is produced by some alteration in that structure itself, or in the capacity of the thorax. Familiar examples are the lateral curvature that is secondary to empyema, collapse of the lung, rickets, and tuberculous disease of the spine, etc.

PATHOLOGICAL CHANGES.—After a time organic changes take place in the ligaments and the bones, so that a curvature, which at first could be easily rectified by appropriate position, becomes more and more permanent. The first change that occurs is an alteration in length of the various fibrous structures on the two sides, those upon the convexity becoming stretched, and those upon the opposite side being proportionately shortened. In advanced cases, the vertebral bodies themselves become altered so that each is of a somewhat wedge-shape, the base of which is directed towards the convexity of the curve. The surfaces of the various articular processes become altered in direction. These bony changes are of course permanent, and account for the intractability of the severe cases.

SYMPTOMS.—The symptoms of scoliosis are generally divided into the objective and subjective symptoms.

Objective symptoms.—These vary very considerably. Sometimes the spine is bent to one side in a large single **C**-shaped curve, which may either occupy the entire vertebral column, or may be confined to the lumbar or dorsal regions. Should a curvature of this kind be at all marked, it will be necessary for the adjustment of the centre of gravity for one or more compensatory curves to be formed in the opposite direction, as otherwise the erect position could not be maintained. These compensatory curves have their curvature in the opposite direction to the main one, and are usually smaller in extent than the primary curve. They occur either at the upper or lower end of the main curve, generally at the upper.

In the more usual variety, two curves are found with their convexities in opposite directions, so that the spine forms a more or less perfectly-shaped letter **S**. Of these, one is usually called the primary and the other the secondary curve. The primary curve cannot always be clearly distinguished, but a fair idea can generally be gained by considering the mechanism of the formation of the curvature. If due to an inequality in the length of the lower extremities, the primary curve will be in the lumbar or lower dorsal region, whilst that in the upper dorsal is merely compensatory; on the other hand, if the curvature be due to faulty position, the primary curve is usually in the upper dorsal region, whilst the compensatory curve is below it. When the primary curve is very marked there may be three or even more curves in the spine; the primary curve is then generally very acute, and at either end of it there is a compensatory curve. This is usually the case in severe dorsal curvature, when there is a compensatory curve in the cervical and another in the lumbar region. In some of the rarer cases certain of the spinous processes may project markedly backwards; the case then requires careful examination in order not to confound it with tuberculous disease.

Amongst the objective symptoms one of the most marked is the asymmetry of the thorax. The shoulder upon the side of the convexity is higher than its fellow; the intercostal spaces are considerably wider on that side whilst they are narrowed upon the side of the concavity. The spinous processes deviate from the middle line. The distance between the lower ribs and the brim of the pelvis upon one side is much increased, whilst there is a deep fold in the corresponding situation upon the opposite side. The total body height is diminished.

When there is much rotation of the bodies of the vertebræ the thorax undergoes extensive deformity; the ribs on the side of the convexity are carried backwards whilst they travel in the opposite direction on the opposite side. The shape of the two sides of the thorax is therefore greatly altered. On the side of the convexity the vertical measurement of

the thoracic cavity is increased, owing to the separation of the ribs, but the transverse one is lessened. On the side of the concavity the reverse is the case, but probably the capacity on the two sides is but slightly altered. The angles of the ribs on the side of the convexity become more acute, whilst those on the opposite side either remain unaltered or the angle becomes more obtuse. The result of this is a prominent ridge upon the side of the convexity formed by the angles of the ribs with the erector muscles over them. The clavicle on that side may have its curves considerably increased, and cases are even recorded where the sternal end has become dislocated. The scapula on the side of the convexity is carried backwards to a plane considerably posterior to its fellow, and is raised and sometimes considerably tilted. The arm on the opposite side hangs away from the thorax.

Subjective symptoms.—The subjective symptoms are usually slight, but may become exaggerated in neurotic subjects or in those in whom the deformity is very great. There is aching pain, and a feeling of weariness in the back and loins, sometimes extending down to the thighs. When the deformity has lasted long and extensive bony changes have occurred, there may be considerable pain, partly from the pull upon the stretched ligaments and partly from direct pressure upon the nerves or the viscera. The lung may be markedly compressed upon the side of the convexity, and patients with longstanding dorsal curvature are very apt to suffer from severe bronchitis; the heart may be also displaced, and the liver and spleen unduly pressed upon.

There should be no difficulty in diagnosing this condition from tuberculous disease, as in scoliosis there is no rigidity and no tenderness on pressure over the affected vertebræ or on jarring down through the head. Moreover, except in rare cases, there is no projection backwards of the vertebræ.

EXAMINATION.—In examining a subject of scoliosis in order to determine the treatment to be adopted, a certain routine should be gone through. The patient should be stripped to the waist and should stand in a position of ease with her back to the surgeon. The spinous processes should then be marked with a carbon pencil upon the skin; this allows a permanent record to be taken by pressing a piece of paper over the skin, when the marks made by the pencil will be transferred to the paper, and this can be varnished and kept for future reference. When the deviation of the spine is only slight it is best ascertained by taking a plumb-line, easily made by weighting a piece of thin string with a small lead button, applying the upper end of the line against the spinous process of the seventh cervical vertebra and letting it hang vertically. Any deviation of the spinous processes from the vertical can be then easily appreciated.

The next important point is to ascertain whether there is any obliquity of the pelvis. The patient is turned round and the surgeon, standing or

kneeling in front, places a thumb upon each of the anterior superior iliac spines and notes whether they are upon the same horizontal level; should there be any doubt upon this point the length of the lower extremities should be measured from the anterior superior spine to the tip of the internal malleolus on each side. The presence of flat-foot or knock-knee should also be looked for.

The next point in the examination is to see how much alteration can be made in the curvature; in other words the flexibility of the spinal column is tested. If the case be a slight one, the patient should be directed to hold herself as erect as possible and any alteration in the curvature is then compared with the measurements that have already been taken in the position of rest. If the curvature be only slight, it will generally be found that marked improvement is produced by the effort necessary to stand at attention. Should the curvature be due to inequality in the length of the lower extremities, suitable blocks should be placed beneath the shortened limb so as to make the pelvis perfectly horizontal, and the effect upon the curvature noted. In early cases this will practically entirely obliterate it.

Should these methods not succeed in entirely obliterating the curve, the patient should be suspended by the hands from a suitable bar, with the feet just off the ground, so that the entire weight of the body is borne by the arms. A more accurate method of doing this is to use a trapeze with two bars, the upper one being three inches above the lower, hung just sufficiently high to swing the patient free of the ground. The lower bar is grasped with the hand upon the side of the convexity, whilst the upper is laid hold of with the other; this pulls upon the spinal column and tends to straighten the curve. The positions of the spinous processes are now noted and compared with those observed in the standing-at-ease position. In young children the bar may be dispensed with, the child being lifted from the ground by the arms. The amount of rotation of the vertebræ is easily gauged by noticing the alteration in the ribs; advanced deformity of this kind is a symptom of bad import as it is more difficult to rectify than the ordinary lateral curvature.

PROGNOSIS.—This procedure is of the greatest importance both to prognosis and to treatment, as it shows how much flexibility remains in the spine and gives a good indication of the result that can be expected from treatment. Should the suspension fail to obliterate the curve entirely, it tends to show that ligamentous or even bony changes have taken place in the spinal column and that therefore no absolutely perfect restoration of the erect position is likely to result from treatment. On the other hand, if the spine be thus rendered perfectly straight, a hopeful prognosis may be given and the chances are that, with proper care and suitable treatment, the curve may in time be entirely obliterated.

When called upon to give a definite prognosis in these cases, the surgeon must remember that a large number of the minor degrees are

of a purely temporary nature, depending probably upon some defect in the general health, and that the curvature will either be arrested or be entirely cured as the muscles recover their normal tone. The disparity between the number of cases of slight lateral curvature coming under notice in early life and those in adults in whom the curvature amounts to an actual deformity proves that something of this kind must occur probably in the large majority of cases: the number of cases occurring in early life is extremely large whilst in adults it is much smaller. The cases most likely to end in spontaneous cure are those in which there are two slight and equal curves rather than a large C-shaped curve. The tendency of the small S-shaped curve is to spontaneous cure, as there is a proper compensation between the two curvatures, whereas the large single one tends to become greater and to result in very important rotation changes since there is no compensation.

When the curvature is due to inequality in length of the two extremities the cases are very amenable to treatment if seen within a reasonable time, and a perfectly good result can generally be obtained. The opposite is the case when the curvature is the sequela of some chest disease, such as empyema.

Perhaps however the most important feature in the prognosis is the condition of the patient's health. Scoliosis associated with profound anæmia is most difficult to treat and, unless a vigorous course of treatment directed to the cure of the anæmia be rewarded with success, the result upon the curvature will be very slight. The most difficult cases of all are those in girls soon after the age of puberty, in whom there is much anæmia associated with dysmenorrhœa, and, when these two conditions are combined with a distinct neurotic taint, the case may prove so rebellious as to be almost intractable.

Another point of great importance is the age of the patient at the onset of the curvature. In a very young child the vertebræ are not fully ossified and are soft and easily moulded, and there is therefore a long period during which the spine if not maintained in its proper position may undergo serious structural alterations. On the other hand, if the disease begins comparatively late there is only a short time before complete ossification has occurred, and there is therefore but little time for advanced changes to take place in the vertebræ. The curvature will therefore develop much more slowly,—a point which is very important with regard to treatment.

TREATMENT.—Before proceeding to deal with the treatment of pronounced scoliosis it may be advisable to say a few words as to the means best calculated to prevent its occurrence in susceptible subjects.

Prophylaxis. 1. When there is obliquity of the pelvis.—Any patient in whom there is inequality in the length of the lower extremities should invariably receive treatment directed to remedying the obliquity of the pelvis which will result. Cases of hip disease with deformity and shortening

should have the deformity remedied as far as possible (see Chap. XIX.), and should then be fitted with a high boot so as to make the two limbs the same length. Cases of congenital dislocation of the hip should receive appropriate treatment (see Part II. p. 130), or, if it be impossible to get the head of the bone into position, a high boot or a suitable apparatus should be fitted. An apparatus will also be required for cases of arrest of development in infantile paralysis, whilst genu valgum and flat-foot should be treated upon the lines laid down in Part II.

2. When heavy weights are carried upon one side.—Here the obvious prophylactic remedy is to see that any weight likely to produce curvature is carried alternately upon the two sides. It is especially necessary to instruct nursemaids to carry children alternately upon either arm,—an order that will benefit both child and nurse alike. In the somewhat rare cases in which one arm is lost, it is difficult to carry out this rule and therefore all that can be done is to attempt to prevent the patient from carrying heavy weights, or, if enough of the limb remains to allow an artificial limb to be added the weight should be carried alternately by the natural and the artificial limb.

3. When there is weakness of the spinal muscles, etc.—The prophylactic measures in these cases are mainly the ordinary rules for personal hygiene, but there are one or two points to which special attention should be paid. In the first place all weakly children or those suffering from rickets should be invariably carried in the horizontal position; they should never be carried upright in the nurse's arms, and even when the child is perfectly strong and healthy this should only be done provided that the child be carried alternately on either arm. The use of massage to the back muscles combined with applications of sea-water douches recommended for kyphosis (see p. 306) is of considerable value. Every weakly child should have the back muscles carefully rubbed night and morning for from five minutes to a quarter of an hour at a time.

Special care is needed in the case of girls who are growing fast and are nearing the onset of puberty. All heavy or constricting garments about the chest or abdomen which interfere with the free play of the thoracic, abdominal, and spinal muscles should be forbidden, and the child should be encouraged to play games, to lead a healthy out-door life, and to go through a mild gymnastic course. Sedentary habits, the desire to remain in the house in the recumbent position constantly reading novels should be checked, and in fact the life of the two sexes should be assimilated as much as possible. Girls who ride on horseback and in whom there is any tendency to curvature should always be made to ride upon a reversible saddle so that the exercise can be taken on alternate sides, and the rides should never be long enough to produce fatigue. Any menstrual irregularities must receive careful and prompt attention. Stays of any kind are bad, and if employed they should be made so as not to compress the chest, their function being merely to support the spine.

It is about this period of life that curvature is very apt to result from faulty positions. Some attention has been directed to the possibility of producing lateral curvature by faulty positions during sleep. Many children sleep upon the back and this of course is obviously the best position. A large number however lie upon one side, and it has been said that, if the child constantly lies upon one side more than the other, this is likely to produce curvature of the spine. This view is probably an exaggerated one, but in all cases it is well, if the child be unable to sleep upon the back, to encourage sleeping upon alternate sides. The child should lie on a firm mattrass and not upon a feather-bed, and the head should not be unduly raised.

The positions usually adopted by children at school when sitting at a desk, writing, reading, or drawing, or when playing the piano, are often

FIG. 81.—THE TYPE OF DESK AND CHAIR SUITABLE FOR CHILDREN'S USE. The details are given in the text. If the child be very weakly, or if there be any actual curvature, a head-rest may be fixed to the chair, and the book may be made to approach the vertical more nearly by increasing the slope of the desk.

faulty, and calculated to produce scoliosis. The child is generally either seated upon a form without any back or, if a chair be provided, the back is usually too straight and is not high enough, whilst the seat of the chair is too far from the ground, and there is a want of proportion between the height of the desk and the chair or form upon which he is sitting. The result is that the child soon gets tired, and, in order to support himself, brings the pelvis to the edge of the chair in order to enable the feet to touch the ground, and he is very often obliged to tilt the pelvis in order to bring one foot into contact with the floor. The spine is thus unsupported

and the child either stoops forward or bends to one side so as to rest his elbow upon the desk at which he is writing.

The want of proper proportion between the height of the seat and the desk also plays an important part, for, when the desk is too high, the right arm has to be unduly elevated if the child is to write, whilst if the desk be too low it has to be unduly depressed and the left shoulder raised. In a weakly child this may lead to the development of a marked lateral curvature.

The following may be taken as the main points requiring attention to avoid these ill effects. The child should always sit upon a chair with a seat sloping slightly backwards, and this should be provided with a back inclined at an angle of 120° and so shaped as to support the curves of the lumbar and dorsal vertebræ (see Fig. 81). The back of the chair should extend upwards as high as the shoulders in all cases, and, should the child be suffering from a weak spine, it should be prolonged high enough to support the head. The seat of the chair should be at such a height from the ground that the feet rest easily upon the floor, or should be provided with a suitable foot-rest inclined at an angle of about 20°. The breadth of the chair-seat should be equal to the length of the child's thighs. A vertical line let fall from the front edge of the desk should just touch the front edge of the chair-seat, and there should be just room between the two for the child's thighs. The precise measurements usually given are that the lower edge of the desk should be an eighth of the height of a girl and one-seventh that of a boy above the seat of the chair. The writing desk should have a gentle slope so as not to force the child to bend forward too much when he wishes to read or write.

Any myopia should be at once attended to, and the child fitted with suitable glasses, as otherwise the stooping it necessitates is likely to act very injuriously in producing curvature. Even in these cases it is well to employ *exercises* to develop the chest and to strengthen the muscles, unless the child be obviously perfectly robust. In addition to the exercises, *massage* should be employed; this is a most important factor in treatment and should never be omitted. The question of exercises will be dealt with immediately.

4. When there has been disease within the thorax, etc.—In some of these cases naturally very little can be done in the way of prophylaxis. In cases of Pott's disease and rickets, appropriate treatment for the disease will stave off the onset of scoliosis. In cases secondary to empyema or collapse of the lung, a certain amount of curvature is inevitable; it may, however, be minimised by the use of suitable exercises mainly directed to bending the spine in a direction opposite to that in which the curvature is expected to take place.

When scoliosis has developed.—These cases may be divided into four large groups: (*a*) the curvatures of infancy, (*b*) those occurring during

childhood and before the onset of puberty, (*c*) those occurring during the period of adolescence, that is to say between puberty and the age at which growth ceases, and (*d*) those occurring after growth is complete.

(a) **The scoliosis of infancy.**—The remarks made with reference to the treatment of kyphosis (see p. 305) will apply very largely to this condition. The general health requires attention: any tendency to rickets must be corrected by proper feeding, by hygienic measures, and by the administration of appropriate drugs (see Part III. p. 208). Besides this, the child should be kept always in the horizontal position, either in the nurse's arms, or preferably upon a suitably padded wicker tray or basket. After the first year, the back support recommended for kyphosis (see p. 305) may be employed, but recumbency must still be strongly insisted upon, so as to relieve the back from the superincumbent weight. The child should always be sent to the country or to the seaside for a considerable period if possible, and, besides this, massage to the back muscles should be employed night and morning so as to strengthen them. The rubbing may be done either with olive oil, some simple liniment, or with sea-water.

Walking should be strongly discouraged; mothers are constantly anxious for the child to begin to walk early under these circumstances, but the importance of the recumbent or semi-recumbent position should be pointed out, and attempts at walking strictly prohibited. The child should be encouraged to sleep upon the back, and may if necessary be fastened down upon a suitably padded wicker tray in that position. For this purpose special bed splints are sold, and may be used if preferred. Should there be a marked curvature however, the lateral position may be usefully substituted for the dorsal, the child then lying upon the side of the convexity of the curve in the dorsal region, with a suitably sized firm pillow or small bolster interposed between the mattrass and the convexity of the curve. The object of this is to unfold the latter, and it will often be of considerable advantage. The mattrass should be of horsehair and firm; a feather bed should be avoided, and the child should sleep with the head supported merely by one small pillow.

(b) **The scoliosis of childhood.**—Great care has to be exercised in the treatment of curvatures during this period of life, for, although on the one hand the spine is extremely flexible, and therefore can easily be influenced by treatment, this very property may be a source of actual danger, because the curve if neglected will lead to such marked distortion of the bones when they become fully ossified as to render treatment very difficult.

Removal of cause.—Before proceeding to attack the curvature itself, the first indication is to eliminate any cause that may originate or keep up the vicious position. Any obliquity of the pelvis, due to inequality in the length of the lower extremities, must be remedied by suitable means, such as boots, operation, etc. Any vicious attitude acquired while sitting or standing at lessons, or even in playing games, must be carefully inquired for and forbidden, while some other attitude or game which tends to rectify

the faulty position thus produced must be substituted. Any physical defects, such as myopia, should receive treatment; adenoids or enlarged tonsils should be removed.

Medicinal treatment.—In addition to this, the general health must receive attention as it is extremely common in this group of cases to find some physical ailment. Of these the principal are anæmia, or, should the child have reached the menstrual age, amenorrhœa or menorrhagia, the latter being an important predisposing cause of this affection by lowering the muscular tone of the patient from the excessive hæmorrhage. The condition of the alimentary canal should be inquired into and dyspepsia or constipation, both of which are very common, should receive suitable treatment.

Certain dietetic and general hygienic points also require attention. The diet should be abundant but light and easily digestible; cod-liver oil should be given when the child is particularly weakly. Stress should be laid upon the patient being as much as possible in the fresh air, in the country or at the seaside, and the size and ventilation of the living and sleeping rooms should receive due attention.

The most important point is, however, the avoidance of fatigue which rapidly enfeebles the muscles and destroys the support of the spine. The treatment of the curvature itself will require a nice discrimination between rest and exercises, the exercises being designed to strengthen the muscles, the rest, to avoid tiring them. On the whole it is advisable that children at this period of life should lead a healthy, active outdoor life if it be possible for them to obtain it. Sitting and standing at lessons must be discouraged as much as possible in favour of vigorous outdoor exercise, which, by improving the general health and the muscular tone, will help to cure the curvature. The question of whether the patient shall continue at school is one that is constantly being asked, and so long as the advice just given is followed, there is no objection to the child doing so. The length of time for which she sits or stands at lessons should be cut down to the shortest possible amount compatible with her education, and, if care be taken to see that she sits upon a proper seat before a well-constructed desk (see p. 314) and if this be combined with a proper amount of rest and the performance of suitable gymnastic exercises (*vide infra*), there is a distinct advantage in the child remaining at school as she will then probably be more amenable to the discipline required for the proper performance of the exercises.

