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ITS PATHOLOGY AND TREATMENT

BY

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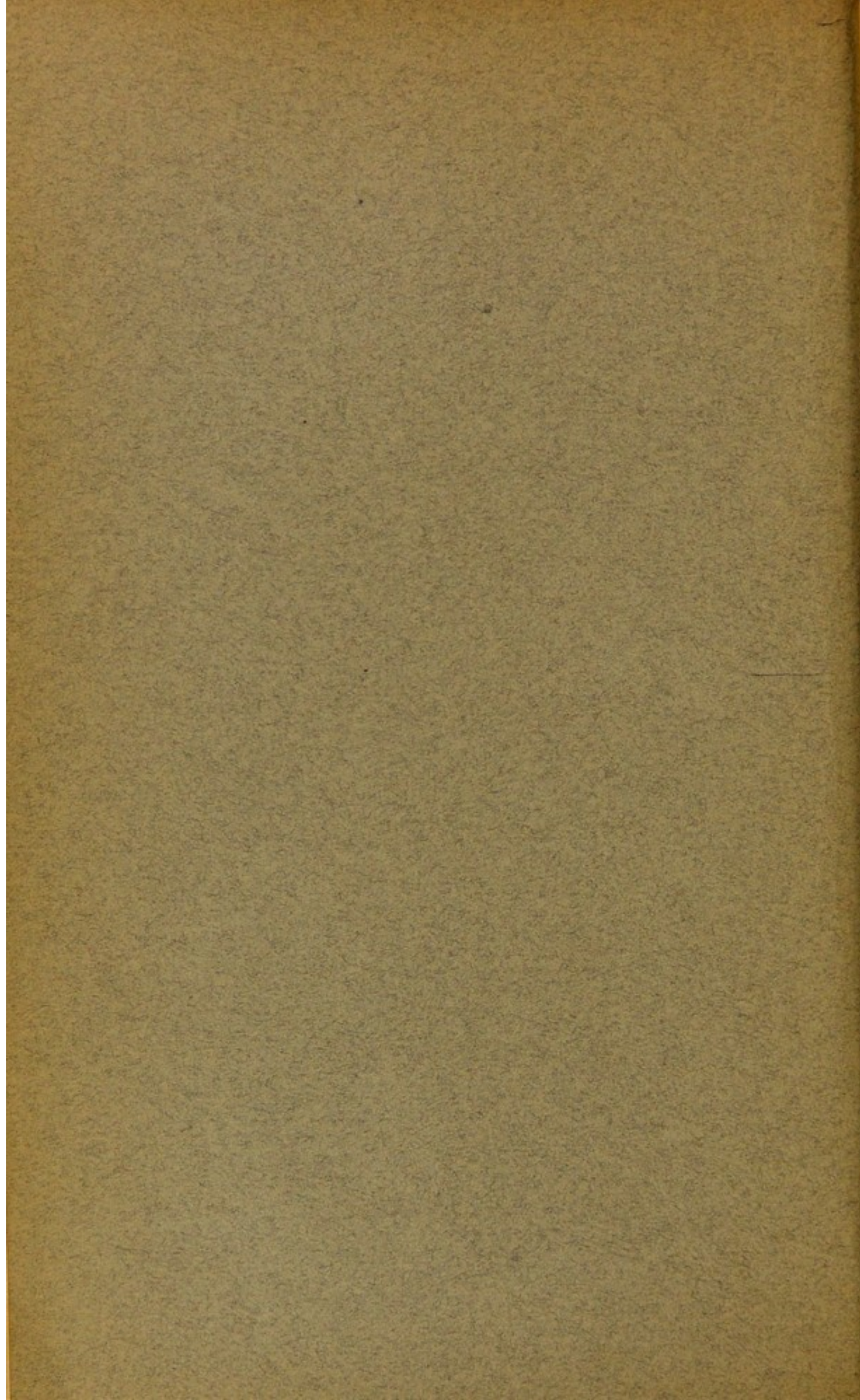
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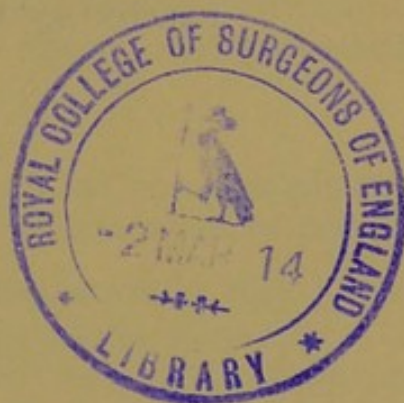
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COXA VARA, ITS PATHOLOGY AND TREATMENT

COXA VARA is an anatomical term indicating the condition of depression of the neck of the femur, so that the angle that the neck of the femur makes with the shaft, normally about 125° , is lessened. Such depression of the neck of the femur may occur by bending at the root of the neck, in the middle of the neck, or close up to the head of the bone, or there may be a general curvature of the whole neck.

The clinical manifestations of Coxa vara are briefly, diminution in the degree of abduction permitted at the hip-joint with real shortening, manifested by elevation of the trochanter. Several other conditions occur in which these clinical manifestations are found, but in which the radiographs show a deformity of the head of the femur rather than a depression of the neck. These are best excluded from Coxa vara; they are: (1) Results of old inflammatory disease, either acute, such as epiphysitis, or chronic, as tuberculous disease; (2) Osteoarthritis; and (3) Pseudo-coxalgie (Calvé).

CLINICAL CONDITIONS SIMULATING COXA VARA, IN WHICH THE DEFORMITY IS IN THE HEAD OF THE FEMUR RATHER THAN IN THE NECK

Tuberculous disease. It is not uncommon to find a case of old tuberculous disease of the hip-joint simulating Coxa vara. As a rule these can be distinguished from true Coxa vara even on clinical grounds—a radiograph will distinguish them for certain, showing destruction of the head of the femur or of the acetabulum, but no deformity of the femoral neck. Tuberculous disease is by some described as a cause of Coxa vara. I have looked for a true depression of the femoral neck in a large series of patients (800) suffering from old tuberculous disease and also in museum specimens of this condition; I have, however, been unable to find any instance of true tuberculous Coxa vara.

In *Epiphysitis* there is most often a loss of the head of the femur, often with a pathological dislocation. An actual depression of the stump of the neck is sometimes present, probably the result of interference with the growth of the neck at the epiphyseal line, but this condition of Coxa vara is in these cases overshadowed by the deformity due to dislocation or by ankylosis, so that although strictly a Coxa vara is present it has no clinical significance.

In *Osteoarthritis* a deformity clinically like that of Coxa vara is common; anatomically this results from the wearing away of the upper part of the femoral head with the deposit of new bone below, with possibly

also enlargement of the acetabulum; so that again the deformity is of the head of the bone rather than of the neck.

In *Pseudo-coxalgia* there is again a flattening of the head of the femur, with perhaps also thickening of the bone in the region of the epiphyseal line. Abduction is slightly diminished and there is a little real shortening, both these resulting from the deformity of the femoral head and not of the femoral neck. This condition is possibly due to an injury followed by atrophy of the epiphysis of the head of the femur. Other similar cases of injury to the epiphysis occur, and may be followed by deformity of the head of the femur, producing clinically the symptoms of Coxa vara. The following case is an example of such.

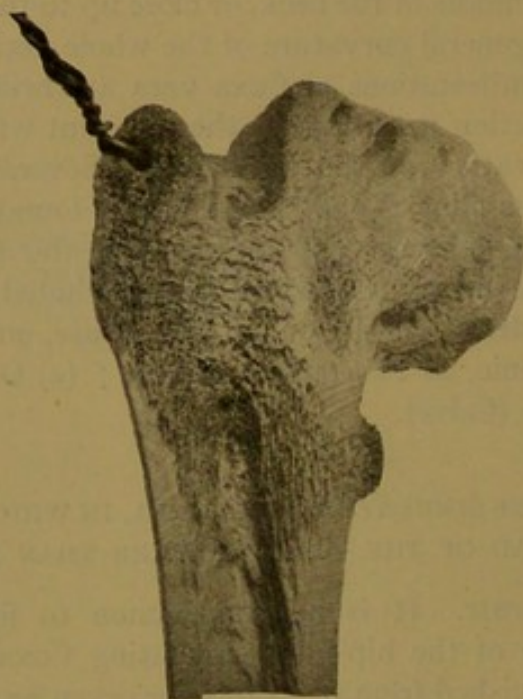


FIG. 1. The upper end of the femur in osteoarthritis.

