DISEASES
of the
HIP - JOINT,
BEING A REPORT AND COMMENTARY
on
SIX ORTHOPAEDIC CASES
treated in
THE ROYAL INFIRMARY OF EDINBURGH.

Assigned for Submission
in the competition
for
The Sir Robert Jones Prize
in Orthopaedic Surgery
and for
The Pattison Prize
in Clinical Surgery.

---

BY AMELIA N. LAWS.

June 1930.
CASES ASSIGNED.

I. Congenital Dislocation of the Hip.

II. Separation of the Epiphysis (Slipped Epiphysis).

III. Osteochondritis Deformans Juvenilis.

IV. Acute Anterior Poliomyelitis
   with subsequent
   Paralytic Dislocation of the Hip.

V. Tuberculosis
   with subsequent
   Pathological Dislocation of the Hip.

VI. Subacute Infective Arthritis.
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In addition an expression of appreciation is due to patients and their relatives, who so willingly collaborated in tracing the sequence of events in their case-histories.
Articulation of the Hip - Joint.

The Head of the Femur articulating with the Acetabulum.

Anatonia Umana.
Heitzmann.
Section of the coxo-femoral Articulation at the level of the upper border of the great trochanter and the internal border of the ilio-pectineal eminence.

The neck of the femur has been divided in the neighbourhood of the lower insertions of the articular capsule and the femoral head removed.
ANATOMY.

THE HIP-JOINT is an enarthrodial diarthrosis, or ball and socket joint, formed by the head of the femur which articulates with the acetabulum.

(Fig. 1)

ARTICULAR SURFACES. The head of the femur is globular in shape, exceeding a hemisphere. It is covered with hyaline cartilage, which is thin at the circumference, thicker towards the centre and absent at the fovea - a depression just below the centre, to which is attached the ligamentum teres femoris. The acetabulum is a deep cup-shaped cavity with a notch on its antero-inferior margin. The hyaline cartilage which covers it is thin at the centre, thicker towards the circumference and deficient at the anterior margin of the acetabular notch. In the centre of the acetabulum there exists a circular depression which in the recent state contains the Haversian gland - a pad of fat continuous under the transverse ligament with the extracapsular fat and covered by synovial membrane.

(Fig. 2)

LIGAMENTS. These are, from within outwards the:

1. ligamentum teres femoris or round ligament.
2. transverse ligament.
3. cotyloid ligament or labrum glenoidale.
The Interior of the Hip-joint showing the Ligamentum Teres

A. K. Maxwell.

Fig. 3.

A window has been cut in the floor of the acetabulum to expose the head of the femur.

a. Ligamentum Teres
b. Transverse Ligament
c. Obturator Membrane.

(Suain.)
4. capsular ligament or articular capsule.
5. ilio-femoral, pubo-capsular and ischio-capsular ligament.

THE LIGAMENTUM TERES FEMORIS (Fig. 3) (absent in 2% of cases) is a triangular flattened band of fibrous tissue attached by one end to the fovea on the head of the femur; by the ischial and pubic roots of the other end to the margins of the acetabular notch and to the lower edge of the transverse ligament bridging the notch.

THE TRANSVERSE LIGAMENT, composed of strong flattened transverse fibres, is a part of the cotyloid ligament or labrum glenoidale. It is attached to the margins of the acetabular notch and protects the nerves and vessels lying in the floor of the notch on their way into the acetabulum.

THE COTYLOID LIGAMENT, or Labrum Glenoidale, consists of a rim of fibro-cartilaginous tissue attached to the entire rim of the acetabulum. As it crosses the acetabular notch it incorporates the transverse ligament. Prismoid in shape, the base of the cotyloid ligament is attached to the margin of the acetabulum and transverse ligament, while its free edge clasps the head of the femur. It is composed of oblique and circular fibres: the former by their attachment to the acetabular brim serve to
Fig. 14

Dissection of the Hip Joint.
Bottom of the acetabulum removed.
Articular Capsule reflected,
showing Retinacula.

(Cunningham.)
Coxo-Femoral Articulation.  
External Aspect.

Obturator Membrane.

Obturator Canal

Pubo-femoral Ligament

Zona orbicularis

Distal insertion of the Plio-femoral ligament

Ischio-femoral Ligament

Zona orbicularis

Fig. 5.

Relationship with the Zona Orbicularis with the Pubo-femoral and Ischio-femoral Ligaments.

(Yoldt.)
deepen the acetabulum, the latter to narrow its opening. Covered with synovial membrane, both externally and internally, it is in contact with the capsular ligament or articular capsule without and the cartilaginous surface of the head of the femur within.

THE CAPSULAR LIGAMENT, or articular capsule, completely invests the hip-joint. Above and behind it is attached to the acetabulum just beyond the margin of the cotyloid ligament; in front to the cotyloid ligament itself; to the transverse ligament bridging the acetabular notch; to the anterior intertrochanteric line on the neck of the femur; to the base of the neck and to the posterior intertrochanteric line. At this point the capsular fibres blend with the periosteum and pass upwards over the neck of the femur to form a tubular sheath, called the cervical reflection. Some of these fibres form raised longitudinal folds or retinacula. (Fig. 4)

Anteriorly, longitudinal fibres in the capsule constitute definite ligaments; while posteriorly, circular fibres are prominent in the so-called zona orbicularis. (Fig. 5)

Of the longitudinal fibres in the capsular ligament there exist three triangular bands, of
The Hip-joint from the Front.

Ilio-trochanteric ligament

Rubo-penonal ligament

Ilio-penoral ligament

Fig. 6.

(Quain.)
The Hip-Joint from Behind.
A. K. Maxwell

The femur has been rotated until the back of the capsule is stretched.
which the Ilio-femoral is the strongest.
Attached proximally at its base to the inferior anterior iliac spine and adjoining rim of the acetabulum, its apex reaches the intertrochanteric line. Because of its strong lateral and medial margins it resembles the letter Y inverted, hence it is also called the Y-shaped ligament of Bigelow.

The upper limb of this ligament may be increased and strengthened by additional longitudinal fibres, extending from the anterior part of the dorsum of the acetabulum to the neck of the femur near the anterior end of the medial surface of the trochanter major. When this occurs it is described as the ilio-trochanteric ligament.

THE PUBO-CAPSULAR OR PUBO-FEMORAL LIGAMENT is attached by its base to the lateral end of the superior ramus of the pubis, the ilio-pectineal line, the obturator crest and the obturator membrane; its apex merges into the articular capsule itself or is attached to the inferior aspect of the neck of the femur.

THE ISCHIO-CAPSULAR OR ISCHIO-FEMORAL LIGAMENT on the posterior aspect of the joint is attached by its base to the ischium between the lesser sciatic notch and the obturator foramen, the apex merging into the zona orbicularis of the articular capsule.

THE SYNOVIAL MEMBRANE. This lines the fibrous
Fig. 8

Muscles related to the Articular Capsule.

(after J. A. Barton.)

(Gray)
stratum of the capsule and is therefore very extensive. From the cartilaginous surface of the head of the femur it is reflected on the internal surface of the capsular ligament, over both surfaces of the cotyloid ligament, over the Haversian gland in the acetabular depression, enveloping the ligamentum teres in the form of a tunular sheath, to be attached to the head of the femur. It may communicate by an opening in the anterior wall of the capsule between the limbs of the ilio-femoral ligament with a synovial bursa situated under the tendon of the ilio-psosas muscle.

(Fig. 8)

MUSCLES RELATED TO THE JOINT.

Anteriorly  - psoas and iliacus, separated from the capsular ligament by a synovial bursa.

Superiorly  - reflected head of rectus and gluteus minimus.

Internally  - obturator externus and pectineus.

Posteriorly  - pyriformis, gemellus superior, obturator internus, gemellus inferior, obturator externus, and quadratus femoris.
BURSAE RELATED TO THE JOINT :-

1. Psoas - between the tendon of the psoas muscle and capsular ligament.

2. Gluteus medius - between the tendon of insertion and great trochanter.

3. Gluteus minimus - between the tendon of insertion and anterior surface of the great trochanter.

4. Gluteus maximus - between the tendon of insertion and vastus externus.

5. Rectus femoris - between the reflected head and the dorsum ilii above the acetabulum.

6. Obturator internus - between the tendon of the muscle and the articular capsule; therefore narrow and elongated in form.

7. Quadratus femoris - between the anterior surface of the muscle and the obturator externus and lesser trochanter.
Nerve Supply to the Hip Joint.
Anterior Aspect of Thigh.

Fig. 9.
Distribution of femoral and obturator nerves.
Anterior Aspect of Thigh.
Nerve Supply to the Hip-Joint.
Posterior Aspect of Thigh.

Sciatic Nerve.

Articular Branch.

Fig. 10.

Distribution of the Sciatic Nerve.
Posterior Aspect of Thigh.

(Joldst.)
Branch from nerve to quadratus femoris.

or

Branch from ileal to hip joint.

Sartorius nerve

Posterior approach of thigh.

Direct supply

NERVE SUPPLY TO THE HIP JOINT

FIG. 10.
Cutaneous nerves of the thigh.

Intermediate cutaneous nerve.

Medial cutaneous nerve.

Cutaneous branch of obturator nerve.

Fig. II.

Areas of referred pain.

(Yollett)
Areas of Referred Pain...
BLOOD SUPPLY TO THE FEMUR.

The vessels of the diaphysis and metaphyses are derived from the nutrient branch of the femoral artery. As a rule it is given off by the second perforating branch, occasionally the third, and in some cases an additional nutrient branch arises from the first or fourth perforating artery. After it enters the diaphysis it divides, one branch passing to either end of the bone. These branches subdivide and terminate at the metaphyses in hair-pin bends, which become of pathological significance by reason of the deposition of organisms carried by the bloodstream.
Blood Supply to the Hip Joint.

Anterior Aspect.

a. Obturator A. with its
   b. acetabular branch
   c. Deep branch of the
      internal circumflex A. with its
      d. acetabular branch
   e. Ascending branch of the
      external circumflex A.
   f. First perforating A.

Fig. 12.
FIG. 12. BLOOD SUPPLY TO THE AREA OF THE HIP-JOINT.

External (Lateral) circumflex

Femoral A.

Profunda femoris

External Iliac

Internal Iliac

Obturator A.

External (Lateral) circumflex

Ascending branch - digital anastomosis.

Articular branch to acetabulum.

Obturating Art.

Articular branch to acetabulum.

below acetabulum to tuber ischii --- inferior gluteal.

Obturator Art.

Anterior Surface

Internal (medial) circumflex.

Femoral Art.

transverse branch - crucial anastomosis.

ascending branch - digital anastomosis.

through acetabular notch along lig. teres to head of femur.
Blood Supply to the Hip-Joint.
Posterior Aspect.

- a. Superior Gluteal A.
- b. superficial branch
- c. deep branch
- d. Superior gluteal
- e. Anastomotic branch
- f. Digital anastomosis
- g. Great trochanter
- h. Internal (medial circumflex)
- i. Lesser trochanter
  (insertion of ilio-psoas)
- j. Ascending branch
- k. First perforating A.

Fig. 13.

(Yoldt.)
BLOOD SUPPLY TO THE JOINT CAVITY.

From the tabulation of the arterial supply to the area of the hip-joint, it can be seen that two arteries, the acetabular branches of the obturator and internal (medial) circumflex arteries, enter into the joint cavity. Professor Fraser, in his book on Tuberculosis of Bones and Joints in Children, describes the anastomosis of these vessels as occurring in the tissue between the capsule and synovial membrane, at the acetabular and femoral extremities of which is formed a circus vasculosus articuli. Anastomosis with synovial vessels takes place in the retinacula, or cervical ligaments of Stanley, on the under surface of the femur; while a further anastomosis with the acetabular vessels occurs in the pad of fat to which the ligamentum teres is attached.
Development of joints.

Fig. 14.

Sagittal Section of Terminal Joint of Finger of Foetus in tenth week of development.

(After Nicolas.)

(Keith.)
MORPHOLOGY.

THE HIP-JOINT

In the sixth week of foetal life, (Keith), the skeletal blastema of the embryo begins to form as the result of condensation of mesoderm cells. In the eighth week centres of chondrification appear in the shape of cartilage cells developing centrifugally. In certain areas these centres do not unite. The space between is occupied by the original mesoderm cells which form the interchondral disc. With the disappearance of its peripheral cells, the synovial space manifests itself, bridged over by the perichondrium extending from two adjacent centres of ossification and developing later into the capsular ligament of the joint. This latter becomes thickened in areas of strain, hence the formation of the ilio-femoral, ischio-femoral and pubo-capsular ligaments. The peripheral cells of the interchondral disc also line the capillaries and eventually form the synovial membrane; aggregations of these cells take part in the formation of the labrum glenoidale or cotyloid ligament.

The ligamentum teres is the best example of an intra-articular cartilage. Originally a part of
of the capsule, it becomes detached from it by the head of the femur, which in process of development expands like a wing on each side. (Keith). By fusion of the wings, the ligament is isolated from the capsule, its original connection being represented later by the reflected ligament, situated on the under surface of the neck of the femur.
Os Acetabuli.

Outline of the lunate surface is represented to show its relation to the bone and cartilage.

Fig. 15. Internal Surface.

Irregular

On acetabuli

Fig. 16.

Os acetabuli

The relationship of the centres of ossification with the synovial membrane of the hip joint.
OS ACETABULI.

In the eighth week of foetal life the ilium, ischium and pubis meet in a \(\geq\) shaped acetabular suture of a cartilaginous nature. In the ninth week the hip-joint is revealed by the appearance of a synovial cavity, also cartilaginous outgrowths from the three elements of the innominate bone, especially the ilium, thus forming the acetabular cup. (Keith) The open part of the \(\geq\) faces forwards, forming the pars acetabularis, and in the cartilage there appear later three centres of ossification. One, the pars acetabularis, appears in the 12th. year and by the 14th. year becomes the os acetabuli, which joins the superior pubic ramus about the 16th. year. (Buchanan). The accompanying diagrams, as depicted in an article on The Epiphyses of the Bones of the Extremities at Puberty, W.E. Sullivan Ph.D., F.D. Geist, M.D., and G.G. Mueller, M.S., University of Wisconsin, show (Fig.15) the relation of bone and \(\geq\) shaped cartilage. The latter, partially removed from the external surface, showed multiple, disseminated centres of ossification, the largest of these being the os acetabuli, situated between the ilium, ischium and pubis. In Fig.16, representing the internal surface, triradiate formation of the os acetabuli is clearly demonstrated: the ossicle in the region of the ilio-pectineal eminence is also a part of it. Fig.17 illustrates in addition the relationship of the centres of ossification with the synovial membrane of the joint.
Epiphipses of the Femur.

Fig. 18.

Ossification of the Femur.

(Cunningham.)
FIG. 19.

Times of Appearance and Union of Epiphyses for the upper end of the femur, according to various authors:

<table>
<thead>
<tr>
<th></th>
<th>Head</th>
<th></th>
<th>Great Trochanter</th>
<th>Lesser Trochanter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Appears</td>
<td>Unites</td>
<td>Appears</td>
<td>Unites</td>
</tr>
<tr>
<td>Buchanan</td>
<td>1</td>
<td>19</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>Cunningham</td>
<td>1</td>
<td>20</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Gray</td>
<td>end of 1st year</td>
<td>20</td>
<td>4 after lesser trochanter</td>
<td>13-14</td>
</tr>
<tr>
<td>Morris</td>
<td>1</td>
<td>19</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>Quain</td>
<td>1</td>
<td>18-19</td>
<td>3-4</td>
<td>18</td>
</tr>
<tr>
<td>C.R. Whittaker</td>
<td>1</td>
<td>18-20</td>
<td>2-3</td>
<td>18</td>
</tr>
</tbody>
</table>

Radiological Investigations of R.S. Paterson.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th></th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>½-1</td>
<td>18</td>
<td>6 mos.</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>18</td>
<td>16-17</td>
</tr>
<tr>
<td></td>
<td>9-11</td>
<td>16-18</td>
<td></td>
</tr>
</tbody>
</table>
A primary centre of ossification is formed in the diaphysis of the femur during the second month of foetal life. Secondary centres, united to the diaphysis by intervening cartilage, form epiphyses, which develop later into the head, great trochanter and lesser trochanter.

In an article on the Radiological Investigation of the Epiphyses of Long Bones, Dr. R.S. Paterson, Hon. Radiologist in the University of Manchester, describes the head of the femur as developing from a small oval nucleus into a hemispherical adult form within three years. The neck is an upward growth from the diaphysis. The trochanters develop also from the shaft, each being capped with an epiphysis. In the case of the great trochanter the epiphysis appears radiographically as an irregular shadow, while in the lesser trochanter it is very small and scale-like.

The accompanying table gives approximate dates for the appearance and the union of the epiphyses at the upper end of the femur, according to different authorities. The variation observed may be partially explained by the fact, pointed out by Adair and Scannon, that ossification proceeds more
rapidly in the female, difference in time occurring in intrauterine development; while disparity becomes more pronounced in the case of fusion of the epiphyses to the diaphysis. Other factors also exert an influence on epiphyseal growth, hyperactivity of the endocrine glands accelerating fusion, hypoactivity retarding it. Ossification is normally completed only when the bones have fully developed.
The Vascular Supply of Bone.

Fig. 20.

(Harris.)
BLOOD SUPPLY to the EPIPHYSES.

This originates in the excavations made by osteoclasts during foetal development. Nutrient vessels pass from the diaphysis to the cartilage in which the epiphyses are formed, while other vessels are conducted thither by the perichondrium.

In an article on the "Vascular Supply of Bone with special reference to the Epiphyseal Cartilage", Dr. H.A. Harris, University College Hospital, London, refers to the "circulus vasculosus articuli", which was first described by Wm. Hunter in 1742. By injecting with carmine gelatin the limb-arteries of actively growing animals and of still-born babes, he proved the absence of any anastomosis between the vessels of the diaphysis and epiphysis.

Further it was evident that the anastomosis in the diaphysis was so poor that the diaphyseal vessels might be looked upon as "end arteries". So distinct are the two areas that on the principle of infarction he considered it possible to differentiate radiographically disease in the epiphyseal cartilage from an injury to the bone itself. Penetration of vessels from one area to the other was in his experience experimentally proved only in the case of pre-existing disease which led to failure of proliferation of the epiphyseal cartilage, as in osteochondritis syphilitica.
Centre of Ossification
from Foetal Limb of Rat,
stained haematoxylin and cosin.
Class in Histology - Second Year.

A. Endochondral Ossification
a. flattened cartilage cells
b. enlarged cartilage cells
c. stellate and irregular cells
   with calcified matrix
d. trabeculae of bone

B. Osteochondral Ossification
   e. subperiosteal osteoblasts
   f. invagination of subperiosteal tissue
   g. osteoclasts
   h. fibrous layer of peristeum
HISTOLOGY.

(Fig. 21)

OSSIFICATION OF BONE consists of two types, endochondral and ectochondral or subperiosteal. Both forms occur coincidently in the formation of long bones in order to allow of expansion in both length and breadth.

In endochondral ossification the flattened cartilage cells become enlarged, then stellate and irregular. The matrix becomes calcified and trabeculae of bone are formed. In ectochondral ossification there occurs an irruption of vasoformative cells, osteoblasts and subperiosteal tissue. This is succeeded by osteoclasts which destroy the calcified matrix in order to allow of the formation of medullary space in which further lamellae of bone are constructed. The medullary canal is itself due to the absorption of the central osseous tissue in the shaft, but this does not enter into the question of joint formation except in its relation to the position of the nutrient artery which is directed towards the principal centre of endochondral ossification. For this reason increase in length in the case of the femur predominates at the proximal end.

Formerly the theory was held that the osteoblasts pertained to the periosteum, but in 1912 Macewen proved that they belonged rather to the cortex of the bone. In physiological growth and in reparative pro-
cesses the osteoblasts work in conjunction with the blood supply. In the diaphysis the two layers of bone are nourished by the periosteum and medulla respectively. In cancellated areas the blood vessels are supported by the marrow in the interstices of the bone. In compact bone the arteries pass along the Haversian canals chiefly in a longitudinal direction, linked by Volkmann's canals running transversely and obliquely towards the interior of the bone.
Formation of Epiphyses.

Section of upper end of ilium of a full grown rabbit.

(A. Biddle)

E epiphysis; A apophysis; D diaphysis
L. ligamentum patellae; c. articular cartilage;
c'. intermediate cartilage; p. perictical bone
of diaphysis; m. ligamentum nucosum.
Epiphyseal development is endochondral in type. Blood vessels, carrying osteoblasts with them, pass from the diaphyseal marrow-spaces into the canals of the cartilage at the upper end of the femur. Other vessels are conducted from the perichondrium into the cartilage, but these take no part in the process of ossification. Independent nuclei of osseous tissue appear. These extend through the epiphyseal cartilage, with the exception of a superficial layer which forms the articular cartilage of the bone. During the period of development the epiphyses are separated from the diaphysis by a layer of cartilage which is constantly growing. Ossification of this layer leads to fusion of the epiphysis with the diaphysis, indicating complete maturity of the bone.
The Intraarticular Cartilage.

Vertical Section of Articular cartilage covering the lower end of the tibia (human).

(Schäfer)

a. Cells and cell groups flattened conformably with the surface.
b. Cell groups irregularly arranged.
c. Cell groups disposed perpendicularly to the surface.
d. Layer of calcified cartilage.
e. Bone.

Fig. 23.

Transitional Area.

a. Cells in the matrix
b. Sprinkle-shaped cell in hexagonal division
c. Capillary loop
d. Connective tissue

e. Fig. 24.

Junction of articular cartilage with synovial membrane, from drawing of fresh specimen.
Histology Class, 2nd year.
I N T R A - A R T I C U L A R C A R T I L A G E.

In examining a section of articular cartilage, (Fig. 23) the matrix appears dim and slightly granular. The cells are in layers, flattened when lying parallel with the surface; irregularly arranged below, becoming vertical as they approach the area of bone. Near the junction with the synovial membrane, there is a transitional area, wherein there may be seen cells in the matrix, spindle-shaped cells, connective tissue prolonged into the cartilage from the periosteum or synovial membrane, and small capillary loops. Here also the matrix of articular cartilage may become converted into fibro-cartilage.
The Articular Synovial Membrane.

Fig. 25.
Section of a Synovial Membrane. (Hammar.)
a. Superficial cell, lying on the inner surface.
b. Superficial cells partly embedded in the membrane, but with projections beyond the surface.
c. Detached cell within the cavity.

Fig. 26.
Haversian fringe seen at the edge of a fold of synovial membrane. (Hammar.)
a. Free surface of the membrane with long and short villi, some of the shorter villi being free from cells.
b. Portion of membrane closely packed with cells.
c. Portions without cells.

Fig. 27.
Transition of cartilage cells into connective tissue corpuscles of synovial membrane. From head of metatarsal bone, human. (Schüfer)
a. Ordinary cartilage cells
b. With branch processes.

Fig. 28.
Villus of synovial membrane. (Hammar.)
THE ARTICULAR SYNOVIAL MEMBRANE.

This is composed of connective tissue fibres with cells varying in shape according to their position. From the surface of the synovial membrane there arise villi, which serve as mucilaginous glands and contain a number of cells and numerous blood-vessels. Morphologically these villi represent the remnants of the interchondral discs (Keith). In the marginal zone, that is, where the synovial membrane passes over the cartilage of the joint, their processes diminish or disappear, the cells merging into cartilage cells, the fibrous tissue at the same time being transformed into fibro-cartilage. In the same area vascular folds or fringes are formed containing adipose tissue; there the cells become stellate in type and avascular secondary villi are to be seen, fungiform in shape, composed of connective tissue fibrils with a few small, rounded, granular cells.

The nerve supply, according to Nicoladoni, consists of a plexus of pale fibrils lying close under the surface of the mucous membrane. As described by Krause, these fibrils terminate in articular end-bulbs.
SYNOVIAL BURSAE.

These consist of a sac of synovial membrane placed between two opposing surfaces in order to allow of frictionless movement. The inner surface of the sac is lubricated with synovia, the outer is attached by areolar tissue to the moving parts they protect.

Deep-seated bursae are usually situated between a muscle or its tendon and a bone or the exterior of a joint, sometimes between two muscles or tendons. The bursa under the psoas muscle is an example of a deep-seated bursa communicating with a joint. Subcutaneous bursae are found under the skin in such areas as the malleoli and olecranon, which they protect from injury. Where synovial membrane is lacking, these bursae resemble enlarged spaces in the subcutaneous areolar tissue.
According to Gray, synovia is a transparent, yellowish-white or slightly reddish fluid, viscid like the white of an egg, having an alkaline reaction and slightly saline taste.

Howell describes it as a fluid resembling lymph which is formed from blood-plasma by the combined action of the physical processes of filtration, diffusion and osmosis with possibly an additional factor in the secretary process of the endothelial walls composing the capillary cells.

In chemical composition synovia in the joints differs from lymph in an increase of solid content and a mucin-like substance of the nature of nucleo-albumin (Hammersten).

According to Salkowski, it contains neither phosphorus nor a reducing sugar. Gray describes its composition as water, mucus, epithelium, albumin, extractive matter and salts. It also contains proteins.
PHYSIOLOGY.

TRABECULAR STRUCTURE OF BONE.

Galileo was the first to point out the relationship between form and function in bone. Duhamel in 1743 drew attention to the architecture of trabeculae and Humphrey in 1858 gave a detailed description of it. Wolff observed differences found in the same species and attributed these differences to the variation of the static conditions in which bones fulfil their functions. In 1892 he published the results of his research.

To the changes in architecture he gave the expression Transformation des Knochens; to the cause to which these changes owed their origin he gave the name Transformationskraft. This force, according to Wolff, would act when static conditions changed as the result of fractures, ankylosis, rickets, etc. in which both external and internal architecture are modified, the fibres of pressure and traction altering their direction and number. Martin and Zschokke further observed that pressure trabeculae rose from the medial diaphyseal lamina and mounted fanwise under the articular surface to the head of the femur; while trabeculae from the great trochanter, acted upon by the traction of muscles, unite in the compact
The Trabecular Structure of Bone
from draught ox or
casqunese breed.
Dr. Maiocco.

Fig. 29.

a. Pressure trabeculae descending
from the head of the femur
b. Traction trabeculae with fibres
passing upwards towards the
pressure fibres
c. Triangle of Ward (pronounced in man)
d. Fibres from the great trochanter
uniting with pressure fibres
in the neck of the femur.
The Trabecular Structure of Bone in Man.

Fig. 30.

Frontal Section of the Upper Extremity of the Femur

Architecture of Long Bones.

(Yoldt.)
wall of the trochanter then radiate obliquely towards the anterior and medial side of the femur, whence some fibres pass towards the head of the bone. From the medial diaphyseal lamina arise the trabeculae of pressure; from the lateral diaphyseal lamina arise those of traction.