Recumbency.—A certain amount of rest in the recumbent position must always be rigidly insisted upon. The period of rest must of course be regulated by the particular features of the case, but in nearly all cases at least two hours a day are required. It is well to divide this period up into two equal portions and to order the patient to rest upon a couch for an hour about mid-day and for another hour in the late afternoon. If the patient will consent to it, the prone position is better than the supine;

many children however strongly object to this, and there is no real objection to employing the other. A good plan is to alternate the position, the child being first placed in the prone position until it becomes too irksome, when the supine position may be assumed. The rest may be taken upon an ordinary hard couch: it is better however to have a suitable spinal couch if it be obtainable, so that the patient lies upon a slightly inclined plane.

Exercises.—In addition to rest, some form of mechanical exercises must be provided, with the double view of strengthening the muscular system generally and of restoring the functions of those muscles that are mainly at fault in producing the curvature. *When the curvature is only slight*, little is required beyond general muscular exercises which can be carried out at home under the supervision of the parents or a capable nurse. Very good types of these exercises will be found in the Appendix (Series A, B, C, E, F, G, I). These exercises should be practised daily for a period varying from five or ten minutes to half an hour at a time, the most suitable time being in the late forenoon, and immediately after them the child should lie down for the mid-day rest. Full details of the position of the patient, etc., will be found in the instructions for the exercises and we need not go further into the matter here. In addition to these, dumb-bell exercises may be performed on rising in the morning for from five to fifteen minutes before dressing and are of considerable value. The dumb-bells should be very light, not exceeding a pound at the outset, the exact weight being chosen with regard to the requirements of the individual case. As the muscles get stronger and the patient more used to the exercises, the weight may be gradually increased, as may also the length of time during which the exercises are performed. The home exercises recommended above may be done with dumb-bells, and they are then equivalent to exercises carried out against resistance.

When the patient is a girl, riding exercise is also useful, provided that it be not practised long enough to cause fatigue. The child should of course ride upon the same side of the horse to that upon which the convexity of the curve is, so that there will be a tendency to open out the curvature. In the early stages of the treatment it is important to impress upon the parents that, when any of these forms of exercise cause fatigue, they should be stopped at once and the child allowed to rest.

Massage.—Massage to the muscles of the back is also very necessary, and should never be omitted. It should be employed twice a day for about half an hour, after breakfast and before going to bed.

When the curvature is very marked, it will be necessary to employ special exercises and other procedures designed to act directly upon the curvature, in addition to those which aim at improving the muscles generally. The case will then be closely allied to those about to be described in the following paragraphs, and the exercises will be the same.

(c) **The curvatures of adolescence.**—The treatment of the curvatures which occur between puberty and the final cessation of growth often

presents considerable difficulty owing to the impossibility of insisting upon that vigorous outdoor life, which it is comparatively easy to secure for younger patients.

The general indications for treatment are much the same as those already given for the preceding group of cases. Any mechanical or other ascertainable cause must be removed, and the general health must be attended to; menstrual irregularities, anæmia or constipation, any or all of which are frequently present, must be vigorously treated; careful personal hygiene should be insisted upon and the patient compelled to take regular exercise, to avoid late hours and hot ill-ventilated rooms, and to take simple, regular and easily digested meals. All ascertainable causes of fatigue should, if possible, be removed, and particular care must be directed to the avoidance of faulty positions, and the desks, chairs, music-stools and the like, that the patient uses, must be carefully inspected and made to suit the individual requirements of the case. A cold sponge bath in summer and a tepid one in winter should be taken on rising in the morning, and at the same time careful and persistent massage should be employed to the muscles of the back, in addition to the exercises which will presently be described.

The treatment of the curvature itself will vary considerably according to the flexibility of the spine, that is to say, according to the amount of straightening that is produced when the patient is suspended. We may divide these cases into (α) those in which the curve can be obliterated, (β) those in which the curve can be ameliorated but not entirely obliterated, and (γ) those in which no alteration can be produced.

(α) **The cases in which the curve can be entirely obliterated.**—Here the prognosis is good, as the muscular apparatus is probably alone at fault, and no bony or ligamentous changes have yet occurred in the spine. The object of the treatment therefore is to strengthen the back muscles, and thus to enable them to properly perform their function of keeping the spine erect. One of the most important factors in effecting this is the employment of suitable exercises.

Exercises.—A multitude of different exercises have been designed for the treatment of these cases, many of which are extremely complicated. There are, however, no specific exercises for the cure of this condition, and the surgeon can easily design perfectly efficient ones for himself by observing accurately the changes that have occurred and the muscles that are at fault. All that is necessary then is to order movements which shall bring into play the defective muscles, and which shall mechanically rectify the physical changes in the trunk. As, however, this requires considerable thought and some experience, we have deemed it advisable to append a number of exercises divided into different series, which are to be found in the admirable work of Dr. Percy Lewis,[1] which he has kindly permitted us to quote. These are extremely simple, easy to perform, and

[1] *The Relief and Cure of Spinal Curvatures.* Dr. Percy G. Lewis, London, 1897.

easy to understand, and some of them will be found suitable for any case for which exercises are required.

These exercises should always be carried out in the presence of someone whose business it is to see that they are properly and regularly performed for the requisite length of time. The simplest plan is for the surgeon who has charge of the case to supervise the first performance of each group of exercises as they are taught, and to point out to the gymnasium master or the parents the exact manner in which they are to be done. It is well to teach a fresh set of exercises at each sitting or each alternate one, so as to stimulate the patient's interest as much as possible; and when the whole series has been learnt, the performance should be judiciously varied. It will be seen that the exercises are so planned that they are carried out first in the horizontal position, then in the sitting, and finally in the standing posture, as the muscular strength improves. An important point in the exercises is that many of them are performed against resistance, the surgeon, or in his absence some form of elastic band, opposing the action of the muscles. After the exercises are over, the patient should lie recumbent upon a couch, preferably in the prone position, for at least half an hour. The period for which the exercises are performed may be gradually increased, if it is thought that they are doing good and that no undue fatigue is produced.

After the simple exercises designed to improve the muscular system generally have been thoroughly learnt and properly practised, the surgeon makes a careful examination to ascertain what effect has been produced upon the curvature. This will generally be at the end of a month or six weeks from the commencement of the treatment. Should it be found, as it probably will in early cases, that the curvature has almost disappeared, and that the patient can hold himself erect without any trouble, little else is needed beyond a continuance of the treatment already adopted. Should it, however, be found that the curvature is still present, special exercises (see Appendix) will be needed with the object of undoing the curve. It is impossible to specify the various exercises appropriate for the particular conditions that may be met with. The surgeon must select these from the list given, according to the physical conditions present. Thus one set of exercises will be required for unfolding a dorsal curve, another for a lumbar curve, whilst an entirely different set of exercises are necessary for the cure of the rotation. These exercises are first performed as directed in the Appendix, and, as the patient becomes accustomed to them and can perform them without fatigue, it is most useful to have them performed against resistance, the simplest method of doing which is to instruct the attendant to oppose the movements which the patient is endeavouring to carry out. This may be done gently at first, and with gradually increasing force as the muscles grow stronger. There are several forms of mechanical apparatus which are designed for the purpose of carrying out movements against resistance. Of these, Dowd's machine (see Fig. 82) is a useful type,

whilst there are various other mechanical exercisers, such as Whiteley's, etc., in popular use. Dumb-bells are a means of doing the same thing in a minor degree.

These simple movements are suited only for cases in which there is no permanent distortion of the spine, that is to say, where suspension of the patient causes the spine to become perfectly straight. As these exercises produce their effect and obliterate the curve, they may be gradually abandoned in favour of more simple home drill exercises designed to improve the muscular system generally (see p. 327); these should be practised at least once a day for a very prolonged period.

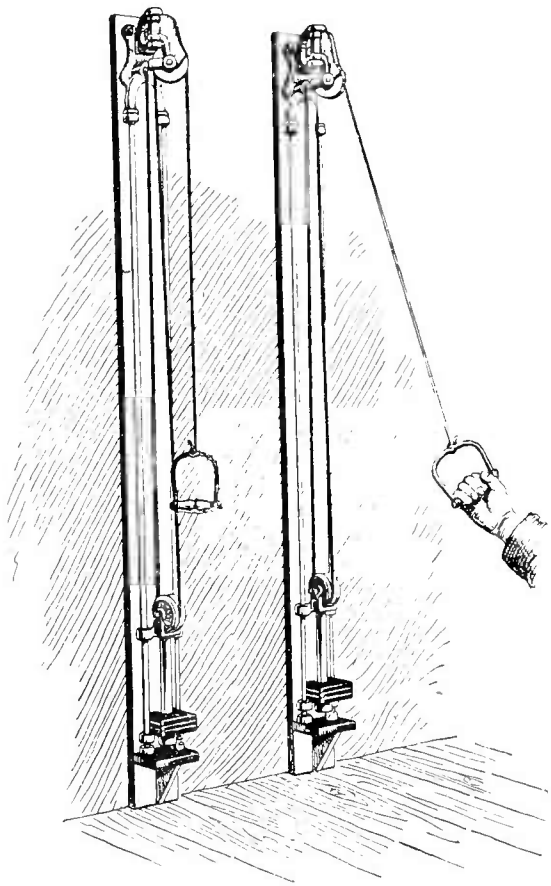


FIG. 82.—DOWD'S MACHINE. The resistance against which the exercises are performed is increased by adding weights to the sliding brackets. Two machines are shown in the figure, side by side. (*Percy Lewis.*)

A useful adjunct to this treatment is to have the child taught singing, which not only develops various muscles of the chest and back, but insures the proper expansion of the lungs, tends to obliterate stooping habits, and improves nutrition generally. Similarly, any adenoids or enlarged tonsils that are present should receive appropriate treatment. Mechanical supports are never necessary in this group of cases; indeed, care should be taken to see that the child does not wear stiff stays; the utmost that should be allowed are stays of stout jean without bones.

(β) **When the curve can be improved but cannot be entirely obliterated.**—It is particularly this class of case of which the treatment is most difficult, because, although the spine can be induced to resume its normal shape up to a certain point, the affection has lasted sufficiently long for such profound bony and ligamentous changes to have occurred as to prevent complete restoration, and therefore the treatment must be directed not only to straightening the spine as much as possible, but to providing against subsequent relapses, which are very likely to occur should the treatment be prematurely abandoned.

Exercises.—The measures to rectify the curvature will be somewhat on the same lines as for the group just described, but of a considerably more vigorous nature; the principle of the exercises is the same, but they should be persevered with more energetically and should be carried out

for longer at a time and at least twice a day. Many useful ones will be found in the Appendix.

Another method also of considerable value in these cases is the suspension of the patient from two parallel trapeze bars, one being a few inches higher than the other. The lower bar, which should be just high enough to lift the patient from the feet, is grasped by the hand on the side of the convexity of the curve whilst the upper one is grasped by the opposite hand. The patient may be taught either to swing upon this or merely to hang free of the ground. The object of the treatment is to allow the whole weight of the body to tell upon the spine and thus to open out the curvature: for moderately severe cases this is an extremely useful method, especially when combined with the exercises recommended above.

FIG. 83.—"RACHILYSIS" APPLIED IN THE STANDING POSITION. The patient stands with the side of the concavity of the curve to be treated against the wall. She is then made to hold weights or to go through set exercises after the padded sling has been applied to the summit of the convexity. Sometimes the surgeon attempts to forcibly unfold the curve by traction (compare also Fig. 84).

"*Rachilysis.*"—A method termed "Rachilysis" has been introduced by Mr. Barwell with the object of mechanically and forcibly unfolding the curves of the spine. Theoretically it is a very promising method although in practice its objects are not always very easy to obtain, but it is valuable in the more severe cases and should always be tried. It consists in passing a broad padded sling, the ends of which are fastened to a hook in the wall about the level of the patient's head, around the convexity of the

curve which it is desired to unfold. The patient stands with the opposite side of the body flat against the wall and then bends over the sling away from the wall and either attempts to pick up a heavy weight beside the feet or practises various exercises (see Fig. 83). Thus the convexity of the curve is fixed against the sling whilst the movements of the patient unbend it at either end. The above is the principle of the method, but its application may of course be varied to suit individual cases; it may be applied, for instance, in the horizontal or even in the sitting position (see Fig. 84).

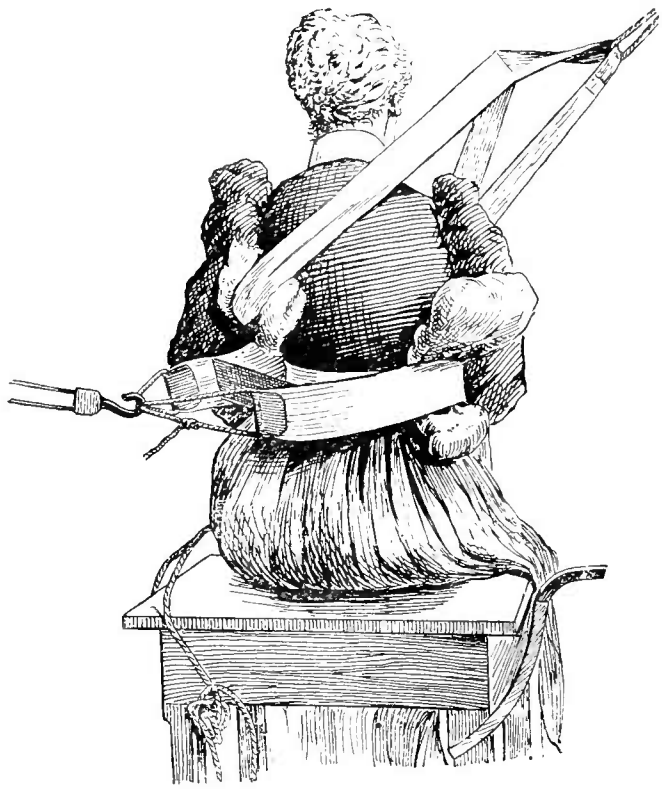


FIG. 84.—"RACHILYSIS" AS APPLIED IN THE SITTING POSITION. Very powerful traction can be exerted in this position by firmly fixing the pelvis and then making traction with the padded slings in such directions as may be necessary to unfold the curves. (*Percy Lewis.*)

Spinal supports.—The value of mechanical supports to the spine—the so-called "Spinal Braces"—in this class of case has been very much debated. Opinion is still divided as to whether or not they should be employed. It may be stated at once that in the early stages no form of brace or support is permissible which keeps or tends to keep the spinal column rigid; such a support is fallacious in the extreme. It undoubtedly supports the spine to some extent, and may therefore make the patient comfortable and relieve him of the heavy, dull aching pain of which he commonly complains. But its action is most mischievous, since it is essential for cure that the muscles primarily at fault shall be encouraged to perform their function of supporting the spine, and the confinement entailed by the use of a tight-fitting jacket must not only fail to effect this but must actually err in the opposite direction by producing actual wasting of the muscles. We are strongly inclined to limit the use of apparatus to cases

in which the curvature shows signs of increasing in spite of vigorous treatment in the directions just mentioned, or to those where the pain is very severe and the weakness of the muscles excessive. In these cases the support should only be worn now and then during the day, not all day long, and we would insist that any support should be of the lightest possible variety consistent with efficacy. It should be made of light steel bars taking purchase from a pelvic band and should be furnished with suitably padded springs so directed as to apply pressure at the requisite spots—which are generally the convexity of the curve and over the angles of the ribs where they are rotated backwards. Again, the apparatus should be so fashioned as only to support the spine when it is in a position of rest; that is to say, it should not be sufficiently tight-fitting to keep the spine immovable and

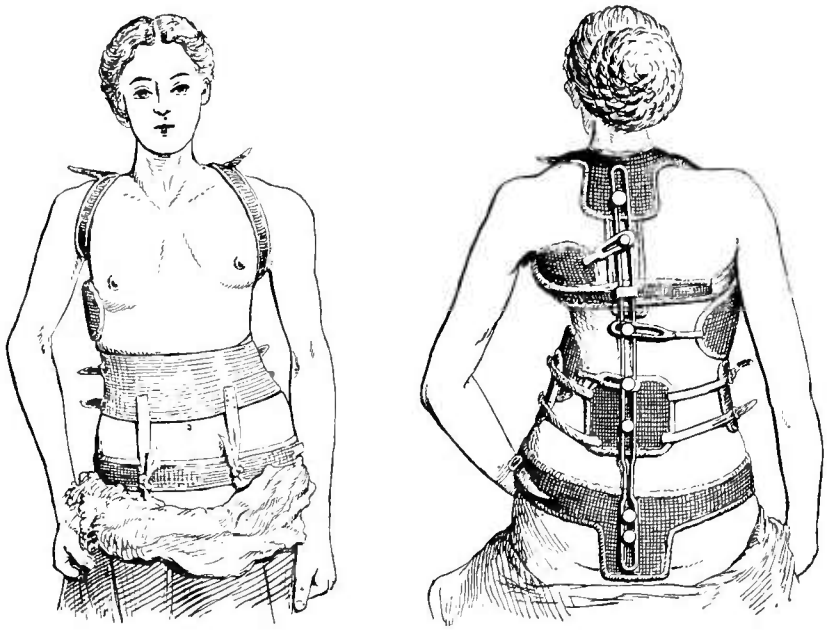


FIG. 85.—SPINAL BRACE FOR SCOLIOSIS. This may be taken as a type of apparatus suitable for the affection. It will be seen that the various parts can be adjusted by means of the nuts shown in the figure. (*Percy Lewis.*)

therefore interfere with the proper action of the back muscles. Even then it is well that the jacket should be worn as little as possible and should be only applied at intervals during the day. At night of course no apparatus should be worn, attention being mainly directed to the posture in which the patient sleeps. A spinal brace of this kind is shown in Fig. 85. It requires careful adjustment as the curvature diminishes.

(γ) **Cases in which the curvature cannot be diminished by suspension.**—Such marked changes may have taken place on the spinal column that the curvature shows little or no improvement on suspension. Here it is practically hopeless to attempt any rectification, and the utmost the surgeon can do is to prevent the affection from increasing and to treat any symptoms, such as pain, that may be complained of.

Spinal supports.—In order to prevent the increase of the curvature, a support of some kind is invaluable, and perhaps upon the whole the best is a suitably-moulded poroplastic jacket strengthened with light steel rods, moulded to the thorax during extension of the spine and laced in position. This will take off the superincumbent weight of the thorax and will often relieve the pain, especially that caused by the narrowing of the intercostal spaces or the approximation of the ribs to the crest of the ilium.

Even in these cases muscular exercises are of value and, if carried out against resistance, they are particularly calculated, by strengthening the muscles, to relieve the pain from which the patient suffers. Very little hope however can be held out that any amount of muscular exercises or stretching of the spine will produce much effect upon the curvature. Theoretically it is of course possible that sufficiently prolonged extension of the spine will influence its shape, but practically this is almost impossible.

(d) **The scoliosis of adult life.**—The condition met with here is precisely similar to that in the group of cases just described, except that the bone changes are perhaps more marked and are more permanent. The treatment is identical with that described above.

APPENDIX.

MEDICAL GYMNASTIC EXERCISES.[1]

THE following system of exercises is designed to improve the general health, to remove some of the causes of curvature, and to cure or improve the deformity. For the first object they are useful for a large number of various conditions occurring in individuals of almost any age, not necessarily the subjects of spinal deviations. It is not intended that every case shall perform all the exercises. The system is intended to present rather a materia medica of exercises, from which the surgeon can prescribe those which he considers best for each case. The cases will always have a large number of symmetrical exercises, but the number and kind of asymmetrical exercises will be prescribed according to the degree and direction of the deformity.

Generally the exercises should be performed twice daily for a period not usually exceeding half an hour. Children must be made to learn the exercise gradually, two or three new ones being added at each lesson as the previous ones are learnt and well done. The chief advantage of the following system is, that the essential part of it may be done at home. Before practising the exercises, however, the patient and one of his relations, if the patient is a child, should be

[1] These are taken *verbatim* from Dr. Percy Lewis' book on *The Relief and Cure of Spinal Curvatures*, London, 1897. The small illustrative figures are derived from the same source.

properly instructed by a skilled person, *e.g.*, a doctor or a gymnastic master. More rapid progress is, however, made by having one of the daily lessons performed at a gymnasium, even where not more of the apparatus than would be fitted up in the patient's house is used. The patient will then be sure of having at least one lesson efficiently, properly, and regularly performed.