W. W., a boy of 14, attended St. Bartholomew's Hospital in October 1912. He gave the following history. In January 1911 he fell off a bicycle on to the right side; he was able to get up and walk home, but had at the time a sharp pain in the right knee. He attended another hospital, where he was treated as an out-patient, three weeks' lying down and two weeks' partial rest, after that he returned to school. In June 1912 he left school and went to work; he had not been off work since. In October 1912 he presented clinically the symptoms and signs of adolescent Coxa vara, that is the right lower limb was half an inch short, the great trochanter being raised and prominent, flexion was free to a right angle, rotation in either direction was limited, and abduction at the hip-joint was abolished. There was no pain and the boy could walk quite well. The radiograph showed a destruction of the upper half of the epiphysis of the head of the femur, which but for the very slight

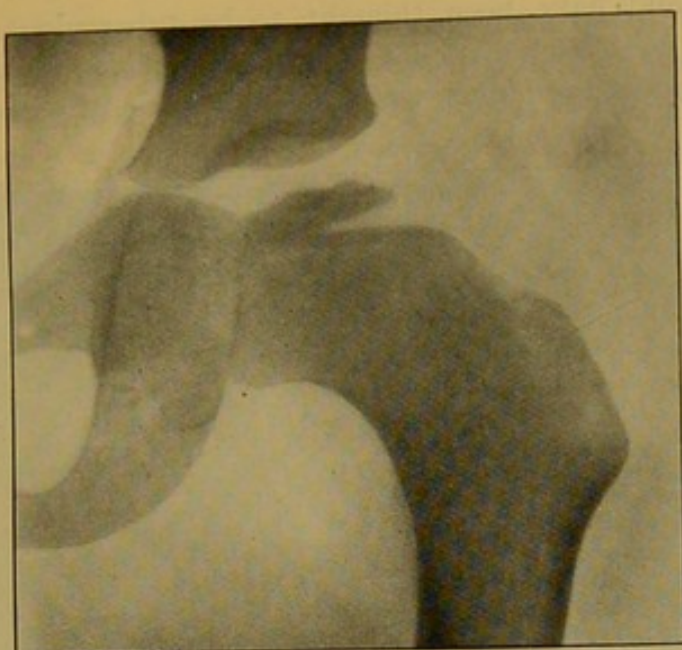


FIG. 2. Radiograph of the hip-joint in a case of pseudo-coxalgia in a boy aged 8.

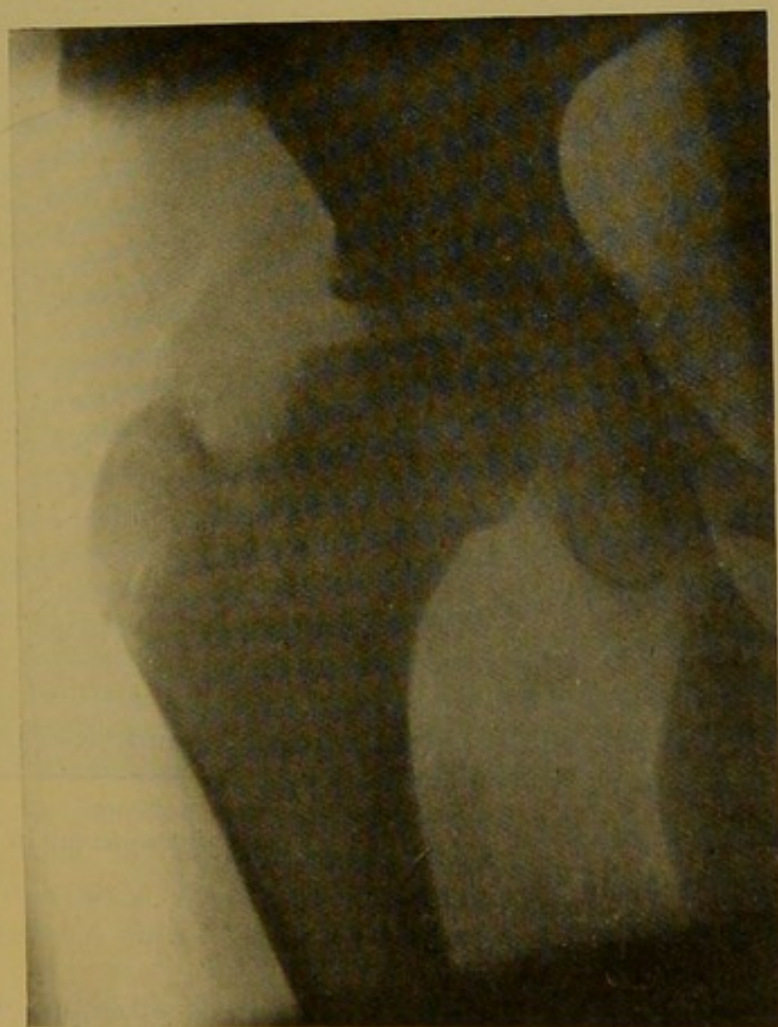


FIG. 3. Radiograph of the hip-joint in the case W. W.

symptoms would have been thought to be tuberculous. In view of the history it was concluded that there had been an injury to the upper half of the head of the femur, which had subsequently atrophied.

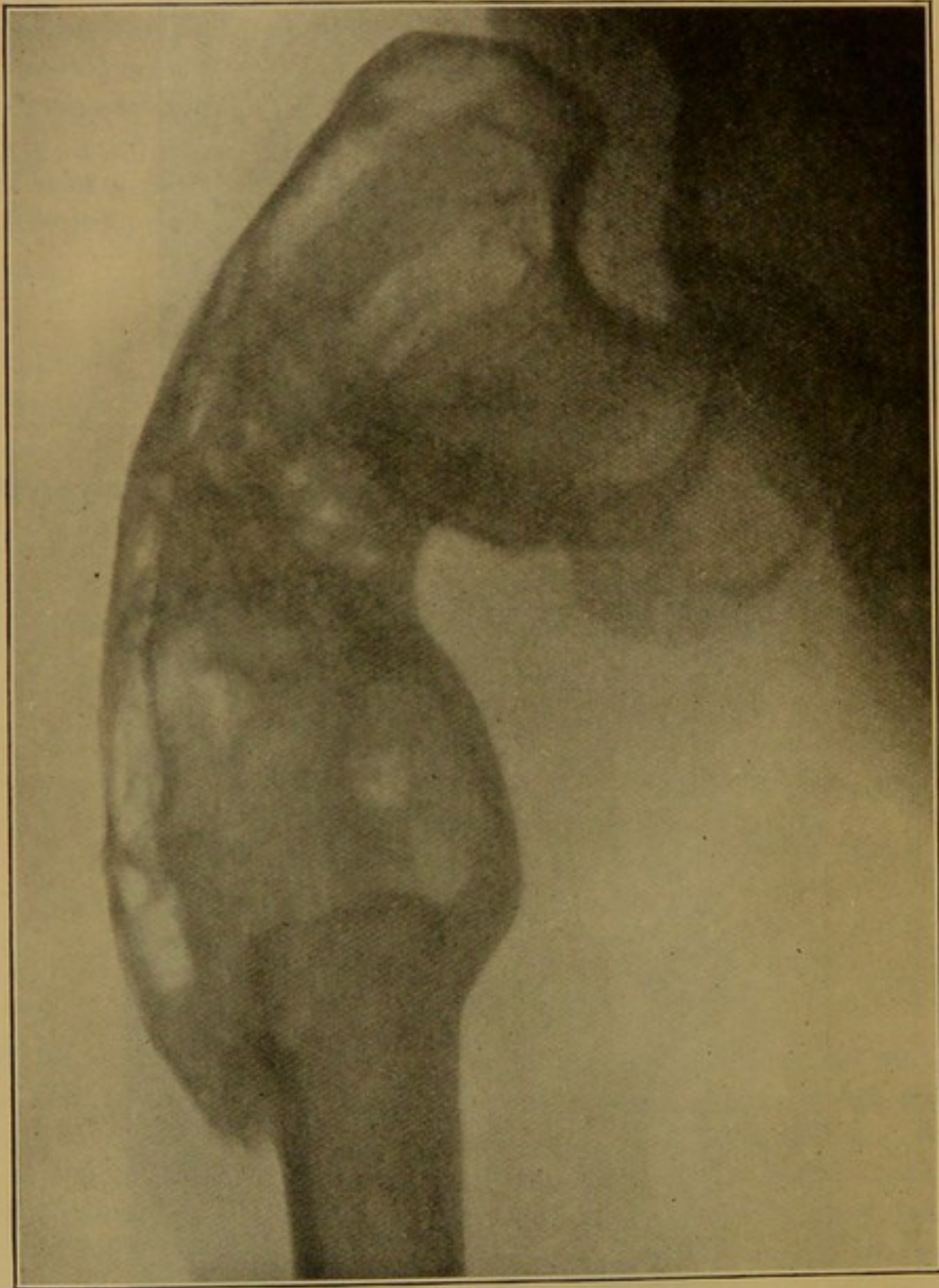


FIG. 4. Radiograph of the hip-joint and upper end of the femur in a case of osteitis fibrosa.

ANATOMICAL COXA VARA

Even though we limit the name *Coxa vara* to an actual depression of the femoral neck, we are still left with an anatomical condition which may vary in different cases, and which may result from different patho-

logical processes. The pathology of some of the forms of anatomical Coxa vara is clear and needs but very brief allusion. These conditions can be included under two headings: (1) Injury, that is fracture of the neck of the femur, with union in a deformed position; (2) processes in which the bone is known to be definitely softened and to give way under pressure, i. e. rickets, osteomalacia, osteitis deformans, osteitis fibrosa.