Dr. Maiocco, in his article on the Internal architecture of Bone, contributed to the Archivio Italiano di Anatomia in 1915, illustrates the foregoing by twelve examples of animals, including milch cows, draught oxen, mountain-bred cattle, also horses destined for riding and the traction of light or heavy loads.

From the data given, it is obvious that according to the exigencies of pressure or traction, there result the general arrangement and the predominance of one or other group of trabeculae.

Of the six radiographic plates shown by Dr. Maiocco, the accompanying drawing best exemplifies the comparative anatomy with regard to the trabecular structure in man, in whom, under stereoscopic examination, there exist two systems of spirals, which likewise arise from the medial and lateral diaphyseal laminae with ogival formation on their passage upwards towards the head of the femur. Their formation and direction are in accordance with the static conditions imposed by erect posture.
In relation to function there are developed two types of epiphyses, namely, pressure and traction epiphyses. In the upper extremity of the femur, ossification of the diaphysis proceeds upwards within the cartilage; by the processes of pressure and traction the head and trochanters diverge. Function dominates ossification, hence the order in the appearance of the centres of ossification—head, great trochanter, lesser trochanter. Pressure on these ensures dovetailing with the shaft to avoid dislocation, the diaphysis developing the form of a three-sided pyramid. The head is therefore an example of a pressure epiphysis. The great trochanter is the traction epiphysis of the gluteus medius and minimus; the small trochanter of the psoas and iliacus. According to Dixon, a third trochanter appears in the 20th year—the traction epiphysis of the gluteus maximus.
THE ACETABULUM - its functional structure.

The physiological value of the measurements and position of the acetabulum was referred to by Fick in his Handbuch of 1911. At his request the subject was further investigated by Dr. Shiino, Professor of Anatomy in the Medical Academy at Mukden, and the result of these investigations published in 1915 by the Royal and Imperial Anatomical Institute of Innsbruck in the Zeitschrift für Morphologie and Anthropologie.

The basis of procedure is shown by the accompanying diagrams.
Measurements of the Pelvis.

Fig. 31.

Fig. 31a.

Measurements of the Acetabulum.

Fig. 32.

Cone Method.

Fig. 33.

Fig. 34.

Acetabula on different planes.

Fig. 35.

Cone placed parallel with oblique diameter.
A. **MEASUREMENTS OF THE PELVIS, Figs. 31 & 31a.**

1. **ANATOMICAL HEIGHT** - from the crest of the ilium to the ischial tuberosity, irrespective of inclination of the pelvis.

2. **PHYSIOLOGICAL HEIGHT** - marked by the same limits but with the normal inclination of the pelvis, i.e. with the anterior superior spines on the same horizontal level and occupying along with the pubic tuberces the same frontal plane.

B. **MEASUREMENTS OF THE ACETABULUM, Fig. 32.**

3. **WIDTH OF ACETABULUM** - an oblique diameter passing through the point on the rim nearest the pubic tubercle to the most distant part posteriorly.

4. **HEIGHT OF ACETABULUM** - a long diameter passing through the point on the rim nearest the anterior margin of the ilium to the most distant part inferiorly.

   These do not lie in the same plane and do not always cross at right angles.

5. **INCLINATION OF THE ACETABULAR AXIS** - a perpendicular uniting the geometrical mid-point of the acetabular floor and the mid-point of its external curvature.

   To determine the acetabular axis in the rare instance where the acetabular rim is in one plane,
a cone may be fitted just inside the rim, the acetabulum being filled with plasticene. A long pin thrust through the axis of the cone till it reaches the floor of the acetabulum indicates the acetabular axis.

To overcome the difficulties of different planes the cone is placed neither on the postero-lateral (Fig. 33) nor on the antero-medial plane (Fig. 34) but on the line intersecting these two planes, i.e. on the long diameter in such a way that the base of the cone lies parallel with the oblique diameter.

The axis of the cone in this position lies exactly in the direction of the acetabular axis.

By mathematical means Dr. Shiino proves the accuracy of his "cone method".

From the tabulated results Dr. Shiino deduces the following statements:

A. **MEASUREMENTS OF THE ACETABULUM.**

1. The acetabular rim is not round, but elliptical.
2. The long diameter is usually somewhat longer than the oblique diameter, which is more deeply placed.
3. The male acetabulum has a rather larger diameter than the female.
4. The anatomical depth is statically and mechanically of little importance, as the depth of the acetabulum is variable.
5. The physiological depth is both absolutely and relatively greater in the male.

6. The shallowness of the acetabulum in the female is accounted for by the weaker formation of the acetabular rim and the more slender skeletal build which accompanies the lighter body-weight and lesser muscular power. Shallowness of the acetabulum is definitely related to greater frequency of congenital dislocation of the hip found in females.

B. POSITION OF THE ACETABULUM.

7. The acetabulum, judged by the direction of its axis, looks not only latero-anteriorly but distally in order to coincide with the proximal direction of the neck of the femur.

8. The axis of the acetabulum is more frontal in the male, more sagittal in the female, therefore it faces more laterally in the former, more anteriorly in the latter.

Waldeyer observed that the more frontal position already existed at birth in the female, thus explaining the greater frequency of congenital dislocation of the hip in the female.

As regards position and depth of the acetabulum Preiser summarised his findings in the statement, "The further the acetabulum looks latero-posteriorly the deeper it is; the more it looks
anteriorly, the shallower it is”. This is correct as regards the depth and direction of the female pelvis, but Dr. Shiino questions the actual relationship with reference to its mechanics and statics. He considers that the depth of the acetabulum is chiefly dependent on the size of the head of the femur and that the frontal position of the pelvis is simply combined with a more shallow acetabulum without its position and depth being interdependent.
The various functions of the articular capsule may be briefly summarised as follows:--

1. Complete investment of the cavity of the hip-joint. Superiorly this is accomplished by the attachment of the capsule to the dorsum ilii and the external surface of the labrum glenoid-ale also to the transverse ligament traversing the acetabular notch.

2. Rotation of the femur. Inferiorly anatomical attachment is limited to the intertrochanteric line and to the great trochanter as far as the tendon of the obturator externus.

3. Strength with mobility - by reason of its fibrous character.


5. Capacity to bear localised strain - This capacity is provided by the triangular form of its strengthening bands. The ischic-femoral and the pubo-femoral ligaments have an acetabular base, the ilic-femoral a split femoral base. (Buchanan).

6. Erect posture. In man the anterior inferior spine has a centre of ossification not found in animals.
6. (Continued)

and the rectus femoris muscle has a straight head. In addition the deep fibres of the reflected head, attached to the acetabular margin, fuse with the ilio-trochanteric band, forming a tendinous sheet inserted into a tubercle on the front of the great trochanter. (Rouviere).

INTRA-ARTICULAR CARTILAGE.

1. Frictionless movement is assured by the smooth and firm texture of the cartilaginous surface.
2. Absorption of shock by its resilience.
3. Freedom from bruising is due to the fact that in health no blood vessels penetrate the articular cartilage, nutrient fluid being conveyed to the tissues by a process of imbibition.
4. Insensitiveness to movement can be attributed to the absence of nerve filaments.

THE SYNOVIAL MEMBRANE.

1. Nutrient function is produced by the vascular folds containing adipose tissue.
2. Lubrication of the joint is made possible by the mucilaginous glands present in the villi.

THE SYNOVIAL FLUID.

This serves as a water-bed for the articular surfaces in contact with it and protects against shock and strain.
THE HAVERSIAN GLAND.

This pad of fat, continuous with the extracapular fat, allows freedom of movement to the head of the femur, adjusting itself to the space available in the joint cavity, thus preventing a vacuum. It also assists in the balance of atmospheric pressure and protects the vessels and nerves which pass under the transverse ligament to enter the acetabulum.
MECHANISM OF THE HIP-JOINT.

The hip-joint is an example of movement combined with stability. This is attained by the depth of the articular cavity and the co-ordination of muscles, powerful ligaments, the acetabular rim and the labrum glenoidale.

In the erect posture a line dropped from the centre of gravity, situated in the second lumbar vertebra, falls behind the line joining the centres of the hip-joints. (Jamieson). The trunk tends to fall backwards but is restrained by the pubo-capsular and medial part of the ilio-femoral ligaments. This position of extension is therefore produced to a large extent mechanically and without sustained muscular action.

The joint may be said to have three axes:
1. Transverse - through the ligamentum teres and great trochanter.
2. Antero-posterior - through the walls of the acetabulum before and behind.
3. Vertical - through the centre of the femur to the centre of the knee-joint.

Movements consist of:
1. Flexion.
2. Extension.
3. Abduction.
4. Adduction.
5. Circumduction.
7. Medial rotation.

1. **Flexion** —
   produced by ilio-psoas, rectus femoris, sartorius, pectineus, obturator externus, adductor longus and brevis, and pubic part of adductor magnus, anterior parts of gluteus medius and minimus:
   limited by hamstrings when the knee is extended, by contact with the abdominal wall when the knee is bent, by the labrum glenoidale in extreme flexion.

2. **Extension** —
   produced by gluteus maximus, hamstrings, ischial part of adductor magnus and by gravity;
   limited by ilio-femoral ligament.

3. **Abduction** —
   produced by gluteus minimus, medius, upper part of maximus, tensor fasciae latae, sartorius, and obturator externus;
   limited by pubo-capsular and medial part of ilio-femoral ligament.

4. **Adduction** —
   produced by the adductors, pectineus, gracilis, quadratus femoris, lower part of gluteus maximus;
limited by contact with the other limb and the ilio-trochanteric ligament.

5. **Circumduction** -
produced by a combination of these movements.

6. **Lateral rotation** - stronger than medial rotation:
produced by gluteus maximus, posterior parts of medius and minimus, both obturators and gemelli, piriformis, quadratus femoris, sartorius, pectineus, adductors longus, brevis, magnus and, when the thigh is flexed, by psoas.
limited by ilio-femoral ligament.

7. **Medial rotation** -
produced by anterior parts of gluteus minimus and medius, tensor fasciae latae and during process of flexion, by ilio-psoas:
limited by ischio-capsular ligament and tension of opposing muscles.
MOVEMENTS OF THE HEAD OF THE FEMUR.

Antero-posteriorly. Head remains in the socket,
Laterally and in Head projects beyond the
rotation. margin of the acetabulum on

The head projects beyond the margin of the acetabulum on
the opposite side of that towards which the movement is
taking place.

Acute flexion (liable to dislo-
cation). Hinder and upper part of the

Head leaves the socket and

bears on the weak under aspect of the capsule.

Straight position. Neck grasped spirally by

ilio-femoral and ischio-

femoral ligaments and head re-
tained in acetabulum, screwed

into socket in extension, out

of it in flexion.

Flexion of hip with adduction of thigh.

Ligamentum teres on the stretch.

Summary of Mechanism given in
Quain's Anatomy Vol. IV. Pt. I.
PATHOLOGY OF THE HIP - JOINT,
With reference to the cases submitted.

MORPHOLOGY

Several theories exist with regard to the cause of Congenital Dislocation of the Hip. These may be summarised as follows:

1. Arrest of development of the parts entering into the formation of the joint.

According to Sir Arthur Keith the outgrowth of the acetabular brim may be arrested at the reptilian stage, occurring in the second month of foetal life: the femoral head, already fully formed, is dislocated as a result. This theory is supported by the fact that anencephaly and spina bifida may accompany congenital dislocation of the hip. With regard to cleft palate, due to mal-development, it may here be noted, without necessarily inferring transmitted arrest of development, that amongst the Recommended Out-Patients attending Professor Fraser's Cliniques in November, 1929, a child was submitted for examination, a case of congenital dislocation of the hip, while the Mother's speech was impaired as in cleft palate, her intelligence being of a low grade.
2. Dislocation in utero.

This is somewhat difficult to prove, as it may be confused with :-

3. Trauma at birth, unrecognised at the time and allowed to persist till observed when the child begins to walk. As the condition is occasionally endemic, it suggests obstetric incompetence requiring investigation, all the more so as the acetabulum of an infant is proportionally deep.

4. Deficient epiphyseal development of the shelf of the acetabulum combined with trauma at birth. This is Ombredanne's view, based on the fact that the shelf of the acetabulum has an additional epiphysis of its own. If this be deficient, the upper part of the acetabulum is shallow. The resultant subluxable hip may in his opinion be converted into complete dislocation by forcible extension of the limbs at birth.

Bilateral congenital dislocation of the hip is significant morphologically, as it rules out the question of physiological function producing only a unilateral condition. The influence of sexual development has been brought forward, inasmuch as the percentage of females is estimated at 70-90, but anatomical variation in the form of the female, versus the male, pelvis, has
Fig. 86.

♀ Bilateral Congenital Dislocation of the Hip
( unreduced )

Death was due to Cancer of the Breast when over sixty years of age.

(From a specimen in the Pathological Museum, College of Surgeons.)
ANATOMY.

(Fig. 36)
The accompanying diagram, sketched from a specimen of Congenital Dislocation of the Hip in the Pathological Museum, College of Surgeons, indicates the anatomical features which are found in such a condition. Two acetabula are present.

The lower—that is, the true acetabulum—is smaller and shallower than normal, irregular in outline, somewhat flat at its upper margin, the deepest part of its cavity being situated laterally. Above and almost connected with it, there is a smaller acetabulum—the false acetabulum—very small, irregular and shallow. The pelvic bone in that area is improperly developed. The femur is disproportionate. The head is small, flattened, and conical instead of globular and hemispherical. The angle of the neck is increased, the neck itself somewhat twisted. The trochanters are poorly developed. The approximation of femur to acetabulum is so limited that stability must have depended on the strength of the articular capsule and surrounding muscles. Reduction of dislocation had not been attempted during life, and death at
the age of 60 was due to cancer of the breast.

In congenital dislocation of the hip the capsule is found to be stretched and relaxed, the ligamentum teres elongated. As the child learns to walk the capsule lengthens and forms an hourglass constriction which prevents the head of the bone pushing its way through it into the socket. Pressure leads to the formation of one or more irregular sockets, the capsule interfering with adequate depth. Alteration in balance leads to dorsal luxation, lordosis of the lumbar region, and a tilting forward of the pelvis. The adductors, hamstrings, psoas and iliacus muscles are shortened, the gemelli, obturators and piriformis lengthened, the glutei and quadriceps only slightly altered.
Two factors predominate with reference to pathological changes observed in bone, namely:

A. Inflammation.
B. Trauma.

Of the cases under consideration Tuberculosis and Subacute Infective Arthritis come into the first category, Slipped Epiphysis and Osteochondritis into the second.

A. Inflammation of bone may affect:

1. the periosteum: in a joint - the perichondrium
2. the bone itself.
3. the bone marrow.

1. The periosteum is composed of vascular connective tissue, by means of which the exterior of the bone receives its blood supply. During an inflammatory process the periosteum is raised from the cortex by an exudate which may be oedematous or purulent.

The perichondrium is analogous in structure, encircling the cartilage as periosteum encircles bone. Its manner of growth is similar, periosteum developing from its osteogenetic layer, perichondrium forming cartilaginous cells from its own plasma cells; but while periosteum develops by superposition of its substance at the periphery,
Fig. 37.

Tuberculous Disease of Child's Tibia, showing sequestrum in medullary cavity.

(Thomson and Miles.)
perichondrium increases both interstitially and peripherally. The relationship between the two is very close in view of the fact that the perichondrium is modified into periosteum when the epiphyses cease to be cartilaginous and become completely ossified.

There is also similarity in the effect produced by inflammation on perichondrium, which by exudate is raised from the subjacent cartilage, as periosteum is raised from the bone beneath.

2. In acute inflammation of bone, Ollier, in his Treatise on the Regeneration of Bone refers to the fact that destruction of blood vessels in itself does not produce such a serious effect as was formerly supposed.

In the absence of inflammation, circulation is re-established quickly in the young subject, but where inflammation has produced capillary obstruction, necrosis supervenes, and is proportional to the narrowness of the Haversian canals.

Subsequent to necrosis there occurs the formation of a sequestrum which is not composed entirely of dead substance but remains a more or less vascular section of bone "separated from" the rest. Absorption takes place - but absorption of the living portion only, the dead area being little affected by the surrounding tissues. In support of his argument he points out that in a case of acute suppurative periostitis, where inflammation has extended to the marrow, the central parts of
the area of bone affected die immediately, being cut off from the blood supply. The extremities, however, retain "an obscure vitality" sufficient to prevent complete necrosis. This explains why sequestra take months or years to detach themselves and why when removed at operation they are often seen to be still vascular. "Living parts disappear by medullisation, the dead portion plays the part of a foreign body and undergoes modification of a purely chemical nature". On probing a cavity a sequestrum is detected by its mobility, but the extent of its living or dead tissue can only be recognised after its extraction. If removed from compact bone a dead sequestrum is absolutely white; if taken from a cancellous area it is yellowish grey. In an untreated case of osteomyelitis suppuration and rapid elimination of the dead sequestrum take place, whereas a tuberculous sequestrum is dense and hard, fit, in the case under consideration, to be incorporated in a bony ankylosis.

In subacute inflammation the Haversian canals, which are narrow and inelastic, are enlarged by osteoclasts in order to make room for the additional exudate. This bony change is revealed in radiograms by a condition/osteoporosis, frequently associated with tuberculosis.

3. The bone marrow is a highly vascular tissue concerned with the formation of blood corpuscles and the nutrition of the interior of the bone.
Its power of absorption is experimentally proved by the injection of coloured liquids which pass rapidly into the general circulation. Septic material thus becomes a source of danger, as is seen in the case of osteomyelitis occurring in the diaphysis of the femur and producing a secondary focus of infection in the epiphysis.

B. Trauma.

The general results of Trauma consist of enlargement of cells, proliferation of their nucleus and the formation of new cells. Swelling takes place, the intracellular substance loses its transparency, and new vessels are formed.

Should the condition not return to normal, the sequence of events is as follows:— chronic induration, increase in size of the part affected, sclerosis, calcification and ossification. If the blood supply be cut off, necrosis will follow; if it be abundant, purulent discharge may take place.

Trauma may involve:—

1. The periosteum.
2. The bone itself.
3. The marrow.

1. When the periosteum is affected its osteogenetic cells proliferate, a cartilaginous nucleus is formed, then a bony mass. In the young a local exostosis may form or an acute periostitis, the inherent
qualities of the periosteum being exaggerated. In the old, where growth has ceased, activity is re-created in order to effect repair.

2. The reaction of bone to trauma consists of an increase in the number of osteoblasts or hyperplasia of medullary cells in the Haversian canals, leading eventually to rarefaction and pus formation. This latter process may be reversed, if irritation has not gone too far: re-ossification may take place succeeded by eburnation, which is the complete cure of inflammation.

3. Protracted irritation of the marrow leads to suppuration and necrosis of bone. In the young, the bony substance internally may be absorbed, the medullary canal being filled with pus; while externally it is being renewed by the osteogenetic layer of the periosteum.

The effect of irritation on cartilage follows general principles, but in addition there may occur an infiltration of lime salts leading to calcification. Hyperplasia of fibrous and cartilaginous tissue may be the precursor of ossification occurring in the ligaments and articular capsule of a joint.
SEPARATION OF EPIPHYSES.

The formation of epiphyses is closely related to the long period of growth in vertebrates. They protect the growing line of cartilage below, but Parsons suggests a pathological basis for their appearance, in that ossification begins in the centre of the cartilage and appears first in the larger areas of cartilage where malnutrition is greatest. This is in accord with experimental work which has proved that ligation of vessels is followed by calcification and ossification.

As expressed by Sullivan, Geist and Mueller, in their article on the Epiphyses of the Bones of the Extremities at Puberty, contributed to the Journal of Bone and Joint Surgery, 1924, the law of Epiphyses is definite - that towards which the medullary canal is directed is the last to appear and the first to unite with the shaft, the lower end of the fibula excepted.

Pathological conditions readily occur in the epiphyses on account of their localised blood supply. Invading organisms are conveyed by periosteal blood vessels to the epiphyseal line or by articular arteries to the osseous centre of the epiphysis, hence tuberculosis, suppurative conditions and diseases due to malnutrition tend to produce separation of the epiphyses, which would not
Separation of Epiphyseal.

Partial Separation of Epiphysis, with Fracture running into Diaphysis.

Complete Separation of Epiphysis.

Partial Separation with Fracture of Epiphysis.

Complete Separation with Fracture of Epiphysis.

Fig. 30.

(Thomson and Mills.)
occur in normal individuals.

Trauma in the form of traction with torsion is a common form of indirect violence, as in the case of accident when a foot is caught by a revolving wheel.

Whatever cause may be admitted, the age is necessarily under twenty-five, by which time epiphyses have fused with diaphysis.

The lesion itself may be complete or partial; that is, the epiphysis becoming completely detached from the diaphysis along with its epiphyseal cartilage, or only partially separated along the epiphyseal line with a fracture extending into the epiphysis or diaphysis.
Fig. 39.

Babcock's Triangle.

Head of Femur rotated to show full extent of triangle.
The accompanying diagram, sketched from a bone rotated to show the posterior and lower surfaces of the neck of the femur, shows the area of Babcock’s triangle, in which tuberculosis of the hip-joint frequently begins. Incidentally it also shows numerous foramina of different sizes and in different areas which, according to Dr. Harris in his article on the Vascular Supply of Bone, give an indication of the capacity for osteogenesis, whether the portion be diaphyseal or epiphyseal.

The boundaries of Babcock’s triangle are:

1. Laterally, the articular capsule with arteries in its external margin.
2. Medially, the retinacula, or cervical ligaments of Stanley, in which is found the circulus vasculosus articuli.
3. Inferiorly, the muscular area of the psoas major and quadratus femoris near their attachments to the bone.

This primary area of infection is intra-capsular but extra-synovial, hence disease progresses by attacking the surface of the bone, destroying the periosteum and invading the synovial membrane. Granulations spread over and under the cartilage and a sequestrum is formed. The epiphyses are eroded.
Blood Supply to the Central Area of the Head of the Femur.

- Light blue = articular cartilage.
- Striped blue = ligaments.
- Green = periosteum.
- Red = synovial membrane.

(Beezley and Johnson)
and pathological dislocation may take place.

Another primary locus of infection is found in the circulus vasculosus articuli situated in the acetabulum. Progress of the disease in this case is rapid, the articular cartilage forming the only barrier to invasion into the joint cavity.

A secondary focus may arise in the joint as the result of the diaphysis being diseased. By reason of the fine terminal "hair-pin bends" of the metaphyseal blood vessels, the bone is directly involved, as the vessels come into contact with osteoid cells in the metaphyseal spaces. The endothelial lining of the vessels is very thin, therefore vulnerable to infection. Embolism occurs by reason of the narrowness of the channels in which the vessels lie and disease may pass backwards along the original artery of supply, leading to thrombosis and necrosis of the diaphysis.

In some cases the periosteal blood supply becomes the principal channel of infection to the joint-cavity, destroying the intra-articular cartilage. Should the circumferential blood supply to the epiphyses be cut off, there still remains the articular branch of the obturator artery, accompanying the ligamentum teres, to supply the central area of the head of the femur. But in 2 per cent the blood supply accompanying it is negative, therefore for prognostic purposes it cannot be relied on.
Fig. 41.

Tubercles invaded by lymphocytes and consisting of epithelioid cells and giant cells.
(Taken from slide in class on Pathology, 3rd year.)

Fig. 42

Tuberculous Arthritis.
Synovial membrane thickened and swollen.

(Boyd)
Magnus refers to the flow of lymph being limited in the case of limbs. The vessels are minute, accompanying the **venae comitantes** on the capsule of the joint, hence when pressed upon during movement they are **occluded**. This gives opportunity for infection to settle and the synovial membrane is particularly liable to become a **nidus** for organisms.

**SYNOVIAL MEMBRANE.**

Tuberculosis of the hip-joint may begin in the synovial membrane as a lymph-borne infection, or it may spread from the adjacent bone, the primary **nidus** being situated in the bronchial or abdominal lymph glands. Trauma in some cases is the cause of a lesion, non-tuberculous in character, which is susceptible to bacterial invasion through the blood stream. The first evidence of disease is the presence of one or more **tubercles**, consisting of epithelioid cells with occasional giant cells. (Fig. 41).

The synovial membrane loses its smooth, glistening appearance, becomes greyish, then reddened, thickened and swollen until it eventually fills the joint-
Fig. 43.

Infective Arthritis.

Chronic type in Lower End of Femur.

1. Synovial membrane red and congested.
2. Areas of ulceration

(Boyd)
cavity. Caseation may or may not be present, but owing to end-arteritis gelatinous degeneration takes place. (Fig. 42).

Arthritis may be due to trauma but is more frequently the result of infection by the bloodstream. In traumatic affections, the synovial membrane becomes very red and congested. (Fig. 43) A serous exudate, turbid because of polymorphonuclear leucocytes, enters the membrane, which becomes soft and swollen in consequence. Occasionally the exudate contains shreds of fibrin, in which case absorption is incomplete.

Where bacterial infection has occurred, as in arthritis following puerperal sepsis, suppuration may take place leading to swelling, congestion and gelatinous degeneration of the synovial membrane.

If much pus be present, granulation tissue is formed in the synovial membrane, ligaments become softened and the joint completely disorganised.
SYNOVIAL FLUID.

In tuberculosis there is little increase of synovial fluid, but its constituents alter materially where blood and lymph are infected; even though the lymphatic vessels, according to Tillmans, do not communicate with joint cavities by means of stomata or lie near the free surfaces like blood capillaries.

The synovial fluid becomes fibrinous then adherent to the under surface of the synovial membrane. Fringes develop at the edge of the membrane; these become detached and form "melon-seed bodies" or "joint-mice".

In infective arthritis the synovial fluid is greatly increased. In mild cases it may be clear or slightly clouded owing to the presence of a small amount of fibrin, but in serious bacterial infection pus cells are more or less numerous, suppuration eventually extending into the surrounding tissues.
Tuberculosis in the articular cartilage is always a secondary infection owing to the absence of blood vessels in its substance. From the deep surface of the synovial membrane vascular granulation tissue reaches down to the cartilage, gradually detaching flakes from its surface. It is to be noted that no tubercles are present in such granulation tissue; from which Phemister concludes that it is due to a purely vascular reaction to deceased tissue.

The cartilage, normally bluish and glistening, becomes yellowish and opaque. Finally it is eroded by granulations until the bone itself is exposed.