As the strength improves, more rapidity is obtained in the improvement by the use of the new developing machines.

The gymnasium is very advantageous, but the whole cure can be done at home, and need not interfere with lessons or any other business.

All the exercises herein detailed are meant to be performed with slowness, ease and grace, without jerking or holding the breath. No exercise is to be continued after the first feeling of fatigue is induced. There should be a rest between each, the length of which should depend upon whether the exercise has been one requiring little or much expenditure of energy. It is advisable as far as possible to interpose an exercise inducing little force between two requiring more. In the different exercises a pause should intervene in moving from one position to another, and before commencing the following exercises the patient must practise breathing properly. He must inspire as freely and deeply as possible through the nose, without strain, then, with the mouth open, expiration should follow at once without effort, being performed by the elasticity of the chest and lungs alone. Both movements should be easily and regularly performed and a short rest should follow each expiration. After each set of three double movements there should be a longer rest occupied by at least three ordinary breaths.

N.B.—Most of the exercises down to Series G are taken from an article by Madame Nageotte-Wilbouchewitch published in the *Presse Médicale* of October 14, 1896.

HOME EXERCISES.

These exercises commence with very mild ones and gradually work up to ones requiring more strength.

The first are performed lying down either prone or supine. The next series are made leaning against the wall or other support. The patient then performs the same exercises standing without support. This order is taken because the patients are mostly too feeble at first to do exercises standing for more than a few minutes and therefore tend to assume bad positions. The recumbent position, as before remarked, is a good one for redressing the curves. In arranging the patient perfectly straight, some assistance may be derived from the pattern of the carpet or the lines on the floor. The upright exercises should be performed before a glass.

Dollinger, of Buda-Pesth, fixes black tapes across the glass which then act as lines of mark. This is a very useful addition, as it enables patients to place themselves in a mesial position and easily makes evident to them any inequality of the height of the shoulders or of the subaxillary spaces.

Series A.—Lying on the back.

General Instructions.—The patient lies down on the floor or table, heels together, shoulders at the same level, head straight, arms extended by the side of the body, palms facing upwards. The shoulder blades are to be pushed back

so as to expand the chest, and the whole posterior surface of the body should be applied to the surface of the table so as to efface the lumbar bend as much as possible.

Note.—The efficacy of most of the exercises from *A* to *F* can be increased by the use of dumb-bells from half a pound to five pounds in weight.

1. *Arms in three positions.*—(*a*) By the sides of the body. (*b*) Straight out, forming a cross with the body. (*c*) By the side of the head touching the ears, and as straight as possible. Breathe while resting in each attitude. Return in the same manner to the position of rest (see Fig. 86).

These movements will exercise the pectorals, all the muscles attached to the scapulæ and latissimi dorsi.

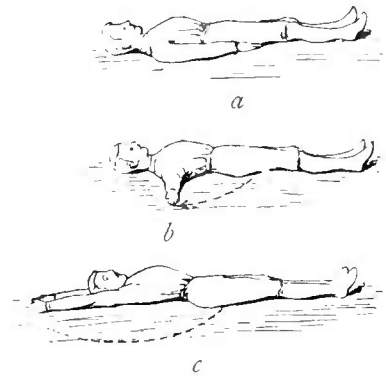


FIG. 86.

2. Raise each leg to the vertical, knee kept straight; return to the position of rest, the other leg immovable. Exercise of the psoas and iliacus and quadriceps extensor (see Fig. 87).

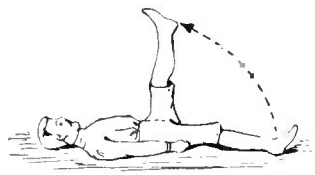


FIG. 87.

3. Bend the head to each side so that the jaw rests on the ground; return slowly to the position of rest without moving the shoulders. The arms must be kept immovable, palms upwards. Exercise of rotators and lateral flexors of head and neck.

Series B.

General Instructions.—Same position as above, except that in each case the movement starts from the following position: the elbows close to the side, forearm bent upon the arm, fists closed, with the thumb side to the shoulder (see Fig. 88).


FIG. 88.

1. (*a*) The length of the body (see Fig. 89 *a*). (*b*) In a cross (see Fig. 86 *b*). (*c*) Vertically upwards (see Fig. 89 *b*). (*d*) By the sides of the head (see Fig. 86 *c*).

Exercise of biceps, and triceps, scapular and pectoral muscles, and latissimus dorsi.

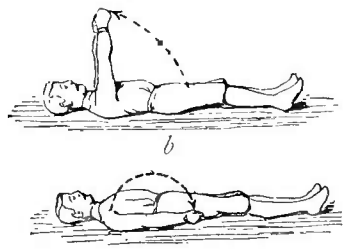


FIG. 89.

2. Move out each leg transversely, knee kept straight, the other leg immovable, return to the position of rest. Exercise of thigh muscles and muscles passing from pelvis to great trochanters (see Fig. 90).


FIG. 90.

3. Bend the head until the chin touches the chest; return slowly to the position of rest (see Fig. 91). Exercise of sterno-mastoid, anterior neck muscles, and splenius, complexus and posterior neck muscles.


FIG. 91.

Series C.

1. *Circular turn of the arms.*—The palms upwards, the arms describe a half circle on the earth, to rejoin at the sides of the head (see Fig. 86 *c*). There the fingers cross each other (see Fig. 92), the patient stretches out as far as possible, and brings the arms back parallel to the side of the body by describing a half circle in a vertical plane (see Fig. 89 *b*). Exercise of all the muscles attached to the scapula and upper end of the humerus.

FIG. 92.

2. *Circular movement of the leg.*—The leg held straight is lifted vertically, carried outwards to the earth, and returned to its place. All the rest of the body immovable. Exercise of psoas and iliacus, and all the muscles of the thigh, including those passing from the pelvis to the femur, and sartorius (see Fig. 87).

3. *Circular movement of the head.*—The head is first bent forwards until the chin touches the chest (see Fig. 91), then the head is inclined in such a manner that the ear touches the shoulder (see Fig. 93); return to the position of rest in the same level. Repeat, inclining the head to the opposite side. Exercise of the muscles on each side of the neck.

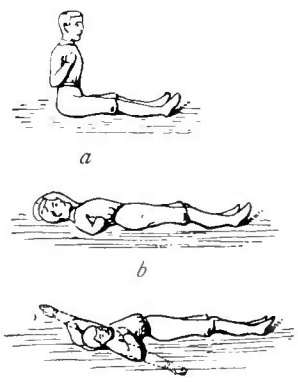
FIG. 93.

Series D.

1. Sit up without the aid of the arms, the back straight, the head stretched out (see Fig. 94 *a*). Lie down again very slowly without bending the back. Exercise of the psoas and iliacus and of anterior abdominal muscles chiefly.

2. Lift the legs stretched very slowly as far as the vertical. Lower them slowly. Exercise of psoas and iliacus and anterior thigh muscles (see Fig. 87).

3. Place the right hand on the ribs as high up and as far back as possible, thumb forwards. Place the left forearm on the head so that the left fingers touch the right ear. Bend all the body above the right hand as far as possible to the right (see Fig. 94 *b*). Take a few deep inspirations and return to the symmetrical position. Exercise for right dorsal curve.



a

b

c

FIG. 94.

4. Repeat the preceding exercise in a reverse manner. Exercise for left dorsal curve.

5. Arms in a cross. Legs and hips immovable, head straight. Bend the whole body to the left (see Fig. 94 *c*). Remain during a few inspirations. Return to the position of rest. Exercise for right lumbar curve.

6. Repeat in the opposite direction. Exercise for left lumbar curve.

Series E.—Lying on the Stomach.

1. Arms strongly stretched at the sides, raise oneself, breathe. Exercise for erector spinæ (see Fig. 95).

FIG. 95.

2. Lift each leg stretched. Perform circular movement. The head rests on the jaw of the side of the limb lifted (see Fig. 96). Exercise of thigh muscles, glutei, extensors, and rotators.

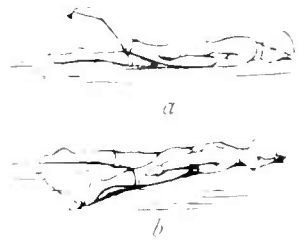


FIG. 96.

Swimming Movement.

3. The palms face the ground during the whole exercise, contrary to the attitude of real swimming. The shoulder blades are not to move on the chest. The elbows and hands are not to touch the ground so as to avoid passive supporting (see Fig. 97). To rest, the patient lies down completely. Exercise for erector spinæ, latissimus dorsi, scapular and pectoral muscles.

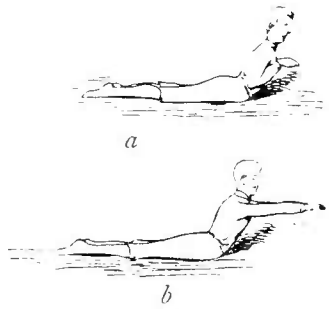


FIG. 97.

Series F.—Exercises, done in the Upright Position with Support.

General Instructions.—The patient either simply leans against the wall, or at first is held there by a strap round the waist until he can hold himself upright without support. More muscles, viz., those required to maintain the erect posture will be brought into play, and the exercise will thus be more severe.

1. The first three series of movements, viz., *A*, *B*, and *C*, are then done in this position (see Fig. 98).

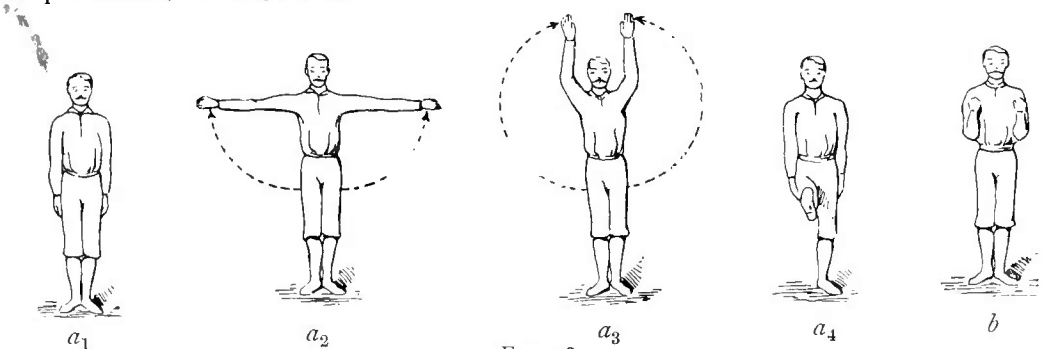


FIG. 98.

2. Then *D*, 3, 4, and 5 (see Fig. 99). No. 5 may, however, be carried still further in this position, viz., until the fingers touch the ground. (*a*) By placing

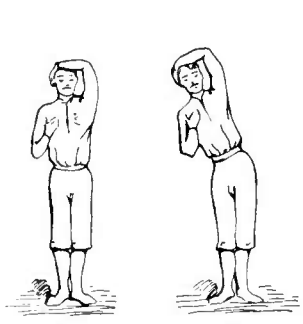


FIG. 99.

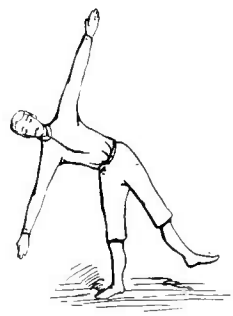


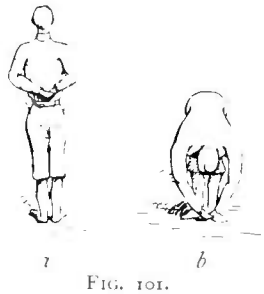
FIG. 100.

the legs apart and bending the left knee, or (*b*) By allowing the right foot to leave the ground so that the body see-saws on the left hip joint (see Fig. 100).

Series G.—Movements made without Support.

All the movements which have been done against the wall should at last be performed without such help; also

1. *Breathing.*—Hands clasped behind the waist, inspire, hands still clasped but arms forcibly stretched downwards, expire (see Fig. 101 *a*).



a *b*

FIG. 101.

2. *Flexion of trunk.* Head straight, arms extended at sides of the head, bend the trunk forwards at the hips, so that the fingers, united by their palmar surfaces touch the ground; return to the previous attitude with the arms in the same position. The legs to remain very straight, the feet a little apart (see Fig. 101 *b*). The repetitions of the movement to be separated by circular movements of the arms. Exercise of anterior abdominal, erector spinæ, glutei, psoas and thigh muscles.

3. Sit down slowly upon the heels with the arms extended horizontally in front: recover to the standing position while letting the arms fall. Exercise of thigh, glutei and erector spinæ muscles.

4. Bend the trunk forwards, backwards, laterally, and lastly circularly, the hands resting upon the hips. Exercise of anterior, posterior and lateral abdominal muscles, and erector spinæ.

5. Separate the arms horizontally backwards as far as possible with inspiration; bring them together in front with expiration. Exercise of pectorals, scapulæ muscles, and latissimi dorsi.

6. *The untwisting exercise.*—Patient standing, the arms straight and horizontal, and inclined as far as possible to the right, are rapidly moved across the body as far as possible to the left; the whole spine at the same time rotating to the left. Thus the hands describe about $\frac{3}{4}$ of a circle in a horizontal plane. Maintain this position for a few moments, then allow the arms to fall and the spine to come into a position of rest. Exercise for rotation to the right.

This is one of the most important and powerful of the asymmetrical movements. Its power is much increased by using the Dowd's machine (see Fig. 113).

7. Reverse the exercise. Exercise for rotation to the left.

8. *For poking of the chin.*—Patient sitting. Slowly bend head forwards until chin touches chest, then rapidly bend backwards as far as possible. Maintain the position a few seconds; return slowly to position of rest. Exercise of complexus, trapezius, splenius, etc.

9. Patient sitting; arms by side, simultaneously draws back both shoulders as far as possible, keeps them in this position whilst he counts four, and then allows them to return to original position. Exercise of scapular and latissimus muscles.

10. Patient sitting; bends the body on to the thighs, then slowly rises again. Exercise of anterior abdominal, psoas and iliacus, and erector spinæ muscles.

11. Patient standing opposite a wall and an arm's length from it, stretches out the arms horizontally in front, and applies the hands flat against the wall;

without moving his feet the patient slowly approaches his body to the wall by bending the arm on the forearm; then he slowly recovers.

This passively expands the chest and causes contraction of the shoulder and arm muscles on both sides.

Note.—All the preceding exercises are at first made by the patient alone. By interposing resistance to the muscular effort the efficacy of the various movements can be increased at the will of the surgeon as the patient increases in strength.

12. The patient is seated in a chair with a straight back, reaching as high as the shoulders, a band fixing the trunk to the back. The patient's back and shoulders should be firmly applied to the back of the chair. A rod or stick about four feet long is then grasped firmly by the hands, about two inches or more from the ends, and raised above the head, the hands still remaining the same distance from the ends. The rod is next lowered behind the back of the chair as far as possible. The hands must still retain their position on the rod, but the elbows must be bent. Alternately raise and lower (see Fig. 102).

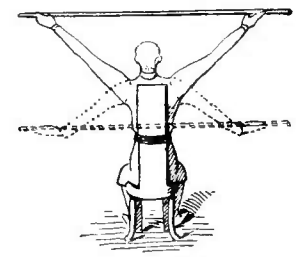


FIG. 102.

Note.—As the patient gets stronger the band will be unnecessary.

This is also a chest-expanding exercise, calling into action the muscles on front and back of the chest.

Series I.—Exercises over the Edge of a Table.

1. Lying down flat on the stomach on the table. The legs fixed by a strap across the ankles, the trunk going beyond the table as far as the hips. The arms stretched behind the back, bend the trunk down as far as the vertical, raise the head first then recover slowly, stretching the arms forcibly and breathing deeply to the maximum of recovery (see Fig 103). Repeat three times in succession. Rest, then repeat six times slowly. To rest, rise on to the knees on the table.

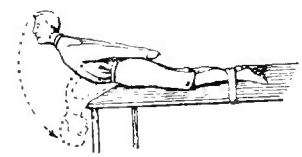
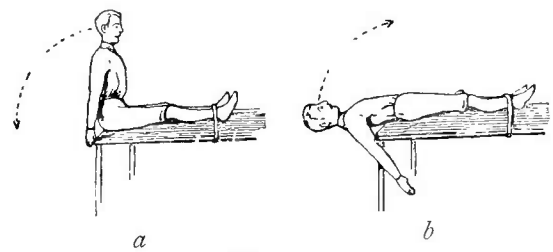


FIG. 103.

N.B.—If the curvature is bad, extension must be limited to rising to the horizontal line.

Exercise chiefly of the erector spinæ and its continuations.

2. Sit at the edge of a table with back at edge, and feet retained by a strap, then head and back straight and arms stretched behind the back, slowly lie down, breathe, return to the first position (see Fig. 104).



a *b*

FIG. 104.

Note.—Until strong enough the patient must be supported through this exercise. The back must be kept straight, not rounded.

This is an exercise chiefly of the anterior abdominal, psoas, and iliacus, and front of thigh muscles.

3. Same exercise lying on the side; the concavity of the principal curve downwards (see Fig. 105). It is an exercise of over correction, which is very difficult to perform and also to teach.

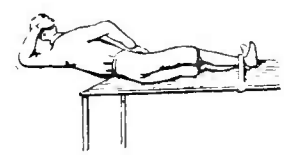


FIG. 105.

Series J.—With Dowd's Machine.

Note.—In using Dowd's machine, the patient is to commence without any other weight than that of the weight-carrier. Gradually weights are added as the doctor may direct. It may, for various reasons, be found necessary to add more weights to one side than to the other. For instance, in the face-to-machine exercises for a patient with rotation to the right, it would be well to place more weights on the right side than the left. In the back-to-machine exercises greater weight on the left would then tend to untwist.

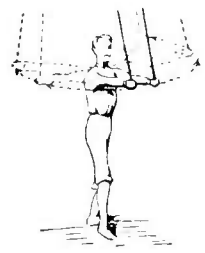


FIG. 106.

1. *Patient facing machine.*—Patient stands facing machine. Right hand straight out in front grasping handle of machine, is made to describe a circle in a horizontal plane, being carried as far back as possible. Return to original position.

2. Ditto, left hand.

3. Same exercise, both hands together (see Fig. 106, which shows the exercise, but with the patient *back to machine*, vide Series K, 3).

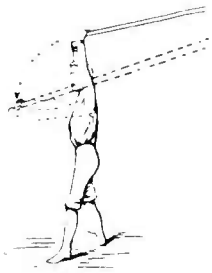


FIG. 107.

4. Right hand held vertically up, grasping handle of machine, is brought down in front, describing a semicircle in a vertical plane.

5. Ditto, left hand.

6. Ditto, both hands at same time (see Fig. 107, which is also *back to machine*, vide Series K, 6).

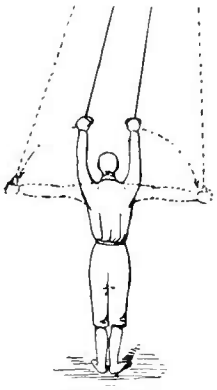


FIG. 108.

7. Right hand held vertically up and straight, grasping handle of machine, is brought down at the side describing a semicircle in a vertical plane. Return to original position.

8. Left hand, ditto.

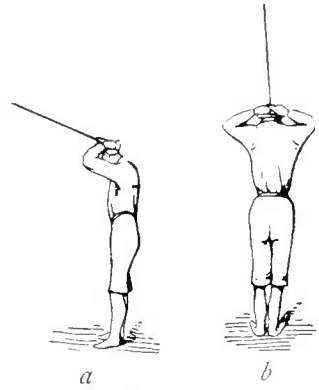
9. Ditto, both hands at same time (see Fig. 108).

FIG. 109.

10. Elbows bent and at sides of body, both hands grasping handles, arms to be alternately straightened and returned to original position (see Fig. 109).

11. Arms straight out in front, hands grasping handles, bend elbows and bring them back until they come to sides of the body; hands remain straight out. Alternately repeat and return to original position.