To these groups I shall not allude further except that the pathology of the idiopathic varieties of Coxa vara is intimately connected with the question of the occurrence of fracture of the femoral neck in children, and that it is necessary to include a brief description of the anatomy of rickety Coxa vara. We are left with the idiopathic cases of Coxa vara, which may be classed according to their history and anatomy into three groups: (1) Congenital; (2) infantile or cervical (*a*) with a fibrous intersection in the neck, (*b*) with a strong neck without any fibrous intersection; (3) adolescent, and possibly a few aberrant cases which do not fall properly into any of these groups.

The pathological anatomy of these groups was worked out by me and published in my Erasmus Wilson Lecture in 1907, my further experience since that time has not caused me to alter any of the views then expressed, but has in fact confirmed these views. The total number of cases upon which the following account of the pathology is based is 77, of which 33 were adolescent, 34 infantile belonging to the first group, 3 belonging to the second group, 5 congenital, only 2 cases remaining aberrant, failing in their anatomical appearances to fit into any group.

DEVELOPMENT OF THE NECK OF THE FEMUR

In order that the anatomical differences between the types of Coxa vara arising in early life and in adolescence may be understood, it is necessary to describe the mode of ossification of the neck of the femur. In the foetus of eight months the head and the neck of the femur, together with the great trochanter, consist of a single mass of cartilage, separated from the shaft by a line of ossification which is nearly transverse and which by its growth adds to the length of the shaft. At birth this line of ossification has become a little higher and slightly oblique, bone now extending into the lower part of the neck. This alteration becomes more evident during the first and second years, the lower half of the neck consisting now of bone, the upper half constituting a cartilaginous bridge connecting the head to the great trochanter. It is only in the fourth year of life that the line of ossification eventually reaches the upper surface of the neck, thus completely separating the originally single mass of cartilage into the epiphyses of the head and of the great trochanter.

It will thus be seen that up to the fourth year there is a single, more or less transverse epiphyseal line, by ossification at which addition to the upper end of the shaft and to the lower part of the neck is occurring.

After this time there are two such lines, that between the great trochanter and the shaft and that between the head and the neck. No very considerable growth occurs at either of these lines, but whereas the former merely adds to a slight extent to the adjoining part of the shaft, the latter is responsible for the development of the femoral neck and, we shall see, is liable to injury and deformity.

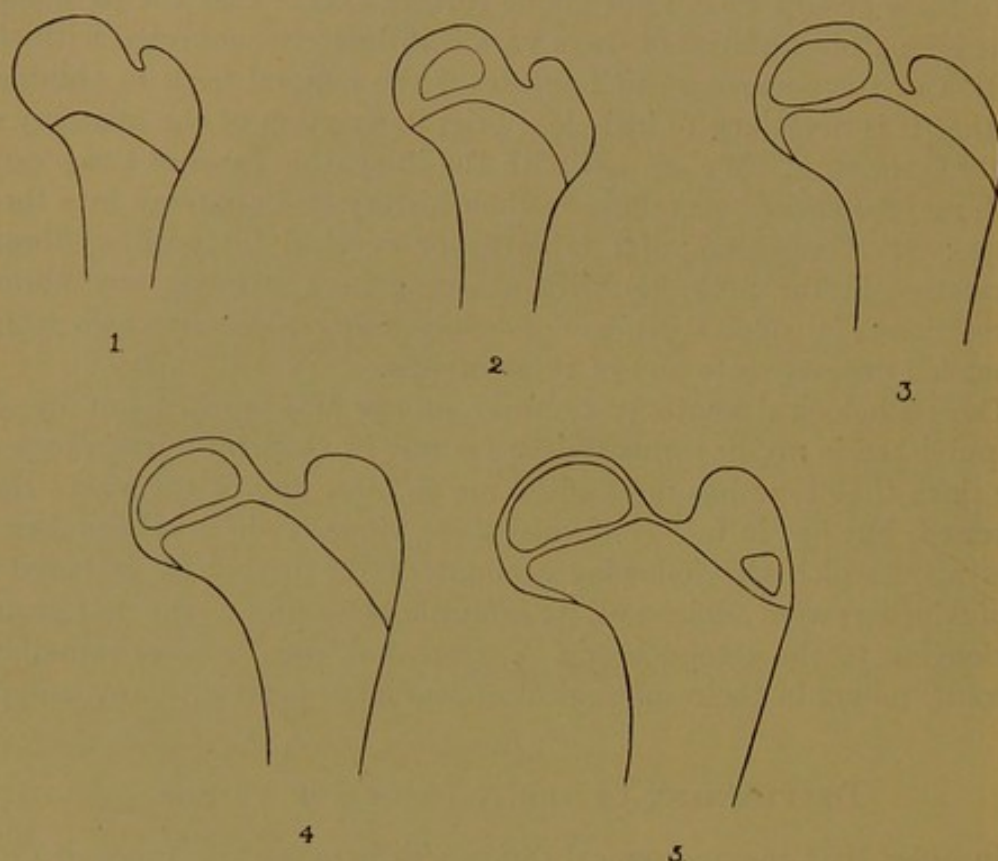


FIG. 5. Diagram of the upper epiphyseal region of the femur (1) at birth, (2) at 1 year 6 months, (3) at 2 years 9 months, (4) 4 years, (5) 5 years 6 months. From radiographs.

ADOLESCENT COXA VARA

Adolescent Coxa vara has its onset as a rule between the ages of 13 and 17; it is very rarely bilateral, only 3 times out of 33 cases, and is far more common in boys than in girls (boys 27, girls 6).

Injury. In taking the history of a patient with adolescent Coxa vara a large proportion will be found to have undergone an accident. Classed according to the relation of the accident to the deformity, we get the following groups: (1) Those in whom the accident is followed immediately by the presence of deformity; (2) those in whom an apparently trivial accident, producing little or no symptoms at the time, is followed some months later by the development of a typical Coxa vara deformity; (3) those who have no history of accident at all; (4) occasional cases in which an accident follows a period during which there were some symptoms, pain, stiffness, or possibly even deformity, in the hip-joint.

It is evident that the pathology of adolescent Coxa vara cannot be settled without a consideration of the occurrence of injuries of the femoral neck in childhood. Separation of the epiphysis of the head of the femur was formerly looked upon as one of the rarest of accidents. Malgaigne in 1847 could only collect 14 cases of intra-capsular fracture before the age of 59 years. In 1894 Tubby could find only 14 cases of separation of the epiphysis; he stated that as a rule they resulted from severe violence. In recent years, however, injuries to this region have received a great deal of attention, and it has been demonstrated that they are by no means rare. Poland in 1898 collected 33 cases, some of which illustrated that very slight violence may produce the injury, that the immediate disability is often small and that later a typical Coxa vara deformity arises. Whitman has paid a great deal of attention to these injuries, pointing out particularly the resultant deformity and its tendency to increase. Several resections of the hip-joint for traumatic Coxa vara carried out by Sprengel, Brahmman, Hoffa, and Schlesinger further demonstrated the existence of a separation of the epiphysis in these cases. In 1903 Hoffa collected in all 87 cases of injuries to the femoral neck in childhood, of which he considered that all but 4 were instances of separation of the epiphysis. He called attention to the facts that Coxa vara is a predisposing factor, and that the symptoms after injury may be so little disabling that often the diagnosis is not made. Kirmisson in 1904 drew special attention to the production of this accident by very slight violence, particularly by muscular violence.

So that instead of the original opinion that accidents to the femoral neck in children were rare and were due to severe injury, we must accept it as demonstrated that such accidents are common, that a very slight injury may be sufficient to produce them, and that the immediate disability may be correspondingly slight. Thus Kirmisson relates a case of a girl who separated this epiphysis while dancing, without any fall, and who was able to walk on the fourth day after the accident. I have recorded a case of a boy in whom this accident occurred during a hurdle race, which he was able to finish and win; and cases in which the epiphysis is apparently separated by very slight wrenches of the hip-joint, the deformity only showing itself some months afterwards, are comparatively common.

The actual site of the injury in the neck of the femur has been a matter of some dispute. I have no doubt that during adolescence the injury is situated close up to the epiphyseal line of the head, but not of course actually through the epiphyseal cartilage, so that, technically speaking, the injury should be classed as a separation of the epiphysis. Bearing in mind, then, (1) that the separation of this epiphysis is much more common than was formerly believed, specially in adolescence; (2) that it is produced by very slight violence and sometimes as the results of several separate accidents; (3) that the immediate symptoms are so slight that the condition usually remains undiagnosed; and (4) that the

subsequent deformity is indistinguishable from Coxa vara, we may suppose that it is possible to class the groups of Coxa vara already mentioned into (i) separation of the epiphyses of the head of the femur, (ii) loosening of the epiphysis of the head of the femur with subsequent gradual slipping and displacement of the head, (iii) adolescent Coxa vara without accident, (iv) adolescent Coxa vara with separation of the epiphysis of the head of the femur occurring after the deformity is established.