In infective arthritis the cartilage is affected on both sides, the under surface being eroded in course of time by granulation tissue occurring in the epiphysis. An attempt at regeneration occurs subsequently to degenerative processes and osteoblasts may succeed in depositing fresh bony substance on both surfaces of the cartilage. In suppurative cases necrosis may take place, followed by disorganisation of the joint as a whole.
Trauma has less effect on cartilage than on bone owing to its absence of vascularity and its smooth, gliding surface intended to absorb shock. Experimentally it has been proved that pricking it in all directions does not injure it materially; but bruising or complete severance of parts diminishes its activity and arrests growth. Indirect irritation, as in the case of diaphyseal osteitis, produces far-reaching results, rapid proliferation taking place in the cartilage along with increase in length in the bone.
Like joints, bursae are supplied with a synovial membrane and synovial fluid. Where they communicate with a joint-cavity, as in the case of the psoas bursa, similar conditions may develop as are produced in the joint. Tuberculosis leads to the formation of granulation tissue and gelatinous degeneration with or without caseation. Infective arthritis causes swelling, tension and thickening of the bursal walls with the formation of "melon-seed" bodies. In infective cases suppuration predominates.

As a source of primary infection bursae are of importance in that such areas may permit of the development of organisms, conveyed subsequently to communicating joint-cavities.
BIOCHEMICAL TEST.

The Suspension Stability Test, described by Mr. Joseph Race, Biochemist, Devonshire Hospital, Buxton, in a Reprint from the Proceedings of the Royal Society of Medicine, March 1929, gives a method of routine examination which the writer saw in practice in the Devonshire Hospital. Its purpose is to determine the stability of corpuscular suspension with reference to the condition of the patient. The technique consists of running into a graduated centrifuge tube at 17°C to 20°C. 10 c.c. of oxalated blood. Four readings are taken at thirty minute intervals, expressed as percentages of the total volume.

Normal healthy blood averages 90 per cent, any morbid condition lowering the figure proportionally.

In tuberculosis, the correlation of the suspension stability with exacerbations and améliorations is not so definite as could be desired, but some of these discrepancies are to be attributed to the difficulty of determining the extent of the active process. (Race). If the test, however, be repeated monthly and sedimentation become progress-
ively slower, it may be inferred that the patient's condition is improving.

With regard to rheumatism, gout, osteoarthritis and infective arthritis, it has been observed that the last-named shows the lowest stability. So rapid is the sedimentation that four readings are required at fifteen minute intervals, further observation being unnecessary. Suspension stability of corpuscles normally lowers during pregnancy and culminates at term. In a case of arthritis following puerperal sepsis it is possible that the degree of morbidity might be, at least, partially estimated by the use of such a test.
Acute Anterior Poliomyelitis.

Fig. 44.

Section of the Lumbar Enlargement of the Spinal Cord.

a. Pia mater.

b. Anterior horn.

c. Inflammatory vessels.

d. Strands of inflammatory cells.

e. Proliferation of ependymal cells.

(Roussy and Bertrand.)
Conditions in the Spinal Cord such as are to be found in Acute Anterior Poliomyelitis.

Fig. 46.

A. Granular corpuscles
B. Commencing proliferation of astrocytes
C. Amitotic division

Fig. 46.

A. Granular corpuscles entering B. Perivascular lymph-sheath

Paraffin sections - stained haematoxylin and eosin.

From slides kindly lent by Dr. Reynolds, Department of Neuro-Pathology, University of Edinburgh.
SPINAL CORD — Histological Changes.

The spinal cord in cases of Acute Anterior Poliomyelitis yields little macroscopic evidence of disease. The brain and cord are somewhat oedematous and the meninges hyperaemic, while minute haemorrhages may be seen in the cases specially affected.

Microscopically the sequence of events can be studied with accuracy, the cervical and lumbar enlargements usually yielding most data for investigation. In the area of the antero-median fissure the vascular supply is greatest, hence the anterior horns are more affected than the posterior horns or white matter of the cord.

Under low power small dark points may be seen representing ganglionic cells, also stippling in the white matter radiating from periphery to grey matter. (Fig. 44) Under high power the process is more clearly defined.

Hypaemia of the blood vessels is followed by infiltration of granular corpuscles into the perivascular lymph spaces: this constitutes the so-called "cuffing" of the arteries. (Figs. 45 & 46). Although most pronounced in the anterior horns, the rest of the cord and to a less extent the brain, medulla and pons are also affected. As the result of infiltration and congestion minute haemorrhages occur; the tissues become oedematous; the capillaries thrombosed; and nutrition of the affected areas
Conditions in the Spinal Cord such as are to be found in Acute Anterior Poliomyelitis.

Fig. 47.
Anterior horn with gliosis complete.
a. shrunken, atrophied nerve cells
b. nuclei of astrocytes which have proliferated, formed fibers and regressed.

Celloidin section—stained by iron haematin and van Gieson's method.

Fig. 48.
a. Patch of gliosis
b. Wall of vein.

Stained crystal violet.

From slides kindly lent by Dr. Reynolds, Department of Neuro-Pathology, University of Edinburgh.
interfered with.

Coincident with these vascular changes the nervous parenchyma undergoes degeneration, the toxic action of the virus itself accentuating the damage done by lack of nutrition. The cell body becomes swollen, the Nissl granules completely lysed, the chromatin substance diffused throughout the cell and the nucleus eccentric in position owing to destruction of the so-called neurofibrils in the cell body. Phagocytes of neuroglial origin carry away cellular débris and deposit it in the perivascular lymph spaces. Astrocytes proceed to proliferate by amitotic division, then form fibres and regress, while nerve cells become shrunken and atrophied.

The last and chronic stage is that of complete gliosis, where the trophic unit of the nerve cells has been destroyed and its processes have degenerated.

The myelin sheath of the axis cylinders undergoes Wallerian degeneration and the nerve fibres are themselves replaced by neuroglia. When all the products of degeneration are finally removed, asymmetrical areas of sclerosis, visible to the naked eye, reveal the extent of the original inflammation.
LABORATORY TESTS in Acute Anterior Poliomyelitis.

   Fluid - clear.
   Pressure - moderate.
   Cell count - increased, usually 200 - 300 per c.mm., maximum in first and second week, returning to normal by the fourth week.
   Cells at first polymorphonuclear, later mononuclear.
   Globulin - increased, maximum in third or fourth week.
   Chlorides - normal.
   Reduction of Fehling's solution - normal.
   Virus - never present.

2. Blood - 20,000 - 30,000 polymorphs, showing that blood is antagonistic to the virus.
The epidemiological features of anterior poliomyelitis were first described in 1890 by Menin, whose facts were based on the study of 44 cases during the Stockholm epidemic of 1887. The pathology of the condition was investigated by Wickmann in 1905 but little was known of its causation till 1909, when Landsteiner and Popper of Vienna succeeded in transmitting the disease by intraperitoneal injection into monkeys. In 1910 Flexner and Lewis proved that by intracerebral inoculation of an emulsion of infected brain or cord, constant results were produced and the disease could be carried on into the second and third generation. The monkey is, however, the only animal susceptible to the disease.

Filterability of the virus was discovered concurrently and independently by Landsteiner and Levaditi and by Flexner and Lewis. The emulsion of an infected brain, passed through a coarse or medium Berkfeld filter, was capable of producing the disease after intracerebral inoculation.

Culture of the organisms was made possible by the method of Flexner and Noguchi, who used sterile human ascitic fluid along with a piece of fresh, sterile rabbit's kidney and incubated it at 37°C.
under anaerobic conditions. Within five days a faint opalescence appeared. Films made from this and treated with Grimsa's stain were found to contain minute, globoid organisms 0.5 - 0.15 \( \mu \) in diameter, lying in pairs, chains or small masses. In 1915 Flexner, Nuguchi and Amoss proved that first cultures could not be obtained on solid media owing to the fact that parasitic organisms do not adapt themselves easily to a saprophytic existence. Subcultures were obtained more easily and, when used for the inoculation of monkeys, proved capable of producing poliomyelitis, though there was considerable difficulty in regaining the organisms from the animals.

The method of intraspinous inoculation of monkeys was tested by Clark and Amoss, who showed that the virus was present in the cerebro-spinal fluid within 48 hours after injection, but by the time symptoms appeared, had passed from the subarachnoid space either into the nervous tissue or into the bloodstream, where it is destroyed. Microscopic evidence corroborates these findings, destruction of nervous parenchyma and absorption by the blood being definite features in the disease.

The channels of infection are as a rule the perineural lymphatics. Experiment has proved that scarification of the mucous membrane of the nose permits the organisms to pass along the perineural lymphatics of the olfactory nerve to the
subarachnoid space, thence to the meninges. Likewise inoculation of the sciatic nerve leads to infection of its sheath and finally the cord. All the tissues of the nervous system are liable to be involved, the virus being essentially neurotropic; but it is also found in lymphoid tissue, such as the tonsil and mesenteric glands. Its presence in the mucous membrane of the intestine suggests that in the case under consideration intractable constipation was a factor in the absorption of the virus into the nervous system.
(FIG. 49) **REFERRED PAIN**
in relation to the **Site of Disease**.

<table>
<thead>
<tr>
<th>Referred Pain</th>
<th>Nerve Supply</th>
<th>Site of Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Inner side of ankle.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Inner side of leg.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. In the Heel.</td>
<td>Sacral plexus.</td>
<td>Posterior aspect of hip-joint.</td>
</tr>
<tr>
<td>2. In the foot.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In many cases pain is complained of remote from the actual area of disease. This has been termed "referred pain" and can be experimentally produced by the stimulation of one sensory branch of a spinal nerve creating painful sensations in the area supplied by another branch of the same nerve. Tuberculous disease of the hip-joint is a case in point. The pathological process stimulates the articular branches of the femoral nerve, but the pain of which the patient complains is referred to the region of the knee, which also receives branches from the same nerve (Johnston). Sir James Mackenzie suggests that abnormal afferent impulses may stimulate the nerve-cells to which they travel and also "overflow" to neighboring nerve cells. Hence in tuberculosis of the hip-joint the original "focus of irritation" may cause abnormal afferent impulses to increase excitability of the nerve cells at a distance, belonging to another branch of the same sensory nerve.

Hilton in his Lectures on Rest and Pain points out in addition the value of "referred" or as he calls it, "sympathetic" pain as a means of diagnosis.
MECHANICAL EXPLANATION for POSITIONS ASSUMED in Disease of the Hip-Joint.

In order to prove the reasons for faulty position, Mr. Owen, in a demonstration on the Anatomy of Hip-Joint Disease in Childhood, (Brit. Med. Jour., Dec. 14, 1878) injected the capsule by a trephine - opening through the pelvic aspect of the acetabulum. As the upper and anterior part of the capsule were unable to expand, the femur abducted itself to give more room. Further injection led to flexion. This was the limit reached by the actual structures of the joint. The position of inversion in disease had still to be accounted for, the explanation for which could be found in the structures lying outside the joint. By contraction the psoas, iliacus, rectus femoris, tensor fasciae femoris and adductor longus inverted the limb in order to make still further room for the joint. The last stage was reached when, in Mr. Owen's quaint language, the muscles became tired with holding the femur and finally compelled the limb to accept the attractive support offered by the front of the opposite thigh.
BACTERIOLOGY

BACILLUS TUBERCULOSIS.

Two types of tubercle bacilli exist, namely, human and bovine.

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Human Type.

Shaped like small rods, straight or slightly curved, uniformly thick, measuring 2.5 to 3.5 μ in length and 0.3 μ in thickness, occurring singly or in pairs, often forming an obtuse angle, non-motile, non-sporing, resistant to drying processes.

Gram positive, possessed of a lipoid sheath which is acid-fast, the bacillus is best stained by Ziehl-Neelsen's method which ensures the application of heat and a strong dye with a mordant to penetrate the outer envelope, also sulphuric or nitric acid to decolourise it. A counter-stain differentiates other substances in the slide.

Glycerin-egg medium is best suited for the development of a luxuriant growth which appears yellowish, dry, irregular, tough and wrinkled.

Bovine Type.

Morphologically, the bovine type is somewhat shorter, thicker and more regular in size. Its growth is dyagonal. On egg medium it appears thin, white, smooth, slightly moist and granular, so
that it is easily broken up. Its virulence is greatest when inoculated into animals, but it is of pathogenic importance in the milk-supply of children, in which case infection takes place by means of the alimentary tract. Muir and Ritchie refer to the fact that Professor Fraser found bovine tuberculosis predominating in the case of children suffering from tuberculosis of bones and joints, a series of seventy cases yielding more than 50%. He also observed that where there was no evidence of human infection in a household, bovine tubercle bacilli were the more likely cause of disease.
Organisms associated with Infective Arthritis.

1. *Streptococcus Pyogenes.*
2. *Staphyloccoci Pyogenes Aureus et Albus.*
3. *Bacillus Coli Communis.*
4. *Gonococcus.*

Additional Organisms associated with Puerperal Sepsis.

5. *Bacillus Diphtheriae*
7. *Bacillus Tetani.*
8. *Bacillus Aerogenes Capsulatus,* a saprophytic organism usually found with the streptococcus and responsible for the formation of gas in the uterus.

Amongst the organisms named, only the first four need be considered with regard to the cases in question.

1. *Streptococcus Pyogenes.*

Spherical or oval, about \(1\mu\) in diameter, occurring in chains of various lengths: Gram-positive; aerobic or facultatively anaerobic,
growing preferably on blood or serum media: on culture, forms greyish-white, semi-transparent, pinhead discs.

If only moderately virulent, inflammation may be localised, as in monoarticular arthritis: if haemolytic in type, cellulitis and puerperal septicemia may arise in appropriate cases.

2. Staphylococcus Pyogenes Aureus et Albus.

Spherical, \(0.8\mu\) in diameter, arranged in clusters: Gram-positive: aerobic or facultatively anaerobic, growing on ordinary media: thick, opaque, moist and yellow in the one case, white in the other: on culture forming circular discs \(2 - 3\mu\) in diameter.

These are found in suppurative conditions such as abscesses, septicaemia and urinary sepsis.

3. Bacillus Coli Communis.

Gram negative \(2 - 3\mu\) by \(0.5\mu\), motile, aerobic and facultatively anaerobic, growing on ordinary media: on culture forming large, thick, white discs.

These occur mostly in infections of the intestinal and urinary tract. Other sites of infection are the uterus and Fallopian tubes, as in puerperal sepsis, also the bones and joints. (Price)


Diplococci with opposed surfaces flattened
or concave: intracellular in inflammatory exudate: Gram negative; aerobic; requires blood or serum for growth; colonies form semi-transparent circular discs with scalloped edges, and radial and concentric markings.

In the female the sites of infection are the urethra, Bartholinian glands, cervix uteri, vaginal mucosa, if sodden by previous discharge, endometrium, Fallopian tubes and in severe cases the peritoneum. The channel of infection is the blood stream, hence areas such as joints, in themselves distant from the original focus may subsequently be invaded.

Muir and Ritchie point out that in Arthritis three conditions may prevail:—

1. Pure culture of the gonococcus may be obtained from the joint.

2. In many cases no organisms are found in fluid aspirated from the joint. They may have been present, however, in the synovial membrane.

3. In suppurative cases pyogenic cocci may co-exist.

In considering subacute infective arthritis following puerperal sepsis, it is probable that several types of organisms were present, inasmuch as the blood stream would convey a mixed infection from the genital tract to other parts of the body.
According to Cushny the action of quinine may be summarised as follows:—

1. General action—protoplasmic poison.

2. In a concentration of 1 : 24,000 it lessens the phagocytic power of leucocytes and the bactericidal capacity of plasma. This concentration is not reached in therapeutic doses but increase of alkalinity increases the toxicity of quinine.

3. Muscle power is at first increased, then weakened. Injections of large amounts kill muscle fibres and lead to sloughing.

4. Heart muscle is weakened by intravenous injection; blood pressure falls.

5. Arterial walls contract, altering the calibre of the vessels.

6. Nerve trunks are more tolerant of quinine than muscle.

7. The central nervous system is at first excited, then depressed.
8. The sense of hearing is disturbed because of degeneration of the spiral ganglion in the cochlea.

9. The field of vision is contracted owing to degeneration of retinal nerve cells.

10. Uterine contraction is increased and the resting uterus is stimulated into contraction.

11. In the blood both leucocytes and lymphocytes are eventually diminished in number.

12. The spleen is reduced by reason of contraction of its muscle fibres.

13. Excretion is carried out, one-third by the kidneys, two-thirds in the tissues. Subcutaneous injection leads to local deposit, which is slowly redissolved.

14. Idiosyncrasies include skin eruptions, gastric discomfort, diarrhoea and albuminuria.
The purpose of surgical treatment is to restore as far as possible the functions of the lower limb which demands mobility combined with stability at the hip-joint. In disease the thigh assumes first the position of abduction, flexion and rotation outwards: later it is adducted and rotated inwards, with or without increase of flexion. The pelvis adjusts itself in order to allow the limbs to remain parallel. With abduction of the thigh it tilts downwards on the affected side, causing apparent lengthening: in the stage of adduction it is elevated on the affected side, causing apparent shortening. Actual destruction of the joint is accompanied by true shortening. (Timbrell Fisher).

a) Surgical Manipulation aims at correcting the aforesaid deformities, at the same time relaxing contracted muscles and minimising friction between the head of the femur and acetabulum. In cases of excessive muscular contracture, subcutaneous tenotomy of the adductor tendons may be required.
b) Open operation becomes necessary when manipulative measures fail or when exposure of the joint is essential. Ollier refers to the continuity of the fibrous septum enveloping organs, bones and joints. Incisions should therefore be planned to allow of reaching the joint by the shortest route without destroying fascial sheaths or muscular attachments. The perios­teo-capsular canal of the joint should be retained intact. The capsule should be opened in its long axis and the articular cartilage preserved, if possible, to allow of growth.

Regeneration of bone is proportional to age, as osteogenetic capacity diminishes in middle life. Under the influence of trauma osteogenesis may be over-stimulated, as in the present case of osteochondritis deformans juvenilis. The head of the femur, broadened and flattened, no longer fits the acetabulum. Treatment therefore consists of removing excessive bone formation, reducing the head of the femur to approximately its normal size and shape.

Where the acetabulum is shallow and the head of the femur under-developed, as in congenital dislocation of the hip, these are best maintained in apposition by a shelving operation.
For a flail joint, such as occurs after anterior poliomyelitis, arthrodesis is accomplished by detaching the great trochanter along with the muscles inserted into it and either fixing the head of the femur into the acetabulum by means of a steel pin or, as in the case under consideration, by fitting the trochanteric graft on to the anterior superior aspect of the head and neck of the femur.

In tuberculosis of the hip-joint, operative measures depend upon the extent of the disease. Free access to the joint is essential, therefore the posterior route is to be preferred in order to allow of examination both of the bones and the synovial lining of the capsule. According to the area involved, the degree of deformity present, and the density of sequestrum formation, an osteotomy is performed, in this case supra-trochanteric, in order to correct the adduction of the limb.
Fig. 50.

Bilateral Congenital Dislocation of the Hip.

October - 1926

Zena Lister - act. 4 years.

Clinical Picture - erect position.
Bilateral Congenital Dislocation of the Hip.

(FIG. 50)

CLINICAL PICTURE. - in the erect position.

Prominent abdomen due to lordosis.

Lines joining the heads of the femora not horizontal and not in normal relationship with the umbilicus: right side higher than left.

Head of the femur protuberant on both sides, particularly the right.

Thighs apparently short in proportion to the body.

Position of Femora asymmetrical.

Right knee higher than left.

Position of tibiae asymmetrical.

Right heel somewhat higher than left.

Metatarsals flattened and spread out, especially those of the right foot.

Weight-bearing is principally on the left foot.
BILATERAL CONGENITAL DISLOCATION OF THE HIP.

Zena Lister, aet. 4 years.
Admitted to Ward 8, October 20, 1926.

History.

A forward curvature in the back is stated by the parents to have been present since birth. The child began to walk about the usual time and appeared to have no difficulty in so doing. No defect was noticed in connection with the hips but on account of her back the child was examined at Perth Infirmary in August 1926. An X-ray photograph was taken and the condition diagnosed as bilateral congenital dislocation of the hip.

Physical Examination.

The general health was good. On walking there was a slight lurch to each side as the foot was put to the ground but the typical waddling gait was not present.

On inspection the space between the thighs was broader than usual and the gluteal folds deeper. The thighs appeared to be short in proportion to the rest of the body. There was no marked muscular wasting. The hips and thighs were symmetrical. In the supine position there was some prominence of the abdomen.

The measurements were the same on both sides.

On palpation there was a distinct lordosis when the legs were extended. The trochanters appeared to be very near to the head of the femur. No pulsation could be felt in Scarpa's triangle.

Movements were free and painless except abduction which was somewhat limited. Adduction was very free. There was no marked telescopic movement.

The clinical picture annexed (Fig. 50) indicates the condition in 1926.

The radiograms of that date are not available, but the picture represented under date of 26:5:28, (Fig. 51) corresponds exactly with the description given of the condition in October 1926.
MANIPULATION OF BOTH HIPS.

Operation:

21st. October, 1926. Mr. Mercer. (Chloroform & ether)

An attempt was made to reduce the dislocation by manipulation under anaesthesia. With an assistant holding the pelvis the thigh was forcibly extended, flexed and abducted, and strong traction was also exerted in order to obtain good relaxation of the muscles. With a hand under the hip, the thigh was then flexed and abducted and everted, but all efforts failed to reduce the dislocation. The attempt on the other hip was similarly unsuccessful.

When patient returned to bed, a piece of domette was firmly bandaged to each leg and a weight attached over pulleys at the end of the bed. At first 1 lb. weight was used. After a few days this was increased to 2 lbs. Counter-extension was obtained by raising the foot of the bed on blocks.

"Attempted reduction by manipulation".

Treatment:

16:11:26. Professor Fraser. (Chloroform & Ether)

Reduction of both hips was attempted by manipulation under anaesthesia. A plaster was applied with the thighs fully flexed and partly abducted and the knees flexed.

"Attempted reduction".

An X-ray photograph showed that both femora had been brought into a position opposite to, but not in, the acetabulum.

Treatment:

23:11:26. Professor Fraser. (Chloroform & ether)

The plaster was removed, reduction of both hips effected by manipulation and a new plaster applied with the legs lower down, so that the thighs were abducted to a right angle and the knees flexed.

"Reduction, both hips".
Discharged:

8:1:27, in plaster. To report in about two months' time.

Re-admitted:

16:2:27, for re-application of plaster.

Treatment:

22:2:27. Professor Fraser. (Chloroform & Ether)

The plaster was removed.

The thighs were extended at the hip-joints and the sartorius and rectus femoris tendons were divided subcutaneously just below the anterior superior spine on both sides. This allowed more complete extension of the hip-joint.

The plaster was re-applied from the waist down to above the knee on both sides with the thighs extended and moderately abducted.

"Re-application of plaster".

Discharged:

8:3:27, in plaster. To report in three months.

Re-admitted:

18:5:27, Still in plaster in the second position.

The plaster was bivalved.

Treatment:

20:5:27. Professor Fraser. (Ethyl chlor.& ether)

The plaster was removed and both heads of the femora were found to be in the acetabula. The hips were straightened and bound together with a bandage, to be taken off and re-applied at night time.

"Removal of plaster".
Fig. 51.

Bilateral Congenital Dislocation of the Hip.

26-6-20.

Zena Lister - act. 6 years.
Bilateral Congenital Dislocation of the Hip.

(FIG. 51)

This picture, dated 26:5:28 corresponds with the description given of the condition found on October 21st, 1926.

Heads of femora are poorly developed, anteverted, opposite to, but not in, the acetabula. The right femur is the one under present consideration.

The left femur is on the level of the upper margin of the acetabulum.

Epiphyses indistinct owing to anteversion.

Acetabulum shallow; contour indefinite in its upper half.

Pelvis tilted according to side of principal weight-bearing when photographed.

Ossification of pubis and ischii not yet complete.
Bilateral Congenital Dislocation of the Hip

(FIG. 52) 30:5:28.

Reduction of dislocation of the right hip.

Right limb put up in plaster in the frog position.

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(FIG. 53) 20:12:28.

Right hip proved to be re-dislocated, contrary to clinical findings.

Operative treatment decided upon.

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Progress:

Treatment of massage and movement was begun in the Royal Infirmary - to be continued at home.


Physical Examination:

It was found that re-dislocation of both hips had taken place.

X-ray Examination: 26:5:28 (Fig. 51) showed the condition to be similar to that before the previous treatment. See page 123.

**RIGHT HIP.**

Treatment:

29:5:28. Professor Fraser. (Ethyl.chlor.& ether)

The right leg was fully flexed on the hip, thus lengthening the psoas and the hamstring muscles. It was then fully abducted so that the adductor muscles might be stretched. The leg was then forcibly extended and an attempt was made to reduce the dislocation on the right side. The leg was fully flexed and then rotated outwards until the frog position was reached. It was then found that the knee could not be extended and the head of the femur was apparently in the acetabulum.

With the right leg held in this position an attempt was made to reduce the dislocation on the left side. This, however, proved difficult, and in view of the great liability of dislocation recurring on the right side, it was decided to leave the left side alone in the meantime.

The right limb was put up in plaster in the frog position.

"Reduction of dislocation of right hip".

X-ray Examination: 30:5:28, showed the hip to be in good position. (Fig. 52)


Physical Examination:

The patient looked fairly well.

Right Hip: Apparently in good position.

Left Hip: Leg shortened. Broadening of buttock and eversion of limb.

Movements painless and free except abduction.

Telescopic movement present.

Xray Examination: 20:12:28. (Fig.53) showed that, contrary to clinical findings, the right hip was not in position, therefore operative treatment was decided upon.

Operation:

28:12:28. Mr. Mercer. (Chloroform & ether)

A sandbag was placed under the left hip and an incision over the right hip was carried from the anterior end of the iliac crest and about 1" below it downwards for 4". The tensor fasciae femoris and gluteus medius muscle were divided in the line of the upper part of the incision, exposing the dislocated head of the femur lying in relation to the false acetabulum. The areolar tissue filling the acetabulum was removed and the head and upper part of the neck of the femur cleared. The femur could then be got to slip in and out of the acetabulum with considerable ease when the limb was abducted. The floor of the false acetabulum was chiselled down parallel to its surface so as to make a ledge united at its lower extremity. This was folded down over the head of the reduced femur and was sutured in position, the catgut being passed through holes drilled in the ledge. The thickened capsule which had been previously divided was also used to strengthen the re-position. The wound was then closed in layers and the operation was completed by applying a
Fig. 6A.

Bilateral Congenital Dislocation of the Hip.

23-10-29.

Result of Shelping Operation.

Jena Lister - act. 7 years.
RESULT OF SHELFING OPERATION AND FURTHER MANIPULATION.

RIGHT HIP STABILISED, SHOWING SLIGHT EXTERNAL ROTATION AND SLIGHT FLEXION.