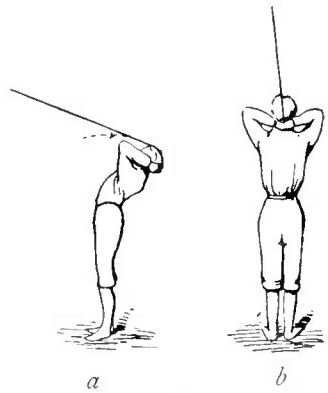
12. Incline head towards machine, grasp one handle with both hands and hold it in contact with back of the head. Bend head as far back as possible from the neck, carrying handle and hands with it. Alternately repeat and return to original position (see Fig. 110).



a *b*

FIG. 110.

13. Same exercise, but bending back and neck as far back as possible (see Fig. 111).



a *b*

FIG. 111.

14. Patient erect, holding handle and hands in same position; bend forwards, bringing head as low as possible. Return to original position (see Fig. 112).

15. Right arm straight out from side, hand grasping handle. Hand describes a circle about a foot in diameter, its first position being the centre.

16. Ditto, left arm.

17. Ditto, both arms at same time.

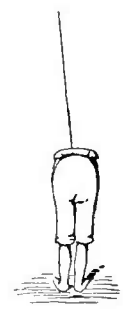
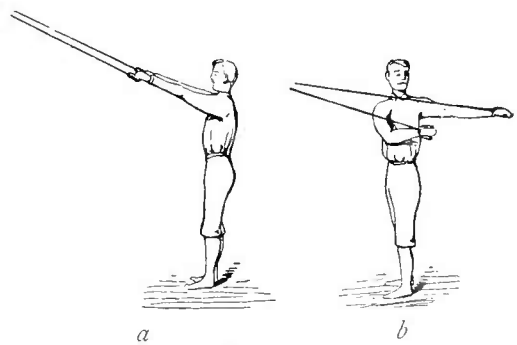


FIG. 112.

18. The untwisting exercise, Series G, 6 (see Fig. 113).

19. Ditto, Series G, 7.

20. Right arm straight out in front, the hand grasping handle is carried vertically upwards, then outwards, downwards as far as possible, and finally returns to original position after describing a circle.



a *b*

FIG. 113.

21. Left arm ditto.

22. Both arms together ditto.

Series K.—Patient with Back to Machine.

1. Series J, Number 1, reversed.
2. „ „ „ 2. „

3. Series J, Number 3, reversed. (See Fig. 106.)
4. " " " 4, "
5. " " 5, "
6. " " " 6, " (See Fig. 107.)
7. " " " 7, "
8. " " 8, "
9. " " " 9, " (See Fig. 108.)
10. " " " 14, " (See Fig. 114.)
11. " " 15, "
12. " " 16, "
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14. " " " 20,
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FIG. 114.

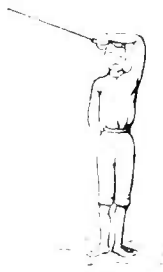


FIG. 115.

Series L.—Side to Machine Exercises.

1. Right side to machine; arm straight out grasping handle is carried upwards to side of head; returns to first position, pauses, and is brought down to side; reverse; repeat.

2. Left side to machine; same exercise for left arm.

FIG. 116.

3. Right side to machine; left forearm resting on head, left hand over right ear grasping handle (see Fig. 115). Patient leans as far as possible towards machine, recovers and leans as far as possible away from it; hips and legs immovable (see Fig. 116).

4. Repeat with left side to machine, right arm over head.

5. Repeat 3, with a circular instead of a to-and-fro movement.

6. Repeat 4, with a circular instead of a to-and-fro movement.

Note.—It will be seen that most of the exercises with Dowd's machine are chiefly the previous exercises performed with apparatus. The machine simply is an accurate means of adding increasing resistance by putting more weights on to the carrier. The same remarks apply more or less to all the developing machines hereafter mentioned.

Series M.—Exercises with a Single Dowd's Machine, the Rope passing under a Pulley attached to the Floor. (Face to Machine.)

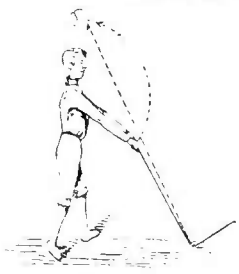


FIG. 117.

1. Right arm obliquely in front holding handle. Raise to the vertical by side of head without bending arm.

2. Left arm ditto.

3. Both grasping handle at same time (see Fig. 117).

4. Right arm obliquely in front, raise forearm as far as possible without moving upper arm.

5. Left arm ditto.

6. Both together ditto (see Fig. 118).

FIG. 118.

7. Right arm obliquely in front grasping handle, is carried backwards as far as possible, and allowed to return to original position.

8. Left arm ditto.

9. Both together ditto (see Fig. 119).

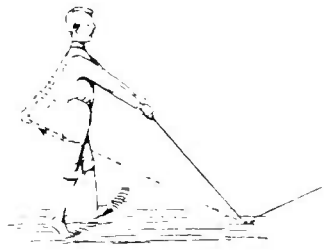


FIG. 119.

10. Arms straight out in front, both hands grasping handle, body bent forwards as far as possible, is raised and carried backwards as far as possible, arms remain straight (see Fig. 120).

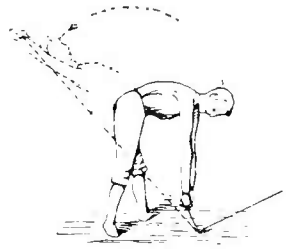


FIG. 120.

Series N.—With Single Dowd as for Series M, but instead of a Handle the Rope is fixed to a Strap which is fastened to each foot in turn. (For Right Foot).

1. Facing machine, right hand resting on back of a chair, leg straight is alternately carried forwards and backwards (see Fig. 121).

2. Similar exercise with back to machine.

FIG. 121.

3. Facing machine, right hand resting on back of chair, leg is brought from being in a line with left as high up as possible by bending the knee. Thigh remains immovable (see Fig. 122).

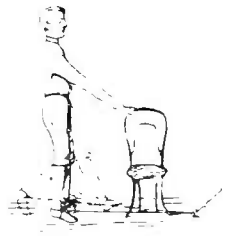


FIG. 122.

4. Left side towards machine, left hand on back of chair, the left leg is alternately in front of right as far as possible to right, and returned to original position (see Fig. 123

FIG. 123.

FIG. 124.

5. Left side towards machine, the right hand on back of a chair, the right leg is carried from contact with the left as far out as possible (see Fig. 124).

FIG. 125.

6. Left side to machine, right hand on back of a chair, left leg held obliquely outwards towards the machine, thigh immovable, the left knee is bent until the foot touches the right leg (see Fig. 125).

FIG. 126.

7. Patient seated right side to the machine, the left foot is alternately turned outwards and allowed to recover.

8. Reverse exercise by turning left side to machine (see Fig. 126).

9. Same as 1, reversed.

10. „ „ 2, „

11. „ „ 3,

12. „ „ 4, „

13. „ „ 5, „

14. „ „ 6, „

15. „ „ 7, „

16. „ „ 8,

Exercises for the Medical Gymnasium.

Note.—Any of the exercises for Dowd's machine may be performed with any of the modifications of it. Thus the high Dowd's (see Fig. 127), may be used in the same way, where it is required to develop especially the lower part of the chest, to help the latissimus dorsi and the lower part of the serratus magnus, trapezius, pectorals, etc., in their elevating action on the lower ribs.

The Quarter-circle Dowd (see Fig. 128), will be especially useful in stooping and posterior curves of the spine

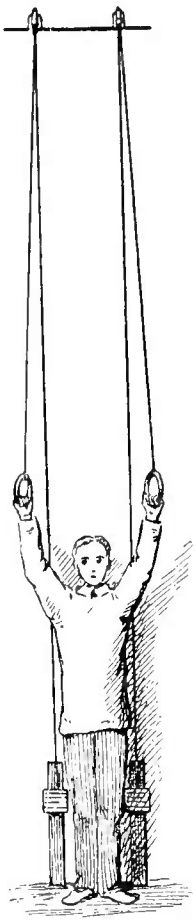


FIG. 127.

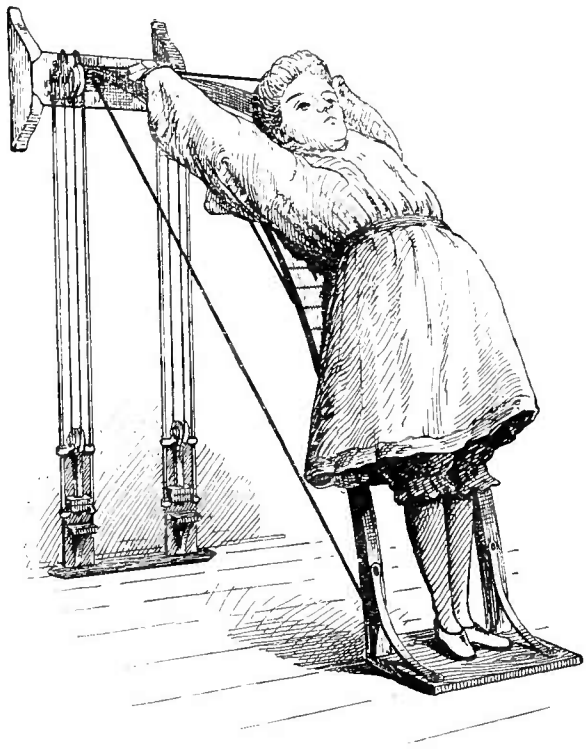


FIG. 128.

The rowing machine (see Fig. 129) is a very powerful combination of all the Dowds, only to be used towards the end of the course. It exercises practically all the muscles of the body.

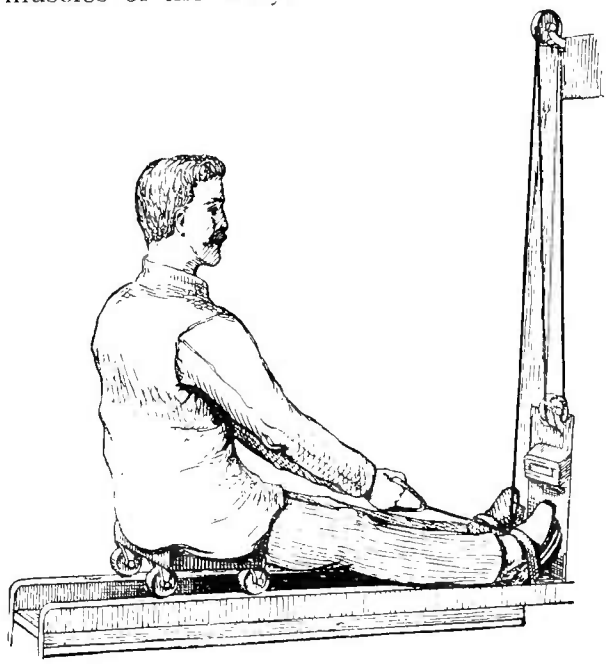


FIG. 129.

Series O.—Wheel Exercise.

1. Patient standing with back to wheel, arms out in a cross grasping the projecting pegs. See-saw action, to and fro (see Fig. 130). Increase resistance according to the patient's strength.

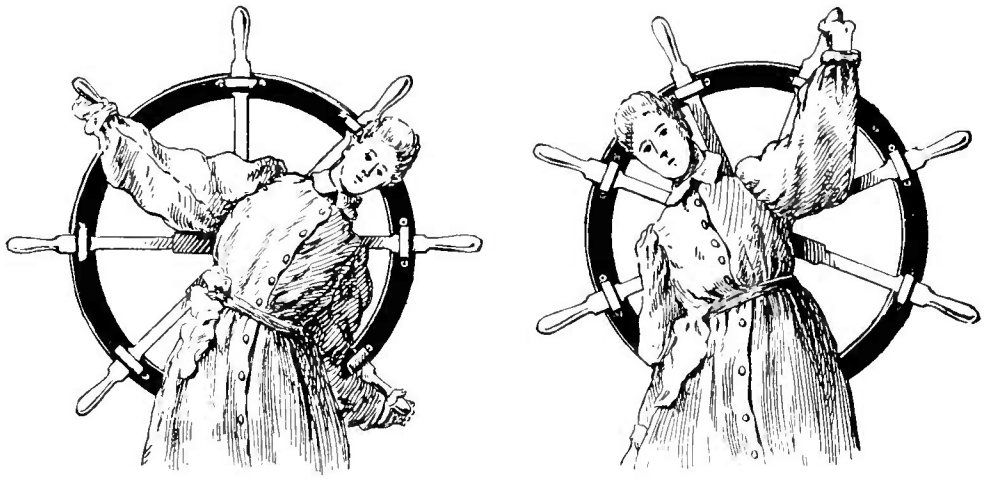


FIG. 130.

2. Right side to machine, left hand on left hip, right hand grasping peg at summit of circle, right foot forwards, spine stiff. Right hand turns wheel from above downwards.

3. Same, left foot forward.

4. Same as 2, reversed.

5. Same as 3, reversed.

6. Right side to machine, feet together, right hand grasping lowest peg, left hand passing over head grasps highest peg, right hand to move forwards, left hand backwards.

7. Same, reversed.

EXTENSION EXERCISES FOR ACTING CHIEFLY ON THE SPINAL LIGAMENTS.

Series P.—Oblique ladder.

1. Patient on back, feet on lowest two rungs, hands on highest rungs he can reach. Raise feet to the rungs of next level, the hands bearing the weight meanwhile. Remove the feet from the rungs for a few seconds so that hands bear all the weight. Raise feet to next level, and so on until the top is reached. Come down in reverse order.

2. Ditto, with right arm always one rung above the left.

3. Ditto, with left arm always one rung above the right.

Series Q.—Exercises with Parallel Rings.

1. Patient stands between rings, which are suspended about a foot above his head, and, keeping feet fixed as a pivot, performs a circular movement

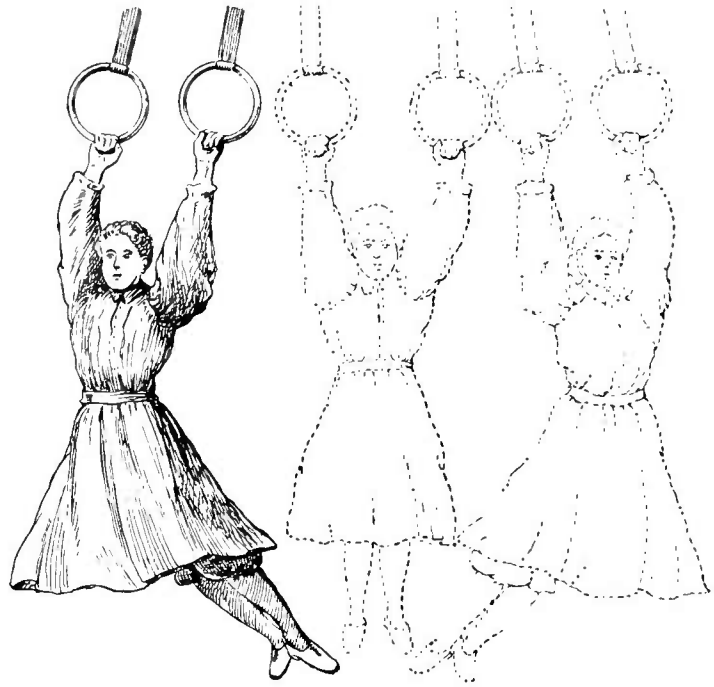


FIG. 131.

of the whole body, from right forwards to left; from left backwards to right (see Fig. 131).

2. The rings may be gradually lowered.

3. Right ring may be a few inches higher than the left.

4. Left ring may be a few inches higher than the right.

Series R.—Vertical Pole or Rope.

Note. This exercise is best performed with the pole or rope rigid or suspended against a wall.

1. Patient standing with back to pole, the hands above head, grasps the pole as high as possible; then raising the heels from the ground, the patient endeavours with one hand at a time, to grasp the pole just above the other hand. The patient then allows the hands to bear the weight in endeavouring to get the heels again on to the ground.

2. Same exercise, right hand always higher.

3. Same exercise, left hand always higher.

Series S.—Trapeze.

1. Patient standing on a stool, trapeze at such a height that the patient can just reach it with hands above head. Patient grasps trapeze, stool is removed, and patient swings backwards and forwards by alternately flexing and extending his legs.

Series T.—Vertical Ladder or Gridiron.

1. Same as Series P, 1.

2. Same as Series P, 2.

3. Same as Series P, 3.

4. Right foot on one of the lower rungs, right hand on one of the upper, so that the right side of the body forms a concavity towards the ladder. Alternately stretch left arm and left leg as far to the left as possible, and allow them to return to the hanging position.

5. Ditto, reversed.

6. Climb with back to ladder using only left hand, right carrying a weight.

7. Same, with face to ladder.

8. Same as 6, left hand carrying a weight.

9. Same as 7, left hand carrying a weight.

Series V.—Dumb-bells.

1. Holding dumb-bell of five pounds or more at level of shoulder in right hand. Alternately raise and lower.

2. Ditto, with left hand.

Series W.

1. Alternately raise above head and lower a heavy steel bar, using both hands. The patient should fix his eyes on the centre of the bar.

CHAPTER XXVIII.

TUBERCULOUS DISEASE OF THE SPINE.

Tuberculous disease of the vertebræ is the most common tuberculous bone disease in children, occurring in about 23 per cent. of all cases of tuberculous disease of bones and joints. The majority of cases commence before the age of ten, the favourite seat of the disease being the dorsal vertebræ from the middle downwards; after them come the upper lumbar and then the upper cervical vertebræ.

SEATS.—The disease may commence either in the body of the vertebra or in one of its processes; it is most common in the body of the vertebra, and what we generally speak of as tuberculous spinal disease is disease of the body. In the body of the vertebra it may commence either in the interior of the bone or on the surface, and, commencing in the interior, it may present the two usual forms, namely soft deposits and sequestra.

Superficial caries.—On the surface of the bone the disease begins in the periosteum, or at any rate very soon involves it, and spreads along the surface of the vertebra for a considerable distance, causing more or less extensive superficial caries. As this extends from one vertebra to another, it spreads in along the intervertebral discs and destroys them, so that there may be superficial erosion of a number of vertebræ and want of continuity between the bodies owing to the destruction of the discs. Hence the curvature in these cases is usually gradual and of considerable extent; it is increased by absorption of the upper and lower surfaces of the adjacent bodies. This form of the disease occurs more especially in adults and is often associated with abscess: if it be present alone there may be no curvature in the first instance or only a gradual bend resulting from the loss of a number of intervertebral cartilages. This superficial caries may either occur as a primary disease, or may be secondary to a deposit in the substance of the bone which has reached the surface.

Osseous deposits.—The deposits in the interior of the bone usually commence near the intervertebral cartilages, but not actually in connection with them, and rarely affect more than one or two vertebræ. They

generally make their way to the surface on the anterior or lateral aspects of the bodies, and, having reached the surface, they spread beneath the periosteum and lead to superficial caries. They may also spread towards the adjacent intervertebral cartilage and destroy it either completely or in part. It is only in rare cases that they extend backwards and reach the posterior surface of the body. These deposits destroy the body of the vertebra in which they occur more or less completely, while the weight of the trunk causes the vertebra above to sink down, and thus more or less acute curvature results. When a single vertebra only is destroyed the curvature is very acute. Not uncommonly however two or three adjacent bodies are attacked simultaneously, the result being that the curvature is not so abrupt and involves three or more vertebræ. Perhaps the most common condition is for one or two bodies to be more or less completely destroyed by primary deposits in their interior and, secondarily to this and as a consequence of periosteal extension, for the intervertebral cartilages of several adjacent vertebræ to disappear, thus leading to a gradual curve affecting a number of vertebræ, with a more acute curve in the centre due to the complete destruction of one or more vertebral bodies. When the deposits reach the surface they often lead to the formation of an abscess either at the sides of the vertebral column or, should they extend backwards, in the spinal canal itself. The deposits in the interior of the bone occur chiefly in children, are less frequently associated with abscess than is superficial caries, and are accompanied by acute curvature and other displacements.