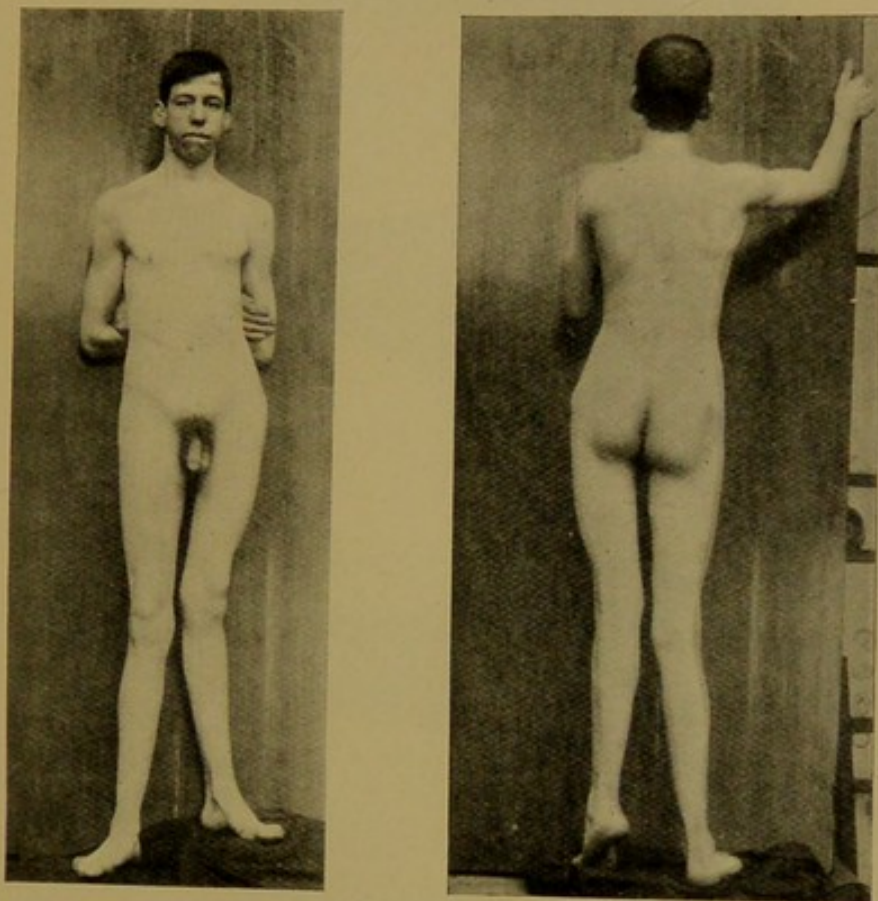
Symptoms. A few points in the clinical symptoms of adolescent Coxa vara assist us to form views as to the pathology—in the first place whether there is an accident or not there is nearly always in the progressive stage of the deformity a period during which the movements of the hip-joint are almost or quite abolished. Hofmeister in his first contribution to the subject laid stress upon this stage, but it seems to have been forgotten by many surgeons who, on account of the fixation of the joint, make the diagnosis of tuberculous disease of the hip. The rigidity is due entirely to muscular spasm; it disappears when the joint is examined during anæsthesia, and its presence is easily understood when it is remembered that the lesion in adolescent Coxa vara is close to the epiphyseal line and that this line is entirely intra-articular. During this stage there is also pain in the hip, extending down to the knee, rapid wasting of the muscles of the thigh and buttock, and a fullness in Scarpa's triangle. These symptoms also are like those of tuberculous disease, they indicate only an intra-articular lesion of the hip-joint.

Physical signs. This period may last a few weeks or several years; sooner or later the movement returns, and the deformity only remains. The limb is now shortened, adducted at the hip-joint, and everted; occasionally also it is a little flexed. The real shortening, measured from the anterior superior iliac spine to the internal malleolus, is seldom more than an inch; the total apparent shortening, measured from the umbilicus to the internal malleolus, is often as much as two and a half or three inches; this and the eversion are usually evident at a glance. The great trochanter is raised to a degree corresponding with the real shortening and is very prominent. Movements at the hip-joint are usually in the later stages free, except abduction and internal rotation, which are limited by anatomical factors.

The actual pathology of Coxa vara must be inferred from points in the history already mentioned, from these physical signs, from appearances seen in radiographs, and from such pathological specimens as have been obtained by resection or otherwise.

Radiography of the Hip. In interpreting radiographs of the hip certain points must be attended to. In addition to its inclination to the axis of the shaft of about 125° the femoral neck is directed forwards when considered in relation to the transverse axis of the lower extremity. This angle of torsion is, according to Mickulicz, very variable, being as a rule, however, between 5° and 20° . In Coxa vara, owing to the posterior

displacement of the head, this angle is diminished or rendered opposite in sign. The shadow thrown by the upper end of the femur varies according to the direction in which the neck is pointing, and owing to this torsion the true angle between the neck and the shaft is shown when the limb is a little inverted, the degree of inversion required being just sufficient also completely to hide the lesser trochanter behind the shaft. In this position, in addition, the head of the femur and the great trochanter are



FIGS. 6 and 7. Photographs of a case of adolescent Coxa vara.

at equal distances from the radiographic plate and thus maintain their relative dimensions in the picture.

Radiographs of a normal femur show the following important alterations in the appearances as the femur is rotated outwards: (1) The head of the bone casts a relatively larger shadow owing to its increasing distance from the plate; (2) the lower border of the femoral neck becomes apparently shortened and its point of origin from the shaft raised; (3) the upper border of the femoral neck at first becomes clearer, but with further eversion is entirely obscured by the shadows of the head and the great trochanter. Owing to these alterations it is necessary when looking at a radiograph of the hip-joint to consider carefully the position in which it was taken. It is generally possible to form some judgement of this from the appearance of the shadow, especially from the

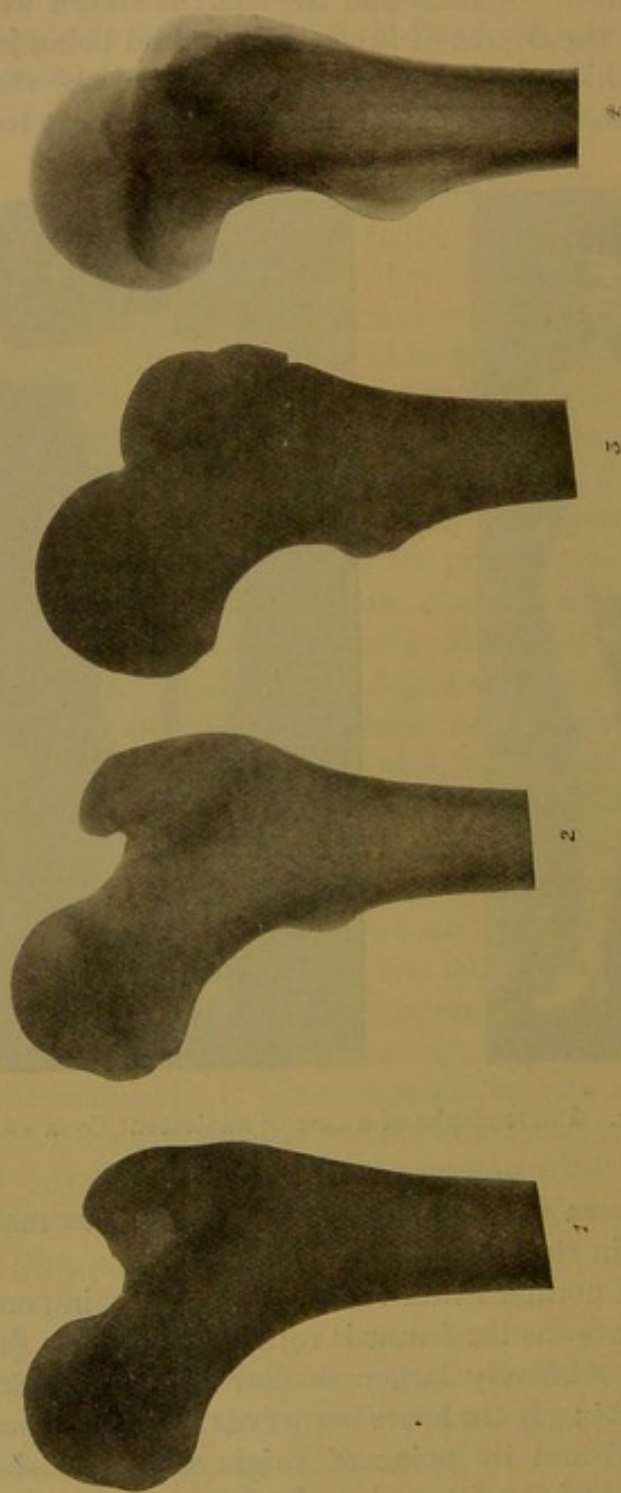


FIG. 8. Radiographs of the upper end of normal young femur (1) in normal position, (2) in inverted position, (3) everted 20° , (4) everted 40° .

outline of the trochanters, but it is advisable to make a note of the direction in which the foot points when any radiograph of the hip is taken. The condition present is often rendered clearer by exposing plates in two or more positions. In nearly all cases the radiograph in adolescent Coxa vara has to be taken with the foot everted.