LEFT HIP IN ITS ORIGINAL POSITION OF HIGH DISLOCATION JUST BELOW THE ILIAC CREST - TREATED BY OPEN OPERATION.
plaster case with the limb abducted to a right angle.

"Shelfing operation, right hip".

Treatment:

14:1:29.  Mr. Mercer.  (Ethyl Chlor. & ether)

The plaster was removed. Further manipulation was carried out and the hip brought into position. The limb being firmly held, plaster was re-applied.

"Manipulation of hip, right".

X-ray Examination: 17:1:29, showed the limb to be in good position.

Discharged:

25:1:29, with plaster fitting comfortably.

X-ray, 15:5:29, right hip. Plaster to be bi-valved at a later date.

X-ray, 23:10:29, (Fig. 54) Plaster off. Right hip quite stable but showed a little external rotation and slight flexion. The patient was encouraged to straighten and move her leg.

Left hip, as before - fixed, high dislocation.

LEFT HIP.

Re-admitted:

29:11:29. for attention to left hip.

Physical Examination:

Left Hip. The greater trochanter was situated just below the iliac crest and was firmly fixed in position. Abduction was extremely limited and there was considerable limitation of all other movements.

There was a slight amount of telescopic movement present but the hip appeared to be relatively
completely fixed.

There was 2" shortening in the left leg.

Additional Notes taken when the case was presented during a clinique 29:11:29.

Physical Examination:

Scar 3½ ins. long.

Measurements:

From anterior superior spine to internal malleolus:

Right leg 21 ins.  left leg 20½ ins.

From umbilicus to internal malleolus:

Right leg 24 ins.  Left leg 21½ ins.

Patient in supine position.

Right leg permitted semi-flexion.

In partial lateral rotation the adductors magnus and longus, also the psoas, muscles became prominent.

Slight rotation of the hip-joint.

Leg could be raised only with the help of the pelvis.

Abduction good.

Adduction very limited.

Muscles somewhat atrophied, especially at the level of the symphisis pubis.

Left leg:

Flexion complete against abdominal wall.

Great trochanter projected 2 ins. at a level of ½ in. below the anterior superior spine.

Muscles well nourished. Upper part of quadriceps and vasti seemed almost hypertrophied.

Medial condyle of the femur was prominent.
Left foot. - Pes equinus varus.

Big toe dislocated backwards, also the other toes, but these were able to rectify themselves somewhat when the toes were pointed.

Metatarsals prominent, especially the first.

Arch of foot exaggerated.

Foot dropped 20° and turned inwards.

In repose the talus and base of the 5th metatarsal became prominent.

Patient in prone position.

Great trochanter 2 ins. higher on left side than on right.

Waist showed a sharp angle.

Gluteal fold was oblique - lower end ½ in. higher than that of the right side.

Left thigh and leg lay normally.

Left Foot extended down in a straight line fitting the bed.

Arch well marked.

Metatarsal prominence obliterated.

Toes straightened.

Right leg lay on its medial side, patella facing somewhat laterally.

Right foot normal.

Movements.

Right Leg.

Extension of knee 2 ins.

Abduction good.

Adduction to mid-line.

Left Leg.

Extension of knee 3 ins.

Abduction 4 ins. from midline.

Adduction 1 in. beyond mid-line.
Operation:

30:11:29. Mr. Mercer. (Chloroform & Ether)

A Smith-Petersen incision was made commencing about halfway along the crest of the ilium and extending forwards and downwards over the front of the thigh for about 4". The interval between the tensor fasciae femoris and the sartorius was defined and deepened and the tensor detached from its origin at the anterior superior spine. The gluteal muscles overlying the highly placed head were cut through and the capsule of the joint exposed. It was found to be dense and fibrous and was opened by an incision in the long axis of the capsule. An attenuated ligamentum teres was found and cut. An hourglass constriction was also found to be present in the capsule and this was freely divided.

The true acetabulum was thus opened up. It was found still difficult to bring the head down towards the acetabulum and the ilio-psoas tendon was accordingly divided through the posterior part of the capsule. The fixed position of the hip was then found to preclude attempts at open reduction. It was therefore decided to tenotomise the adductor tendons and to close the wound and trust to prolonged extension to carry the head downwards inside the acetabulum. The adductor muscles were therefore severed near their attachment to the pubis and the divided gluteal muscles sutured to each other with interrupted catgut. The tensor fasciae femoris was then approximated to the sartorius muscle by a series of interrupted catgut sutures and the skin edges closed with silk worm gut.

"Open operation for congenital dislocation of hip, left".

Progress:

Following the operation the patient was fixed in a Bradford frame and extension applied by means of strapping on her left leg. The cord of the extension was placed over a pillow and a weight of 5 lbs. applied. This gradually brought the head down about 1/2 in. until it was approximately on the same level as that on the opposite side.

It was then decided to perform a shelf-graft operation.
Operation:

The usual Smith Petersen incision, made at the former operation, was reincised and deepened and the fibres of the gluteal muscles divided a short way below the iliac crest. The tensor fasciae latae was separated from the sartorius in front. The gluteal muscles were strongly retracted and further separated by a subperiosteal reflection of the wing of the ilium. The head of the femur and the capsule came into view. A small incision was made in the capsule and the position of the head verified. The capsule, which was partly adherent to the ilium, was then separated with a periosteal elevator until the rim of the acetabulum became visible. The bone in this region was cleared and it was decided to form a shelf from this. An osteotome was inserted into the wing of the ilium about \( \frac{3}{4} \) in. above the head and a rectangular portion about \( 1\frac{1}{2} \) ins. long was turned down. From a point higher up on the ilium a similar rectangular piece of bone, consisting of an outer table and some of the diploe, was removed to form a buttress. Some further small portions of cancellous bone were nibbled away from the ilium and packed into the space left by turning down the shelf.

A drill hole was made at each end of the shelf which had been turned down, and a similar drill hole made at each corner of the rectangular portion of bone removed from the higher ilium. This buttress was now laid into position behind the shelf and firmly wedged there in order to keep the shelf well down.

A strong catgut suture was passed through, uniting the shelf and the buttress. In this way a strong acetabular rim was formed. The muscles were then joined with interrupted catgut sutures and the skin edges approximated with interrupted silk worm gut.

"Shelf-graft operation, left".

Progress:

Patient was extremely well, following operation, and her plaster was comfortable.
Fig 65.

Bilateral Congenital Dislocation of the Hip.

19-4-30.

Left Hip in Good Position

Zena Lister - act. 6 years.
X-ray Examination was satisfactory.

Discharged:
11:1:30 in comfortably fitting plaster. To report in three months.

Re-admitted:
19:4:30, when the plaster was removed.

X-ray Examination:
19:4:30, showed the left hip in good position.

Discharged 19:4:30.
COMMENTARY
on
BILATERAL CONGENITAL DISLOCATION
OF THE HIP.

1. Clinical Summary of the Case.
2. Etiology.
3. Pathology.
4. Radiological Examination.
5. Clinical Features.
6. Absolute Diagnosis.
7. Differential Diagnosis.
8. Treatment.
CLINICAL SUMMARY.

Physical Examination: October 20, 1926.

1. Lordosis at birth points to a congenital condition in which the inclination of the pelvis is increased beyond the normal 60°. In addition there is a possibility of bilateral defect of the hip-joints, proved later by radiography.

2. Walking was not delayed, but at the age of four a lurch to each side indicated bilateral displacement of the head of the femur.

3. Inspection was corroborated by the clinical picture. (Fig. 50).

4. Palpation amplified the observations already made and suggested in addition anteversion of the femur. The vascular test proved the absence of bony support normally felt when the head of the femur lies behind the femoral vessels.

5. Movements were limited in certain directions. Abduction was interfered with by contact of the head of the femur with the ilium. Adduction was extreme because of the absence of limiting structures in the normal joint cavity. The position of the joint was not such as to allow of much vertical movement.
MANIPULATION OF BOTH HIPS.

Treatment: Oct. 21, 1926, consisted of manipulation with the aim of reducing the dislocation on one or both sides. It was so far successful in that the heads of the femora were proved by radiography to lie opposite the acetabula. In order, however, to approximate the femora to the acetabula, the sartorius and rectus femoris tendons were divided subcutaneously just below the anterior superior spine on both sides. (16:11:26) The operation was to all appearance successful, but in May 1928 both hips were found to be re-dislocated. (Fig. 51)

RIGHT HIP.

The right hip was again manipulated and put up in plaster in the frog position. (Fig. 52). In December 1928 clinical examination indicated a satisfactory result, contradicted by X-ray findings. (Fig. 53) On December 28, 1928, a Hoffa-Lorenz shelving operation was performed and on January 14, 1929, further manipulation was carried out to bring the hip into position. A radiogram in October 1929, showed the right hip to be quite stable with slight external rotation and slight flexion.

The left hip remained to be treated.

**Right leg:** post operative result.

1. Measurements showed that the right hip-joint was at its normal level in comparison with the left hip, which was displaced upwards, making the left leg seem shorter.

2. Semi-flexion only was obtained. The pelvi-femoral muscles were taut, limiting lateral rotation. Slight rotation existed in the hip-joint.

Extension could not be carried out by the hip-joint without assistance of the pelvis.

Abduction showed that the head of the femur was no longer impeded by the ilium, but free to move in a socket.

Adduction was now reduced by limitation of the shelf.

Muscles were atrophied at the level of the symphysis pubis.

**Left Leg:**

1. The left hip was situated above the level of the acetabulum $\frac{1}{2}$ in. below the anterior superior spine.
2. Extensor muscles were hypertrophied to overcome their antagonists.

3. Lateral position of the leg brought the medial condyle of the femur into prominence.

**Left Foot:**

In a position of equinus varus, due to peroneal paralysis, which may occur concomitantly with congenital dislocation of the hip.

**In Prone Position.**

Dislocation of the hip was corroborated. Lordosis was pronounced. Trendelenburg's sign proved dislocation of the left hip, the gluteal fold being higher on the left side.

Movements showed correction of right hip deformity; exaggeration of left.

Treatment of the left hip, 30:11:29, consisted of opening the hip-joint, approaching it by the Smith-Petersen incision.

An hour-glass constriction was present and divided. The ilio-psoas tendon and adductor muscles were tenotomised in order to allow of prolonged extension bringing the head downwards into the acetabulum, open reduction being found impossible.

Post-operative measures consisted of a Bradford frame with extension strapping and 5 lbs.
weight attached. When the head of the femur reached the level of that on the opposite side, a shelf-graft operation was performed.

Ten days later the patient was discharged in plaster, which was removed in three months.

X-ray Examination, 19:4:30, showed the left hip in good position. (Fig. 55).
ETIOLOGY.

The cause of dislocation in this case is probably morphological. Lordosis at birth in absence of trauma points to intrauterine maldevelopment of the pelvic girdle.

It also indicates a bilateral condition as opposed to unilateral, which would have been accompanied by scoliosis.
PATHOLOGY.

The head of the femur is displaced upwards and usually backwards, anterior dislocation being less common. The neck of the femur is anteverted, while both head and neck are thickened and deformed owing to the abnormal relationship of femur to acetabulum.

The ligamentum teres is frequently absent. The acetabulum is shallow and partially filled with fibro-fatty tissue. The capsule becomes stretched with weight-bearing and serves as a suspensory ligament, which becomes thickened, fibrous and adherent to the acetabular rim, an hour-glass constriction forming in the lumen of the capsule and interfering later with reduction. The structures related to the joint are shortened. These include the adductor muscles, femoral artery and sciatic nerve. As a result reduction becomes more difficult and in some cases inadvisable, especially where there is risk of narrowing the lumen of the femoral artery by a pull in the longitudinal direction.
RADIOLOGICAL EXAMINATION.

1. The femur is displaced upwards.

2. The head and neck are maldeveloped. The latter is usually anteverted, the position being accurately diagnosed by means of stereoscopic photography.

3. The epiphyseal cap is small and may be displaced outwards.

4. The acetabulum is shallow.
CLINICAL FEATURES.

In this case signs and symptoms were typical, although lordosis preceded gait and walking was not delayed. The trochanters were abnormally high, but telescoping of the hip-joint was very slight.

The clinical picture shows a prominent abdomen, which accompanies lordosis, tilting of the pelvis, broadening of the perineum and shortening of the thighs in proportion to the trunk.

Before manipulation the gluteal folds were deep; after correction of the right hip, the gluteal fold was higher on the left side - the so-called Trendelenburg sign.
ABSOLUTE DIAGNOSIS

of

Bilateral Congenital Dislocation.

1. Lordosis may or may not be evident at birth.

2. Waddling gait.

3. The perineum is broadened.

4. The trochanters are above Nelaton's line and prominent on the lateral aspect of the buttocks.

5. Abduction is limited, other movements particularly free.

6. Radiological Examination.
In the absence of actual disease of the hip-joint, differential diagnosis consists of:

1. Double coxa vara
   a) Congenital
   b) Rachitic.

2. Bilateral infantile paralysis of the gluteal muscles.

3. Congenital dislocation of the hip - in this case bilateral.

1. Double coxa vara may be a primary congenital deformity accompanying defective formation of the femur, or it may be secondary to intrauterine pressure or disease of the bone. The acquired type is usually rachitic, the softened neck of the femur yielding under the weight of the body. In later years it may be the result of osteomalacia from absorption of lime with subsequent weakening of the bone, or it may follow osteomyelitis, arthritis deformans, tuberculosis of the hip or osteochondritis deformans. It may also accompany congenital dislocation of the hip, which it resembles in signs and symptoms.
2. Bilateral infantile paralysis of the gluteal muscles would indicate paralysis of the superior and inferior gluteal nerves, arising from the fourth and fifth lumbar and first sacral branches of the sacral plexus. The signs would, however, be localised. The inclination of the pelvis would be normal and there would be no disproportion on the anterior and lateral aspects of the body.

3. Bilateral congenital dislocation of the hip. While the signs and symptoms point to such a condition, radiography proves it conclusively, at the same time eliminating a concomitant diagnosis of coxa vara. Allowing for the angle of the femur being $135^\circ$ in a child, it is in this case not less than $120^\circ$, which is considered the criterion for diagnosis of coxa vara.
Bilateral Congenital Dislocation of the Hip.

Fig. 56.

Apparatus for Control of Lordosis.

(ărst)
ORTHO PAEDIC APPARATUS.

Such appliances are essentially cumbersome, but in cases where manipulation is of no avail and operation inadvisable, mechanical aid may be required. Its purpose is:

1. To transfer the weight of the body from the hip-joint to the tuberosity of the ischium.
2. To prevent the head of the bone from sliding upwards.
3. To control the lordosis and consequent tilting of the pelvis.

In his book on Orthopaedic Apparatus, Mr. F.G. Ernest, Orthopaedic Mechanician to the Royal National Orthopaedic Hospital, gives appropriate illustrations of appliances adapted for adults and children. (Fig. 56)

For children a fulcrum is secured by a pelvic band encircling the pelvis in conjunction with blocked leather hip portions and taking its bearing on the sacrum and particularly over the heads of the great trochanters. The back lever takes its bearing at the level of the upper dorsal region.

The body belt draws the trunk backwards while
the arm pieces are fitted in excess of the distance from the heads of the great trochanters to the axillae in order to ensure a downward pressure of the bones.

Age and build of the child require to be taken into consideration, while growth interferes with the permanence of such an apparatus.
CONSIDERATIONS IN TREATMENT.

Appropriate Treatment depends upon the consideration of certain factors.

J.B. Moore, A.B., and J.O. Vaughan, A.B., Stanford University, California, place congenital dislocations in two groups:

1. True congenital dislocations - not merely a combination of shallow sockets with deformed, easily dislocated heads and necks.

2. Dislocated hips which gradually travel upwards, anteriorly or posteriorly.

THE HEAD OF THE FEMUR MAY BE:

1. on a level with, but somewhat distant from, the acetabulum.

2. on a level with the anterior inferior spine.

3. on a level with the anterior superior spine.

4. on the dorsum of the ilium above and posterior to the anterior superior spine.

ADDITIONAL FACTORS ARE:

1. Imperfect development of the head of the femur.

2. Anteversion of the neck.
3. Shallowness of the acetabulum.

4. Fibro-fatty tissue in both true and false acetabula.

5. Hour-glass constriction in the fibrous capsule.

6. Constriction of the adductor muscles.

7. Shortening of the femoral vessels.

8. Shortening of the sciatic nerve.

The leg and foot are not necessarily affected by congenital dislocation of the hip beyond their reaction to malposition. In this case equinus varus in the left leg would point to a paralytic condition of the peroneal branch of the sciatic nerve, possibly due to pressure or stretching of the highly placed left hip.
Fig. 5-7
Method of Treatment for
Congenital Dislocation of the Hips.
(under 12 months)
Prof. Puzzi, Bologna.

Fig. 5-8
Wedge-shaped Cushion
for the Treatment
of Out-patients.
Prof. Puzzi, Bologna.
Reduction may be carried out by

A. Manipulation.

B. Operation.

A. Manipulation.

The Optimum Age is considered to be about two years, by which time the bones have become firmer and the child has acquired physiological control. Professor Putti of Bologna, however, urges the lowering of the age limit. In a contribution to the Journal of Bone and Joint Surgery, October 1921, he refers to geographical distribution of congenital defects and adds that in certain areas training is given in the early recognition of diagnostic signs, hence children are brought for treatment as soon as abnormal contour is observed by the mother.

Professor Putti's method in hospital is to place the child on an apparatus which can be adapted to the angle desired for hip correction. In the case of out-patients the child's legs are fitted on to a wedge-shaped cushion covered with waterproof cloth, abduction being increased by
The underlying principle is to compel the head of the femur to exert pressure on the acetabulum for several months in order to direct the normal plastic forces at work.

Removal of the cushion for graduated abduction and rotation is simple, and the habit in Italy of carrying infants on a pillow or slinging them to the roof of peasant huts, out of the reach of snakes, makes the method easy and acceptable to the mother. The treatment lasts from eight to twelve months, terminating when clinical and X-ray examination show reduction completed and reconstruction of the joint well advanced. Arguments in favour of such early treatment are:

1. The frequency of subluxation rather than dislocation.
2. The avoidance of anaesthesia.
3. The absence of manipulation with risk of trauma leading to osteochondritis.
4. Economy, private and public.

Spontaneous recovery is possible in some cases.

Professor H.C. Slomann, Copenhagen, differentiates between subluxation and complete dislocation, preferring to keep patients under observation in the hope that the acetabulum will deepen.
RELAPSE is most frequently due to torsion of the upper end of the femur, which fails to attain stability against the ilium. In order to estimate the amount of anterior distortion, Dr. Arthur Krida, New York, takes two X-ray exposures:

1. with the patella in the sagittal plane.
2. with the limb rotated inwards in order to show more head and neck.

REDISLOCATION is stereoscopically proved to be usually antero-lateral.

Dr. Krida's method of correction is:

1. To stretch the adductors and bring the head of the femur over the posterior rim of the acetabulum.
2. Two weeks later to place the femur in its definite position and fix the limb in internal rotation.
3. If distorted anteriorly, to correct internal rotation three months after the beginning of treatment, fracture the supracondylar region and rotate the lower fragment outwardly till the patella is in the sagittal plane. Fixture in moderate abduction, slight flexion of the hip and moderate flexion of the knee retains the fragments in position till ambulatory treatment is permitted six weeks
later. If the condition be bilateral, the patient lies in a plaster bed.

METHODS OF REDUCTION

The method advocated by Sir Robert Jones consists of four stages:

1. With the pelvis and opposite thigh fixed in the supine position, the affected thigh is flexed to a right angle, rotated inwards and then abducted without loss of flexion and rotation.

2. By means of counter pressure the trochanter and head are brought forwards: the latter may audibly slip over the acetabular rim.

3. The soft tissues are then stretched to bring the knee into the same plane as the body.

4. The limb is encased in plaster in a frog position, that is, with the leg flexed to a right angle and abducted to a position where the anterior part of the knee is posterior to a plane connecting the two anterior superior spines.

In some cases instrumental traction is taken advantage of, but is only advisable in experienced hands.
Two days after reduction an X-ray is taken to verify results, the child remaining in hospital for one or two weeks.

Of the other methods employed, three may be briefly referred to:

1. Davis reduces the dislocation with the child in the prone position. Flexion of the knee, abduction of the thigh and pressure on the acetabulum constitute its main principles.

2. Putti of Bologna makes use of Codavilla's blocks on which the patient is laid in a lateral position and which have a hemispherical gap to allow upward pressure of the surgeon's thumb on the head of the femur during hyperabduction of the thigh.

3. Denucé's method is essentially gentle and consists of gradual manual stretching of the adductors during abduction of the limb; full flexion of hip and knee; pressure along the axis of the femur; gradual circumduction; extreme hyperabduction. Meanwhile the head of the femur is kept under control until it slips into the acetabulum.

A plaster spica, bivalved after six months; heat; massage; gentle exercises in a brine bath continue for another month while the child still uses the posterior half of its plaster casing.
In cases of posterior dislocation which cannot be reduced owing to excessive shortening of muscles, vessels and nerves, it is considered advisable to transform such into anterior dislocations which permit of better function.

After-treatment consists of protecting all prominences with cotton wool before applying a plaster of Paris spica to the whole leg of the corrected side and the thigh of the opposite limb. Special attention must be paid to retention of the great trochanter in its new position and to nursing requirements.

Final extension of the limb is attained by the method of Sir Robert Jones, who applies three plasters in succession. The first is kept on for three months. If the hip be found stable, the angle of flexion and abduction is lessened and the thigh rotated inwards. The second plaster is retained two months. The hip is then brought down to its final position, the total period of after-treatment covering six to nine months.

Mobilisation of the hip must on no account be forced. Stiffness may be diminished by heat and heliotherapy. Gentle, active movements are best practised in hot brine baths, after which re-education of the limb progresses till stiffness disappears.
PROGNOSIS in reduction depends largely on the age of the patient, laxity of the capsule, telescoping of the joint and shortening of muscles, vessels and nerves. Re-dislocation may occur, as in the present case, but according to Jones and Lovett, good anatomical and functional results may be obtained in 50 - 75 per cent of cases under favourable conditions.

B. Operation.

Operative treatment is advisable.

1. In the case of older children, adolescents and adults.

2. After manipulation has failed.

3. In re-dislocation due to shallowness of the acetabulum.

METHODS OF OPERATION.

In 1888 Poggi deepened the acetabulum to receive the replaced head of the femur. In 1890 Hoffa operated on the same principle, his method being to scoop out the fibro-fatty tissue from the acetabulum and remove sufficient articular cartilage and bone to receive the head of the femur. He succeeded in forming a stable joint, but on recovery there was pain on movement, stiffness of the hip, shortening of the leg and eventually proliferative arthritis.
Lorenz improved on this method, the resulting Hoffa-Lorenz operation consisting of opening the joint through an anterior incision passing along the outer border of the tensor fasciae femoris.

Obstacles to reduction were removed, the acetabulum deepened and the head of the femur guided into the acetabulum with the aid of a special retractor.

In cases where re-dislocation occurs or where the rim of the acetabulum is imperfect, Jones and Lovett recommend reconstruction of the acetabular shelf, according to Fairbank's method.

By a Smith-Petersen incision, as described in the notes of operation, dated November 30, 1929, the joint capsule is exposed, reducing the hip within the capsule without opening it, if possible. A groove along the upper and posterior border of the socket is made by turning down a flap of periosteum and attached bone which is stitched to the capsule. A bone graft taken from the iliac crest is inserted into the groove and fixed by bone pegs. If necessary, the operation may be carried out in two stages, division of capsule and shortened muscles being followed by actual reduction.

Albee's method, described in his book on Bone Graft Surgery, is somewhat different. His incision is made from the anterior superior spine of the ilium to the great trochanter, then backward one or two inches towards the ischial tuberosity.
The tip of the trochanter with its muscle attachments is turned upwards and the head of the femur manipulated. A semi-circular area is then taken from above the acetabular rim and turned downwards to deepen the acetabulum. The slackened capsule is reefed with kangaroo tendon at right angles to the long axis of the femur. A graft with triangular cross-section is taken from the tibia, three portions of it being fitted into the gutter made above the acetabulum. Bone pegs are usually driven through the graft into the pelvic bone in order to keep the graft in position. The tip of the trochanter with its muscle insertions is sutured back into its normal position and the skin closed. The limb is kept in an abducted position in plaster of Paris from thorax to toes for six weeks, followed by a shorter spica for other six weeks, when passive and active exercises are instituted.

For cases of long standing Dr. Dickson, Kansas City, Ohio, refers to still another method in an article on the Operative Treatment of Old Congenital Dislocation of the Hip.

He makes use of the false acetabulum, turning it down as a flap, with the view of retaining its modified smooth, thickened, fibrous tissue as a structure resembling the normal capsule. In this way he claims to prevent adhesions and ankylosis, 80 per cent of cases having proved satisfactory.

When manipulative reduction is impossible and
open reduction inadvisable, a Lorenz bifurcation osteotomy may substitute Kirmisson's sub-trochanteric osteotomy. In the bifurcation operation the femur is divided obliquely and the upper end of the distal fragment abducted and thrust inwards until it engages the pelvis at the level of the acetabulum. (Jones and Lovett). It compensates for shortening, but is not suitable for a child on account of interference with further growth.

Where the joint is suffering from arthritic changes causing pain, arthrodesis may be the best course to adopt.
PROGNOSIS.

In A Review of End Results of the Treatment of Congenital Dislocation of the Hip, Dr. Stephens, New York, refers to the tabulation of 240 cases, followed up during the period of 1891 - 1910. Anatomical and functional cures are estimated at "not over 15 per cent". From that Dr. Stephens argues that methods of treatment are not satisfactory in view of the fact that many people with congenital dislocation of the hip go through life untreated with comparatively little discomfort or disability.

On the other hand unstable hips with lax capsules causing bad limps are a potential source of pain and may become arthritic in later life.

Each case, as it presents itself, requires special consideration. Where possible, manipulation should be attempted first, but if it becomes obvious, as in the present instance, that re-dislocation is inevitable, the only course to adopt is open reduction with shelf-graft to keep the hip permanently in position and so stabilise the joint.
CASE II.

SEPARATION OF THE EPIPHYSIS.

MARY GILHOOLY. aet 14 years.
Admitted to Ward 8. November 18, 1929.

HISTORY.

About a fortnight before admission the patient began to have an occasional gnawing pain like toothache in her left hip. A week later her parents noticed that she limped on walking and three days before admission the pain in the hip became much more acute, shooting down the inner side of the thigh to the knee. The patient was unable to walk about, the pain being exaggerated by making the least movement at the hip. Rest relieved the pain, but while trying to fall asleep one night she was disturbed by sharp twinges in the joint.

There was no local swelling over the painful area and apart from the pain the patient felt quite well. She was not flushed and had no systemic disturbance. The bowels had been regular. There were no urinary symptoms. The patient had always enjoyed good health.