In these cases the destructive processes are to a large extent due to osteitis and absorption of the inflamed bone. The inflammation is set up in the first instance by the tuberculous disease, and is then kept up by the pressure which is partly due to the weight of the head and upper part of the spinal column causing bending of the body forwards at the seat of the disease, and partly to the contraction of the muscles surrounding the spine, which keep the inflamed parts in constant and firm contact; the absorption is mainly due to this. This tonic muscular contraction is of very great importance, because, unless measures be taken to counteract it, the curvature may go on in spite of apparatus which apparently supports the upper part of the spine.

When the disease primarily attacks the transverse or spinous processes, it usually commences as a superficial caries quickly followed by abscess.

SYMPTOMS.—The symptoms of tuberculous disease of the spine are well known and we need not go into them in any detail. In the early stages there is uneasiness and aching in the back, sometimes neuralgic pains around the body or down the limbs, difficulty in bending, difficulty in going downstairs, the occurrence of curvature followed by abscess, nervous symptoms from pressure on the spine leading to pain, abnormal sensations in the limbs and ultimately paraplegia. Rigidity of the spine is one of the most important early symptoms, and is, as has already been said, due to the tonic

contraction of the muscles surrounding the affected vertebræ. It is a most important diagnostic point especially in distinguishing the disease from hysterical affections.

The deformity has already been mentioned, being either an abrupt acute curvature, a gradual curve, or the two combined. In some cases it may be somewhat lateral also; this is not a true lateral curvature, which has already been described (see Chap. XXVII.), but results from absorption of the vertebræ on one side more than on the other. When the case is untreated, the patient usually dies from exhaustion from prolonged suppuration, from phthisis or from tuberculous meningitis.

Abscess.—As in tuberculous disease elsewhere, the formation of a chronic abscess is a frequent accompaniment of tuberculous disease of the spine. It occurs most commonly in cases of superficial caries and is thus more frequent in adults than in children, and more common when the curvature is slight or apparently absent than when it is marked. These abscesses form in front of or at the sides of the bodies of the vertebræ, and occasionally in the spinal canal itself; they point in various places according to the region affected. *In the upper cervical region* they usually form in front of the vertebræ and give rise to a retro-pharyngeal abscess. In other cases they may extend into the upper part of the anterior triangle, or may pass backwards and point in the sub-occipital region. Lower down in the neck, they usually appear in the lower part of the posterior triangle, or they may project forward beside the œsophagus or trachea; thence they may pass down into the thorax or into the axilla.

In the dorsal region the abscesses form inside the thoracic cavity in front of or at the sides of the vertebræ, and they generally make their way backwards between the transverse processes and project in the back, forming dorsal abscesses. In other cases they extend laterally beneath the pleura and pass out between the ribs at the side, or even on the front of the chest, giving at first sight the impression that the case is one of abscess in connection with disease of the rib; indeed the rib may be actually diseased at the point where the abscess becomes superficial owing to infection from the pus. Abscesses from disease in the dorsal region may also pass downwards through the pillars of the diaphragm and, entering the sheath of the psoas muscle, form typical psoas abscesses. In other cases, though very rarely, they extend into the posterior mediastinum and burst into the pleura or the lung.

In the lumbar region the abscesses generally pass downwards in the sheath or substance of the psoas muscle, forming psoas abscesses, or they may pass backwards and form lumbar abscesses. When the last lumbar vertebra is affected, the pus may collect in the iliac fossa and point above the outer part of Poupart's ligament; sometimes, though rarely, the abscesses extend backwards through the sacro-sciatic notch, or pass through the obturator foramen and they then point in the buttock, the back of the thigh, or even the perineum.

Pressure symptoms.—The disease may also exert pressure upon the spinal cord. In a considerable proportion of cases pressure symptoms become manifest after a time, and lead to interference with the innervation of the parts below the seat of the disease. This pressure originates in two ways, the most common being the condition known as pachymeningitis, in which the dura mater is infected and thickened; the thickened membranes fill up the spinal canal and press on the cord. In rarer cases an abscess forms in the spinal canal outside the dura mater, and, projecting backwards, compresses the cord against the laminæ. In the latter case the pressure symptoms may suddenly subside when an abscess is opened in the ordinary position, as the internal abscess communicates with and empties itself into the external one. It is very doubtful whether interference with the functions of the cord is ever caused by the acuteness of the curvature, though some have supposed that, in a very acute bending, the cord may be stretched over the bodies of the vertebræ and pressed upon, or that a spicule of bone may compress the cord; it has also been supposed that, under similar circumstances, the symptoms may arise from kinking of the cord and interference with its circulation. It is possible that some cases may arise in this way, but they are very rare; in the great majority of instances one or other of the conditions just mentioned is present and suffices to account for the paralysis. If this pressure be not relieved, myelitis occurs at the seat of compression, the cord becomes flattened, softened, and in some cases almost diffluent, and secondary degenerations spread from this point.

In addition to pressure on the cord, the nerves passing out through the intervertebral foramina about the seat of the disease may be pressed upon and undergo structural alteration.

TREATMENT.—The treatment will vary considerably according to the region of the disease. It will be best to consider separately the treatment for disease in the upper cervical region—frequently spoken of as "atlo-axoid disease"—for disease in the lower cervical and upper dorsal regions, for disease in the dorsal or dorso-lumbar regions, and for disease in the lumbo-sacral region. We shall first say a few words as to the treatment of the disease in general.

(a) **Of spinal disease in general.**—As in the case of other bones and joints, the first essential in treatment is to place the affected part absolutely at rest and to remove all sources of irritation as far as possible. In order to place the spine completely at rest three points must be attended to. In the first place it is necessary to prevent antero-posterior and lateral movement; in the second, to take off the weight of the upper part of the body; and in the third, to put a stop to the tonic contraction of the muscles of the spine surrounding the diseased area. These requisites may be met by (1) placing the patient horizontal upon a firm mattrass without a pillow and by applying heavy sandbags on each side rolled up in the ends of sheets passing over the legs, pelvis, and thorax; in this way movement of

the spine is prevented, and at the same time the weight of the body is taken off the diseased area: and (2) the tonic muscular contraction may be abolished by employing extension and counter-extension to the feet and head.

Rest.—Formerly it was the fashion to place the patient in the prone position, the advantages claimed for this being that the patient can read, play, eat, etc., much more comfortably than when lying on the back, that there is no direct pressure upon the spine and that the abdominal muscles cannot pull upon the curve. The prone position is however in our opinion essentially bad because it does not give the spine absolute rest, because it cannot be combined satisfactorily with extension, because the thorax and abdomen are pressed upon and the functions of the contained organs are consequently interfered with, because there is pressure on the anterior or diseased part of the spine and because the bowels and bladder cannot be relieved satisfactorily without moving the patient. Hence, we consider it most essential that the patient should be placed upon his back.

The mattrass should be of hair upon a firm spring bed or upon fracture-boards (see Part III. p. 26). If the mattrass be too soft or the springs too weak, the body sinks in the middle, and so the upper and lower parts of the spine are pressed together. In fact, as long as there is no risk of bedsore, it is best to use fracture-boards and to do away with the spring mattrass in the first instance. No pillow or bolster should be used, but the head should lie flat in a line with the body and should not be raised for any purpose, except when the disease is in the lower lumbar region, when the head may be raised, provided that the shoulders are not moved.

To allow of manipulation of the bed-pan and attention to the sacrum without moving the patient, the divided mattrass, previously described (see p. 287), should be employed; the narrow portion beneath the pelvis is divided into two lateral halves, and, when the bed-pan is used, one half is pulled out, the bed-pan slipped in so as to give support in its place, and the other side is drawn slowly away so as to allow the pan to come into position. The thighs must be kept horizontal as well as the body because the drawing-up of the thighs throws the psoas muscles into action, and, in dorso-lumbar or lumbar disease, this means disturbance at the seat of disease. In disease of the cervical region, the head and neck must be placed between short broad sandbags. In very restless subjects it may be advisable to mould a light plaster of Paris casing over the front and sides of the trunk so as to control movement sufficiently. Usually however the sandbags suffice.

Extension.—One of the most valuable factors in the treatment of spinal disease at all stages and in all situations except perhaps the lower lumbar region is extension to the head and lower extremities. It is done as follows: the ordinary extension apparatus (see Part III. p. 23) is

attached to both thighs and, in children, a weight of about three pounds to begin with is affixed to each, the limbs being somewhat abducted. A similar weight is attached to the head by means of a chin-strap and an occipital band meeting above the ears and continued up to a pulley at the head of the bed (see Fig. 132). As a rule three pounds is as much as can be comfortably borne at the head, but in adults a little more may be put on at the extremities. It is not however necessary or desirable to have powerful extension, because it is not required to stretch the spine but to tire out the contracted muscles around it, and a comparatively light weight constantly acting will generally suffice for this purpose. The combination of double extension with absolute fixation of the spine is in our opinion the ideal treatment for spinal disease during the progressive stage and in all parts of the spine, and a few months of this will do more for a case than very prolonged treatment with the various forms of spinal supports.

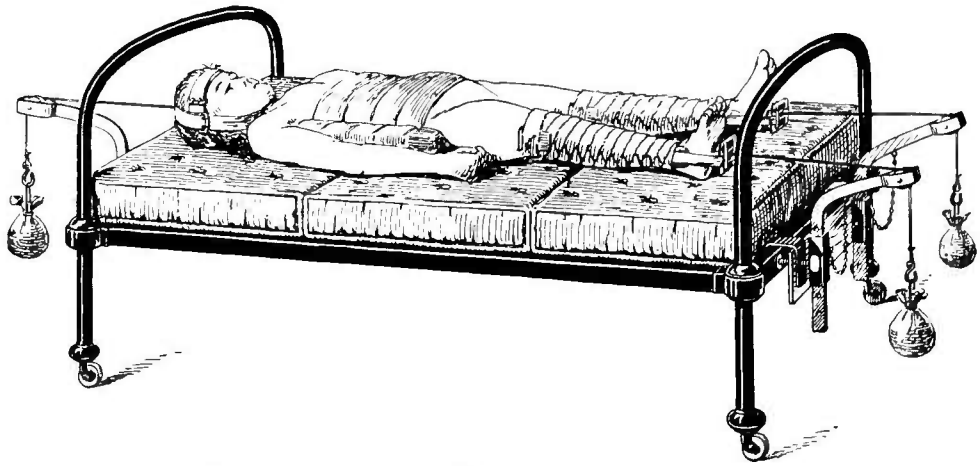


FIG. 132.—DOUBLE EXTENSION FOR TUBERCULOUS SPINAL DISEASE. In addition to the extension from the legs, weight extension is applied to the head by means of the headstall shown above.

It might be thought that the general health would suffer from the confinement in bed, but the contrary is the case. The immediate cessation of the inflammatory process, the pain, etc., leads to improvement in health, appetite, and general condition, and, if the patient be kept under good hygienic conditions, the general health will not suffer for a long time. When improvement in these respects does not follow confinement to bed, it usually means that efficient rest is not given to the affected part or that some grave visceral disease is present as well.

This treatment should be carried out until the pain in the spine has disappeared and the disease is evidently in a fair way to recovery. Six months at the very least will be necessary for this, and in most cases considerably more; in fact, in children this treatment should be continued until the disease is cured, because in them it is impossible to fit on a suitable spinal support owing to the non-development of the pelvis. In

adults, however, when the disease is not higher up than the mid-dorsal region and has apparently come to a standstill, steps may be taken after a few months to allow them to get about with the aid of a spinal support. These spinal supports are not efficient in disease of the mid- or upper dorsal region, and in these cases it is best to continue the rest in bed.

Spinal supports, etc.—To enable the adult patient to get about when the disease is quiescent, a spinal support may be used when the disease is suitably situated; children, however, must be put into some form of apparatus in which, though still kept recumbent, they may be easily carried about and taken into the air.

Phelps's box.—One of two forms of apparatus may be employed for this latter purpose, viz. either Phelps's box—or one constructed on his principles—or a double Thomas's splint. Phelps's box is a wooden tray made to fit the body of the patient, with two narrow troughs diverging from each other below to receive the lower extremities (see Fig. 133). The box should be somewhat broader than the patient, so as to allow for lateral pads, which wedge him in, while he lies upon other pads so arranged as to prevent undue pressure upon the curve. The floor of the tray is cut away opposite the buttocks so as to permit of defæcation without taking the child out of the splint. The sides of the tray are about six inches high for the trunk and less for the legs; they are hollowed out opposite the shoulders so as to allow free play for the arms. There are vertical foot-pieces, to which the feet are bandaged, a pad, of course, intervening. The box should be about 18 inches longer than the patient, so as to leave a space above the head for elastic extension from bands beneath the chin and occiput (see Fig. 134) carried over the top of the splint. The patient is carefully wedged in with pads and bandaged to the splint.

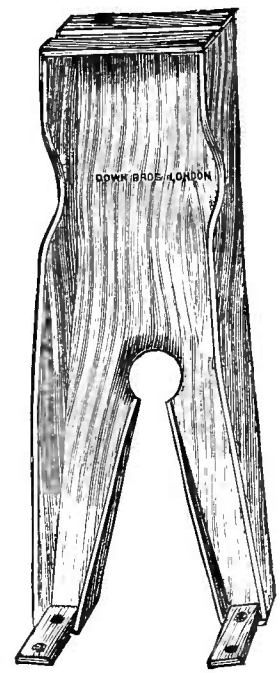


FIG. 133.—PHELPS'S BOX. The splint is here shown without the pads, etc.; in the next Fig. it is shown in use. The holes in the foot-pieces and the slit in the upper end of the splint, through which extension and counter-extension can be made if desired, are seen here, as also the hollows in the sides of the box over which the child's arms can lie.

In this apparatus the child lies at absolute rest, and is easily carried about. Further, if the head extension be applied and the lateral pads carefully wedged in, the box may be tilted up so that the patient may look out of the window, etc. Defæcation and micturition are performed without any disturbance. By undoing the bandages, the front, sides and limbs of the child are easily washed without moving him, and when it is necessary to wash the back, the apparatus is turned upside down on a bed, the bandages undone, and the splint lifted off the child, who is replaced in the reverse manner, and not by lifting him into the box. Children should be kept in this apparatus for at least two or three years. The whole apparatus

with mattrasses costs from 15s. to 20s. and is a most valuable one; in private practice the boxes can be made more elegant by having the sides of strong wicker-work, the bottom remaining wood.

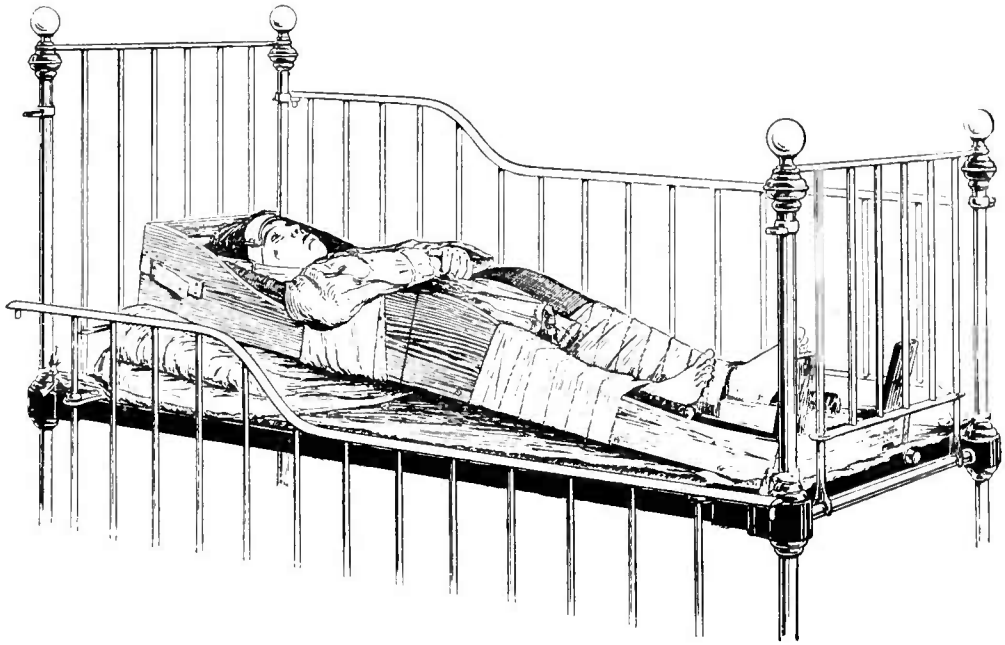


FIG. 134.—METHOD OF APPLICATION OF PHELPS'S BOX. The child lies upon suitable firm cushions made to fit the splint; other similar ones are inserted between the sides of the splint and the body. The legs are kept in their respective troughs by bandages, the thorax is encircled by a broad towel or folded sheet over the splint. The sketch shows the head fastened to the end of the splint by a headstall, and the child's weight allowed to tell upon it by raising that end of the splint. This produces moderate extension which is most useful in cases of disease high up. If more powerful extension be required, it can be obtained either by attaching strong india-rubber door-springs on either side of the head of the splint, in place of the buckle shown in the figure, or a cord and pulley as in Fig. 132.

Double Thomas's splint.—An apparatus in some ways more convenient but by no means so efficient is a double Thomas's splint, provided with pelvic bands and a head rest, the interval between the two upright bars from the buttocks upwards being filled in with strong canvas.

Jackets.—When the child is practically well, a light poroplastic jacket worn for a few weeks gives him a feeling of security and prevents too sudden use of the spine, and is, therefore, of some advantage; but at an earlier stage, as a support for the spine in children, it is not only useless, but in many cases positively harmful.

In adults, when the disease is in the lumbar, dorso-lumbar, or the cervical region, it may be treated from the first with suitable spinal supports, but it is much better, if possible, to employ absolute recumbency with double extension for the first three to six months. It is, however, unnecessary to confine the patient to bed for a longer period when the disease is in these situations. With perfect recumbency and extension, the inflammatory material will have become organised and to some extent ossified in a few months, and the pelvis gives a fairly efficient basis of

support. When the disease is in the lumbar or dorso-lumbar regions, and is not extensive, Sayre's plaster of Paris jacket, put on while the patient is suspended from the tripod in the ordinary way acts fairly well; when a removable apparatus is desired, a poroplastic jacket is a fairly efficient substitute. They are not however at all equal in value to the various forms of "braces," and should only be used when the latter cannot be obtained.

Braces.—The idea that these jackets act by lifting up the thorax from the pelvis is erroneous; they really act by preventing the upper part of the spine from falling forwards, and this is much more effectually done by the forms of apparatus spoken of by the Americans as braces, of which Taylor's brace is one of the best. It must be remembered that the articular pro-

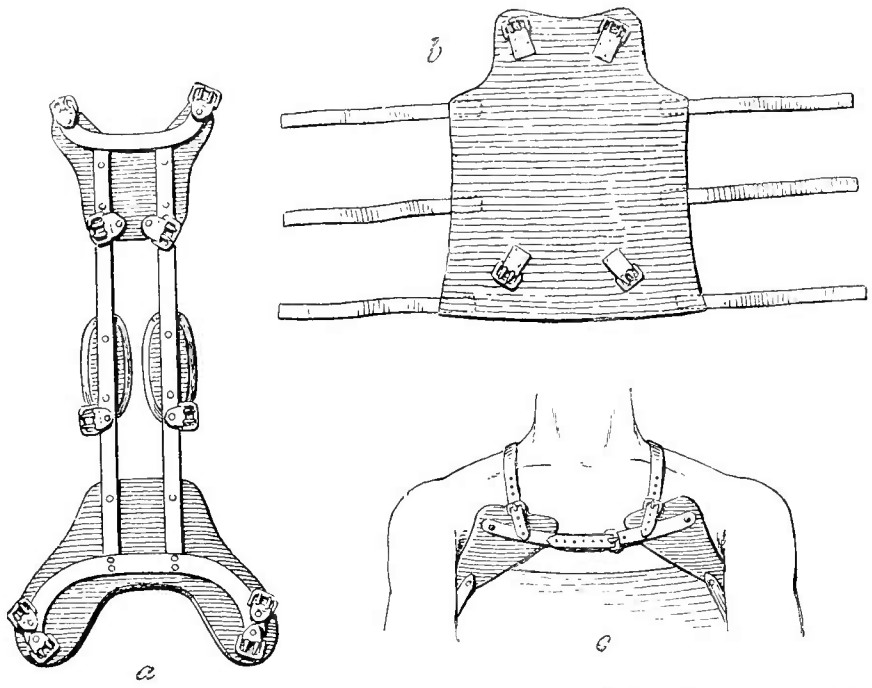


FIG. 135.—TAYLOR'S BRACE. The instrument is seen before application. *a* is the spinal support, *b* the apron, and *c* is Dr. Taylor's chest-piece. The full description of all these will be found in the text. (*After Bradford and Lovett.*)

cesses, the laminæ, the spines and their ligaments, all remain intact although the bodies of the vertebræ are destroyed, and that the upper part of the spine falls forward and does not descend bodily; the object of the apparatus therefore is not to push up the upper part of the trunk as a whole, but to prevent the upper part of the spine from bending forwards on the pivot formed by the articular processes, etc., and thus crushing the softened bodies together. The principle of the brace is to place a bar on each side of the spine, having their fixed points at the pelvis, and their fulcrum at the seat of the disease, and then by an apron over the front of the thorax to pull back the upper part of the spine, or at any rate to prevent it from falling forwards.