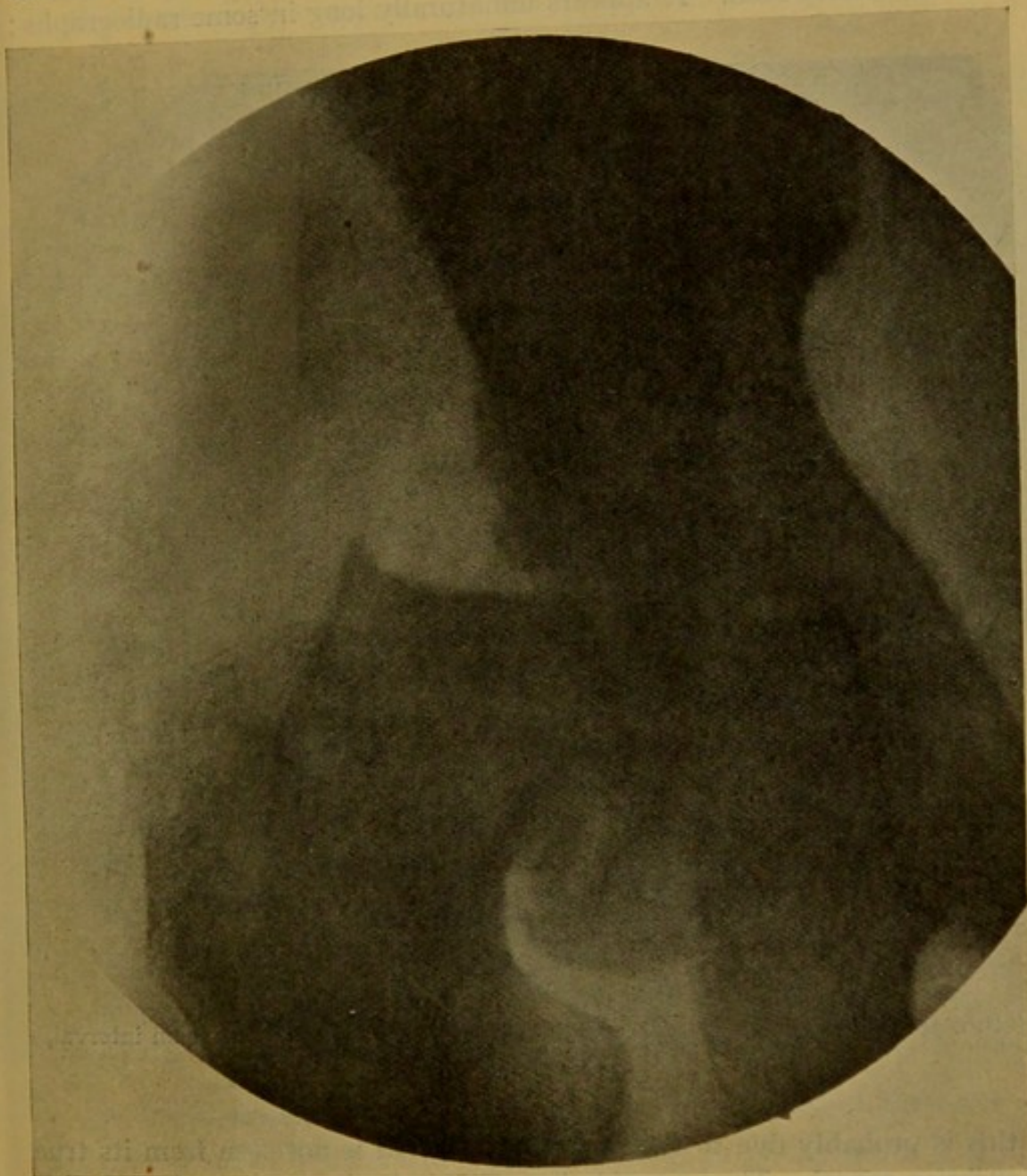


FIG. 9. Radiograph of a case of separation of the epiphysis of the head of the femur.

Radiographs of Coxa vara. In acute traumatic Coxa vara a definite downward displacement of the epiphysis of the femoral head is seen, the upper part of the fractured end of the neck appearing above as a prominence. In cases following at an interval after an accident, after several slight accidents, or without any accident, the appearances are

almost identical and are as follows: The head of the femur is displaced downwards, so that the lower part of its joint surface no longer lies in the acetabulum. In spite of the fact that most radiographs are taken with the limb everted, the head does not appear unnaturally large; this indicates that it is displaced posteriorly. The epiphyseal line is, as a rule, clearly seen. It appears unnaturally long in some radiographs;

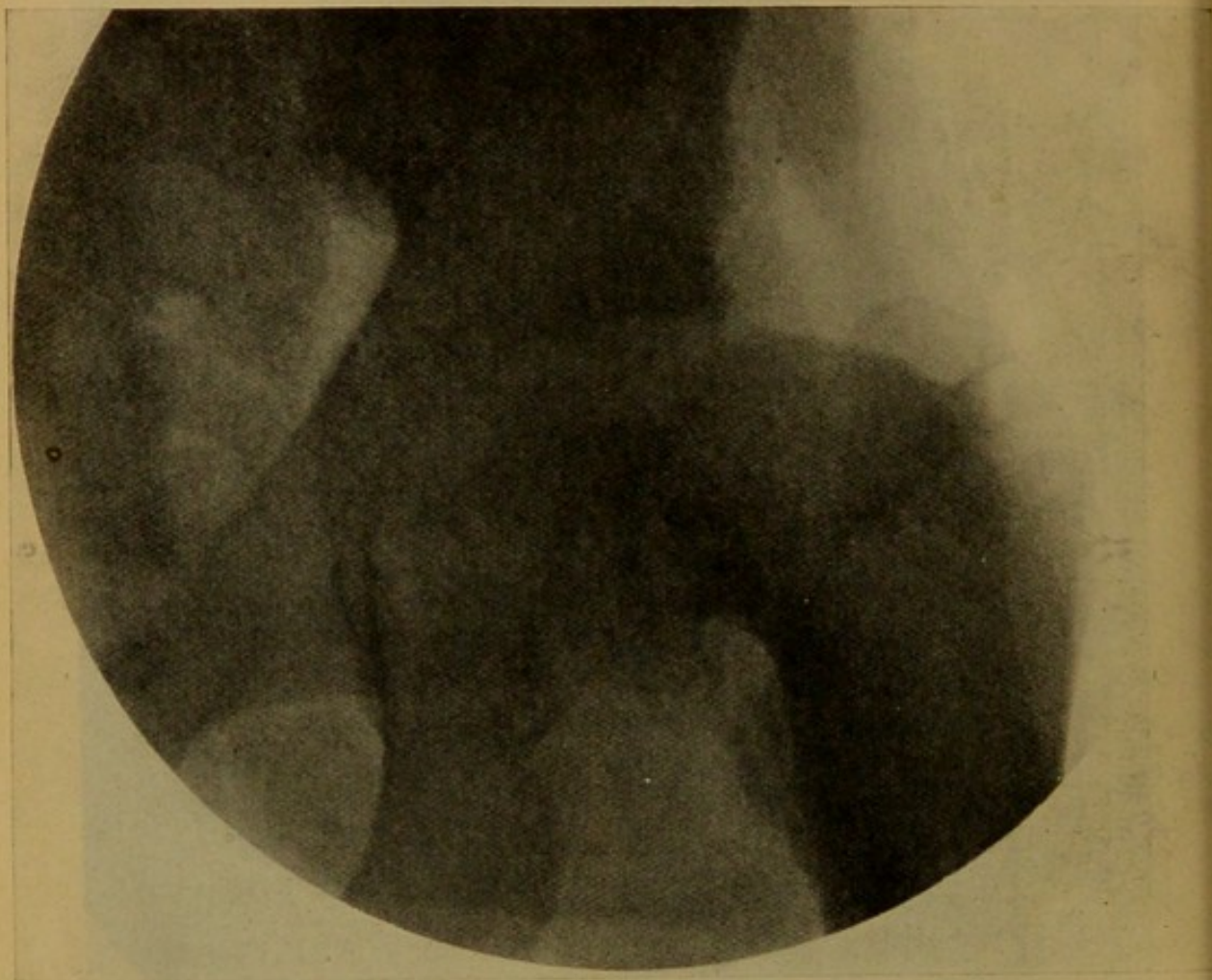


FIG. 10. Radiograph of a case of adolescent Coxa vara arising after an interval, after an accident.

this is probably due to the fact that the head is not seen from its true anterior aspect. Thus, considering the epiphysis as a cup-shaped disk with the concave side towards the neck, the view includes part of this concave surface. The femoral neck in most cases shows two parts: the part next to the shaft has its natural direction, at any rate as regards its lower border; the upper part, though springing naturally from the trochanteric region, being rounded off above. The part of the neck near the head, however, slopes downward and inward to join it; the lower border here takes as a rule a sharp downward curve like a hook, and below the head overhangs it 'like a mushroom'. The upper border

of this part forms a continuous upward convexity, internally continuous with the surface which faces the epiphyseal line; it shows, however, in many radiographs a prominence varying in size and situated nearly opposite the upper margin of the acetabulum. This, doubtless, is the spot to which the outer extremity of the epiphysis was attached.