There is no history of accident to the hip, and no history of tuberculosis in the family.

On further inquiry, the mother wrote that the local doctor attributed the condition to trauma at birth, one leg having been pulled, presumably in a breech case.

The child began to walk at the age of one year and ten months.

PHYSICAL EXAMINATIONS:

The patient was a healthy, well-developed young girl, but seemed to be suffering from severe pain.
Fig. 59.

Separation of the Epiphysis.
Before Reduction
undated.

Mary Gilhooley - act. 14 years
SEPARATION OF THE EPIPHYSES.

(Fig. 59)

BEFORE REDUCTION.

1. Head of the left femur displaced downwards in the acetabulum.
2. Shenton's line interrupted accordingly.
4. Neck of the femur foreshortened owing to rotation.
5. Lesser trochanter prominent.
6. Interval between great trochanter and brim of acetabulum diminished.
7. Interval between great trochanter and pelvis also diminished.
LOCAL EXAMINATION:-

Left hip-joint. The left leg, as the patient lay in bed, assumed a position of slight abduction, slight flexion and marked external rotation, suggesting almost a fracture of the neck of the femur. The leg on measurement proved to be 1/2 in. shorter than the right.

On inspection the trochanter was found to be at a higher level than that on the right side.

No abdominal fullness could be detected in the region of the joint.

Any attempted movement of the joint was extremely painful and was resisted by firm spasm of the muscles around the hip-joint.

There was marked diminution in abduction and flexion. Hyper-extension was also considerably limited. No abscess formation could be detected and there was no great tenderness in any region of the joint - over the upper end of the femur or over the great trochanter.

CIRCULATORY and other Systems: Nil to note.

DIAGNOSIS: Slipped epiphysis of femur, left.

RADIOLOGICAL EXAMINATION: Undated, (FIG. 59).

Operation: 23:11:29. Mr. Mercer. (Chlor. and ether)

The knee on the left side was flexed to almost a right angle. Thereafter the thigh was slowly abducted and hyperextended at the hip-joint. After a fair degree of abduction had been obtained, the femur was strongly internally rotated at the hip-joint. In this position - which approximated to the Royal-Whitman position for fracture of the neck of the femur - the limb was encased in plaster from the pelvis to half-way down the thigh on the affected side.

"Reduction of slipped epiphysis with application of plaster".
Fig. 60

Separation of the Epiphysis.
After Reduction
25-11-29

Mary Gilhooly - act. 14 years
SEPARATION OF THE EPIPHYSIS

(FIG. 60)

B. AFTER REDUCTION.

Epiphysis in its normal position in the acetabulum.

Neck of the femur apposed to the epiphysis in the position of abduction.

Shenton's line re-constituted. Stereoscopically the head may be lying a little in front of the neck.
RADIOLOGICAL EXAMINATION: - 25:11:29. (FIG. 60)

The epiphysis was found to be in good position.

Discharged: -

5:12:29, in a comfortably-fitting plaster. Asked to report in three weeks for further examination.

7:5:30 - The case sheet was not available. On inquiry the mother stated that the patient was using a splint. The leg was somewhat stiff but was being treated by massage.
The condition apparently dates back to trauma at birth. The child began to walk at the age of one year and ten months. Nothing untoward occurred until the age of fourteen, when the patient felt a gnawing pain in the hip. A week later she was observed to limp. Referred pain occurred down the inner side of the thigh to the knee. Pain at the hip-joint was increased by movement and relieved by rest. Sharp twinges were felt during the night. No local swelling was present and the general health of the patient was good.

On examination the leg was seen to lie in a position of slight abduction, slight flexion, and marked external rotation, simulating a fracture of the neck of the femur.

The left leg was $\frac{3}{4}$ in. shorter than the right.

The trochanter was higher on the left side. Movement was painful and resisted by muscular spasm, but there was no sign of abscess formation.

Radiological Examination showed a slipped epiphysis. This was reduced by manipulative measures, after which a further X-ray showed the epiphysis to be in good position.

In May the patient reported that she was using a splint and being treated by massage.
ETIOLOGY.

Separation of the Epiphyses may be due to:

1. Direct violence - rare.

2. Indirect violence - usually the result of traction combined with torsion.

3. Pathological conditions, such as congenital syphilis, tuberculosis, rickets, suppuration, tumour.

4. Endocrine disturbance - a debated point.

Age Incidence:

Trauma in the region of the hip is most liable to occur during the period of greater physiological activity and muscular exertion, therefore separation of the epiphyses is most common between the ages of eleven and eighteen. After twenty-five trauma no longer produces separation of the epiphyses but dislocation, the epiphyses by that time being fused with the shaft.

In this case there is no history of disease, strain or accident immediately associated with the onset of the condition, but correspondence with the mother elicited the fact that there had been a probable injury at birth. This corroborates the statement that trauma may antedate the deformity by months or years. (Cochrane). The original
lesion had healed. Walking had been delayed but otherwise there had been no sign of weakness during childhood.

Pain before admission was probably due to increased exertation which a physiologically weakened epiphysis was not able to bear.

1. The position of slight adduction and slight flexion assumed by the patient is due to displacement and resultant fracture of the neck of the femur.

2. Shortening occurs by reason of slight displaceent of the neck of the femur. Accurate localization of the shortening may be ascertained by the relationship of the head and neck of the femur to Delbet's line and Bryant's triangle.

3. Abduction is limited because of impingement of the neck of the femur against the roof of the acetabulum.

4. Rotation is limited because the neck of the femur is partially or wholly separated from the head, which in this case had slipped downwards and no longer fitted the acetabulum.
CLINICAL FEATURES

1. The position of slight abduction and slight flexion assumed by the patient in bed is due to displacement and resembles fracture of the neck of the femur.

2. Shortening occurs by reason of upward displacement of the shaft of the femur. Accurate localisation of the shortening may be ascertained by the relationship of the head and neck of the femur to Nelaton's line and Bryant's triangle.

3. Abduction is limited because of impingement of the neck of the femur against the brim of the acetabulum.

4. Rotation is limited because the neck of the femur is partially or wholly separated from the head, which in this case had slipped downwards and no longer fitted the acetabulum.
1. With the limbs accurately placed as regards rotation, the lesser trochanter becomes more visible in proportion to the external rotation of the femur.

2. In this position the proportions of the head and neck are reversed: the former seems large, the latter appears short.

3. The head and neck form a curve with the convexity upwards.

4. The curve of the neck of the femur is not in continuity with the upper border of the acetabulum, but more or less above it.

5. The interval between the great trochanter and brim of the acetabulum is diminished.

6. The interval between the great trochanter and the pelvis is diminished.
DIAGNOSIS

Absolute diagnosis rests on the following data:

1. History of trauma or disease.

2. Clinical signs of abduction combined with flexion, shortening of the limb, and limitation of movement in the directions of abduction and flexion.

3. Radiological findings.

In the absence of a history of trauma or disease, X-ray examination is essential, as such cases are liable to be missed.
DIFFERENTIAL DIAGNOSIS.

1. Traumatic dislocation of the head of the femur.
2. Fracture of the neck of the femur.

1. **Traumatic Dislocation.** This may occur in a backward or forward direction. If the head of the femur lie on the dorsum ili or near the sciatic notch, it may be felt under the gluteus maximus; the normal depression under the great trochanter is lost; the gluteal fold is raised. If it lie in the obturator foramen, the body is slightly bent to relax the ilio-psoas muscle and ilio-femoral ligament. Extension and adduction are limited. Radiological examination shows that head and neck of femur are intact.

2. **Fracture of the neck of the femur.** The characteristic feature of this condition is eversion of the limb. There may be shortening and elevation of the great trochanter. Abduction and internal rotation are limited. Absolute diagnosis rests on Xray findings.
3. **Congenital Coxa Vara.** This becomes apparent when the child begins to walk. The clinical signs are prominence of the trochanter, increased adduction and diminished abduction. There is no history of trauma.

4. **Congenital Dislocation.** In a position of extreme flexion and adduction both head and trochanter are prominent. The deformity is usually observed when the child begins to walk.

...
TREATMENT.

A. MANIPULATIVE.

1. If the case has been diagnosed early, the deformity is corrected by putting the limb in plaster of Paris in a position of extension, internal rotation and abduction. Union should be complete by the end of three months.

2. If the case has been one of neglected strain, followed by increasing disability, the fragments have to be restored to their normal alignment by the addition of traction. Plaster is retained for three months.

B. OPERATIVE.

Approach to the hip-joint is made by a Smith-Petersen incision in order to expose the capsule. This is opened and the epiphysis replaced in correct position. After closure of the wound the limb is put in plaster and kept there for three months. After-treatment consists of the use of a caliper splint and massage.
**Prognosis.**

In an article on Slipping Femoral Epiphyses, contributed to the Journal of Bone and Joint Surgery, October 1929,

Dr. Theodore A. Willis, Cleveland, Ohio, points out that no matter how the condition is treated, whether by closed or open method, the lesion causes premature fusion of epiphyses with shaft, growth being adversely affected thereby. If untreated or inefficiently treated, the typical deformities of coxa vara develop: the acetabulum and head of the femur become flattened; the neck of the femur shortened and thickened; there is limitation of abduction and flexion. Restriction of function is in direct proportion to the amount of deformity, which in turn dependent on efficiency of treatment.
CASE III.

OSTEOCHONDRTIS DEFORMANS JUVENILIS.

MRS. JENIMA BINNIE. aet 30 years.

Admitted to W ard 6. 29th. October, 1929.

To simplify the case it is advisable to begin with the :-

PREVIOUS HISTORY :- (details given by the elder sister of the patient).

The child was normal at birth, but after what the mother considered a premature removal of the stump of the cord, it was observed that the limbs remained in a position of acute flexion. They could only be straightened after ten days had elapsed, during which period the child cried when any attempt was made to move them. Both legs were equally affected. For several months the legs were rubbed with butter or olive oil in order to soften the areas of the groin and below the knee. The child had no difficulty in learning to walk and was able to play games like other children. Her general health was excellent.

(Details given by the patient herself):-

At the age of ten she jumped from a plank 10 ft. high, having been taunted by other children with inability to do so. She fell on gravel, her leg doubled beneath her. The medial side of the leg was badly bruised, but she did not tell her mother till five days later when bathed, by which time the bruise had become yellow.

A slight limp was noticed during adolescence, but movements were not hampered in any way and no pain was associated with the condition.

FURTHER HISTORY:- (Details partly from case-sheet, partly from patient).

The patient dates her present condition from an illness in 1919, subsequent to her beginning field-work. She is unaware of any discomfort in
the hip before that period, but since then the knee has been liable to dislocation.

The sequence of events is as follows:

One day, while walking to her work, she felt a sudden, acute pain in her right hip. She fell in consequence and was carried home. Diagnosed without examination as a case of sciatica, she remained in bed for six weeks, treatment consisting of local ironing with a hot iron and brown paper. Her condition improved, but on resuming normal life, pain in the joint and stiffness increased. Gnawing pain persisted, keeping her awake at night. She could cycle without pain, but standing increased it and made her unfit for her work.

In 1920 the patient married. From 1920 - 1924 the pain became progressively worse both on standing and walking. In 1924 she complained to the doctor of dysmenorrhoea which had existed since menarché at 16 and increased since her marriage. Pain in the leg was worse when accompanied by dysmenorrhoea and very severe after it had ceased.

In 1925 the patient consulted a doctor but was not examined by him. She requested a letter of recommendation to the Medical Out-Patient Department. An X-ray was taken, the patient lying on her left side. Diagnosed as a case of osteoarthritis, she was sent to the Massage Department and received treatment for three months in the form of massage and radiant heat, but did not benefit therefrom. She requested to remain under observation and was sent to Ward 30. There she was asked to walk up and down and told that nothing further could be done.

For the next four years, that is, till 1929, pain in the leg continued. The knee, when bent, was liable to be dislocated if the patient turned quickly in bed. It could be reduced by the patient herself if no one were available to pull the leg by the ankle.

In 1929, on removal to Kirknewton, the patient was examined for a gynecological condition and admitted to Ward 36 for dilatation and curettage. While there, reference was made to pain in the leg. Mr. Cochrane examined the patient and requested that an X-ray be taken of pelvis and hips in a supine position.
Fig. 61.

Osteochondritis Deformans Juvenilis.

January 1929.

Pre-operative Condition. - Right side.

Head and neck of the femur flattened and broadened.

Areas of condensation and rarefaction.

Irregular outline of the acetabulum.

Partial dislocation - a late stage.

Elevation of Shenton's line.

Mrs. Binnie - act. 30 years.
PHYSICAL EXAMINATION AT THAT PERIOD.

(Details taken from case-sheet).

Gait:- The patient was able to walk without support though she habitually used a stick. There was no limp. Hip movements appeared normal. The right leg appeared one inch shorter. No other deformity was present.

Movements:- There was no pain on active or passive movement of the joint. (The patient attributes this to preceding rest in bed). Extension and adduction were normal. Flexion was resisted, but when resistance was overcome full flexion was possible. Abduction was practically nil and rotation impossible. Complaint was made of pain on the medial side of the right knee on movement of the right hip, but on examination no lesion in the joint was demonstrable.

RADIOLOGICAL REPORT: Jan. 1929. (FIG. 61)

The right hip showed:

a) Broadening of the head and neck of the femur.
b) Partial extension of the head with elevation of Shenton’s line.

CIRCULATORY SYSTEM:- Heart not enlarged, sounds closed.

RESPIRATORY SYSTEM:- No abnormality detected.

OPERATION:-

2:11:29. Mr. Cochrane. (Ethyl Chlor, & ether)

Incision from posterior superior spine of ilium to posterior superior angle of great trochanter and down and back to posterior inferior angle. Gluteus maximus split and retracted. Capsule exposed and opened. The head of the femur was greatly enlarged and was partially dislocated. The head of the bone had lost its glistening appearance and was greatly hypertrophied with beak-like posterior extension and marked lipping. Two loose bodies were found under the "rim" of the head. The head was trimmed down, more completely dislocated and pared down to a peg shape. A third loose body, the size of a hazel nut was removed.
Fig. 62.

Osteoehondritis Deformans Juvenilis.
December 1929.
Post-operative Condition. - Right side.

Head of the femur pared down to a peg-shape, lying in the upper half of the acetabulum. Elevation of Shenton's Line.

Mrs. Binnie - act. 30 years.
The head was returned to the acetabulum, the joint capsule closed and obturator internus tendon sutured.

Muscles were replaced and fascia sutured. The skin was closed with a drain.

**SUMMARY:** Arthroplasty for Perthes' Disease.
Loose bodies. Bone trimmed away - sent for culture and section.

**BACTERIOLOGICAL REPORT:** No organisms present.

**PROGRESS:**

The patient had a great deal of post-operative pain - comparatively little in the hip but acutely felt below the knee. The simple extension strapping was cut away from the region of the head of the fibula in case pressure on the peroneal nerve was the cause of pain. Removal of possible pressure, however, gave no relief from pain, hence the nerve was not involved. On the fifteenth day after operation the weights were all removed, whereupon the pain lessened, 27/11/29. The patient was discharged with instructions to rest at home and report in four weeks' time.

In the end of December she reported and conditions were found satisfactory.

20:12:29. A further Xray was taken. (Fig. 62).

In the second week of February the patient reported again, was examined, the knee being rolled outwards with the hip firmly held meanwhile, and the result pronounced satisfactory.
COMMENTARY
on
OSTEOCHONDRTIS DEFORMANS JUVENILIS.

1. Synonyms.
2. Clinical Summary of the Case.
3. Etiology.
4. Pathology.
5. Radiological Examination.
7. Absolute Diagnosis.
8. Differential Diagnosis.
9. Treatment.
SYNONYMS.

1. Legg's Disease.
2. Perthes' Disease.
3. Calvé's Disease.
4. Pseudacoxalgia.
5. Coxa Plan a.
6. Osteochondritis Deformans Juvenilis.

First described by Legg in 1910 and based on radiological examination, the terminology of the disease rests on:

1. Its association with the names of its investigators.
2. Its resemblance in adults to true coxalgia.
3. Its radiological appearance.
4. Its pathological significance related to age incidence.
CLINICAL SUMMARY.

Shortly after birth the child's limbs remained in an attitude of acute flexion which passed in ten days. The mother attributed this to premature removal of the cord; but radiological examination, (Fig. 6) of the pre-operative condition suggests the possibility of a bilateral congenital abnormality, associated later with maldevelopment of the epiphyses. The patient is unaware of any defect in the left hip, yet the pre-operative X-ray shows somewhat similar malformation on both sides.

Walking was not delayed; normal exercise was not interfered with, till in a spirit of emulation the girl, at the age of 10, jumped from a height of 10 ft. and injured her right hip. It remains open to question whether this fall be the origin of the present condition or an incident occurring subsequently to a congenital defect.

At the age of twenty, the patient began field-work. The stooping involved had aggravated the original condition. With sudden acute pain and inability to stand, the present illness began. Inadequate treatment was followed by increasing pain and stiffness, associated with weight-bearing and related to gynecological abnormality.
In 1925, that is, six years later, the hip was examined radiologically and the condition diagnosed as osteo-arthritis. No benefit was derived from massage and radiant heat. Other four years passed with increasing pain, also liability to dislocation of the knee, which could be reduced by the patient herself if assistance were not available.

On re-admission to the gynecological ward, complaint was again made of pain in the hip. Physical examination revealed no abnormality beyond shortening and a disinclination to walk without support.

Radiological Examination, January 1929, (Fig. 61) proved that it was a case of Osteochondritis Deformans, occurring at the age of ten, but not then diagnosed.

Operative Treatment consisted of an arthroplasty of the hip with removal of three loose bodies.

Bacteriological findings were in the negative.

Further Radiological Examination, 20:12:29, (Fig. 62), followed by clinical examination six weeks later, proved the result to be satisfactory. With renewed stability of the hip-joint there was no longer any tendency to dislocation of the knee.
ETIOLOGY.

Various theories are held with regard to the origin of Osteochondritis Deformans Juvenilis. These may be summarised as follows:--

1. **Trauma** - Legg in 1910 propounded the theory that injury disturbs the balance in the circulation between the epiphysis and femoral neck. Diminished blood supply in the former leads to compensatory hyperaemia in the latter: as a result the epiphysis atrophies while the neck hypertrophies. (Jones and Lovett).

2. **Inflammation or infection** - This view is supported by Perthes, Pphemister, Kidner and Platt, and is based on histological and bacteriological examination of the area involved; but it is possible that a distinction should be made between subacute infective epiphysitis and non-infective coxa plana.


4. **Congenital ischium varum with flattened socket**, leading to disproportion between the curve of the acetabulum and that of the femoral head. - This, according to Murk Jansen, predisposes to coxa plana.
In the present case it may be considered that two factors are involved, namely, congenital malformation and trauma. Umbilical hernia might have led the child to flex the limbs, but that does not account for actual stiffness in the region of the groin and below the knees. Acute flexion with pain on movement and apparent muscular spasm for approximately ten days suggests some inherent defect in the hip-joint.

Such an opinion is favoured by X-ray examination, which gives the opportunity of studying in this case both the treated and the untreated hip-joints. There is no clinical evidence of abnormality on the left side, yet radiologically the left hip is not normal in shape. Comparison with the preceding case of slipped epiphysis is suggestive, taking the left hip as standard, there being no proliferative changes to obscure the issue.

**Slipped Epiphysis.**

The acetabular curve is hemispherical and equal in both hips.

**Osteochondritis Deformans.**

The acetabular curve is elliptical, irregular and unequal.
Slipped Epiphysis.

The slipped epiphysis is hemispherical: its junction with the metaphysis neatly concave; its relation to the acetabulum proportionally distant.

Osteochondritis Deformans.

The epiphysis is elliptical; its junction with the metaphysis not clearly defined; its relation to the acetabulum disproportionately narrow above and wide below.

Further comparison of the left hip with the right, in the case of osteochondritis deformans juvenilis, suggests that proliferation of bone on the right side is superadded to a condition originally similar on both sides. One may therefore infer that this case is possibly an example of:

1. Congenital malformation of the acetabulum along with or preceding a compensatory malformation of the head of the femur.

2. Trauma leading to proliferative changes in the head and neck of the femur.

These inferences lead to the further observation that coxa plana and osteochondritis are not necessarily one and the same disease but associated conditions; coxa plana being anatomical in origin,
osteochondritis being the expression of a reactive process to trauma or infection, or both. In this case the bacteriological report was negative, therefore one may conclude that osteochondritis was due to trauma.

The histological effects of trauma on cartilage and bone has already been referred to...

Radiological examination in this case corroborates the statement that in the event of the condition not resulting from infection, there are produced circumscribed foci, in case of the part affected, sclerosis, ossification and hypertrophication.
PATHOLOGY.

The histological effect of trauma on cartilage and bone has already been referred to.

Radiological examination in this case corroborates the statement made that in the event of the condition not returning to normal, there are produced chronic induration, increase in size of the part affected, sclerosis, calcification and ossification.
RADIOLOGICAL EXAMINATION.

Radiologically the disease may be divided into definite periods:

A. Destruction with fragmentation.

1. During the first six months the epiphyseal nucleus is shrunken, more opaque and dense. The acetabulum and neck of the femur are meanwhile unchanged.

2. During the next two years fragmentation occurs. The nucleus is broken up into three or more pieces. The roof of the acetabulum becomes oblique and the neck of the femur is thickened by reason of deposition of bone in its under surface. Its angle remains unaltered. (Cochrane).

B. Recalcification and Regeneration.

3. During the next two to five years regeneration takes place. The head becomes enlarged and flattened; the neck is broadened and shows areas of condensation and rarefaction in the subepiphyseal region. The acetabulum alters in conformity with the femur. (Jones and Lovett).
CLINICAL FEATURES.

Osteochondritis deformans juvenilis is characterised clinically by slight lameness with limitation in rotation and abduction caused by reflex muscular spasm. Muscles may be somewhat atrophied but there is little pain. The disease creates little disability but is apt to become serious when the hip is subjected to prolonged strain. In this case field-work, involving much stooping, irritated the joint unduly, while inadequate treatment increased the pain and stiffness. The fact that the patient could cycle but not walk, shows that weight-bearing is an important element in the condition.
ABSOLUTE DIAGNOSIS.

1. Disability of the hip is slight.

2. Limitation of movement exists in abduction and rotation, but not to a great extent.

3. No gross deformity is present.

4. There are no constitutional signs, such as rise of temperature or malaise.

5. Xray findings are characteristic of coxa plana.
DIFFERENTIAL DIAGNOSIS.

1. Acute epiphysitis.
2. Rheumatoid arthritis.
3. Gonorrhoeal arthritis.
4. Tuberculous arthritis.
5. Osteo-arthritis.
6. Congenital syphilis affecting one joint only.
7. Charcot's Joint.
8. Osteochondritis followed by osteoarthritis.

1. Acute Epiphysitis:- The condition is caused by the lodgment of organisms at the epiphyseal line or in the osseus centre of the epiphysis. It therefore shows in a radiogram isolated foci and later new bone formation. It may occur in the early stage of osteochondritis deformans, but in that case is associated with an infective condition accompanied by constitutional disturbance.

2. Rheumatoid Arthritis:- This is characterised by local pain, swelling, impairment of function tending to ankylosis and muscular spasm. Radiological examination shows little change in the joint-cavity during the early stage and there is no bony overgrowth.
3. **Gonorrhoeal Arthritis:**— Proliferative in type; bacteriological examination of the genito-urinary tract is conclusive. Investigation of the case under consideration excludes the likelihood of gonorrhoea.

4. **Tuberculous Arthritis:**— There are usually present in this condition pain, swelling, muscular spasm, deformity of the limb and elevation of temperature. Clinical evidence is against tuberculosis in the present instance.

5. **Osteoarthritis:**— Malposition with muscular spasm, adduction and flexion leading to practical shortening and lameness are the characteristic clinical features. Radiograms show proliferation of the acetabular rim, osteophytes round the neck of the femur, and a head broadened at its lower border. The disease is associated with middle life.

6. **Congenital Syphilis:**— The monoarticular type occurring after trauma has been proved to exist in cases diagnosed as Perthes' Disease. In the present instance there is no suggestion of either congenital or acquired syphilis in the history of the patient, and there were no stigmata of syphilis in eyes, teeth, throat or reflexes. Further examination was not possible or deemed necessary.
7. Charcot's Joint:— The characteristic features are swelling and excessive mobility concomitant with an organic nerve lesion. None of these features were present in the case under review.

8. Osteochondritis deformans juvenilis, occurring in youth, may lead to the development of osteoarthritic changes in adult life owing to the effects produced by a mechanically incorrect joint or sclerosis of blood vessels.
TREATMENT.

In the early stages manipulation consists of abducting the limb and rotating it internally, keeping it in a short plaster spica for six months. With a patten under the sound foot the patient can move about with crutches. Instead of the spica a Thomas' walking caliper may be used. (Cochrane).

In adult cases where hypertrophy is extreme and osteoarthritic changes have occurred owing to the irritation of the imperfect joint, operative measures in the form of arthroplasty may be adopted. The head and neck of the femur are pared down into a form which allows of replacement into the acetabular socket and loose bodies are removed.

When walking is again permitted, training should be given to ensure correct posture, as the use of a single stick is injurious when care is not exercised to maintain proper balance.
PROGNOSIS.

In untreated cases, not subjected to strain, the limp and limitation in movement disappear during the natural process of regeneration.

Where osteoarthritic changes have occurred, the prognosis is not so good owing to functional impairment. In the case under consideration, walking is as yet difficult and exhausting, while pain and swelling recur with fatigue. A part of the patient's disability should pass in time and with practice of correct movement, but gynecological conditions are possibly responsible for referred pain in the hip.
CASE IV.

ACUTE ANTERIOR POLIOMYELITIS
with subsequent
PARALYTIC DISLOCATION OF THE RIGHT HIP.

CISSIE GILCHRIST aet 15 years.

Admitted to Ward 8. 8th June 1929.

(Details obtained from the mother):-

HISTORY:-

With the exception of chronic constipation, the patient was in good health up to the age of eighteen months when her right lower incisor tooth began to trouble her.

At the same time constipation became intractable, terminating in a week of obstruction, during which, the mother states, she progressively stiffened until she was compelled to lie on her side with head retracted and elbows tightly flexed. On placing her on a table the doctor found her in a condition of opisthotonos and accordingly sent her to the Sick Children's Hospital. Diagnosed as meningitis, she was not expected to recover.

On studying the chart when visiting her, the mother observed that progress was coincident with the return of normal intestinal activity. In a week's time the child returned home in a condition of complete flaccid paralysis. The incisor was found to have erupted meanwhile.