Taylor's brace.—We may quote the description of Taylor's brace from Bradford & Lovett's *Orthopædic Surgery*:—"In the first place, a tracing of

the back is made. This is done as follows: The patient lies upon a hard surface, and a strip of flexible metal (lead, or a mixture of lead and zinc), strong enough to retain its position and pliable enough to be readily bent, is laid upon the back, from the neck to the sacrum, so as to accurately fit the lines of curve, presented by the spinal column. The lead is removed, laid on its side upon a piece of stiff cardboard, and the inner outline traced. The simplest antero-posterior apparatus consists of two uprights of annealed steel three-eighths or one-half of an inch in width, and thick enough to be rigid. The gauge numbers of the steel as to thickness should be eight to twelve. These uprights should reach from just above the posterior superior iliac spines to about the level of the second dorsal vertebra. The uprights are joined together below by an inverted U-shaped piece of steel, which runs as far down on the buttock as possible without reaching the chair or bench when the patient sits down. The uprights are joined above by another U-shaped piece, the upper ends of which should pass over to the anterior aspect of the elevation of the shoulders, or rather to the root of the neck.

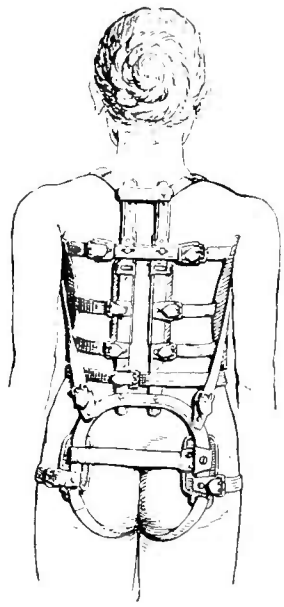


FIG. 136.—TAYLOR'S BRACE APPLIED. (*After Bradford and Lovett.*)

"The uprights should be far enough apart to support the transverse processes of the vertebræ and not the spinous processes. They should be bent according to a card-board tracing of the back, taken as described, and then adjusted to the back. The neck and bottom pieces should be cut out in cardboard to pattern. The whole should then be riveted together and tried on the patient, who should be lying on his face in the recumbent position. Any alteration necessary in the curves of the steel in order to have the appliance fit closely to the back along its whole length can be made with wrenches. The brace can then be wound with strips of Canton flannel, faced with hard rubber and covered with chamois, or be covered smoothly with leather. An accurate fit is essential, the covering is merely a matter of detail.

"Pad-plates covered with felt or hard rubber are needed. In some instances, at the points of greatest pressure (the fulcrum of the lever, etc.), the bars of the brace, if well padded, answer every purpose. Buckles are needed at the ends of the neck piece, at a level with the axilla, opposite the middle of the abdomen, and at the lower end of the brace.

"It is, of course, essential that the trunk be properly secured to the brace. This can be done by means of an apron which covers the front of the trunk, the abdomen, and the chest, reaching from the clavicles nearly to the symphysis pubis. The apron is provided with webbing

(non-elastic) straps, which are fastened into buckles attached to the brace. Padded straps passing from the top of the brace, around the arms, under the axillæ, and attached to buckles in the middle of the brace help to secure it; but the scapulæ, being movable, cannot be relied upon alone to fix the trunk, and the apron must be furnished with straps at the top which pass over the shoulders to buckles in the top of the brace.

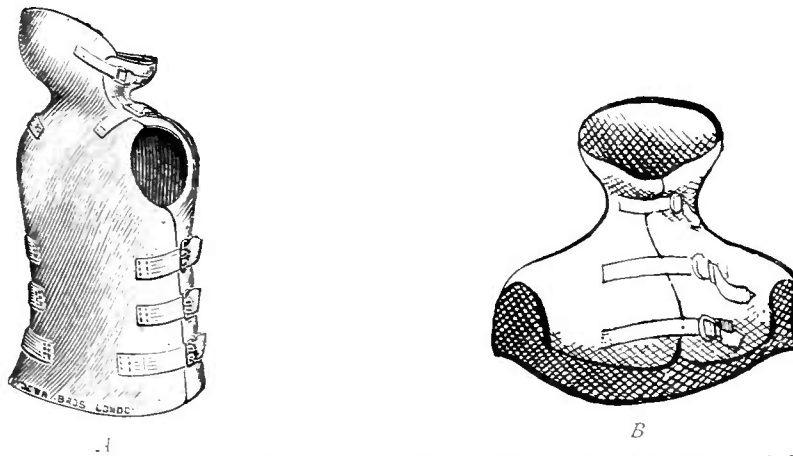
"In adults, it is often convenient to have the apron split down the front and provided with webbing straps and buckles. It can then be adjusted by the patient himself without touching the straps at the back, which secure the apron to the brace.

"A useful addition in certain cases of dorsal caries is found in the use of Dr. Taylor's chest piece. By means of hard rubber pads a definite counter point of pressure is furnished at the upper part of the chest which keeps the brace closely against the back. The pads of the chest piece may be made of hard rubber and fit in below the clavicles where they cause no discomfort, and restrict the chest movements less than the apron, besides affording more definite support.

"The brace should be worn day and night, and removed daily that the back may be bathed. While the brace is off the patient should lie on the face or the back. On no account should he sit erect. The back after being washed should be rubbed with alcohol and then powdered with face powder, corn starch, or fuller's earth. The brace should then be applied and buckled tightly in place.

"Chafing of the back is sometimes unavoidable in summer. When a severe chafed spot forms, the brace must be removed for the time, and the child lie flat in bed till the ulcer heals."

Collars.—When the disease affects the cervical region, the best apparatus takes the form of a collar supported from the shoulders, and grasping the head



A *B*

FIG. 137.—POROPLASTIC COLLARS FOR SPINAL DISEASE. *A* is the good form of apparatus, taking its support from the pelvis and enclosing the entire thorax. It is easily seen that *B* is a faulty form, as it allows a certain amount of movement of the entire apparatus, which rests upon the shoulders.

so as to fix and support it. There are several of these collars which act very well; a very simple and effectual one is that made of poroplastic material.

The essential basis of support should be the pelvis (see Fig. 137): a poroplastic jacket should extend upwards from a pelvic band, grasping the thorax, covering the shoulders, and expanding above to receive the head. Flexion of the cervical spine is thus effectually prevented, which is not the case when the apparatus rests on the shoulders or even when it is fixed round the thorax. Another very good arrangement is to attach a steel ring to Taylor's brace by an upright rod, the ring being made to open in front, and arranged so as to act as a rest for the chin, and occiput, counter pressure being arranged at the upper part of the dorsal region (see Fig. 138). Other supports of this kind for cervical disease need not be detailed here.

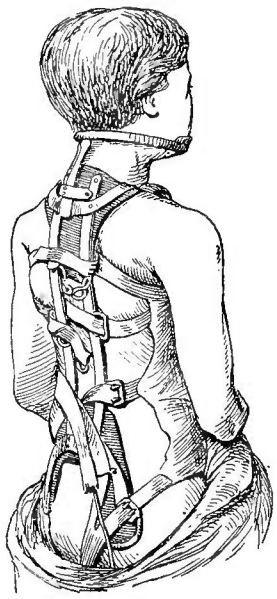


FIG. 138.—TAYLOR'S BRACE AS MODIFIED FOR USE IN CERVICAL SPINAL DISEASE. This is the ordinary brace to which is added the metal ring supporting the chin which is fixed to an upward prolongation of the spinal support. (*After Bradford and Lovett.*)

Of complications.—The two chief complications are paralysis and abscess.

Paralysis.—When paralysis is present or is threatened, we are strongly of opinion that double extension should be rigorously employed in the first instance; in a large number of cases in which we have used this method it has acted like a charm, the paralysis being very rapidly recovered from and all necessity for operative interference being avoided. Indeed in children improvement was actually noticed within three days from the commencement of the extension, and progressed steadily until recovery was complete. Mere recumbency in bed, however rigidly the spine be fixed, is not sufficient, and the double extension evidently acts by tiring out the muscles and preventing their tonic contraction, whereby the inflammation of the spine and the secondary inflammation of the membranes is diminished, so that absorption of the inflammatory products very quickly occurs. The marked benefit of double extension as compared with simple rest in bed shows what an important influence this tonic contraction of the muscles plays in keeping up the disease. Even in old-standing cases of paralysis, we think that, before proceeding to operative measures, a fair trial should be given for some weeks to double extension, with increasing weights if necessary. In our experience laminectomy will not be required in the great majority of instances.

Laminectomy.—Certain cases remain however in which laminectomy is the only treatment which promises relief; such for example are abscesses or masses of caseous material in the spinal canal, or constriction of the cord from thickening of the dura mater around it, *i.e.* pachymeningitis. The operation of laminectomy has already been described (see p. 288). On opening the spinal canal one or other of the conditions already mentioned

should be looked for, more especially the presence of pus in front of the cord, or the presence of thickened dura mater; in the latter case the dura should be slit down from behind and the pressure thus relieved.[1] Pus must be evacuated if present; spicules of bone should be removed, and any soft granulation tissue or cheesy material in front of the cord scraped away. In these cases the laminæ and spinous processes must be removed altogether; they would, if replaced, be liable to become affected with tuberculous disease.

Abscess.—We have already described the treatment of chronic abscess generally (see Part I., p. 248); in the case of spinal disease we usually limit it to the plan of scraping and washing out the abscess, injecting iodoform and glycerine, and stitching up the skin wound again. It is only in abscess connected with posterior disease, especially of the spines, or in some rare cases of cervical abscess, that we can dissect out the abscess wall and deal with the diseased bone. The abscess should be opened on the one hand at a point which gives the freest access to the whole cavity, and on the other at one as far removed as possible from sources of contamination, so that, should union by first intention fail, the dressings are not likely to be soiled.

The best situation for opening *a retro-pharyngeal abscess* is behind the sterno-mastoid; it should never be opened from the throat. An incision is made parallel to the upper third of the posterior border of the sterno-mastoid muscle, above the point of exit of the spinal accessory nerve; after dividing the deep fascia, the muscle is lifted up, and the finger or a blunt instrument is gradually insinuated behind the vessels and in front of and close to the transverse processes and bodies of the vertebræ, until the abscess cavity is reached and the pus let out. A sharp spoon is then introduced and the abscess wall thoroughly scraped, care being taken not to perforate the pharyngeal wall; sometimes the actual focus of disease in the spine can be reached and a sequestrum or a caseous deposit removed. A small quantity of iodoform and glycerine is then injected, and the wound stitched up. Should the cavity fill up again or should healing fail to occur, it is easy to open up the wound and repeat the process or insert a tube. The hair must be shaved for a good distance around.

When the disease is in the *lower cervical region* and the abscess is in the posterior triangle, the greater part of the wall can usually be removed, and the affected bone scraped or gouged away. In clearing out *dorsal* or *lumbar abscesses*, the narrow channel through which the pus has passed backwards should be thoroughly opened up, and the whole cavity cleared out. In *psoas abscess*, the best incision is just internal to the anterior superior spine; if necessary a second incision can be made further back over the crest of the ilium, in order to facilitate access to

[1] If the dura mater be left open, great care must be taken for the first few days to prevent any excessive escape of the cerebro-spinal fluid. The patient should lie on his face with the head low and the foot of the bed raised on blocks.

the bone in disease of the lumbar vertebræ. It is however impossible to deal satisfactorily with the bone disease in this region; in the first place it is too far away, and in the second place it is too extensive, and not sufficiently limited to one side to allow it to be properly dealt with. Sequestra may, however, be removed through the upper incision.[1]

(b) Of the disease in special situations.—The variations in treatment according to the situation of the disease have been already to some extent indicated. *In disease of the upper cervical spine* complete recumbency should be enjoined until the case is practically well. Towards the later stages, however, when there is no longer any pain on movement and the patient is evidently in a fair way to recovery, he may be allowed to get about with a suitable apparatus. Of these the best is, as we have already said, a Taylor's brace with a ring support for the head (see p. 352). The common form of apparatus, viz., the jury-mast, is practically of no value and only leads patients and practitioners astray if they place trust in it. The support of the head piece should be taken from the shoulders as well as from the pelvis.

In the cervico-dorsal or upper dorsal region a neck collar is absolutely essential if the patient is to be allowed to walk about, but here again we would strongly advise that he be kept lying flat until he is well. *In disease lower down*, in children, as we have already indicated, the patient should be kept in a Phelps's box or a double Thomas's splint with a head-piece until recovery has taken place; but in adults, the patients may be allowed to get about wearing a Taylor's brace after the acuteness of the disease has passed off.

(c) Of the deformity left.—Recently Calot has proposed to straighten the spine forcibly, so as to get rid of the curvature and the pressure on the diseased surfaces, and this method has been carried out in a large number of cases. In some of these, striking results in the way of recovery from paralysis have been obtained, while in a few instances death has resulted. We do not describe the method, because we cannot recommend it, and we believe that as good results, both as regards reduction of the deformity and recovery from paralysis, will be obtained by the methods we have described above, more especially by double extension, as by Calot's forcible procedures, and with much less risk to the patient. We refer any one interested in the matter to the *Transactions of the Clinical Society* for 1898 and to the medical papers of November, 1897, for the discussion at the Clinical Society on this subject.

DISEASE OF THE SACRO-ILIAC SYNCHONDROSIS.

This disease may be primary or it may be secondary to disease of the lower lumbar vertebræ; in either case it is very often combined with

[1] Upon the question of the removal of sequestra through a lumbar incision, the original paper by Mr. Treves, in the *Med. Chir. Trans.*, Vol. LXVII., may be consulted.

lumbo-sacral disease. When secondary to lumbar disease, it most usually commences as a periostitis. When it begins primarily in connection with the joint, it generally takes the form of a deposit in the sacrum or ilium, usually the former; as these deposits enlarge they gradually invade the articulation. The interosseous ligament is usually only partially destroyed: it sometimes remains intact.

SYMPTOMS.—The first symptom of the disease is pain, especially in the lumbar region, which is of course worse after exertion; there is often also pain in the buttock, or along the course of the sciatic nerve. There is generally a little puffiness to be noticed over the joint behind, and the muscles of the buttock waste. The patient limps, the limb on the affected side appearing longer because the pelvis is tilted downwards. Pain may be elicited by pressure over the joint behind, or by grasping the anterior superior iliac spines, and pressing them together. As time goes on, the pain and difficulty of movement increase, the leg often becomes swollen from pressure on the iliac vein, and abscesses form in various situations either in front of or behind the joint. If behind the joint, they point there, but generally they form in front, and may then burrow in various directions according to circumstances, running upwards and pointing above the crest of the ilium, backwards through the sacro-sciatic notch either into the buttock or under the gluteus maximus into the thigh, downwards through the obturator foramen or into the perineum, or outwards into the iliac fossa or along the sheath of the psoas into the thigh.

The prognosis is grave, because phthisis is often present, and because of the great difficulty in getting complete fixation of the parts. In young subjects, also, when recovery takes place, anchylosis follows, and oblique deformity of the pelvis is apt to result.

TREATMENT.—The first essential is rest in the recumbent posture between sandbags, or better, in some arrangement like Phelps's box (see p. 347), even in adults. No apparatus is satisfactory which allows the patient to get about. The actual cautery applied behind the articulation before suppuration has taken place is sometimes of use. When operative interference is desirable, the joint may be got at from behind, and portions of bone chiselled away until the disease is reached; should the disease be in the anterior part of the joint, the sciatic notch may be enlarged by the chisel so as to give free access to it.

The best plan, when there is no abscess and when one is not certain which bone is affected, is to make a long curved incision with the convexity running along the middle of the sacrum and going well above the bones and over the sacro-sciatic notch. The flap is thrown outwards, and the glutei detached from the bone and also turned outwards. The chisel is then applied to the ilium and the sacrum and the bones chiselled away until the whole joint is excised or till the bone deposit is found and removed. Great care must, of course, be taken towards the anterior surface.

CHAPTER XXIX.

SPONDYLITIS DEFORMANS: ACUTE OSTEO-MYELITIS: ACTINOMYCOSIS: NEW GROWTHS OF THE SPINE: HYSTERICAL SPINE: SACRO-COCCYGEAL TUMOURS.

SPONDYLITIS DEFORMANS.

THIS is the name given to chronic rheumatoid arthritis of the spine, which usually occurs in persons past middle age. In it there are alterations in the articular surfaces similar to those found in other joints, and likewise outgrowths around the margin of the intervertebral discs. Osteophytic outgrowths also occur in connection with the transverse processes and the bodies, and there is a tendency to ossification of the ligaments and anchylosis of the vertebræ. The spine usually assumes a uniform kyphotic curve forwards, and is rigidly fixed.

Symptoms.—The symptoms are mainly great pain and rigidity, the pain not being limited to the spine itself, but running down the course of any nerves which may be pressed upon as they pass out of the spinal canal.

Treatment.—The condition is a very hopeless one. There is no special form of treatment for the spinal affection; it must be on the lines already detailed (see p. 151) for rheumatoid arthritis elsewhere.

ACUTE OSTEO-MYELITIS.

This is an extremely rare affection, and, beyond pointing out the possibility of its occurrence, we need say very little about it. The condition is more often fatal even than it is in the long bones, possibly on account of the large amount of medullary tissue in the bodies of the vertebræ; sometimes, however, cases recover if the condition be diagnosed and the pus evacuated sufficiently early. Only a very few of these cases are on record.

ACTINOMYCOSIS.

This is another very rare disease of the spine, which, when it occurs, is accompanied by abscesses that can only be treated by scraping. When actinomycosis attacks the spine, it usually involves other structures in the neighbourhood, such as the pleura and ribs, at the same time, and the chances of recovery are extremely slight.

NEW GROWTHS.

Tumours in connection with the spine may be divided into those which occur in connection with the bones, and those which occur in the interior of the canal forming the so-called tumours of the spinal cord.

OF THE VERTEBRÆ.—The tumours in connection with the bones may be either primary or secondary, the **primary tumours** being usually *exostoses* and *sarcomata.* The most common malignant tumour of the spine is the **secondary** *carcinoma* following a primary growth elsewhere, more especially in the breast; this generally affects the bodies of the vertebræ, and leads to extensive destruction.

Symptoms.—The earliest and most marked symptom of cancer of the vertebræ is intense pain, which is not merely limited to the spine, but after a time radiates along the course of nerves which pass out of the intervertebral foramina in the immediate neighbourhood. A second characteristic symptom is paralysis, which sets in very quickly, and has not that gradual onset which is seen in cases of tuberculous disease, or of tumours of the spinal cord; complete paralysis may develop within a few hours. Angular curvature also occurs in some cases of cancer of the spine, but it is not such a marked feature as the pain and the paralysis.

Treatment.—With the exception of the exostoses, the treatment of these tumours must be purely palliative, and aimed at relieving the symptoms. In cases of secondary cancer, where curvature is becoming evident, the pain may be to some extent alleviated by the application of a spinal support—such as a Taylor's Brace—with the view of preventing the bones being pressed together. As, however, most of the pain is due to the involvement of nerves, the chief agent in the treatment must be morphine.