These radiographic appearances are sufficient to establish the seat of

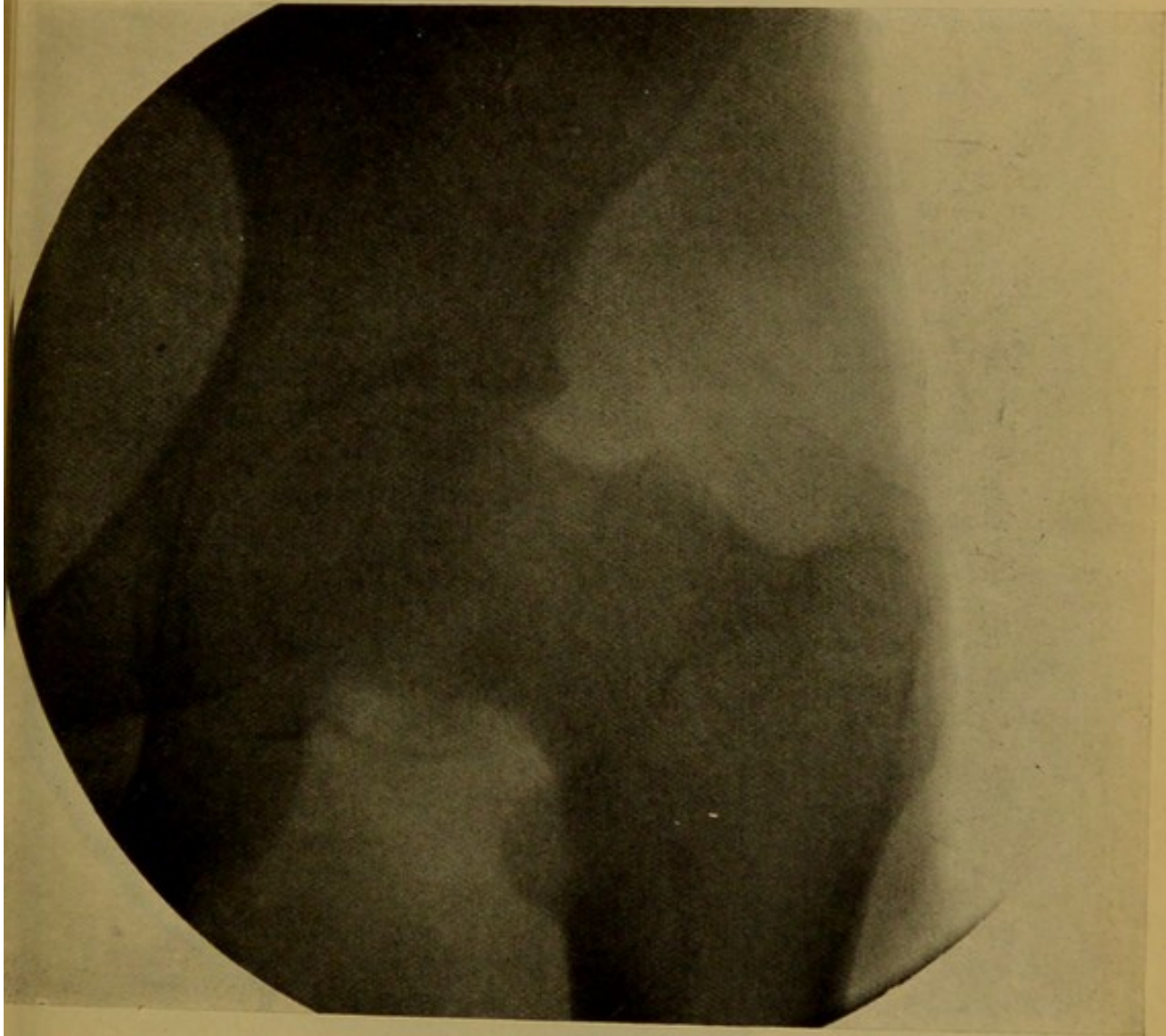


FIG. 11. Radiograph of a case of adolescent Coxa vara in which there was no accident.

the lesion in adolescent Coxa vara as being in the neck close to the epiphyseal line. This, though put forward long ago by Sprengel and Schlesinger and later by myself, does not seem even yet to have been generally accepted.

With stricter differentiation of the cases of this deformity into their respective classes and a better radiographic method there is no doubt, however, that this slipping of the epiphysis will be found to be the anatomical condition in all adolescent cases; indeed, in the absence of any process of softening of the bone already formed, the only point in the

femoral neck at which the deformity can be conceived as being gradually but rapidly produced is in the region of the new bone near the epiphyseal line. A consideration of the descriptions of resected specimens, both

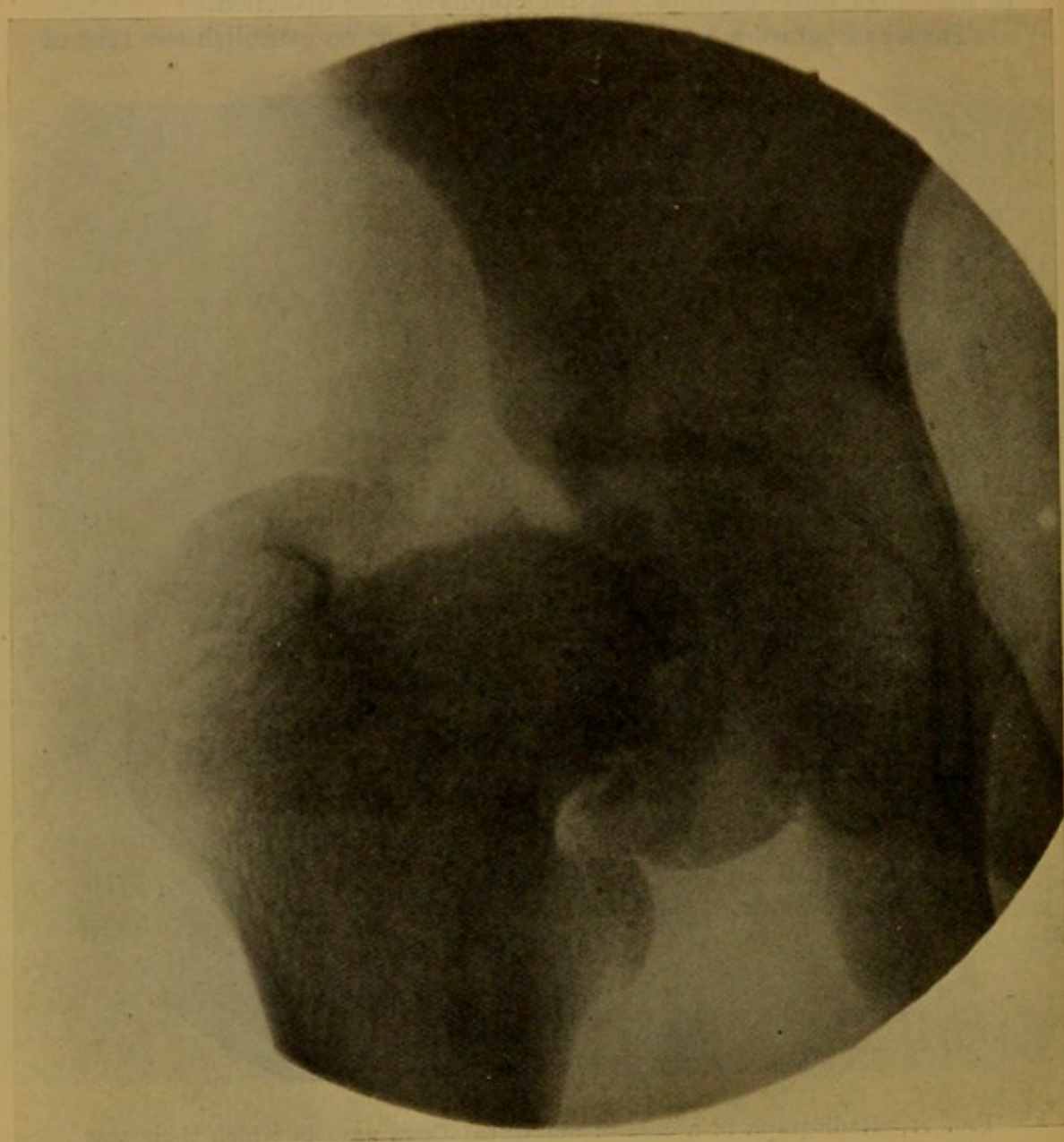


FIG. 12. Radiograph of a case of adolescent Coxa vara in which the deformity followed repeated accidents due in each case to muscular violence.

traumatic and non-traumatic, renders support to this view of the pathological anatomy.