Constipation became as pronounced as before, until the mother gave her three tablespoonfuls of Syrup of Figs in one day. With the resultant elimination progress continued, but the tendency towards constipation remains, being only relieved by cascara.
A week after returning home the child began to sit up. Later she was able to kneel, but when placed on her feet she found she could not stand on her right leg. The toes of the right leg also drooped.

When two years of age, the patient was taken to Professor Bramwell who ordered massage without electricity. Treatment was carried out for three months, ceasing when the mother became unable to take her daily to the Infirmary. The mother says she massaged her for an indefinite period herself, but on seeing another little girl with a splint, she took her child to the Sick Childrens' Hospital for further examination. A splint was ordered, reaching to the middle of the thigh; a strap over the ankle protected the joint and the toes were held up by the boot, in order to prevent tripping. The splint enabled the child to attend school, but her leg was always cold and blue, and she suffered from chilblains on both foot and leg. The splint was renewed at intervals, but she was liable to slip when walking. At the age of twelve the patient was conscious of subluxation at the hip with clicking sounds on reduction. A visit to the Sick Childrens' Hospital resulted in the substitution of the short splint by a Thomas' walking caliper to support the hip, but as the leg became longer, the caliper adjusted itself to the femur rather than to the tuber ischii. Subluxation increased in degree and recurred frequently, being reduced by placing a hand on the hip while rotating the thigh and leg medially. When turning to the left in bed, complete dislocation took place very readily and was as easily reduced by the patient herself.

June 8, 1928. The patient at the age of fifteen was admitted to Ward 8.

PHYSICAL EXAMINATION :- at that date (according to case-sheet) was as follows :- The patient is thin and somewhat anaemic.

LOCAL EXAMINATION :- The patient is unable to move the right leg. It lies extended and slightly externally rotated with the foot extended. The muscles of the right leg show considerable wasting, particularly above the knee. No active movements are possible in the right leg. Passive movements at the knee-joint are unrestricted; dorsiflexion of the right ankle cannot be induced.

Knee jerks present on right side.
Left Leg:— Nil to note.

Circulatory and other systems:— Nil to note.

DIAGNOSIS:— Infantile Paralysis, right.

OPERATION:—


A tourniquet was applied to the right thigh. A curved incision was made on the lateral aspect of the leg behind the lateral malleolus, extending forwards to the base of the 5th metatarsal. The peroneal retinaculae were divided and the peroneal tendons exposed and divided. The capsule of the ankle-joint was then incised and the joint freely opened up by forcibly inverting the foot. The talus was then freed from its attachments and lifted out of its bed. By means of a chisel the cartilage was removed from the lower end of the tibia, the lateral aspect of the medial malleolus and the medial aspect of the lateral malleolus; from the upper surface of the calcaneus and the lateral side of the calcaneus the cartilage was also removed from the medial side of the navicular. The foot was then manipulated — it was pushed back so that the two malleoli were in contact with the navicular and the anterior part of the calcaneus. With the foot held in this position the capsule and peroneal tendons were stitched in position and the skin edges were with some difficulty brought into position with interrupted silk wound. Dressings and plaster were applied (Mr. Mercer) from above the knees to the toes.

"Whitman's Astragalectomy".


RE-ADMITTED:— 13:10:29, owing to dislocation of the hip.

OPERATION:—

19:10:29. Mr. Mercer. (Chloroform & ether)

A Smith-Petersen incision was made along the iliac crest and down the front of the thigh and the cavity between the tensor fasciae femoris and the sartorius defined. The tensor was divided from its origin at the anterior superior spine and the incision carried backwards and the gluteal muscles reflected subperiosteally from the wing of the ilium
Fig. 63.

Paralytic Dislocation of the Right Hip
subsequent to Acute Anterior Poliomyelitis.
28th Oct. 29.
Cissie Gilchrist - 60 yrs.
PARALYTIC DISLOCATION OF THE RIGHT HIP
SUBSEQUENT TO ACUTE ANTERIOR POLIOMYELITIS.

(Fig. 63)

POST-OPERATIVE.  23:10; 29.

Two bone shadows present -

a) Head of the femur opposite the upper half of
the acetabulum.

Great trochanter and part of the shaft
removed.

b) Eminence of the great trochanter rotated to
allow the sharpened end of the wedge of bone
to be inserted as a graft into the ilium.
and turned downwards to expose the upper aspect of the hip-joint and the great trochanter. The trochanter and the upper portion of the femoral shaft were cleared, an Albee's saw inserted about 1 \( \frac{1}{4} \)" down the shaft, and a graft consisting of the upper portion of the shaft of the bone and of the trochanter split upwards and left attached only by the muscles inserted into the trochanter. With the muscles as a pivot, the graft was swung round in front of the head and neck of the femur. The capsule of the joint was opened and the head and upper surface of the neck rawed and prepared as a bed for the graft. The free end of the graft was then sharpened and the graft laid in the space along the anterior superior aspect of the head and neck, the sharp end being driven into the cancellous tissue of the iliac bone forming a firm ankylosis. The limb was then slightly abducted and a plaster of Paris case applied from the pelvis to the toes of the affected limb.

"Arthrodesis of hip, right".

PROGRESS:

The patient's temperature remained rather unsettled for a few days after the operation but gradually settled down.

RADIOLOGICAL EXAMINATION:

23:10:29. (Fig. 63) Post operative result.

DISCHARGED:

28:10:29 in a comfortably fitting plaster.

REPORTED in two month's time when the stitches were removed.

REPORTED:

18:1:30. The plaster was bivalved, the posterior position being worn for another month. The patient was then advised to use her former splint along with crutches.
COMMENTARY on ACUTE ANTERIOR POLIOMYELITIS with subsequent PARALYTIC DISLOCATION OF THE RIGHT HIP.

1. Clinical Summary of the Case.
2. Definition.
3. History.
4. Etiology.
5. Virus of Infection.
8. Serum Therapy.
10. Clinical features with reference to case quoted.
11. Absolute Diagnosis.
12. Differential Diagnosis.
13. Treatment:
   a) manipulative
   b) electrical
   c) orthopaedic apparatus
   d) operative.
CLINICAL SUMMARY

The patient's clinical history dates from a period of intractable constipation at the age of eighteen months coincident with the eruption of her right lower incisor tooth. Progressive stiffening, culminating in opisthotonos, led to the diagnosis of meningitis. With the return of normal intestinal action the child recovered but remained in a state of flaccid paralysis. Further recovery was closely associated with the administration of laxative medicine.

The postures of sitting and kneeling were quickly acquired but paralysis of the flaccid, lower motor neuron type prevented standing and normal extension of the right foot. Massage was succeeded by a splint with strap to prevent "dropped foot". Circulation was poor. Liability to fall was succeeded by partial dislocation, demanding a Thomas' Hip Splint which with growth failed to adjust itself to the tuber ischii.

Subluxation developed into frequent dislocation, reduction being carried out with ease by the patient.

On admission to the Infirmary the leg was in
a position of extension with partial external rotation, the thigh muscles wasted, active movements absent, passive knee movements unrestricted, ankle dorsiflexion non-existent. Absence of exaggerated knee jerks and ankle clonus excluded a spastic degree of paralysis.

In June 1928 Whitman's Astraectomy was performed on the right foot.

Within ten months the patient complained of frequent dislocation of the hip, for which an arthrodesis of the right hip-joint was performed in October 1929, the leg being put in plaster.

Radiological Examination, 23:10:29 (Fig.63), showed the graft in position.

In January 1930 the plaster was bivalved, the posterior portion alone being worn for another month. Since then the patient has been using her former splint along with crutches.
DEFINITION

Acute Anterior Poliomyelitis is defined by Price as an acute, specific, infectious, febrile disease which occurs sporadically and sometimes epidemically. Associated with a micro-organism which gains entry to the body by the respiratory tract, its clinical features consist of a short incubation of 1 - 4 days, a febrile stage with nervous symptoms, and a flaccid paralysis, more or less extensive, of one or other portions of the brain or spinal cord.

The disease is variously called:

1. Anterior poliomyelencephalitis - a term of pathological significance.
2. Heine-Medin Disease - from its original investigators.
3. Infantile Paralysis - from its age incidence.
In 1840 acute anterior poliomyelitis was first described by Heine. In 1887 an epidemic occurred in Stockholm. Medin at that time observed 44 cases of poliomyelitis, hence it is also known by the name of the Heine-Medin disease. In 1899 another epidemic occurred in Sweden. This led Wickmann to study its pathology, on which the following classification is based:

4. Cerebral type or Acute encephalitis - leading to spastic monoplegia or hemiplegia.
5. Cerebellar or ataxic type.
6. Meningitic type.
7. Polyneuritic type.
8. Abortive type.

In 1907 a wide-spread epidemic took place in New York, as the result of which a Commission was appointed to investigate the disease, both clinically and experimentally.
ETIOLOGY

Anterior poliomyelitis is not influenced by heredity. It occurs equally in both sexes and chiefly in the late summer months, that is, July to October in the northern hemisphere, March and April in southern latitudes.

Age incidence:— During the first year of life partial immunity seems to be conferred by the mother, but during the second and third years the disease is more frequent. It is not associated with school epidemics, though it occurs during adolescence. Its incidence during middle age is very rare.
THE VIRUS OF INFECTION.

This has been dealt with in the section devoted to bacteriology and may here be briefly summarised.

Anterior poliomyelitis is due to a filterable virus. Films taken from a culture show "globoid organisms" 0.5 - 0.15 μ in diameter, lying in pairs, chains or small masses. Subcultures are capable of producing the disease experimentally by way of perineural lymphatics. The virus is essentially neurotropic though it may also be found in lymphoid tissue.
Both clinical and experimental evidence point to secretions of the naso-pharynx as being the chief mode of infection. This is corroborated by droplet infection, which is the chief source of spread of the disease, infectivity being greatest during the early stages. The intestinal mucous membrane of the intestine is also apt to harbour the virus, hence the need for care in dealing with excreta.

Flexner's researches in connection with transmission by flies suggest that their infectivity during 48 hours may affect food. In addition there is the possibility of flies infecting the nostrils of children by alighting there during sleep.

The question of carriers is dealt with in the Milroy Lecture on Epidemic Diseases of the Central Nervous System, delivered by Dr. Arthur Salisbury Mac Nally and contributed to the Lancet, 7:3:25. In that lecture he states that usually a carrier epidemic, largely devoid of symptoms, is in advance of and in association with a much smaller case-epidemic. He classifies carriers as follows:

1. Persons suffering from an acute typical attack of poliomyelitis.
2. Individuals having a mild or atypical form.
3. Healthy persons in close contact with the sick but who have not developed an attack.
4. Chronic carriers recovering from a present attack.
IMMUNITY.

Re-infection never occurs in man nor in a monkey experimentally infected with anterior poliomyelitis. Some power of neutralisation is developed in the serum which destroys the virus in vitro. What this property is has not yet been proved, but Boyd states that serum kept for 30 years has still retained this power.
SERUM THERAPY.

Immune serum may be used for the purposes of both diagnosis and treatment.

Except during epidemics, diagnosis of acute anterior poliomyelitis in its prodromal stage is likely to be missed. Serum from convalescents or recovered cases may not be available or may not be used in time, either as a diagnostic or prophylactic measure.

For the purposes of treatment 500 c.c. of blood are withdrawn from an adult, 200 c.c. from a child under 10. The blood is allowed to clot, the serum is separated, inactivated at 55°C for one hour, tested for sterility and put into sterile bottles. As much cerebrospinal fluid as possible is withdrawn from the patient and 10 c.c. less than that amount of serum is run in by gravity. This method avails only, however, in the febrile stage of the disease. Incidentally it may be stated that the immune body, present in the blood, does not exist in the cerebro-spinal fluid.
PATHOLOGY.

Successive stages in the development of Acute Anterior Poliomyelitis have been aptly summarised by Dr. Reynolds in the following terms:—

1. Inflammation of interstitial tissue in the grey matter of the cord.
2. Destruction of nerve elements.
3. Infiltration of small round cells into the pia mater, thence into the cerebrospinal fluid; this represents the process of lymphocytosis associated with the early stage of the disease.
4. Occurrence of small haemorrhages.
5. Infiltration of small round cells around the blood vessels - the so-called "muffing" or "cuffing" of the arteries.
6. Thrombosis leading to necrosis.
7. Presence of neurophages derived from glia elements adherent to nerve cells.
8. Necrosis.

As a result of sclerosis, the nerve supply to the injured area is more or less cut off. Definite groups of muscles are affected, such as the extensors of the foot, entailing the operation of astragalectomy. Likewise the muscles, ligaments and fascia around the hip-joint become lax, the result being a paralytic dislocation, necessitating the operation of arthrodesis in order to secure an osseous ankylosis of the hip-joint.
in Acute Anterior Poliomyelitis

with reference to the case quoted.

---

General symptoms of Anterior Poliomyelitis are those of an acute infection with abrupt onset. Feverishness, preceded sometimes by convulsions in children, malaise, headache and body pains may be accompanied by vomiting or diarrhoea. Jones and Lovett point out that numbness precedes paralysis, a fact which can only be elicited from adults. Occasionally delirium is followed by stiffness of the neck, pain and rigidity on attempting to move head or back, head retraction with Kernig's sign and incontinence. French authorities have drawn attention to the fact that the disease is frequently associated with teething. It was so in the present case but that may have been a mere coincidence.

One feature stands out in the history, that of chronic constipation. On inquiry the writer found that the whole household suffered from constipation; that the child in question disliked all laxative articles of diet; that the mother strove
to give her family the best of nourishing food, means being sufficient to do so, but was ignorant as to the items in a meal which might be suitably combined. Her methods in cooking were not such as to produce easily digested food and the younger children showed signs of nutritive disorders. Without stressing the fact unduly, it may be suggested that in presence of invading organisms, a probably over-fed child with little eliminative power was fit soil for disease to develop.

Regarded from an orthopaedic standpoint, the patient passed through the phases associated with Poliomyelitis.

1. The Acute Stage.

Tenderness due to acute haemorrhagic myelitis and meningitis lasted for one week, indicating the meningitic form of the disease.

2. The Convalescent Stage.

Rest for a second week, during which haemorrhage, oedema and perivascular infiltration were diminishing, was followed by attempts to resume normal function. Trophic disturbances revealed themselves in the child's inability to use her right leg and foot.

3. The Chronic Stage.

The condition became stationary and finally retrogressed, as splintage became inadequate. Circulation diminished. Trophic changes con-
sisted of paralysis of the extensors of the foot and paralytic dislocation of the hip-joint. The distribution of paralysis is very variable and in this case it was not possible to ascertain the groups of muscles affected, the limb being in plaster when the patient was visited.
ABSOLUTE DIAGNOSIS.

This rests on the initial symptoms of an acute infection occurring, in Northern Latitudes, between July and October and accompanied by sweating, hyperaesthesia and head retraction. Jones and Lovett recommend immediate lumbar puncture for diagnostic purposes, giving as their reasons:–

1. Protection of the family and community from further infection.
2. Isolation of the patient.
3. Immediate rest.
4. Observation of early signs of paralysis.
5. Adequate recognition of the disease.

Lumbar puncture shows definite changes in the spinal fluid. These have been already referred to in the section on pathology.

After the acute stage has passed, paralysis of the lower neuron type may develop, affecting chiefly the cervical and lumbar enlargements, also the reflex arcs.
DIFFERENTIAL DIAGNOSIS.

1. Acute Rheumatism with painful joints - In this condition both superficial and deep reflexes are active as compared with absence of reflexes in poliomyelitis.

2. Meningitis - comparative results of lumbar puncture are as follows: -

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<tr>
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<th>Meningitis</th>
<th>Poliomyelitis</th>
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<tr>
<td><strong>C.S.F.</strong></td>
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<tr>
<td>Pressure</td>
<td>Variable</td>
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<td>Fluid</td>
<td>Turbid</td>
<td>Clear</td>
</tr>
<tr>
<td>Cells</td>
<td>Polymorphs</td>
<td>At first polymorphs later lymphocytes</td>
</tr>
<tr>
<td>Organisms</td>
<td>Intracellular</td>
<td>Diplococci</td>
</tr>
<tr>
<td>Globulin</td>
<td>Increased</td>
<td>Increased</td>
</tr>
<tr>
<td>Sugar</td>
<td>Fehling - increased</td>
<td>Fehling - normal</td>
</tr>
</tbody>
</table>

Clinical signs and symptoms indicate in this case the meningitic form combined with the spinal form of poliomyelitis.

3. Acute polyneuritis - This is associated with chemical poisoning or alcohol, specific fevers and altered metabolism, therefore it occurs in older people. Its spreading nature precludes
poliomyelitis.

4. **Landry's Paralysis** - Usually afebrile, it is associated with trauma, syphilis, alcoholism, enteric and influenza, chiefly between the ages of twenty and forty-five. It sometimes occurs along with poliomyelitis, taking the form of an ascending paralysis which may terminate in paralysis of the diaphragm.

5. **Acute Myelitis**, of rapid onset, is usually preceded by an infective disease and occurs in later life. The sphincters are usually involved.

6. **Haematomyelia** produces sudden spinal paralysis with little pain.

7. The history of the case excludes nervous diseases characterised by a slow onset due to pressure or tumour formation, causing sensory loss or lack of sphincter control.
TREATMENT.

1. During the Acute phase:-

This stage terminates with the disappearance of tenderness, not before. Absolute and uninterrupted rest is essential to allow of physiological repair, therefore the child should be laid in a comfortably lined plaster of Paris shell, treatment consisting of very light diet suited to the age of the child. When tenderness diminishes, warm saline baths may be given in order to improve the nutrition of the muscles and to re-distribute the circulation. The warmth of the water also soothes existing hypersensitivity. (Gordon & Thomson).

All due support should be provided for weakened muscles and joints.

2. During Convalescence:-

Correctness of posture must be maintained throughout. When able to sit up in bed the patient should be surrounded by pillows to prevent any lateral deviation of the spine; weakened arms should be supported; legs protected by a cradle from the weight of blankets; and feet guarded from assuming a position of pes cavus, which is estimated to occur unrecognised in 30 - 40% of cases owing to the extensor digitorum longus and peronei becoming
overstretched. In the case of the lower limbs, extreme care must be exercised when movement is eventually permitted. No strain should be put upon them until the trunk is fit to take its share in correct posture, sagging of abdominal muscles tending to alter the balance of the body. Deformity in any direction leads to muscular weakness.

Manipulative Treatment:

a) In Kellgren's method of manipulative treatment, stress is laid on nerve supply to injured areas. This the writer found essential in treating paralysis during the war. In such a case as this, the injured area includes not only the limb involved but also the viscera supplied by the same nerve segment. The first step is therefore to investigate the degree of total involvement. Tenderness would probably be elicited over the right kidney and bladder, while both abdominal and spinal muscles would be weak. Initial rest necessarily includes all parts. Manipulative treatment begins in the area of comparative health, that is, the upper part of the back. Conduction of impulses along the spinal cord is instituted by very fine running vibrations. This term the writer finds to be misunderstood. It consists, not of violent mechanical vibration, but of transmission from operator to patient of vibrations, generated, it is estimated, at the rate of 7 to 12 per second. According to the fineness of touch in
the operator and the immediate need of the patient, vibrations can be graduated in quality, strength and direction. They may be fine, medium or strong; stationary, rotatory, side to side, or running in type. A few minutes of running, vibratory treatment with the mental co-operation of the patient suffices during the initial stage. This should be accompanied by head exercises. Light vibrations over the renal plexus with trunk flexion and extension may follow. Running vibrations from neck to heel are succeeded by light side to side friction over the sciatic and femoral nerves. When these are ready to function, the patient is asked to prepare for action by practising movements in thought along with, then independently of, the sound limb. The object is to secure a pathway for transmission of impulses before movement in the weakened limb is attempted. If sufficient time be allowed for this process, spontaneous movement as a rule takes place - the precursor of quiet, steady progress.

Only when massage of muscles is well advanced and resistive walking movements in bed can be accomplished, should the patient be allowed to put his, or her, foot to the ground. Seated on a chair, foot movements at right angles to, then somewhat behind, the level of the knee are trained; next - rising and sitting down with support; then,
Orthopaedic Apparatus
for Drop Foot.

(Ornat.)
when standing, transference of balance from one foot behind to the other in front; finally - complete walking. Correct posture is maintained by the patient's hands being placed on the shoulders of the assistant in front, who meanwhile walks backwards, supporting the patient's arms.

Crutch - walking is later strictly supervised.

Modifications of such a method can be made to suit individual need, but its main features are:

1. Rest afforded to weakened areas.
2. Adequate stimulation of nerve supply.
3. Path-finding on the part of the patient, combined with physical rest.
4. Graduated movement with detailed massage of muscles involved.

b) Electrical Treatment:

Where response to faradism is lost, galvanic treatment may be applied to weakened muscles in addition to heat and light massage. During recuperation faradism may again be tried in order to create stimuli at regular intervals. Electricity, however, should not be made use of in the early stage of the disease.

c) Orthopaedic Apparatus:

L. Splint for Drop Foot. (Ernst). (Fig. 64).

An appliance, consisting of a sandal sole with lateral steels reaching to a calf band, is
Fig. 66.

Modified Caliper Splint.

(Jones and Lovett.)
1. (Continued)

provided with two elastic elevators, having holes at the top in order to adjust tension. A cross piece of light steel, fixed to the anterior part of the sole plate, prevents compression of the foot.

2. **Modified Caliper Splint** for routine treatment. (Jones & Lovett) (Fig. 65).

This consists of a half-closed ring at the top, passing from an inch below the adductor origin round the back of the leg a little below the transverse fold of the buttock. The uprights, shaped to the leg, are fitted into a tube running through the heel.

3. **Apparatus for Dislocation of the Hip.** (cf. Fig. 56).

This consists of leg pieces attached to a body brace.

4. **Thomas' Caliper Splints** for both legs. These may be used along with crutches for the purpose of tripod walking in a case of almost complete paralysis of the lower limbs.

*d) Operative Treatment:*

Subluxation followed by complete dislocation of the hip, due to paralysis of the gluteus maximus, may be treated in several ways.
Fasciotomy, in cases of contracture of hip flexors, is done by incising the posterior part of the capsule of the hip-joint, making a flap of part of the capsule, drawing the lower portion through the button-hole and re-closing the capsule. (Jones and Lovett).

Transplantation of the tensor fasciae femoris from its function of abductor flexor to that of abductor extensor. This operation is described by A. Mackenzie Forbes, M.D., Montreal, in an article on the Stabilisation of Paralytic Hips, contributed to the Journal of Bone and Joint Surgery, 1928. It is carried out by transplanting the origin of the tensor fasciae femoris from its position external to the anterior superior spine to a new position near the posterior superior spine, that is, posterior to the axis of the hip-joint. The result is stability, an improvement in gait, and ability to elevate the leg in a supine position.

In the present instance Hibb's Arthrodesis Operation was performed in order to stabilise the hip by the formation of an acetabular shelf.
Large epidemics are usually characterised by serious cases, mortality being higher at the beginning than at the close of the epidemic. Individual prognosis depends mainly on the extent of involvement in limbs and trunk, respiratory paralysis and pneumonia being the principal dangers connected therewith. As regards function, recovery is less likely in cases of slow, progressive poliomyelitis and persistent tenderness. The greatest improvement is made within the first six months. This may continue for two years, but little spontaneous recovery is to be expected after that time. In absence of treatment, deformity is likely to occur, but with appropriate measures progress is possible even after a considerable lapse of time.
CASE V

TUBERCULOSIS OF THE RIGHT HIP
WITH SUBSEQUENT PATHOLOGICAL DISLOCATION.

THOMAS SEYMOUR aet 14 years.

Admitted to Ward 7, 24th November 1929.

(Details obtained by correspondence with the Mother):

FAMILY HISTORY:
Mother’s grandfather died of tuberculosis.
Mother well, but stout and subject to bronchitis.
Father healthy.
Relatives on both sides healthy.
The patient is the eldest child.
Two others alive, frequently troubled with bronchitis.
One died of capillary bronchitis.

Mother’s brother-in-law died lately of tuberculosis.
His two children have been in a sanatorium.
As playmates of the patient, they are admitted to be the direct source of infection.

PERSONAL HISTORY:
The patient was a healthy child, at birth,
weighing 10 lbs. Four months later he won the second prize in a baby show, his weight then amounting to 23 lbs. 2 ozs. During the first year he suffered very much from bronchitis. At no period had he any intestinal disorder. He began to walk at the age of fourteen months, conditions being normal till he was eighteen months old, when he was observed to fall occasionally. Treatment consisted of brine baths followed by massage with olive oil. When two years of age an abscess formed in the groin of the right leg. This was painted with iodine for three days then operated on at Dunfermline. The wound was treated for six months by the district nurse who advised taking the child back to Dunfermline. Another operation was performed, when a sequestrum was removed, the wound healing in a fortnight. The child regained his walking power to a certain extent, but always required to push a chair in front of him.

At the age of three he was sent to the Sick Children's Hospital where he remained for eight weeks, returning home with his leg in plaster. Three months later he was fitted with a Schaffer's Extension Splint which served for six months, during which period he spent nine weeks in the Glenlomond Sanatorium. He was again sent to the Sick Children's Hospital and there fitted with a Thomas' Splint, which he used along with crutches for fifteen months.

In 1924, at the age of 6, the patient complained of pain in the right hip-joint and was treated for tuberculosis of the hip by Professor Fraser at the Royal Hospital for Sick Children.

Neither full details nor radiograms are available with regard to this stage, but during a clinique reference was made to three periods of treatment:

1) Fixation of the joint in plaster of Paris in a position of abduction.
2) A later illness when the hip was fixed - with resultant persistent adduction deformity.
3) Correction of this deformity by an osteotomy performed at the Royal Hospital for Sick Children.

DETAILS FROM CASE-SHEET:

In the beginning of 1929 there was a recurrence of discharge from an old sinus over the hip-joint: this has since ceased. In November 1929 the patient reported at the Royal Infirmary because of further deformity and difficulty in walking. His general health has been good.
Pathological Dislocation of the Right Hip due to Tuberculosis.

Pre-operative Condition. 25-10-29.

Thos. Seymour, age 11 years.
PATHOLOGICAL DISLOCATION OF THE RIGHT HIP DUE TO TUBERCULOSIS.

(Fig. 66)

Pre-operative condition  25:10:29.

Lumbar lordosis.
Pelvis tilted downwards on right side.
Ilio pectineal line irregular.
Projection of bone into deeper part of pelvis.
Symphysis pubis on right side not on the same plane as that on left, the disparity being more pronounced in the negative photograph.

Acetabular margin blurred and irregular with some rarefaction above the brim. Acetabulum deepened.
Indefinite mottled shadow replacing the inter-articular space.

Rarefaction and erosion of head and neck of femur with disappearance of great trochanter.

Shenton's line absent.