OF THE SPINAL CORD.—Much more interesting and important than the tumours of the bones are those of the spinal cord, for in a certain proportion of cases, operative measures may relieve the symptoms, or indeed effect a cure.

Tumours in the interior of the spinal canal may be extra-meningeal, intra-meningeal, or even in the cord itself. Their most common seat is within the dura mater, and they may take the form of any known kind of tumour. The most common form is probably a *myxoma*, while *lipomata*, *sarcomata*, *tuberculous tumours*, and *syphilitic gummata* occur; *echinococcus cysts* have also been found.

In the early stages, pain extending down the limbs, according to the seat of the tumour, is usually the first symptom. This is followed first by paralysis of motion and later by paralysis of sensation. As time goes on, the pain is associated with clonic spasms, usually accompanied first, by extension of the affected limbs, and later, as the extensors lose their power earlier than the flexors, by flexion; the condition known as spastic paraplegia then develops. The symptoms are frequently unilateral or more marked on one side than the other, and the motor paralysis is then generally on the same side as the tumour while the anæsthesia is on the opposite side. There is also usually hyper-æsthesia on the same side as the tumour in the early stages, on which side moreover the reflexes are exaggerated; in the late stages they are lost. Usually there is a certain amount of dull pain in the back in the neighbourhood of the tumour and there may be spasm of other muscles than those of the limbs; sometimes there is spasm of the spinal muscles leading to scoliosis.[1] Along with the paralysis there is, in the early stages, retention of urine, followed later by incontinence with cystitis, paralysis of the bowel, bedsores, etc. Unless relieved by operation, the patients usually die in from one to three years from exhaustion, bedsores, pneumonia, or nephritis.

Treatment.—The treatment of cases of tumour of the spinal cord must be laminectomy and an attempt to remove the growth. If left alone the patient is certain to die, and, although the tumour may not be removable, yet, in a considerable number of cases,—about 80 % according to Horsley—the symptoms may be relieved entirely by operation, and even those in which the pain cannot be entirely relieved will be much benefited by the diminution of the pressure.

An important point with regard to operative treatment is that the pain is always referred to a lower level than the lesion, and therefore it is of great importance in operating to open the spinal canal well above the area of even doubtful diminution of sensibility. In Horsley's case for example the tumour was diagnosed to be in connection with the roots of the fifth dorsal nerve, but at the operation it was found to involve the roots of the third.

Laminectomy.—The steps of the operation have already been described (see p. 288). In these cases it may very often be possible to turn up the laminæ *en bloc* without entirely removing them (see p. 291). When the dura mater has been exposed and when it is seen that the tumour is not external to it, this structure must be opened by a free median incision with the usual precautions against the too sudden escape of cerebro-spinal fluid (see p. 291). In one case on which we operated, the tumour was

[1] For further information on the subject of the symptoms and localisation of these tumours various authorities may be consulted. The first paper was published by Gowers and Horsley, in the *Medico-Chirurgical Transactions* as long ago as 1888. See also Starr in *The Medical News*, February, 1895; Thorburn: On the Surgery of the Spinal Cord.

found lying between the dura mater and the cord and compressing the latter; it was readily removed by pulling on it and separating its connections with the membranes by means of a blunt instrument. Care must be taken, if the tumour winds round any of the nerves, to disentangle it without injury to them. After the operation, all bleeding is arrested, the dura mater is sewn up, and the laminæ are replaced. It is well to fix the latter in place by drilling the lamina on each side below the line of section of the ligamenta subflava (see Fig. 78), and drilling the lowermost of the replaced laminæ in corresponding situations; fine silver wire may then be passed from one to another. One or two sutures will bring the spinal muscles together in the middle line and the skin wound is closed without a drainage tube.

In syringo-myelia, which is usually a form of *glioma* of the spinal cord leading to dilatation of the central canal, the spinal canal has been opened in several cases, but without any benefit resulting.

HYSTERICAL SPINE.

The spine is one of the most common seats of so-called hysterical disease, and the affection is sometimes mistaken for Pott's disease or for lateral curvature. The distinguishing features about it, however, are the absence of rigidity, the marked hyperæsthesia which is usually very evident even on light pressure on the skin, and the completely normal appearance of the spine. When the pain complained of is in the lower dorsal vertebræ, in a thin patient who has been wearing tight corsets, the spinous processes may be very prominent, and the skin over them red and tender, so that a casual examination may lead to the belief that the prominent spinous processes indicate angular curvature; when the patient bends the back, however, the absolutely free mobility at once shows that this is not the case.

Treatment.—The treatment of hysterical spine is the same as that already discussed in connection with hysterical joints (see p. 144). It must be directed towards the improvement of the general health, and the removal of any existing visceral disease, more especially ovarian or uterine disorders. No sort of apparatus should be applied; probably the best treatment is the Weir Mitchell treatment, without paying any special attention to the spine.

SACRO-COCCYGEAL TUMOURS.

Certain swellings occur about the lower part of the sacrum, which are evidently the remains of a detached fœtus, and if they cause trouble an attempt may be made to remove them. The true sacro-coccygeal tumours occur in front of the coccyx in connection with the post-anal duct. They are usually cystic, and may be small and lie in the concavity of the sacrum, or they may be large and project behind the anus, pushing the coccyx backwards.

Treatment.—The removal of these tumours is always a very serious matter on account of the great risk of sepsis owing to their close connection with the anus; unless, therefore, they are doing harm, it is well to avoid interfering with them, at any rate until the patient is grown up. When removal is undertaken, special pains must be taken not to open into the rectum, which it is very easy to do, owing to the connection of the tumour with that structure. It must always be borne in mind that there may be a free communication between the tumour and the spinal canal, and consequently the cerebro-spinal fluid may escape during the operation.

INDEX.

PART IV.

ABSCESS in acute arithritis, 95
chronic spinal, treatment, 343
dorsal, in tuberculous spine, 343
treatment, 353
lumbar, in tuberculous spine, 343
treatment, 353
psoas, in tuberculous spine, 343
treatment, 353
retro-pharyngeal, 343
treatment, 353
sub-occipital, in tuberculous spine, 343
tuberculous, of joints, 113, 122, 124
ankle, 236
hip, 168
treatment, 180
knee, 202
treatment, 218
shoulder, 250, 252
wrist, 268
os calcis, 238
spine, 343
Acetabulum, changes in, in dislocation of hip, 58
enlargement of, in hip disease, 168
formation of new, in dislocation of hip, 60
osteo-myelitis, of, treatment, 167
seat of tuberculous disease in, 167
Actinomycosis of spine, 358
Acute epiphysitis of tarsal bones, 228
inflammation of joints, 92 (*see* Joints, acute inflammation of)
osteo-myelitis of spine, 357
rheumatoid arthritis, 149
suppurative arthritis, 94
of elbow, 257
hip, 166
knee, 199
shoulder, 249
synovitis, 92
of ankle and tarsus, 228
elbow joint, 258
knee joint, 195
phalangeal joints, 273
shoulder joint, 249
wrist, 266
Adam's osteotomy saw, 190
Adhesions, fibrous, in joints, 162
in joint neuroses, 144
synovitis, 93
Aix massage in rheumatoid arthritis, 153
Alimentary troubles in fractured spine, 284
Ambulatory treatment of osteo-arthritis, 155
Amputation in acute arthritis, 97, 229
in Charcot's disease, 143
compound dislocations, 6
septic wounds of joints, 87, 88
tuberculous joint disease, 122, 125, 135
of ankle, 237
knee, 219
phalanges, 275
Anchylosis, varieties, 161
of ankle joint, 237
knee, 202, 221
shoulder, 254, 255
with deformity in tuberculous joints, 136
Ankle and tarsus,
arthritis, acute, of, 228
Charcot's disease of, 230
rheumatoid arthritis of, 230
synovitis, chronic, of, 229
syphilitic affections of, 230
tuberculous disease of, 231
of ankle joint, 231
treatment, 231
of primary osseous deposits, 232
of synovial thickening, 232
when abscesses or sinuses are present, 236
when there is recovery with deformity, 237
of the tarsus, 237
diffuse disease, 244
treatment, operative, 244
amputation through the leg, 248
complete tarsectomy or Mikulicz's operation, 246

Ankle and tarsus
tuberculous disease of
of the tarsus
diffuse disease
treatment, operative
partial tarsectomy, 244
of individual bones, 238
of first metatarsal, 242
os calcis, treatment, 238
other tarsal bones, 243
excision of internal cuneiform, 243
of scaphoid, 244
Ankle joint, diseases of, 228 (*see* Ankle and tarsus, diseases of)
dislocations of, 70
excision of, 236
injection of, 121
primary osseous deposits in, 231, 232
tuberculous synovial disease in, 232
Arthrectomy and excision, choice between, in tuberculous joints, 123, 125, 128
Arthrectomy in tuberculous joint disease, 122, 125
for anchylosis with deformity, 137
when sinuses are present, 136
of ankle, 233
elbow, 260
hip, 177
knee, 209
in children, 213
with septic sinuses, 219
Arthritis, acute suppurative, 94
of ankle, 228
elbow, 257
hip, 164
knee, 199
shoulder, 249
wrist, 266
deformans, 221
gonorrhœal, 98
of hip, 165
knee, 199
wrist, 267
gouty, of phalangeal joints, 273
in connection with specific fevers, 104
rheumatoid, 149
of ankle, 230
elbow, 258
hip, 192
knee, 221
phalangeal joints, 274
shoulder, 255
senile, 150
traumatic, 150
Arthrotomy, for loose bodies, 159
in suppurative arthritis of hip, 165
in tuberculous knee disease, 209
Aspiration, in Charcot's disease, 143
in chronic synovitis, 106
gonorrhœal arthritis, 103
treatment of sprains, 80
Astragalus, dislocation of, 74
excision of, 72, 237
removal of, 233, 237
tuberculous osseous deposits in, 232
Axillary artery, injury to, in dislocation, 24, 26, 27
Axillary nerves, injury to, in dislocation, 28

BANDAGE elastic, for dislocated patella, 62
for sprains, 79
syphilitic joints, 139
Bannatyne and Blaxall's theory of rheumatoid arthritis, 149
Bavarian splint for dislocated semilunar cartilage, 66
Bed, preparation of, in fracture of spine, 293
sores in fractured spine, prevention of, 293
Biceps, inflammation of bursa beneath, 257
Bier's congestion method, 122, 133, 208
Bigelow's method for hip dislocations, 52, 56
Blisters, in chronic synovitis, 106
in sprains of spine, 278
tuberculous joints, 118
Blood, effusion of, in sprains, 77
Bones, alteration in, in Charcot's disease, 141
tuberculous deposits in, 129
Bonnet's wire splint for hip disease, 176
Bony anchylosis, treatment of, 161
Braces in scoliosis, 323, 325
tuberculous spinal disease, 349
Brachial plexus, injury to, in dislocations of shoulder, 24, 28
Bullet wounds of the spine, 294
Bunger's method of injecting hip joint, 121
Bursa beneath biceps tendon, inflammation of, 257

CALCANEUS, talipes in spina bifida, 296
Calot's method of straightening the spine, 354
Capsule, changes in, after dislocation of hip, 58
over-distension of in sprains, 77
Caries, superficial in spine, 341
in tuberculous joints, 112
Carpal bones, dislocation of, 45
Carpus, dislocation of, 45
in tuberculous wrist, 268
Cartilage, changes in, in rheumatoid arthritis, 150, 151
changes in, in tuberculous joints, 112
destruction of, in hip disease, 169
ulceration of, 132
Cartilages, loose in joints, 158
in elbow, 258
knee, 222
semilunar, dislocation of, 65, 224
treatment, 66, 225
Catheter, Jaques' red rubber, 292
Cauda equina, pressure on, in fracture of spine, 285
Cautery actual in tuberculous joint disease, 118, 130
of hip, 172
of shoulder, 251
Cervical spinal abscess, treatment of, 353
Chalkstones, 273
Charcot's disease, 141
treatment, 143
of ankle and tarsus, 230
elbow, 259
hip, 193
knee, 221

Charcot's disease
of shoulder, 256
Chronic abscess, treatment of, in tuberculous joints, 122, 124
in tuberculous hip disease, 168
treatment of, 181
in tuberculous spinal disease, 343
treatment of, 353
inflammation of joints, 105
rheumatoid arthritis, 150
synovitis, 105
of ankle and tarsus, 229
hip, 167
knee joint, 197
wrist, 267
with effusion, 105
with synovial thickening, 107
Circumflex nerve, injury to, in dislocations of shoulder, 24
Clavicle, dislocation of, 9
of acromial end, 9
sternal end, 12
Clean-cut wounds of joints, 84
Climate in tuberculous joint disease, 114
Cod-liver oil, in rheumatoid arthritis, 150, 152
in scoliosis, 305
tuberculous joints, 115
Collars for tuberculous spine, 351
Concussion of the spine, 279
Congenital dislocations, 1
Contused wounds of joints, 85
Convalescent homes in tuberculosis, 115
Coronoid process, treatment of fracture of, in dislocation of elbow, 35
Counter-irritation in sprains of spine, 278
in tuberculous joint disease, 118
Croft's splints for sprains, 79
in synovitis of ankle and tarsus, 229
tuberculous disease of ankle, 232
of knee, 205
Cuboid, tuberculous disease of, 243
Cuneiform internal, excision of, 243
tuberculous disease of, 243
Curvature, angular, of spine, 342
kyphotic, 304
lateral, 306
ricketty, 304
Cystitis in fracture-dislocation of spine, 284
treatment of, 292

Dactylitis syphilitica, 140
Deformity, accompanying bony anchylosis, 162
in tuberculous joints, treatment of, 136, 184
the hip, 170
the knee, 202
Deltoid, atrophy of, in arthritis of shoulder, 255
Desks suitable for children, 314
Diet for rheumatoid arthritis, 151
tuberculous joint disease, 115
in the Weir Mitchell treatment, 146
Diffuse tuberculous disease of tarsus, 244
Diseases of joints, 92
of individual joints (*see* various joints)
Disinfection of skin in punctured wounds of joints, 83
Dislocations, classification, 1
causes, exciting and predisposing, 2
complicated by fracture, 5
by injuries to vessels or nerves, 5
compound, treatment of, 5
after-treatment, 6
congenital, 1
in hip-joint disease, 168
in rheumatoid arthritis, 150
of individual joints, of ankle and foot, 70 (*see* Ankle)
of clavicle, 9 (*see* Clavicle)
elbow, 33 (*see* Elbow)
hip, 50 (*see* Hip)
knee and its cartilages, 64 (*see* Knee)
patella, 61 (*see* Patella)
shoulder, 14 (*see* Shoulder)
spine (*see* Spine), 282
wrist and fingers, 45 (*see* Wrist)
partial, 1
pathological, 1
simple, treatment of, 2
traumatic, 1
unreduced, treatment of, 6
Dorsal spinal abscess, 343
treatment of, 353
dislocation of hip, 51
Douching in rheumatoid arthritis, 153
in sprains of the spine, 279
Dowd's machine, 321
high form, 337
quarter-circle form, 337
Drainage in acute arthritis, 95, 96
in Charcot's disease, 143
Drilling bone in rheumatoid arthritis, 156
Dumb-bells in scoliosis, 318, 321
Dura mater, exposure of, in laminectomy, 291

Elbow joint, acute suppuration of, 257
acute and chronic synovitis, 258
arthrectomy of, 260
Charcot's disease of, 259
dislocations of, 33
varieties of, 33
of both bones of fore-arm, 33
backwards, 33
treatment of, 34
of complications, 35
compound dislocation, 37
simple dislocation, 34
unreduced dislocation, 38
combined backward and lateral dislocation, 39
forwards, 40
laterally, 39
inwards, 40
outwards, 39
of either bone alone, 40
radius alone, 40
treatment, 41
after-treatment, 41
unreduced dislocation, 43
ulna alone, treatment of, 40
"pulled arm," 44
excision of, 263
after-treatment, 264
inflammation of bursa beneath biceps, 257

Elbow joint
injection of, 121
loose cartilages in, 258
osseous deposits in, 259
osteophytic outgrowths in, 258
rheumatoid arthritis of, 258
tuberculous disease of, 259
treatment, 259
expectant, 259
operative, 260
Electricity in rheumatoid arthritis, 154
Empyema tuberculosum, 114
diagnosis and treatment of, 131
Epi-condyle internal, detachment of, in dislocation of elbow, 36
Epiphysitis acute, as cause of arthritis, 94
of ankle and tarsal joints, 228
of hip, 166
Everted dorsal dislocation of hip, 51
Excision, in bony anchylosis, 162
in rheumatoid arthritis, 156
in spina bifida, 298
cases suitable for, 299
osteo-plastic procedures, 301
in tuberculous joint disease, 122, 128
of the hip, 179
cases suitable for, 180
difficulties in, 179
with chronic abscess, 182
deformity, 186
septic sinuses, 184
of the knee in adults, 213
with septic sinuses, 220
in treatment of unreduced dislocations, 8
of individual joints, the ankle, 236
of the elbow, 263
of the hip, 187
indications for, 179, 182, 186
methods of, 187
by an anterior incision, 187
after-treatment, 189
an external incision, 190
a posterior incision, 191
of the knee joint, 215
after-treatment, 217
of the shoulder joint, 252
of the wrist joint, 269
Exercises for scoliosis, 315, 318, 319, 321, 326
Extension, after excision of hip. 189
in tuberculous joint disease, 117
of hip, 177
of shoulder, 251

FARADIC current in joint neuroses, 146
Femur, absorption of neck of, in hip disease, 169
changes in head of, in unreduced dislocation, 58
dislocations of (*see* Hip joint), 50
Fevers, specific, as cause of acute arthritis, 92
Fibrous anchylosis, treatment of. 162, 163
Fomentations in acute synovitis, 93
of hip, 164
Foot, dislocations of the, 71
of astragalus alone, 74
sub-astragaloid dislocation, 71
of other bones of tarsus and metatarsus. 75
of metatarsal bones, 75
Foot, dislocation of the
of other bones of tarsus and metatarsus
of metatarso-phalangeal joints, 75
transverse tarsal joint, 75
Foreign bodies in joints, 158
Fracture-boards, 287
Fracture complicating dislocations, 5
of the shoulder, 24
Fracture-dislocation of spine (*see* Spine, fracture-dislocation of), 282

GELENKMAÜSE, 159
Glenoid cavity, treatment of, in excision of shoulder, 254
ligament, division of, in thumb dislocations, 49
Gonorrhœal arthritis, 98
of ankle, 228
hip, 165
knee joint, 199
suppurative, treatment of, 103
rheumatism, 98.
Gooch's splinting, after arthrectomy of the knee, 212
in displacement of semilunar cartilages, 225
in excision of knee, 217
in synovitis of the knee, 196
Gouging in rheumatoid arthritis, 155, 156
Gouty arthritis of ankle and tarsus, 228
of phalangeal joints, 273
Guaiacol in rheumatoid arthritis, 150, 152
Gummata of joints, 139
Gymnastic medical exercises for scoliosis, 326

HÆMATO-MYELIA, 281
Hæmato-rachis, 279
Hæmophilia in knee joint, 222
Hæmorrhage, in sprains, 77
into spinal cord, 281
intra-spinal, 279, 281
Hereditary syphilis of joints, 140
Hey's saw in laminectomy, 291
Hip-joint, arthritis of, after typhoid, 165
gonorrhœal, 165
pyæmic, 166
suppurative, 164
arthrotomy of, 165
Charcot's disease of, 193
dislocations of, 50
causes and pathology of, 50
changes when unreduced, 58
treatment, of irregular forms, 58
of regular forms, 52
backwards, 52
on to dorsum ilii, 52
into sciatic notch, 55
forwards, 55
pubic, 57
into thyroid foramen, 56
of unreduced, 58
after-treatment, 59, 60
varieties, 50
regular dislocations, 50, 51
dorsal, 51
everted dorsal, 51
pubic, 51
sciatic, 51