The microscopic changes described by different observers have been various; they can be reduced to the following: (1) Irregularity in growth of the epiphyseal cartilage with irregular ossification; this leads to the production of columns of cartilage cells which contain several

cells in a capsule and occasionally also to the inclusion of cartilage islands in the bone. (2) Absorption of the bone in places, and formation of new bone in others, probably secondary changes adapting the bone to new pressure conditions. The irregular ossification is similar to, but never as extreme as, that in rickets, but its significance in this respect is destroyed by the fact that exactly similar alterations were found by Cornil and Coudray after traumatic separation of an epiphysis in rabbits. In fact, all the alterations may be explained as resulting from injury ;

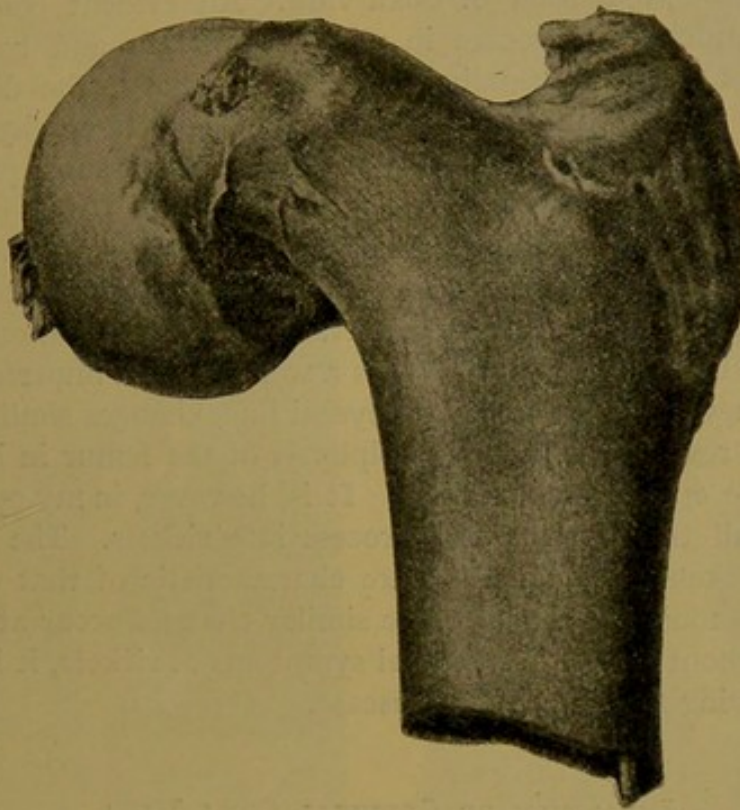


FIG. 13. Upper end of femur from a case of adolescent Coxa vara in which resection was carried out by Schlesinger.

the injury being, perhaps, not any actual accident, but rather consisting in the altered pressure conditions to which the epiphyseal region is being subjected. The observed changes may, in other words, be entirely the result, and in no sense the cause, of the deformity.

Sufficient has now been said to make it clear that it is not necessary to assume conditions of local osteomalacia or such-like pathological conditions in order to explain adolescent Coxa vara. It is quite evident that the deformity is the slipping backwards and downwards of the head of the femur upon the neck ; the only question that is now left open is the cause of the slipping. Now that we are aware how slight are the accidents which will cause the separation of this epiphysis and how trivial the resultant symptoms are, it is easy to suppose that many of these accidents, occurring perhaps six or eight months before the onset

of a Coxa vara deformity, have passed completely from the memory of the patient, or are related only after very careful questioning. The occurrence of Coxa vara, moreover, largely among patients of a working class, whose work is rough and who are liable to many slight injuries of which they take little notice, is further in favour of the great importance of the traumatic factor. Whilst, therefore, it is certain that there is a great difference in the ease with which this slipping of the epiphysis occurs in different individuals, I believe that more and more importance will in the future have to be assigned to these slight accidents in the production of Coxa vara. An evident corollary from this is that much greater care in the examination and treatment of these injuries than is usually taken is necessary, the diagnosis by means of a radiograph of the existence of a juxta-epiphyseal sprain or partial diastasis ought to save the patient from subsequent severe deformity.

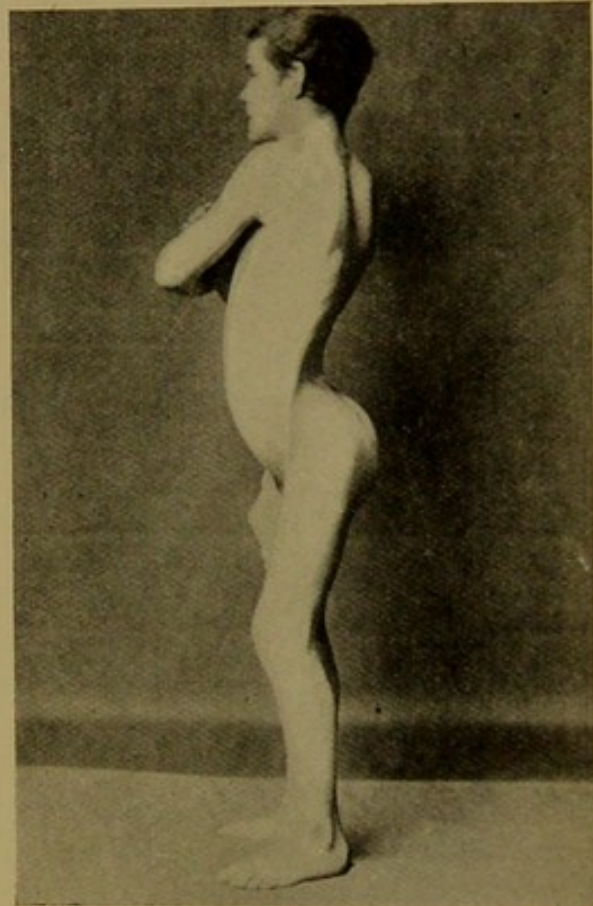
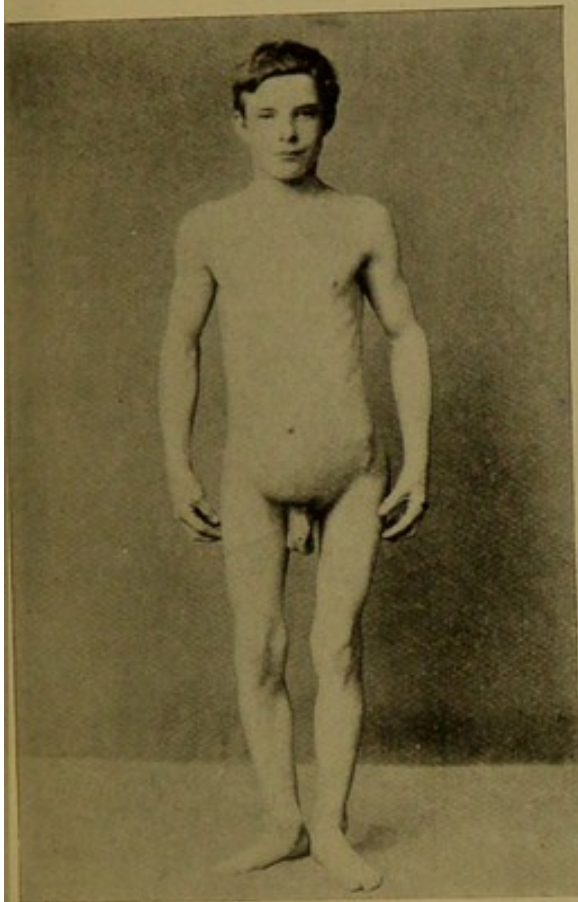
But all cases are not traumatic in origin. For some, another explanation of the occurrence of this slipping of the epiphysis is necessary, and this is particularly so for the rare bilateral cases. In these non-traumatic cases it must be assumed that there is a weakness, an imperfect ossification, of the new bone near the epiphyseal line, changes similar to those found in the region of the lower epiphysis of the femur in knock-knee and in all the epiphyses in rickets. It is, however, in my opinion misleading to call this purely local process late rickets. The epiphyseal changes of rickets although they are characteristic of that disease are not pathognomonic of it, and where similar changes occur at particular epiphyses without any of the general symptoms of rickets, it is better to avoid identifying them with that disease.

INFANTILE OR CERVICAL COXA VARA

The cases of Coxa vara occurring in children before the adolescent period present very distinctive features. This group was recognized by Hofmeister under the name of Coxa vara adducta, and by other German authors is alluded to as Coxa vara of healthy children—that is, children not suffering from rickets.