Large sclerosed sequestrum with irregular outline underlying joint cartilage.
PHYSICAL EXAMINATION: -

The patient looked healthy and well nourished. No obvious stigmata of tuberculosis were present. He lay in bed without apparent deformity owing to the extreme tilting of the pelvis and lordosis assumed to overcome the error.

LOCAL EXAMINATION: -

There was found to be 2 ins. of shortening in the right leg. The right hip-joint was held in a position of abduction to half a right angle and of flexion to about 30°. There was a sound, bony ankylosis and no movement was elicited at the hip-joint.

Neither swelling of the synovial membrane nor muscular spasm was present. The old sinus wound was completely healed.

No reference is made in the case-sheet to cervical, mesenteric or inguinal glands.

DIAGNOSIS: -

Tuberculosis of the right hip-joint in a position of extreme abduction and flexion deformity.

RADIOLOGICAL EXAMINATION: - 25:10:29. (Fig. 66).

OPERATION: -

5:11:29. Professor Fraser. (Chlor.& Ether)

An incision was made over the posterior aspect of the greater trochanter in the line of the fibres of the gluteus maximus. The muscle was split and the upper part of the trochanter exposed. An oblique incision was made along the trochanter, and the gluteus medius muscle along with a cartilaginous shaving was removed from the trochanter. The lower border of the pyriformis was pulled well upwards and the neck of the femur exposed. The bone was
then divided above the trochanter and the neck fractured. A subcutaneous tenotomy of the sartorius and the rectus femoris was then performed at their origin from the anterior superior spine.

The limb was adducted, and extended, and a plaster case was applied.

"Supra-trochanteric osteotomy with correction of deformity, right hip".

**DISCHARGED:**

9:11:29, in comfortably fitting plaster.

**REPORTED:**

6:5:30. The condition of the limb was satisfactory. Advised to use a caliper splint and to report in three months.
COMMENTARY
on
TUBERCULOSIS OF THE HIP-JOINT
WITH SUBSEQUENT
PATHOLOGICAL DISLOCATION.

1. Clinical Summary of the Case.

2. Etiology.
   a) Bacteriology.
   b) Age-incidence.
   c) Pre-disposing Factors.

3. Pathology.

4. Clinical Interpretation of Pathological conditions.

5. Radiological Examination.

6. Tests used in Diagnosis.

7. Absolute Diagnosis.

8. Differential Diagnosis.

9. Treatment.
   a) Systemic.
   b) Artificial Sunlight.
   c) Tuberculin.
   d) Local.
   e) Operative.

The patient weighed 10 lbs. at birth and more than doubled his weight within four months.

This can be accounted for by the fact that after weaning from the breast at the age of fourteen months, he was fed on rusks and puddings, that is, excess of carbohydrates. He suffered early from bronchitis; had no intestinal disorder; began to walk at the age of fourteen months; and at eighteen months was observed to fall occasionally.

The subsequent course of disease is as follows:

1. Abscess formation in the groin with partial recovery.

2. At the age of three, treatment for five months, presumably in plaster.

3. Schaffer's Extension Splint for six months with the treatment in Glenlomond Sanatorium.

4. Thomas' Splint with crutches for fifteen months.

5. At the age of six, plaster in abduction.

7. Osteotomy to correct adduction deformity.

8. At the age of eleven, that is, in 1929, sinus discharge, further deformity and difficulty in walking.

Physical Examination during a clinique showed that the patient lay in a position of "surgical disguise", the pelvis tilted, right leg abducted and partly flexed. There was no swelling or muscular spasm. The sinus wound was closed.

In November 5, 1929, a supra-trochanteric osteotomy was performed by Professor Fraser, the result on May 6, 1930, being satisfactory. The patient was advised to use a caliper splint and to report in three months.
ETIOLOGY.

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a) **Bacteriology** :-

In the section on bacteriology a short description has been given of the two types of tubercle bacilli associated with tuberculosis in the human being. In favour of infection by the human type in this case is the fact that tuberculosis in the great-grandfather may be responsible for a diathesis of bronchitis in the mother and four children. Contact with tuberculous cousins would suffice to develop in the patient the human type of tubercle bacilli. Against the probability of infection by the bovine type through milk is the fact that the child never suffered from any intestinal disorder.

b) **Age Incidence** :-

According to Sir Robert Philip primary tuberculous infection always occurs in childhood and at one definite point, such as the skin, mucous membrane or tonsil, and usually during a period of lowered resistance. It is not recognised at the time; there follows a latent period when no apparent pathological process is at work; finally the lymphatic system is involved.
Secondary Infection has its source frequently in a distant focus and is influenced by physiological activity, hence during the period of most active growth it occurs most frequently in the long bones, carried thither by the blood stream. Boys are more frequently affected than girls and the percentage with regard to age is approximately 80 per cent before 10 years of age; 45 per cent between 3 and 6 years of age.

c) Predisposing factors are:

1. local injury
2. heredity
3. environment
4. toxaemia from a primary focus, such as the bronchial or mesenteric glands.

1. Injury in itself does not necessarily favour tuberculous infection, but where effusion takes place, it permits the lodgment of organisms in an area of sluggish blood or lymph flow. There is no indication of trauma having occurred in the present case.

2. Heredity is a debated point. It has been asserted that tubercle bacilli have been found in the placenta, but although present in the sinuses it does not necessarily follow that infection passes from the maternal to the foetal tissues. It is
known that the villi are highly resistant and the placenta has been proved to exert a "barrier" action. Maternal blood cells do not pass into the foetal blood nor do large parasites; on the other hand diffusible toxins affect the foetus (Johnstone).

Sir Robert Philip states that infants are not born tuberculous as a rule, but there are exceptional cases of inherited tuberculosis.

Jones and Lovett, however, point out that the term heredity should be limited to its Mendelian sense of transmission of unit character through successive generations. In this sense heredity of tuberculosis is impossible. Congenital transmission, however, may occur from the moment of fetalisation to birth, in which case tuberculosis is possible, though rare. The greater risk lies in post-natal contact with a tuberculous parent or relative. In this case infection can be traced to two cousins. Although there is no evidence of tuberculosis before the hip-joint was affected, some primary focus no doubt existed, probably in the bronchial glands.

3. Environment plays an important part in the life-history of a tuberculous child. Experimentally it was proved by Dr. Trudeau, the first physician in America to carry out investigations on such lines, that of three groups of rabbits:
the first, inoculated but provided with good food and fresh air, were capable of reacting normally, forming small fibrous tubercles and showing no systemic phenomena:
the second, also inoculated, but living in cramped quarters, on reduced diet and with little fresh air, showed rapidly advancing disease, culminating in death within three months:
the third, not inoculated but in the same conditions, lost their vitality.

In this case the patient's environment was good. On physical examination there were no systemic manifestations. Tuberculosis was apparently limited to the hip-joint, the primary focus having created no generalised symptoms.

4. Toxaemia from a primary focus, such as the bronchial or mesenteric glands, is the most frequent cause of tuberculosis of bones or joints. The original site of disease may or may not have been recognised, the history may be vague, but as a rule there is some indication of infection by the respiratory or alimentary tract. Of the joints involved, the hip is the most frequently affected because of weight-bearing and liability to trauma. By reason of its anatomical structure, infection by the lymph stream is of minor importance; whereas the blood supply, already described, lends itself to the deposition of organisms in well-defined ways.
The changes produced by tuberculosis on bone and joint structures have already been referred to in the section dealing with the pathology of the hip-joint. The condition may however be briefly summarised as follows:

Tuberculosis of the hip-joint is a secondary infection arising in:

1. Babcock's triangle.
2. The upper part of the neck of the femur or
3. The acetabulum.

It may be synovial or osseous: if the former, it is usually lymph borne; if the latter, blood-borne, having its origin in bronchial or mesenteric lymph nodes. Histological proof is found in the epithelialoid cells of the tubercle with or without giant cells. By contiguity infection spreads to the synovial membrane, at which stage clinical symptoms begin to manifest themselves. Granulations spread over and under the cartilage which is gradually destroyed. The surrounding structures become swollen and the bones eroded and softened, leading to pus formation. Abscesses may occur during any period of the disease but are most often associated
with the acute stage when caseated tubercles break down and combine with the synovial fluid and serum in the joint. Occasionally a sequestrum is formed. In the present case an abscess developed at the age of two, followed shortly afterwards by a sequestrum. This was removed, but nine years later radiography showed the presence of another large, dense sequestrum, taking part in a bony ankylosis of the joint.

One point in the history requires special mention in view of the fact that the case was assigned as an example of a pathological dislocation of the hip. During the second of the three periods of treatment at the Royal Hospital for Sick Children reference is made to an illness when the hip was flexed - with resultant persistent adduction deformity. Professor Fraser, in his book on Tuberculosis of the Bones and Joints in Children, states that in the natural cure of hip-joint disease, the head of the femur may be pushed out of the acetabulum, this being a method of separating the diseased surfaces. Bradford and Lovett suggested the adoption of this as an operative procedure, the resultant adduction deformity being corrected later by an osteotomy. In the present instance pathological dislocation may have occurred spontaneously as the result of disease or it may have been an operative measure, the third period of treatment consisting of an osteotomy performed at the Royal Hospital for Sick Children.
There are three stages in tuberculosis of the joint.

1. Where the synovial membrane is affected and effusion is pronounced, the joint becomes stiff, the muscles fixed and the leg somewhat flexed. There may be pain and temperature of 104°, with severe reaction suggestive of osteomyelitis. Differential proof consists of excision of a portion of the synovial membrane or, in the case of abscess formation, inoculation of pus into the guinea-pig. Tubercle bacilli are rarely found in the pus, but its injection into the guinea-pig produces pathological proof of the disease.

2. Where the articular cartilage is involved and effusion is increased, pain becomes severe, night cries occur; the muscles become completely fixed, the leg more flexed and adducted in order to separate the opposed surfaces of bone. Measurements taken at this stage show apparent shortening.
3. Where, in addition to the other pathological features, the underlying bone is destroyed, pain lessens; the joint is completely fixed owing to both muscular and ligamentous shortening or fibrous ankylosis; adduction deformity leads to true shortening of the limb; and the patient limps with a short step to protect the injured joint, finally becoming unable to walk at all.
RADIOLOGICAL EXAMINATION.

The X-ray evidence of tuberculous degeneration of a joint occurs in a definite order.

1. The synovial membrane becomes visible because of its increased thickness.

2. The outline of the bones is less distinct and may become blurred owing to increased vascularity.

3. The articular cartilage has a nibbled appearance due to its destruction by disease from the synovial membrane.

4. The joint loses definiteness of outline; the bone may show osteoporosis owing to decalcification; there may be present a dense shadow, indicating a sequestrum.

No radiograms are available which would show the progress of the disease in the early period of this case.

Fig. 66 represents the condition after an osteotomy had been performed.
TESTS used in DIAGNOSIS.


2. Bacteriological - Tubercle bacilli may or may not be present in pus or in the wall of an abscess.

3. Histological - Tubercles may be found in tissue removed from the site of infection.

4. Inoculation - In the human type of tubercle bacilli, the guinea-pig survives, or dies within 6 - 12 weeks and shows at autopsy typical tuberculous nodules related to the lymphatic system. In the bovine type there is an acute generalised tuberculosis, death occurring within two months.

5. Von Pirquet Cutaneous Test - This consists of the application of two drops of "old" tuberculin to the scarified skin of the upper arm. If positive, inflammatory redness and swelling appear round the site of inoculation within a few hours, developing at the end of twenty-four hours into a papule with a pale centre.

6. Moro's Ointment - a percutaneous method attained by rubbing an oily preparation of "old" tuberculin on to a fleshy portion of the skin, usually that overlying the pectoralis muscle. Reddening occurs within 18-24 hours.
ABSOLUTE DIAGNOSIS

The onset of tuberculosis is as a rule insidious. Time may have elapsed since the occurrence of an injury, but both systemic and local manifestations may be present.

A. Systemic Manifestations:
   1. A toxic pink and white complexion.
   2. Impairment of digestion.
   3. Rise of temperature in the afternoon or evening.
   4. Disturbed sleep.

B. Local Manifestations:
   1. A tender, definitely outlined swelling, producing a doughy sensation on palpation, indicating a thickened, synovial membrane.
   2. Night cries due to destruction of articular cartilage, the pain produced by contact of opposing surfaces being relieved by extension of the limb.
   3. Rapid muscular atrophy due to toxaemia produced by tubercle bacilli.
These three conditions are pathognomonic of tuberculosis but there are others worthy of consideration:

4. Spasm of the psoas muscle with adduction and rotation, accompanied by tenderness and swelling of the neck of the femur. Radiography here shows alteration in the osteoid area of the neck.

5. Pain with a history of a sudden twist, indicating a slight widening in the angle of the epiphysis, which involves injury of the endothelial lining of the blood vessels and passage of infective organisms into the bone.

6. Undue early fatigue with a tendency to support one foot on the other; this may be indicative of systemic tuberculosis with local reaction.

7. Weight borne by the balls of the toes in order to allow of increased flexion at the hip and its substitution by the lumbo-sacral joint. When flexion on examination is indefinite, diminution of the gluteal fold serves as a corroborative sign.

8. Limitation of movement in all directions.

9. Abscess formation due to a mixed infection associated with a primary focus of osteomyelitis in the diaphysis.
DIFFERENTIAL DIAGNOSIS.

1. Local Injury - The immediate results of trauma as a rule pass quickly. Where blood-supply has been seriously interfered with, the epiphysis may become congested and effusion may take place into the joint cavity, but recovery is rapid and permanent. In this case the condition developed slowly, persisted and increased.

2. Inflammation of glands during the early period - Pain and swelling would have been present but the femur would not have been involved.

3. Acute Anterior Poliomyelitis - The onset of the disease is characterised by constitutional disturbance, including feverishness and vomiting. This is followed by paralysis of one or more groups of muscles. Inflammation is restricted to the nervous system, joints becoming affected secondarily to paralysis.

4. Acute arthritis or epiphysitis - This may occur in young children after an infectious disease or as the result of trauma. The history does not indicate such, nor do X-ray findings point to injury of the joint-cavity or epiphyses alone.
5. Unilateral congenital dislocation of the hip - Such a condition is characterised by scoliosis, abnormal contour of the hip, broadening of the perineum and apparent shortening of the thigh. X-ray examination is conclusive.

6. Osteochondritis deformans juvenilis (Perthes’ Disease) - The clinical features are irritation of the joint principally during weight-bearing, a minor degree of lameness, and limitation in rotation and abduction. Radiological examination is distinctive and unlike the picture presented by this case.

7. Slipped epiphysis - A history of pain, usually associated with definite trauma and unaccompanied by abscess or sequestrum formation exclude it from present consideration.

8. Syphilitic Joint Disease - This is usually bilateral and more commonly affects the knees. Mobility is characteristic in contrast with muscular spasm seen in tuberculosis.

9. Osteomyelitis - In this disease abscess and sequestrum formation are common. The condition may develop in the neck of the femur, rendering diagnosis difficult, but as a rule it begins in the diaphysis and spreads by the bloodstream to the joint-cavity. If the mixed in-
9. Infection include tubercle bacilli, it is possible for osteomyelitis in the diaphysis to be the precursor of tuberculosis in the hip-joint.

Radiological examination shows the following characteristics, - irregularity of outline, rarefaction, periosteal thickening, scattered areas of necrosis in the cortex and small sequestra surrounded by sclerosed bone.

10. Tuberculosis - The points in its favour in this case as against osteomyelitis are:-

Early bronchitis, possibly of tuberculous origin or creating a lowered resistance towards infection; later, weakness of the hip followed by abscess and sequestrum formation. At six years of age the history gives a definite diagnosis of tuberculosis, doubtless based on physical and radiological examination.

The X-ray photograph, available for reproduction, confirms the diagnosis, in that it shows rarefaction, erosion and a dense sclerosed sequestrum, capable of being incorporated into a therapeutic ankylosis for tuberculosis of the hip-joint.
TREATMENT.

This may be divided into five groups:

A. Systemic.

B. Artificial Sunlight.

C. Tuberculin.

D. Local.

E. Operative.

A. Systemic Treatment consists of the application of general principles of hygiene for tuberculous patients. These include fresh air, sunshine, good food and occupation according to physical ability and mental capacity.

In an article on the Modern Treatment of Tuberculosis of the Bones and Joints, contributed to the Journal of Bone and Joint Surgery 1924, G.R. Girdlestone, F.R.C.S. Oxford, refers to the methods of Dr. Rollier at Leysin. During active disease the latter advocates immediate, uninterrupted rest; while during the stages of healing he advises comparative immobilisation, that is, rest from pressure but not from minor movement. By such means
the blood supply to the part is improved and muscles are restored to a condition capable of stabilising and moving the affected joint. In view of the fact that a tuberculous focus is only part of a deep-seated disease, Dr. Rollier is not in favour of operations before the age of sixteen. After that age he considers arthrodesis the best course to adopt.

B. Artificial Sunlight, referred to in a lecture on surgical tuberculosis, requires careful application, as it has been found that with excess of X-rays synovial fluid is unduly increased, the ligamentum teres stretched and the central artery strangulated.

C. Tuberculin Treatment is based upon the following original observations:

a) Injection of the protoplasm of bacilli is capable of producing pathogenic effects of a toxic character. - To obtain this protoplasm an extract is made of bacilli grown on a medium of nutrient broth, the result being the toxic products of the bacilli and what emanates from them during preparation of the extract. This is represented by Koch's Old Tuberculin.

b) Injection of dead bacilli tends to produce local lesions. - To make this injection the
bacilli themselves are ground in a mortar. According to subsequent preparation the result is a fluid, e.g. Koch's New Tuberculin, or an emulsion, called Koch's bacillary emulsion.

Inoculation of tuberculin into the human body produces the following results:

1. In a healthy individual there is no reaction.
2. In a person infected by tuberculosis there is what is called a tuberculin reaction composed of:
   a) local irritation at the area of inoculation,
   b) focal reaction, due to serous exudation and increased circulation of blood at the site of disease.
   c) general reaction, that is, feverishness and malaise, the result of toxins associated with tuberculin.

The response of a tuberculous patient to such inoculation is referred to as tubercular sensitivity, while the reaction produced by repeated inoculation depends upon the so-called tolerance of the patient.

The therapeutic application of tuberculins is described by Professor Fraser under the following headings:
1) the clinical method
2) the scientific method.

The clinical method aims at producing a focal reaction while avoiding systemic disturbance. Tolerance to tuberculous poisons is shown by partial withdrawal of some of the symptoms. The scientific method is based upon the opsonic index and aims at increasing the opsonic power of the patient. This is the method most commonly employed.

Results of tuberculin treatment depend largely on the stage of the disease during which they are applied. Unnecessary during the early period, tuberculin renders most service when suppuration and sinus formation have already taken place.

D. Local Treatment :-

I. Stage of acute Symptoms.-

Simple traction in the form of extension strips, stirrup, weight and pulley provide immediate rest and relieve the symptoms of pain, muscular spasm and flexion. Where apposition of joint surfaces occurs notwithstanding, traction may be increased by raising the foot of the bed to provide counter-extension and applying a bandage round the thigh with weight attached in order to pull the neck of the femur laterally. Traction is maintained until pain and spasm have disappeared.
2. Stage of recumbency.

This is indicated in cases where the systemic condition is bad, showing a rise in afternoon temperature; also where local disease has destroyed the articular cartilage, or produced abscess formation.

The methods employed are:

(1) Plaster of Paris, extending from well above the pelvis to the ankle, sometimes including the foot. It is strengthened by strips of aluminium in front and behind the hip-joint and behind the knee-joint, being placed in position between the layers of plaster bandages. The aim of fixation is to immobilise the joints immediately above and below the one affected.

(2) The Bradford Gas Pipe Frame, made comfortable and held in position by folded sheets or a leg piece so placed as to correct any deformity present. Normally traction by weight and pulley in the line of the body is sufficient, but in cases of flexion and adduction the line of traction must be in the line of deformity, until such time as correction may be gradually attained by bringing the position back to normal. Proportionate weight in traction approximates
Fig. 61

Jones Abduction Frame.

(Jones and Lovett.)
(2) Continued -

one pound for each year of the child's life. Counter-extension may be increased by perineal straps or by raising the foot of the bed.

(3) The Thomas Hip Splint. (cf. Fig. 68).

Variations of this occur to suit differing conditions.

a) Where simple fixation is desired before adduction deformity has begun, the double Thomas abduction hip splint may be used. This provides a second stem for the sound leg and permits of extension.

b) For slight adduction and flexion Jones' modification of the Thomas' double splint is used. This is also known as Jones' abduction frame. (Fig. 67).

c) In cases of gross deformity, the patient is anaesthetised, the deformity corrected as much as possible, and the limbs placed on an abduction frame with fixed extension.

Recumbent treatment lasts approximately twelve months and should be combined, if possible, with outdoor life.
Fig. 69.

The Thomas Hip Splint.

(Jones and Lowett)
3. Stage of Convalescence.

Ambulatory treatment demands fixation, traction and protection from weight-bearing. (Jones & Lovett). These are attained by the following types of splints:

1. **The long plaster spica**, extending from the inferior angle of the scapula to just above the malleoli, with the limb in a position of slight abduction. In children hip fixation is secured by continuance of the plaster on the sound side almost down to the knee. (Fig. 68)

2. **The Thomas Hip Splint**, extending from the inferior angle of the scapula to the junction of the middle and lower thirds of the leg and consisting of an upright stem with chest, thigh and calf bands. Two bends in the upright stem occur, one opposite the buttock, the other just above the joint, so that the leg and body portions are on parallel planes. This splint is used in conjunction with a patten attached to the boot of the sound foot, sufficiently high to prevent the toes of the diseased limb from touching the ground. Axillary crutches permit of locomotion.
Fig. 69

Bradford Hip Splint.

(Jones and Lovett)
The Bradford Hip Splint, combining fixation with traction in order to overcome muscular spasm. (Fig. 69).

The apparatus consists of two steel rods, longer than the limb, having at the lower end a flat steel bar, provided with a windlass to which adhesive strapping is attached, and an open ring on the upper side. In appearance it resembles a Thomas' Knee Splint, but abduction of the hip is ensured by a perineal band passing over the symphysis pubis and under the perineum of the sound side, of a length and form which will not interfere with the sitting position.

Return to normal conditions is a very slow process requiring skilled judgment as regards modification of treatment. The general health of the patient must be considered in addition to local freedom from pain, tenderness or muscular spasm.

Fixation in a splint may be replaced by plaster of Paris reaching below the knee; this allows movement in bed. An ambulatory splint may be removed for one hour daily, until the joint proves sufficiently healthy to allow the splint to be replaced by a firm, spica bandage. Any weakness in the joint demands prompt attention and a return to protective measures. Where traction has been employed a
perineal crutch, a Thomas caliper knee splint, or a Bradford hip splint with its ends turned inwards, may be used to protect the foot from weight-bearing, this method lasting for one or two years.

E. Operative Treatment.

Albee's Method of Arthrodesis for long-standing adult cases of tuberculosis is by an anterior incision extending 5 ins. downward from the anterior superior spine. The sartorius is retracted outwards, the iliacus and rectus femoris inwards. The capsule is opened and one-third of the upper hemisphere of the head of the femur is removed with osteotome or chisel. The acetabular roof is transformed into a shelf for approximation of the modified femoral head, the thigh being in a position of abduction. The capsule and soft tissues are then sutured.

Albee's Sub-trochanteric Osteotomy is performed in cases of gross deformity with bony ankylosis in a position of extreme adduction. It consists of a wedge of bone being removed from below the trochanter in order to restore parallelism to the limbs.

In this case Professor Fraser performed a supra-trochanteric osteotomy with the same end in view.
PROGNOSIS.

This may be considered in relation to both systemic and local conditions. Where there are scattered foci of tuberculous infection, associated with constitutional disturbance such as high temperature and night sweating, the prognosis is poor. It is likewise poor in cases where abscesses have burrowed into soft tissues, exposing a large area to septic infection. Systemic conditions affect the life of the individual independently of local function, hence the need to take both into account in the consideration of treatment. Prognosis at any stage depends on arrest of disease in its various aspects and is influenced by the condition in which the patient is presented for treatment. Function is dependent on the amount of articular damage and on the degree of ankylosis present. Where the early stage of cure by rest and splintage is past, ankylosis in the optimum position must be the aim of treatment. This is attained by flexion of 200 - 300° with neither abduction, adduction nor external or internal rotation. (Jones and Lovett).
The prognosis in the present case is good, so far as the joint itself is concerned, but at eleven years of age the factor of growth has still to be taken into account. The right leg will necessarily be shorter than the left and will require special consideration through the period of adolescence. When maturity is established, the comparative length of the leg will determine the permanent measures required. Systemic tuberculosis may or may not develop, but the choice of occupation will be restricted.
CASE VI.

SUBACUTE INFECTIVE ARTHRITIS.

MRS. CLARK.  act 35 years.

Admitted to Ward 8; November 12, 1929.

HISTORY:-

In view of the sequence of events in a prolonged case, the history is treated in sections, the details of which were given principally by the patient herself.

1. PREVIOUS HISTORY :-

Measles in childhood.

Pleurisy at 18 years of age.

Influenza when in W.A.A.C., February 1917, as munition worker.

No tuberculosis in family.

Children have had measles, whooping cough, chickenpox, mumps, sore throats; two eldest tonsils removed.

2. GYNECOLOGICAL HISTORY :-

Menarché at 14.


Character of labours :-


29:5:23. 2nd. 11½
277


After a fright due to a chimney going on fire when eight weeks pregnant, the patient was sick for ten days. Five and a half months later she woke with a dark discharge. The doctor sent her to Dunfermline where she was treated by:

1. Quinine till deaf
2. Packing - unsuccessful.
3. Injections of quinine in the hips during a period of 30 hours, after which the child was born, surviving 12 hours.

The mother recovered and went home on the tenth day.

9:7:28 Twins born after treatment in the Royal Maternity Hospital for albuminuria, the patient having been sent in ten days before labour occurred. First twin-breech case.

During 1928 the patient suffered from rheumatism in ankles and wrists, not knees or hips. In October 1928 the patient again became pregnant. Five months later she suffered from localised, dragging, down-bearing pains. Her legs and face were swollen. A specimen of urine was sent to the doctor but she was not visited by him. On July 13th, 1929, as the result of a fall forwards, she felt pain shooting through to the back. Next morning she woke with a choking sensation, feeling as if something had risen into her throat. The doctor had found nothing abnormal in the previous specimen of urine but now observed signs of kidney disease in her puffy eyes and swollen feet. With treatment the swelling passed from the face, but a week after the accident there was a copious, clear, white, stringy discharge which became tinged with red on July 29th. At 10 a.m. she sent for a nurse. At 11:25 a.m. the doctor made a vaginal examination and found the os four fingers dilated. Shortly after mid-day chloroform was administered. On regaining consciousness she was informed that delivery was not possible. She asked to be sent to the
Simpson Memorial Hospital, Edinburgh, in preference to Dunfermline. By request the doctor came across from Fife the same evening. The patient was informed that an operation might be necessary. At 7 p.m., next day, she was delivered instrumentally.