Hip-joint, arthritis of, after typhoid
dislocations of
varieties
regular dislocations
supra-spinous, 51
thyroid, 51
irregular, 50, 51
excision of, 187 (*see* Excision of Hip)
hysterical disease, 193
injection of, 121
loose bodies in, 194.
rheumatoid arthritis of, 192
suppurative arthritis, 164
after typhoid fever, 165
pyæmic, 166
synovitis of, acute, 164
chronic, 167
tuberculous disease of, 167
clinical stages, 169
course, 168
prognosis, 170
seats, 167
treatment, 170
of first stage, 170
primary bone disease, 171
synovial disease, 172
of fourth stage, 184
of second stage, 177
of third stage, 180
with unopened abscess, 180
with septic sinuses, 182
Home medical exercises, 327
Humerus, fracture of complicating dislocation of elbow, 36
complicating dislocations of shoulder, 24
removal of head of, in tuberculous shoulder-joint disease, 251
Hydrocephalus in spina bifida, 296
Hydrops tuberculosus, 114
diagnosis and treatment of, 131
Hypnotism in joint neuroses, 147
Hysterical joint affections, 144
of hip, 193
knee, 222
spine, 360

Iliac abscess in tuberculous hip, 168
Injections, irritant, in chronic synovitis, 106, 109, 198
Injuries of joints, 1
Inter-articular fibro-cartilage, detachment of, 77.
Internal cuneiform, excision of, 243
tuberculous disease of, 243
Internal epi-condyle, detachment of, in dislocated elbow, 36
Inter-phalangeal joints, dislocations of, 46
Intra-spinal hæmorrhage, 279, 281
Iodide of potassium for syphilitic joints, 139
Iodoform emulsion in tuberculous joints, 120
injections in tuberculous ankle, 232
in tuberculous knee, 208
Irrigation in chronic synovitis, 106
continuous, in suppurative arthritis, 96
for septic wounds of joints, 88

Jacket, plaster, in fractured spine, 287
in tuberculous spinal disease, 348
Jaques' red rubber catheter, 292
Joint, neuroses, 144
preservation of functions of, after dislocations. 4
Joints, affections of, 1
anchylosis of, 161
inflammatory affections, 92
acute inflammation, 92
acute suppurative arthritis, 94
treatment of, 95
when attempt is made to save limb, 95
when general condition is bad, 97
acute synovitis, 92
chronic synovitis, 105
with effusion, 105
with synovial thickening, 107
of synovial fringes, 107
of synovial membrane, 109
gonorrhœal arthritis, 98
treatment, 100
points common to all types, 100
of cases with excessive effusion, 103
of cases with suppuration, 103
of ordinary variety, 101
of rheumatic form, 100
other forms of infective arthritis, 104
injuries to :
dislocations, 1
sprains, 76
loose bodies in, 158
nervous affections of, 141
rheumatoid arthritis, 149
sprains, 76
treatment, 79
surgical diseases of :
anchylosis, 161
inflammatory affections, 92
loose bodies, 158
nervous affections, 141
rheumatoid arthritis, 149
syphilitic affections, 138
tuberculosis, 111
syphilitic affections of, 138
tuberculosis of, 111
wounds of, 82
treatment of recent wounds, 82
clean cut, 84
contused, 85
punctured, 82
of septic wounds, 87

Knee-cap, elastic in dislocation of patella, 62
Knee joint, acute suppurative arthritis of, 199
acute synovitis of, 195
arthritis deformans of, 221
Charcot's disease of, 221
chronic synovitis of, 197
dislocation of, 64
treatment, 65
excision of, 215
gonorrhœal arthritis of, 199
hæmophilia of, 222

Knee-joint
hysterical affections of, 222
internal derangements of, 222
detachment of ligamenta alaria, 223
injury to semilunar cartilages, 224
loose cartilages, 222
papillary synovitis, 223
ligamenta alaria, detachment of, 223
loose cartilages in, 222
papillary synovitis of, 198
points for injection of, 122
rheumatoid arthritis of, 221
semilunar cartilages, injury to, 224
synovitis, acute and chronic, 195, 197
syphilitic affections of, 200
tuberculous disease of, 200
treatment of, 202
of diffuse disease, 205
of first stage, 205
expectant, 205
operative, 208
of fourth stage, 220
in adults, 221
in children, 220
of second stage, 213
of third stage, 217
with unopened abscesses in adults, 219
in children, 217
with septic sinuses, 219
in adults, 220
in children, 219
of localised deposits, 202
osseous, 203
synovial, 203
Kocher's incision for arthrotomy of elbow, 42
reduction of dislocations of the shoulder, 16, 30
Krause's points for injections into various joints, 121
Kyphosis, 304
treatment, 305

LAMINÆ, defect in, in spina bifida, 296
fractures of, 288
Laminectomy, 288
after-treatment, 291
in hæmato-rachis, 279
spinal growths, 359
tuberculous spinal disease, 352
Leeches, in acute synovitis, 93, 196
Leiter's tubes, in dislocation of knee joint, 65
in dislocation of patella, 61
in sprains, 78
Ligamenta alaria, detachment of, 223
Ligaments, damage to, in sprains, 76
destruction of, in Charcot's disease, 142
Linimentum iodi in gonorrhœal arthritis, 100
"Lipping of articular ends" in rheumatoid arthritis, 151
Lister's splint for tuberculous wrist, 268
Liston's splint, for dislocation of the hip, 58, 59
in suppurative synovitis of hip, 165
tuberculous hip disease, 171
Localised tuberculous deposits in joints, 113
"Locking of the knee joint," 66, 225
Locomotor ataxia, joint disease in, 141
Loose bodies in joints, 158
Loose bodies in joints
in elbow joint, 258
hip joint, 194
knee, 222
Lotions, evaporating in sprains, 78
Lumbar spinal abscess, 343
treatment, 353

MACINTYRE'S splint, for displaced semilunar cartilages, 225
in synovitis of knee joint, 196
Malformations and paralyses in spina bifida, 296
Malum coxæ senile, 192
senile, of shoulder joint, 255
Massage, in acute synovitis, 93
in joint neuroses, 146
scoliosis, 318
sprains, 79
of spine, 279
synovitis of knee, 196
Meningocele, 295
treatment of, 302
Meningo-myelocele, 295
treatment of, 302
Metacarpal bones, dislocation of, 46
Metacarpo-phalangeal dislocations, 46
Metatarsal bones, dislocation of, 75
tuberculous disease of, 242
Metatarso-phalangeal dislocations, 75
Metatarsus, dislocations of, 75
Mikulicz's operation, 246
Micro-organisms in osteo-arthritis, 149, 150
Mon-articular rheumatoid arthritis, 150
Morton's fluid, in spina bifida, 297
Muscles, contracture of, in joint neuroses, 144
injuries to, in sprains, 77
Myelocele, 296
treatment of, 303

NECROSIS of os calcis, 228
Nerve troubles in fractured spine, 284
Nerves in spina bifida, 295
Nervous affections of joints, 141
due to Charcot's disease, 141
neuritis, 144
neuroses, 144
organic lesions, 141
syringo-myelia, 141
Neural arches, fracture of, 288
Neuritis, joint affections from, 144
Neuroses, joint, 144
treatment, general, 145
local, 147.

OPERATION in rheumatoid arthritis, 155
Os calcis, excision of, 239
necrosis of, 228
osteo-myelitis of, 228
tuberculous disease of, 238
Osseous deposits, primary tuberculous, 111
tuberculous in ankle joint, 231, 232
in elbow, 259
knee, 201
shoulder, 249
spine, 341
wrist, 267
Osteo-arthritis, loose bodies in, 159
of ankle, 230

Osteo-arthritis, loose bodies in
of elbow, 258
hip, 192
knee, 221
phalangeal joints, 274
shoulder, 255
Osteo-chondritis, 140
Osteo-myelitis, of acetabulum, treatment, 167
of ankle and tarsus, 228
spine, acute, 357
tuberculous, 11
of phalangeal joints, 274
Osteo-plastic operations in spina bifida, 301
Osteophytes in rheumatoid arthritis, removal of, 150, 156
Osteotomy in tuberculous joints, 137

PACHYMENINGITIS in tuberculous spine, 352
Papillary synovitis, 223
of knee joint, 198
Paraplegia in spina bifida, 295
in spinal caries, treatment, 352
Patella, dislocation of, causes, 61
varieties, 61
inwards, 62
outwards, 61
unreduced, operation for, 62
vertical, 62
removal of, in excision of knee, 215
Pelvic abscess in tuberculous hip disease, 169
Phalangeal joints, diseases of,
acute synovitis, 273
gouty arthritis, 273
rheumatoid arthritis, 274
sprains of, 273
synovitis of, 273
syphilitic dactylitis, 275
tuberculous osteo-myelitis, 274
Phalanges, dislocations of, 46
at interphalangeal joints, 46
metacarpo-phalangeal joints, 46
of thumb, 46
Phelps's box, in hip disease, 176
after excision of hip, 190
in tuberculous spinal disease, 347
Pressure in synovitis, 93
in tuberculous joints, 119
Pressure symptoms in tuberculous spinal disease, 344
Psoas abscess, 343
treatment of, 353
Pubic dislocation of hip, 51
treatment of, 57
"Pulled arm," 44
Punctured wounds of joints, 82
Pyæmia, as cause of acute arthritis, 94
of knee joint, 199
as result of acute arthritis, 95
Pyæmic arthritis of hip, 166

"RACHILYSIS," 322.
Radius, dislocation of, 40 (*see* Dislocations)
and ulna, dislocation of, 33 (*see* under Dislocations)
"Railway spine," 280
Recumbency in scoliosis, 317
Respiratory troubles in fractured spine, 284
Retro-pharyngeal abscess, 343
Retro-pharyngeal abscess
treatment of, 353
Rheumatism, gonorrhœal, of wrist, 266
as cause of acute synovitis, 92
gonorrhœal, 98
in synovitis of ankle and tarsus, 228
Rheumatoid arthritis, 149
acute, 149
chronic mon-articular, causes, 150
pathological changes, 151
treatment, general, 151
local, 152
ambulatory, 155
operative, 155
thermal, 152
mon-articular, 150 (*see* chronic)
of individual joints:
ankle and tarsus, 230
elbow, 258
hip, 192
knee, 221
phalangeal joints, 274
shoulder, 255
"Rice bodies," 158
Ricketty spine, 304

SACRO-COCCYGEAL tumours, 360
Sacro-iliac synchondrosis, disease of, 355
Sayre's jacket for tuberculous spine, 349
Scaphoid, excision of, 244
tuberculous disease of, 243
Scapula, tuberculous deposits in, 249
Scarlet fever, acute arthritis after, 104
Schuchardt's irrigation in gonorrhœal arthritis, 103
points of papillary synovitis, 108
Sciatic dislocation of hip, 51
treatment of, 55
"Scissor leg," treatment of, 187
Scoliosis, causes, 306
examination of cases, 310
pathological changes, 308
prognosis, 311
symptoms, 309
treatment,
gymnastic exercises in, 327
prophylaxis, 312
when developed, 315
Scottish douch in rheumatoid arthritis, 153
Scott's dressing in chronic synovitis, 106
in sprains of fingers, 273
tuberculous joints, 119
knee, 208
Semilunar cartilages, dislocations of the, 65
injury to, 224
removal of, 210
"Senile arthritis," 150
Septicæmia after acute arthritis, 94
Septic infection as cause of acute arthritis, 94
complicating Charcot's disease, 142
wounds of joints, 87
Sequestrotomy in hip disease, 182
Sequestra in tuberculous joints, 111
Shields in spina bifida, 297
Shoulder-cap in dislocation of clavicle, 11
Shoulder joint, anchylosis of, 254
acute suppuration of, 249
acute and chronic synovitis of, 249

Shoulder joint
Charcot's disease of, 256
dislocations of, 14
compound, treatment of, 28
displacements in, 15.
simple, complications in, 24
treatment of, 15
after-treatment, 23
treatment of complications, 24
unreduced, causes of, 29
treatment of, 29
time for reduction, 29
varieties of, 14
excision of, 252 (*see* Excision)
inflammatory affections of, 249
injection of, 121
malum senile of, 255
rheumatoid arthritis of, 255
synovitis of, 249
tuberculous disease of, 249
treatment, 250
after-treatment, 254
Sinuses, septic, in tuberculous joints, 113, 122, 125, 135, etc.
choice between excision and amputation in, 136
in ankle, 236
elbow, 262
hip, 182, 191
knee, 202, 219
tarsal disease, 239
Spina bifida, 296
treatment, 297
operative, 297
excision, 298
osteo-plastic procedures, 301
palliative, 297
varieties, 295
Spina bifida occulta, 295
Spinal cord, hæmorrhage into, 281
new growths of, 358
supports, 323, 325, 347
braces, 323, 349
collars, 351
double Thomas's splint, 348
jackets, 348
Phelps's box, 347
Taylor's brace, 249
Spine, actinomycosis of, 358
acute osteo-myelitis of, 357
concussion of, 279
"railway spine," 280
dislocation of, 282
fracture-dislocation of, 282
prognosis, 285
symptoms, 283
treatment, 285
of fracture of bodies of vertebræ, 285
complications, treatment of, 291
of fracture of spinous processes and laminæ, 288
after-treatment, 293
hæmato-rachis, 279
hysterical, 360
injuries of, 276
new growths of, 358
Spine
ricketty, 304
sprains and strains of, 277
tuberculous disease of, seats, 341
symptoms, 342
treatment, general, 344
of complications, 352
abscess, 353
paralysis, 352
of disease in special situations, 354
of the sacro-iliac synchondrosis, 355
wounds of, 293

Splint, anterior suspension, for ankle, etc., 90, 241
interrupted plaster for knee, 90
Lord Lister's, for tuberculous wrist, 268
for sprains of phalangeal joints, 273
Thomas's double, for spinal disease, 348
wire, in acute arthritis, 96
Splints, in Charcot's disease, 143
in dislocations of acromial end of clavicle, 9
of patella, 61
radius, 41
semilunar cartilages, 66, 67, 69
in rheumatoid arthritis, 155
Spondylitis deformans, 357
Sprains of joints (*see* Joints), 76
of phalangeal joints, 273
of spine, 277
Sub-acromial dislocation, 15
Sub-acute rheumatoid arthritis, 149
Sub-astragalar dislocation, 71
Sub-clavicular dislocation, 14
Sub-coracoid dislocation, 14
Sub-glenoid dislocation, 14
Sub-occipital spinal abscess, 343
treatment, 353
Sub-spinous dislocation, 14
Superheated air treatment for gonorrhœal arthritis, 102
for rheumatoid arthritis, 154
Supports for the spine, 305, 323, 325, 347
Suppurating wounds of joints, 87
Suppuration, acute, of ankle and tarsus, 229
of elbow joint, 257
hip joint, 169
shoulder joint, 249
Suppurative gonorrhœal arthritis, 103
Supra-acromial dislocation, 15
Supra-spinous dislocation of hip, 51
Sustentaculum tali, removal of, 240
Syme's amputation, for suppuration in ankle, 229
in tuberculous disease of ankle, 237
Synchondrosis, sacro-iliac, disease of, 355
Synovial fringes, hypertrophy of, in chronic synovitis, 107
in tuberculous joints, 112
masses in knee, 203
membrane, changes in, osteo-arthritis, 151
gummatous infiltration of, 139
inflammation of, 105
removal of, in excision of hip, 188
for papillary synovitis, 198
thickening, 108

Synovial membrane
thickening of, 105, 107, 109
tuberculous deposits in, 130
thickening in chronic synovitis, 105, 107
tuberculous in ankle joint, 232
tuberculous deposits in knee joint, 200
disease, general, 133
Synovitis, acute, 92
of ankle and tarsus, 228
suppurative form, 229
of elbow, 258
hip, 164
knee, 195
phalangeal joints, 273
shoulder, 249
wrist, 266
after sprains, 77
chronic, 105
of ankle and tarsus, 229
elbow, 258
hip, 167
knee, 197
phalangeal joints, 273
shoulder, 249
wrist, 266
in syphilis, 138
papillary, 223
of knee, 198
Syphilis of joints, 138
hereditary, 140
osteo-chondritis, 140
syphilitic dactylitis, 140
secondary, treatment, 138
tertiary, treatment, 139
Syphilitic affections:
of ankle and tarsus, 230
dactylitis, 140
of knee joint, 200
phalangeal joints, 275
Syringo-myelia, 360
joint disease in, 141
Syringo-myelocele, 295
treatment, 302

TALIPES, in spina bifida occulta, 295
Tallermann's apparatus, 154, 163, 225
Tarsectomy, complete, 246
partial, 244
Tarsus and ankle, diseases of, 228 (*see* Ankle and tarsus)
acute synovitis, 228
Charcot's disease, 230
chronic synovitis, 229
rheumatoid arthritis, 230
syphilitic affections, 230
tuberculous disease, 231
Tarsus, diseases of, 228
tuberculous, 237
diffuse form, 244
dislocations of, 75
Taylor's brace, 349
Tenotomy, in joint neuroses, 147
in hip disease, 179
Tertiary syphilis of joints, 139
Thermal treatment of osteo-arthritis, 152
Thomas's hip splint, double form, 175
after excision of hip, 190
for spinal disease, 348
Thomas's hip splint
single form, 172
in hip disease, 179, 186
knee splint, in Charcot's disease of hip, 193
in Charcot's disease of knee, 222
tuberculous knee-joint disease, 206, 212
Thumb, dislocation of, 46
treatment, 46
manipulation, 47
operation, 48
Thyroid dislocation of hip, 51
treatment, 56
Tibia, dislocation of, backwards, 64
forwards, 64
laterally, 65
Transverse tarsal joint, dislocation of, 75
"Traumatic arthritis," 150
dislocations, 1
Trophic changes in fracture of spine, 284
Tuberculosis of joints, 111
causes, 111
pathological changes, 111
primary osseous deposits, 111
primary synovial disease, 112
symptoms, 112
when primarily osseous, 112
when primarily synovial, 113
treatment, general, 113
local, 116
palliative, 116
against chronic inflammation, 116
Bier's method, 122
operative, 122
amputation, 122, 125
arthrectomy, 122, 125
excision, 122, 128
special points for various types, 129
Tuberculous abscess:
in ankle, 236
hip, 134
knee, 218
in adults, 219
children, 218
os calcis, 238
spine, 343
treatment, 353
caries, 112
disease of ankle and tarsus, 231
diffuse of tarsus, 244
of base of first metatarsal, 242
elbow, 259 (*see* Elbow joint)
hip, 167 (*see* Hip joint)
knee (*see* Knee joint), 200
phalangeal joints, 274
sacro-iliac synchondrosis, 355
shoulder, 249 (see Shoulder joint)
spine, 341 (*see* Spine)
wrist, 267 (*see* Wrist)
osseous deposits, diagnosis, 129
in ankle, 231, 232
knee, 201
treatment, 203
primary, 111
removal of, operation for, 129, 130
osteo-myelitis, 111

Tuberculous abscess:
sequestrum, formation of, 111
spinal abscess, 343
treatment, 353
synovial deposits in ankle joint, 232
in knee joint, 200
treatment of, 203
operation for, 131
primary, 112
Typhoid, acute arthritis after, 104, 165

"ULCERATION of cartilage," 132
of sac in spina bifida, 302
Ulna and radius, dislocations of, 33
Ulna, dislocation of, 40
Urinary disorders in fracture of spine, 284

VERTEBRÆ, fractures of bodies of, 285
of arches of, 288
Vessels and nerves, injuries to, in dislocation, 5
of the elbow, 36

WALSH on thermal treatment of osteo-arthritis, 153
Water-bath in acute arthritis, 96
in septic wounds of joints, 89
Water-bed in spinal fractures, 293
in synovitis of hip, 165
Weir Mitchell treatment, 145
Wiring in dislocations of clavicle, 11
Wrist, acute inflammation of, 266
chronic inflammation, 267
dislocation of, 45
excision of, 269
gonorrhœal rheumatism of, 266
injection of, 121
synovitis of, 266
tuberculous disease of, 267
Wrist and fingers, dislocations of, 45
Wrist and hand, diseases of, 266
of phalangeal joints, 273
of wrist, 266
Wounds of joints, 82 (*see* Joints, wounds of)
Wounds of the spine (*see* Spine, wounds of)

Y-ligament, importance of, in hip dislocations, 50

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