The patient learned that at each birth the coccyx had given trouble.

ADDITIONAL DETAILS - relative to the patient's condition, culled from her case-sheet, Simpson Memorial Hospital, (By favour of Professor Johnstone).

HISTORY OF PRESENT PREGNANCY:--

Oedema of legs during last three months, of face and hands in the early morning. Some visual disturbances and frontal headache. No sickness.

PELVIC MEASUREMENTS:--

Intraspinous 10½ ins.
Intracristal 11+
Os half dilated, membranes ruptured.
Laceration of anterior lip.

FROM LABOUR RECORD :--

General condition toxic. T 99 P 112 R 24

In the third stage haemorrhage from the placental site.

Placenta adherent for 40 minutes in spite of repeated Crede manoeuvres. Manually removed.

One hour after labour T 97 P 120 R 24

Height of fundus above pubes 7 ins.
Total duration of labour 37 hours.

Treatment - Aseptic ergot. 1cc.

Pit. ¼cc. Intrauterine douche.

I.V. Antistreptococcal Serum 25 c.c.
I.M. " " 50 c.c.
Patient transferred to isolation ward.

31:7:29. Temp. 100.4. Fell at 10 p.m. to 98.2.
I.M. Antistreptococcal Serum 50 c.c.

2:8:29. Temp. 101.2 at 6 p.m., fell to 100.4, pulse rapid, lochia pink but not purulent. Quinine I.M. 5 grs.

3:8:29. Temp. 100.4 at 6 a.m. Lochia very purulent.

Patient sent to Fever Hospital.

Details obtained in December 1929 from the patient during an interview kindly granted by Dr. Benson, City Hospital.

The patient stated that she remained feverish for two or three weeks after admission to the City Hospital. She was not aware of any pain while in the Simpson Memorial Hospital, but on the first night spent in the City Hospital she was given an injection in the left hip. Next morning her legs were painful on abduction for the vaginal administration of glycerine. Shortly afterwards she was treated for a greenish discharge. Pain and weakness were experienced on raising herself while holding on to the bars at the back of the bed; she could lift the right hip off the bed but not the left. This she attributed to the strain of a nerve or muscle in the buttock. She states definitely that the pain was not in the line of the nates, nor on the lateral aspect of the hip-joint, but between the two.

In the beginning of September pain was felt on both sides, but particularly in the left. She was wakened by a tearing sensation in the left thigh, followed by a steady pain reaching the big toe. On moving the joint pain was felt in the back of the thigh. The knee inclined medially and was put in a box splint.

On September 20th., 1929, the left hip was X-rayed. The radiogram showed no evidence of any bony lesion.

Dr. Benson examined the patient's back and found nothing to explain the condition.
Fig. 70.

Subacute Infective Arthritis.
A month later Professor Johnstone visited the patient in the City Hospital and arranged for her transference to Ward 35, Royal Infirmary. Gynecological examination revealed nothing abnormal.

Intense pain continued in the top and back of the left thigh, shooting down to the knee and sometimes as far as the big toe. Movement of the joint caused pain and the patient wakened frequently with a start.

Mr. Mercer examined the patient and arranged for her transference to Ward 8.

**PHYSICAL EXAMINATION** :- (from case-sheet)

The patient lies with her knees supported on a pillow so that the thighs are somewhat flexed, which flexion gives relief. There is some swelling over the lateral aspect of the hip-joint accentuated by marked wasting of the muscles of the thigh.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Left.</th>
<th>Right.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 handbreadth above knee</td>
<td>12 ins.</td>
<td>13 ins.</td>
</tr>
<tr>
<td>8 ins. above top of patella.</td>
<td>18½ &quot;</td>
<td>15½ &quot;</td>
</tr>
</tbody>
</table>

The distance between the adductor tubercle and the anterior superior spine is the same on both sides, 13½ ins.

There is complete restriction of movement of the joint because of the muscular rigidity due to pain. It is tender all over. Postero-laterally there is a sensation of fluctuation. This part was explored with a needle in the City Hospital and a diagnosis made of acute infective arthritis of the left hip.

October 30, 1929. Radiological report :-

"An area of rarefaction in the upper part of the neck of the left femur. The joint space is partially obliterated. The appearance is consistent with a tuberculous condition, but there is little general rarefaction". (This Xray is not available for insertion).

**Temperature Chart annexed**, indicates an infective condition. (Fig. 70)
Fig. 11.
Subacute Infective Arthritis.
30-11-29
Mrs. Clarke - age 35 years.
SUBACUTE INFECTIVE ARTHRITIS.

(FIG. 71)

Post operative condition, November 30, 1929 - in plaster.

Lack of definition of the outline of the structures constituting the affected joint.

Darkening of the interarticular space superiorly.
This would indicate synovitis.

Increased density of the articular cartilage, with narrowing of the joint space.

Seen in the early stage of arthritis.
Fig. 72.

Sub-acute Infective Arthritis

27-1-30

Head of the Femur in good position.

Mrs. Clarke - 50 years.
The left hip was manipulated, the deformity being corrected as far as possible, a certain amount of flexion being still present, and the limb encased in plaster in the position of 10° abduction.

A window was cut about 4 ins. square, in the plaster, over the lateral aspect of the hip-joint.

"Manipulation and plaster".

PROGRESS:-

After the application of the plaster the patient ran a temperature for some days, but this gradually settled down and she complained of sharp pain in the left hip-joint at irregular intervals. The patient, however, was of a neurasthenic temperament and it was questionable how much real ground there was for her complaint.

XRAY EXAMINATION :- November 30, 1929. No radiological report found accompanying the Xray photograph.

9:12:29. Discharged in satisfactory general condition and comfortably fitting plaster to the City Hospital. To report in six weeks for removal of plaster.

XRAY EXAMINATION:- 27:1:30. The head of the femur was found to be in good position. The plaster was to be retained for another period of six weeks.

11:3:30 - Readmitted from City Hospital.

HISTORY:- The patient has been well since last she reported. The pain in the hip-joint has now disappeared. The patient is still in plaster.

PHYSICAL EXAMINATION :-

The plaster was bivalved and the hip examined again. It was found that there was a satisfactory degree of ankylosis occurring, but there were still
a few degrees of mobility in all directions of the left hip-joint.

On palpation no pain was present anywhere in the region of the hip, but when undue movement was attempted at the hip-joint the patient complained of a severe degree of pain.

TREATMENT:— 22:3:30. It had at first been decided to measure the patient for a walking caliper splint, but owing to the slight degree of mobility still present and the pain when this normal range of movement was exceeded it was decided to apply a fresh plaster for a period of three months.
COMMENTARY
on
SUBACUTE INFECTIVE ARTHRITIS.

1. Clinical Summary of the Case
2. Etiology.
3. Pathology.
4. Radiological Examination.
5. Clinical Features.
6. Differential Diagnosis.
7. Treatment.
8. Prognosis.
CLINICAL SUMMARY.

This may be divided into seven periods:—

I. Previous History includes pleurisy at 18;
influenza at 23; no tuberculosis in the family.

II. Gynecological History:—
Leucorrhoea since 18 years of age.
Seven confinements.
First two - instrumental deliveries.
Third - spontaneous delivery.

In the fourth confinement labour was induced by quinine exhibited to the point of toxicity.

Preceding the fifth confinement - when twins were born - albuminuria for ten days. 

Rheumatism during the following year.

During the sixth pregnancy - down-bearing pains with albuminuria at the fifth month. A fall forwards during the ninth month caused pain to shoot through to the back, followed next day by oedema in face, throat and limbs. A week later labour commenced with failed forceps delivery. The coccyx is said to have been a difficult factor in each labour.
After Transference to Simpson
Maternity Hospital:

Os found half dilated, membranes ruptured, anterior lip lacerated.

Patient in a toxic condition.

Postpartum haemorrhage with placenta adherent in spite of Crede manoeuvres.


One hour after labour T 97 P 120 R 24.

Total duration of labour - 37 hours.

Treatment - Aseptic ergot, Pituitarin, intrauterine douche, antistreptococcal serum, administered intravenously and intramuscularly.

Patient transferred to isolation ward.

31:7:29. T. 100°4. Fell at 10 p.m. to 98°2.

Antistreptococcal Serum injected intramuscularly.

2:8:29. T. 101°2 at 6 p.m. - fell to 100°4

Rapid pulse, lochia pink but not purulent.

Quinine administered intramuscularly.

3:8:29. T. 100°4 at 6 a.m. Lochia very purulent.

Up to this period the patient experienced no pain in the hip.
After transference to Fever Hospital:

Injection administered into the left hip - probably antistreptococcal serum.

Next morning - legs painful on abduction.
The patient felt pain and weariness on raising herself while holding on to the bars of the bed.
She was able to lift the right hip off the bed, not the left. The pain was felt midway between the nates and the lateral aspect of the hip-joint.

Feverishness lasted two to three weeks, during which period a purulent discharge was treated.

September 1929:

Pain felt on both sides, especially the left. A tearing sensation in the left thigh was followed by pain reaching down to the big toe. Movement of the hip-joint was accompanied by pain in the sciatic nerve. The knee inclined medially and was put in a box splint. X-ray examination showed no bony lesion. Pain in the joint continued and during the night "starting-pains" were experienced.

After transference to Ward 8.

Physical Examination:

Relief obtained by flexion of thighs with support of knees by a pillow. Swelling over lateral aspect of the hip-joint. Left thigh muscles wasted to the extent of:
1 in. - a handbreadth above knee.
2½ " - 8 ins. above patella.

Length equal on both sides.

Muscular rigidity with complete restriction of movement of the hip-joint.

Fluctuation posterolaterally.

Aspiration proved the case to be one of Acute Infective Arthritis of the left hip.

Radiological Examination suggested tuberculosis although there was little general rarefaction. (Fig. 70) Temperature Chart indicates an infective condition.

November 16, 1929. Manipulation consisted of correcting the deformity, retaining a slight amount of flexion. The leg was put in plaster in a position of 10° abduction. A window 4 ins. square was cut over the lateral aspect of the hip-joint.

PROGRESS: - Temperature lasted for some days. Pain was felt in the left hip.

XRAY EXAMINATION: - 30:11:29, indicated synovitis and the early stage of infective arthritis. (Fig. 71)

PHYSICAL EXAMINATION: - 11:3:30 -

The plaster was bivalved. Ankylosis was incomplete. Movement produced severe pain, therefore the leg was again put in plaster, instead of being fitted with a caliper splint, as at first intended.
ETIOLOGY
related to the gynecological element in the history.

The case presents a gynecological sequence which may have some bearing on later orthopaedic conditions.

Pelvic measurements were ample. In 1921, 1923 and 1925 pregnancies were normal. The need for instrumental delivery in the first two cases may have been due to rigidity of the coccyx. In 1926 the psychic factor enters into the question. What influence that may have had on the site of implantation of the ovum or on the vascularity of the endometrium, according to different existing theories, it is not possible to say. Fright may or may not have been a factor in the formation of a placenta praevia. Therapeutic abortion was brought about by the use of quinine. The effects of quinine are manifold, changes occurring in the blood and tissues. Although there was ample time between pregnancies for recovery from local effects, there may have existed in the patient a latent idiosyncrasy tending towards albuminuria. Without investigation of a large series of case-histories an opinion on this point would be unjustifiable, but it is suggestive, as each succeeding pregnancy showed an increase in
albuminuria. Other causes may be looked upon as essentially anatomical or pathological. In the first instance the ureter is liable to be kinked during pregnancy by reason of the growth and twist of the uterus. In the second instance kinking or obstruction of the ureter favours the lodgment of B. Coli, which may reach the ureter either by the periurethral lymphatics or directly from the kidney. Pre-disposing causes of postpartum haemorrhage would in this case be the rapid succession of pregnancies and the presence of a placenta praevia.

Still another factor demands consideration. Failed forceps delivery involved considerable trauma, not only in the laceration of soft tissues but probably also to the sacro-spinous and sacro-tuberous ligaments. On interviewing the patient, who could not be palpated because of her plaster cast, accuracy in describing the localisation of pain was insisted upon. Anatomically pain was seemingly not related to the coccyx nor originally to the hip-joint, but midway between the two and posteriorly to the latter. The history of failed forceps delivery does not indicate the area of obstruction or whether the forceps were applied high or low; but pain at a later date reached the level of the lumbo-sacral plexus. The nerves issuing from that plexus may have been subjected to mechanical pressure; the sacro-iliac ligaments may have been strained and the sacro-iliac joint affected. The so-called "neurasthenic"
temperament of the patient may be justifiably ex-
plained by strain to internal ligaments, for the
patient stated that after the limb was encased in
plaster, pain above the buttocks was transferred for
two or three days from the left to the right side.
This would indicate a re-adjustment on the part of
the sacro-iliac joint with a possible transference
of balance from one side to the other. Pain
eventually radiated down the whole length of the
sciatic nerve to the termination of its branches,
that in the big toe being due to sensitiveness of
the superficial peroneal nerve - a branch of the
common peroneal nerve - or of the deep peroneal
nerve - a branch of the anterior tibial nerve.
Probably both were involved by reason of impulses
from the main trunk.

With the onset of "starting pains" localisation
of joint-tenderness becomes definite, the articular
cartilage being partially destroyed.
ETIOLOGY
related to the orthopaedic element in the history.

According to Jones and Lovett there are three causes for arthritis:

1. Infectious - from some purulent focus.
2. Toxic (metabolic) - from absorption of bacterial or chemical toxins,
3. Traumatic - from overuse or prolonged strain.

Spread of Infection may take place:

1. From neighbouring tissues.
2. By the blood-stream.

The present case may be placed in the category of toxic absorption, subsequent to puerperal sepsis, infection occurring most probably by the blood stream, although neighbouring tissues may also have been involved. Other factors already mentioned may have a bearing on the case. Pain in the hip dates from a definite period. A succession of intramuscular injections of both quinine and antistreptococcal serum may have affected the tissues of both hips. In addition the last injection may have been given sufficiently near to the capsule of the hip-joint as to affect it directly.
The patient was very definite in her statement that up till that period she had no difficulty in rais­ing both hips off the bed, but from that date the left hip became involved.

In an article on the Reactions of Joints to Mild Irritants in Experimental Arthritis, contributed to the Journal of Bone and Joint Surgery, October 1929, by J. Albert Kay, M.D., it is pointed out that as the result of injection directly into a joint, a definite sequence of events takes place. The following day there is marked infiltration of the tissues with leucocytes, also engorgement of blood vessels near the joint surface. Leucocytes are extravascular and lie -

1. on the synovial surface.
2. in the layer of cells in the synovial surface.
3. in the loose tissue beneath these cells.

In an experiment in which citrated blood is used on more than one occasion, the results are as follows: -

1. The synovial membrane becomes thickened.
2. The synovial lining cells increase in size and number.
3. Connective tissue cells proliferate in the loose subsynovial tissues.
4. Macrophages and leucocytes infiltrate these areas.
5. Leucocytes disappear on the third day but macrophages remain.

In this case two factors may be combined:

1. Previous toxicity of the blood stream.
2. Local injury to gluteal muscles, sciatic nerve or joint-cavity.
Arthritis is generally classified in two groups:

1. Proliferative or Rheumatoid Arthritis.
2. Degenerative or Osteo-Arthritis.

In the first instance cartilage, perichondrium, connective tissue and endosteum are involved in a process of proliferation. Granulation tissue occurs in synovial membrane and capsule. The tissues surrounding the joint may become swollen but there is little sign of actual inflammation. The process is slow, therefore subacute, with possible exacerbations at intervals. A certain amount of rarefaction of bone occurs resembling tuberculosis; but in arthritis this is due to disuse with absorption of lime salts, as compared with tuberculosis, where wasting takes place in the central area accompanied by subperiosteal thickening.

In the second instance destruction of cartilage leads to hardening of the underlying bony surfaces. The perichondrium becomes thickened and osteophytes form as a regenerative process around the joint.
The bacteriological report did not differentiate the organisms present in the fluid aspirated from the joint.

Four types of organisms are commonly associated with infective arthritis of the hip, viz., staphylococcus, streptococcus, B. Coli communis and gonococcus. On investigation of the labour record at Simpson's Maternity Hospital, there was no indication of gonorrhoeal infection. This was corroborated by the resident. Of the other organisms mentioned, the staphylococcus and streptococcus are intimately related to puerperal sepsis and to infective arthritis in general. B. Coli communis may have been present, if, in addition to albuminuria, there was an accompanying pyelitis or cystitis, of which there is no record. It would certainly be included in the intestinal flora, and in puerperal sepsis absorption and migration of organisms would be facilitated by the purulent discharge for which the patient received prolonged treatment.
A. In rheumatoid arthritis -

1. The joint-space is diminished.

2. The margins of the bones become blurred and may later become stippled.

3. A certain rarefaction of bone is present but no bony ankylosis.

B. In osteo-arthritis -

1. Lipping of articular margins takes place.

2. Osteophytes are formed in the more advanced stage.
CLINICAL FEATURES.

The predominant characteristic of rheumatoid arthritis is the position assumed by the patient. Owing to pain in and around the hip-joint the leg is adducted and flexed, muscular spasm being pronounced. Pain radiates down the sciatic nerve. Walking becomes difficult because of the lack of balance between the adductors and their antagonists: lameness increases. During periods of acute exacerbations the patient is obliged to remain in bed with knees drawn up, supported by a pillow, as in the present case.
DIFFERENTIAL DIAGNOSIS.

1. Coccydynia.
2. Acute epiphysitis.
3. Osteomyelitis.
4. Acute coxitis.
5. Coxa vara.
6. Fracture of the neck of the femur.
7. Tuberculosis.
8. Rheumatoid Arthritis.

1. Coccydynia. With a history of difficult labour and the information that the coccyx had given trouble at each confinement, coccydynia is a possibility to be considered owing to the factor of referred pain.

The coccyx is supplied by the 4th. sacral nerve. The pudendal nerve comes off the 2nd, 3rd. and 4th. sacral nerves.

The posterior aspect of the hip joint is supplied by branches of the 1st., 2nd. and 3rd. sacral nerves.

In cases where the sciatic nerve gives direct supply to the hip-joint, the link with the coccyx is through the pudendal nerve.
In addition the posterior femoral and perforating cutaneous nerves are directly connected with the 3rd. sacral nerve.

In this case coccydynia may have been present for a time, aggravating pain in the hip-joint, but it does not explain the joint condition, proved both clinically and radiologically.

2. **Acute epiphysitis** - This is essentially associated with young subjects, but if of congenital syphilitic origin, permanent injury may be done to the joint. In this case there was no evidence of syphilis, congenital or acquired.

3. **Osteomyelitis** - This also occurs mostly in the young. It may originate in the upper end of the femur but usually begins in the diaphysis. The history of the present case does not lend itself to such a diagnosis nor is Xray evidence in favour of it.

4. **Acute coxitis** - This is characterised by pain due to alteration in intraarticular tension and pressure or, later, to changes in the bone itself. Swelling, tenderness, muscular rigidity and muscular atrophy are the main clinical features. Bacteriological and radiological examination are essential in differentiating this condition.

5. **Coxa vara** - This may be due to trauma or a pathological condition of the neck of the femur.
a) Trauma, involving slipped epiphysis, can only occur during adolescence.

b) Rickets in this case may be excluded by the general appearance of the patient and the absence of other abnormality in bone formation.

c) Osteomalacic pelvis, with coincident absorption of lime salts in the neck of the femur, need not be considered here, as pelvic measurements were ample and there was no sign of softening of the skeletal framework of the body.

d) Osteomyelitis, tuberculosis and arthritis deformans may be associated with coxa vara, but in such cases coxa vara is the secondary, not the primary, lesion.

6. Fracture of the neck of the femur may be intracapsular or extracapsular. Diagnosis may be difficult in cases of impacted fracture when the leg is capable of bearing weight, but as a rule the limb is in an everted position; abduction and internal rotation are limited; and there may be a certain amount of shortening. In this case there is no history of accident; and X-ray examination is conclusive.

7. Tuberculosis - Clinical features are pain, swelling, muscular rigidity, rapid muscular atrophy and limitation of movement in all
directions. Radiological examination in the early stage may suggest rheumatoid arthritis, but later, osteoporosis and dense sequestrum formation are indicative of tuberculosis.

8. **Rheumatoid arthritis** - may be monoarticular or polyarticular; acute, subacute or chronic. In this case only one joint is affected. X-ray examination suggests early arthritis, (Fig.70) while the temperature chart reveals an infective condition of a sub-acute type.
F.G. Thomson, M.D., and R.C. Gordon, M.D. in their book on Chronic Rheumatic Diseases, have given the classification of foci of infection as follows:

1. Pyorrhoea leading to chronic intestinal infection.
2. Apical abscess affecting the blood stream.
3. Tonsils, especially the small, retracted inflammatory type, which reveal pus when pressed from below.
4. Achlorhydria leading to dyspepsia.
5. Streptococcus haemolyticus in faeces.
6. Gonococcal or streptococcal infection of the uterus after labour.
7. Non-venerel endometritis.
8. B. Coli communicis in the bladder.
10. Chronic appendicitis.

With these in view examination and treatment are directed towards the cause of disease.

1. Where a focus of infection can be removed, as in the case of the tonsils, this should be done.
2. Hygienic measures are essential.

3. Diet should be adjusted to the condition of the patient, taking into consideration any organic lesion present. As a rule carbohydrates should be reduced. In some cases cod liver oil should be administered.

4. Where altered metabolism is associated with hyperthyroidism, French tincture of iodine may be prescribed.

5. Vaccines have proved unsatisfactory.

Hydrological treatment should be undertaken only after the acute phase has passed. Where volcanic mud is available, hot mud packs are preferred, along with hot air or vapour baths. In spas with radio-active water, metabolism is stimulated by a gentle "under current" or low pressure, warm douche. This is followed by massage of the muscles, the joint being left alone in order to avoid local irritation. Reaction pains after baths are less severe and less frequently observed in cases of rheumatoid arthritis than in gout, but with weekly routine examination of suspension stability tests in such cases, metabolic results should be accurately recorded.

Where bony ankylosis has not yet occurred, manipulation may be undertaken to relieve muscular spasm. In his article on The Mechano-Therapeutics
of Acute and Chronic Synovitis of the Knee-Joint, contributed to The Practitioner, April, 1929, Dr. Edgar Cyriax refers to the methods based on Ling's Swedish System and elaborated by Henrik Kellgren. The movements employed are as follows:

2. Passive movements.
3. Active (resisted) movements.
4. Frictions on the nerves of the affected limb.

1. The technique of manual vibrations consists of the formation of rapid alternating contraction and relaxation of some of the muscles of the forearm, these vibrations being conducted through the finger-tips to the joint under treatment. The result is a series of fine, rapid, wave-like movements of alternating application and removal of pressure. The effect of these vibrations is as follows:

a) Promotion of absorption of the effusion.
b) Promotion of circulation of the lymph in the affected area.
c) Promotion of the venous return in the affected area.

By the alternating application and removal of pressure, or elongation and shortening of the lymphatics, a flow of lymph is maintained from the deep to the superficial lymphatic vessels.
Absorption of effusion is only possible when exudate is enabled to pass through the synovial membrane. Vibrations assist in expressing this effusion through the synovial fluid into the lymphatics. In this way swelling is diminished and pain reduced.

2. **Passive Movements** are facilitated by applying traction during movement in order to separate articular surfaces. In the case of the hip this is accomplished by the patient steadying the pelvis while the manipulator grasps the distal end of the thigh.

3. **Traction** is still more important during active movements in order to prevent contracting muscles from approximating articular surfaces. Such resisted movements prevent the formation of adhesions, tend to remove them when already formed, improve the circulation and prevent atrophy of muscles.

4. **Friction** consists of side to side movements at right angles to the nerves supplying the joint and to the posterior branches of the spinal nerves, the anterior branches of which are related to the joint. By such means the nervous supply to joint and muscles is stimulated and the central nervous mechanism of repair is promoted.
Where destruction of the hip has already begun, fixation of the limb in plaster is the best method for securing rest and a bony ankylosis in good position. When ankylosis is complete, the plaster is substituted by a walking caliper.
PROGNOSIS.

This depends upon:-

1. The stage of disease when it comes under observation.

2. The extent of disease as regards the number of joints affected and the destruction of articular surfaces.

3. The presence or absence of adhesions.

4. The discovery and possible elimination of a focus of infection.

5. The skill in manipulative treatment.

6. The reactions to hydrological treatment.

7. The result of ankylosis.

Prognosis should be guarded where the focus of infection cannot be eradicated or where no amelioration has succeeded removal. The severity of the disease at the beginning and the progress
made thereafter are also factors to be taken into consideration, as damage to joint structures with resultant ankylosis is liable to occur early.

In this case the initial infection was severe, the condition prolonged and the pain acute. Treatment aims at rest with bony ankylosis. When attained, local cure may be complete, but recurrence in some form may take place elsewhere, if gynecological conditions are such as to liberate any toxic element into the blood.
SUMMARY OF
DISEASES OF THE HIP-JOINT,
as exemplified by the
SIX CASES ASSIGNED.

Disease of the Hip-Joint may be placed in
three categories: -

A. Congenital - 1. Congenital Dislocation
B. Traumatic - 2. Separation of the Epiphysis
               3. Osteochondritis Deformans Juvenilis
C. Inflammatory in origin. - 4. Paralytic Dislocation
                              subsequent to Acute Anterior Poliomyelitis
                              5. Pathological Dislocation subsequent to Tuberculosis.

Fundamentally these follow in chronological
order: -

1. Morphological development.
2. Interruption of physiological growth.
3. Abnormality in physiological activity.
4. Arrest of nerve function - malnutrition.
5. Bacteriological infection - the seed and the soil.
6. Pathological Sequence.

Again these may be grouped under the following headings: -

1. Developmental forces over which the individual
   has no control.
2. Mechanical injury.
3. Individual responsibility.
5. Social responsibility.
6. Deranged physiology.

The first classification is largely based on the anatomy of the human frame.

The second takes into consideration the physiological development of the human being.

The third correlates anatomy and physiology with natural law.

Each case in itself shows arrest of development or infringement of law at some point.

The study of dis-ease is fundamentally that of cause and effect in the laboratory of human life. The Science of Healing represents the best in skill and treatment; but it is based on injury already done. In the recognition of natural law; in the systematic teaching of obedience to law; and in the acceptance of responsibility; both private and public, in the fulfilment of law, lies the Art of Preventive Medicine.