Clinical History and Symptoms. Coxa vara in children is more equally distributed between the two sexes than it is in adolescence; of 34 cases there were 13 boys and 21 girls. So that the proportion of boys to girls is the reverse of that in the adolescent form. A bilateral deformity was present in 10 out of 34 cases, again a much larger proportion than in adolescents, and this observation is corroborated by the literature. The onset of the condition is apparently very insidious, parents or patients being in many instances unable to fix even approximately the time when the symptoms appeared. In a considerable proportion, however, a waddling gait is noticed when the child first commences to walk; in others the symptoms become evident between

the ages of six and eight years—that is, when the child commences to grow rapidly. The patients may come under observation at ages varying from five years upward; there is no essential difference in the symptoms at the different periods, but there are great differences from the adolescent form. The hip is permanently flexed often as much as 30° to 40° and greatly adducted, the limb being sometimes inverted but usually everted, though the extreme eversion seen in some of the adolescent cases does not occur. The movements of the hip-joint are never restricted in all



FIGS. 14 and 15. Photographs of a case of bilateral Coxa vara of the infantile or cervical type.

directions and there is no period of immobility, but complete extension is generally impossible, rotation is often limited both in the outward and inward direction, and abduction is usually completely abolished. The result of this condition of the hip-joint is to cause lordosis, and sometimes in unilateral cases much apparent, as well as an inch or more real shortening, the great trochanter being displaced upwards to a degree corresponding with the real shortening. In the bilateral cases the lordosis is usually very great, the legs tend to cross, and walking is very irksome, the body swaying from side to side and the whole condition simulating that of double congenital dislocation of the hip. The symptoms increase in severity with growth; there is great disability, and often periods of

considerable pain in the hip occur, brought on by any exercise, as well as the stiffness and discomfort which patients with Coxa vara always feel after sitting still.

Occasionally there is a clear history of this variety of Coxa vara following injury. Joachimsthal first described such a case arising in a little girl after a slight injury occurring in the fifth year, in which the clinical and radiographic appearances corresponded exactly with those

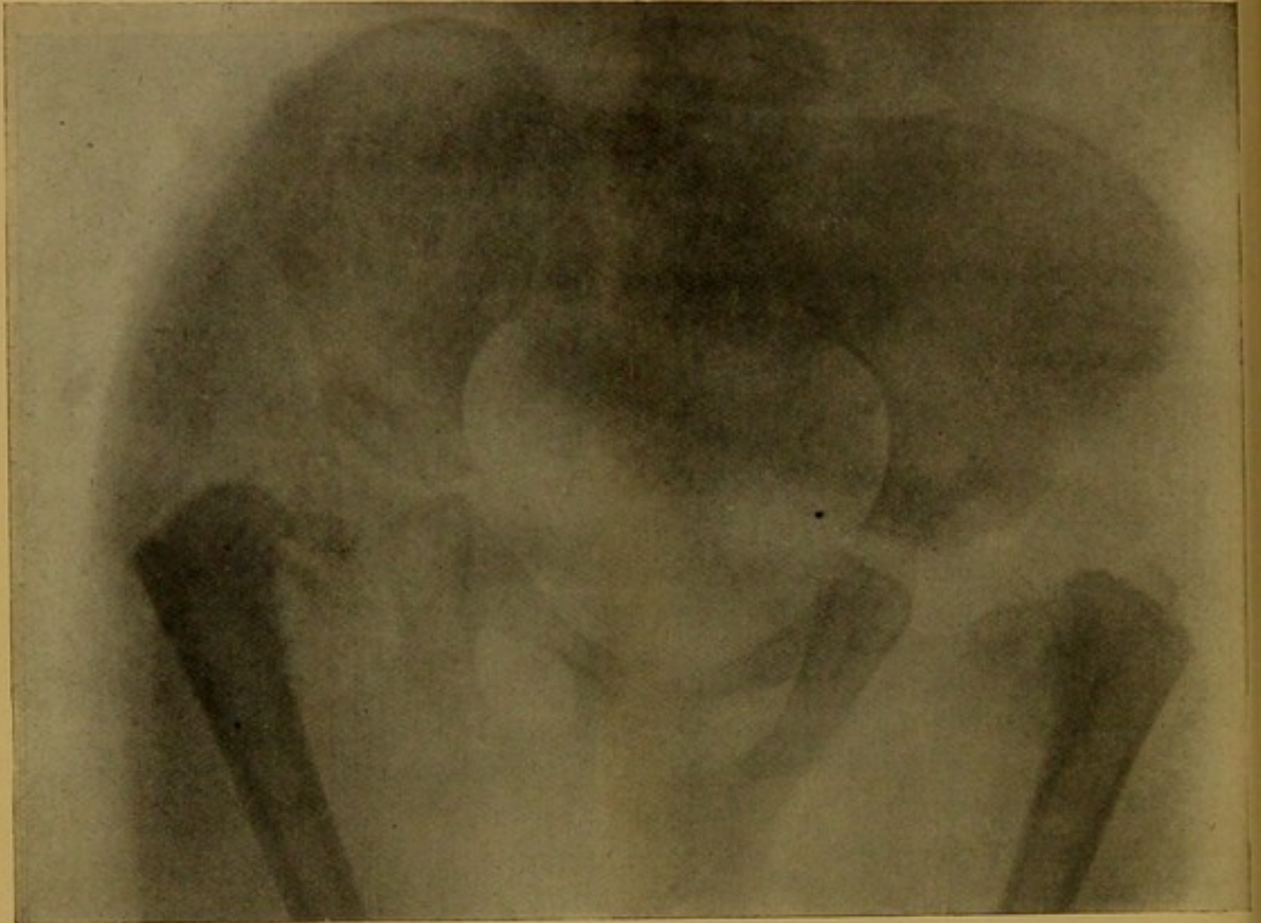


FIG. 16. Radiograph of a case of bilateral infantile Coxa vara in a child aged 5, showing displacement downward of the head of the bone, carrying with it the epiphyseal line and a fragment of the bony neck.

in the non-traumatic cases; several such cases have come under my notice.

Pathological Anatomy. For the pathological anatomy of this variety of Coxa vara we have to look chiefly to radiographic evidence; the only two resected specimens are those of Hoffa and Robert Jones, both showing late stages of the deformity. Specimens from another bilateral case are in the museum of St. Bartholomew's Hospital; they were removed from the body of a woman in the dissecting-room and were without history; they have hitherto been catalogued as fractures of the femoral neck, but having regard to the fact that the condition was bilateral and that

the appearances agree exactly with those in Robert Jones's specimen, I think there can be no doubt that they are really instances of this deformity.

In radiographs of three cases of the deformity taken at the age of five years, a downward displacement of the head of the femur, carrying with it the adjoining portion of the base of the neck, is seen. If this has occurred in the manner shown in the diagram (Fig. 17), at some time before the cartilaginous bridge in the upper part of the femoral neck has disappeared, it will be understood that the lower part of the separated fragment will probably be retained in apposition with the base of the femoral neck by its periosteal covering, whilst in the upper part a V-shaped gap will appear owing to the solution of the continuity of this cartilaginous bridge. This displacement, whether occurring as the

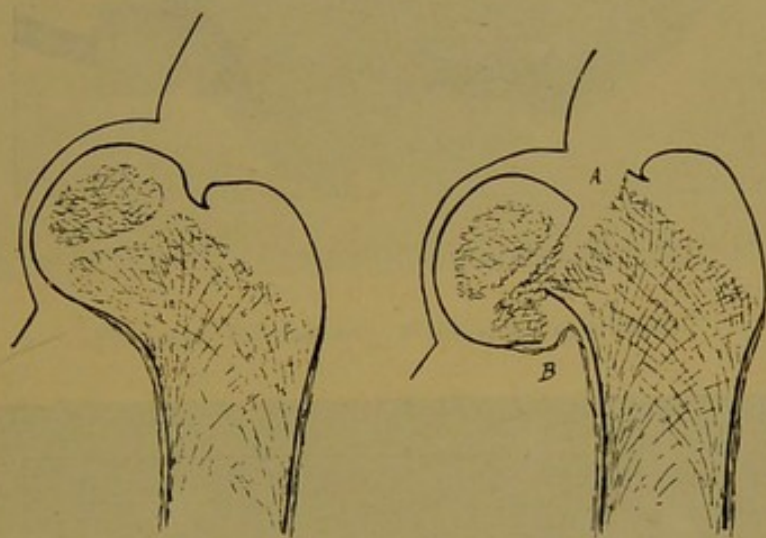


FIG. 17. Diagrams illustrating the mode of production of infantile Coxa vara :
A, V-shaped gap in the femoral neck, which becomes filled with fibrous tissue ;
B, periosteal attachment to lower border of neck.

result of a sudden accident or by a process of gradual slipping, exactly accounts for the appearances seen in radiographs. The normal epiphyseal line of the femoral neck is almost horizontal in direction, the newly formed bone being thus protected from cross strain ; when the head has been displaced, however, the downward pressure of the body weight transmitted through the upper margin of the acetabulum is directly transverse to the line of the gap that has been produced and nearly transverse to the epiphyseal line. It would therefore be expected that with increasing age the displacement of the head would increase owing to this mechanical factor. Moreover the neck of the femur, which develops from this epiphyseal line chiefly after the fifth year, will be developed in the wrong direction, owing to the line of growth being now nearly vertical instead of horizontal. Finally, it might be expected that below, where the displaced fragment remains in contact with the base of the neck and is covered by the periosteum, close union would occur,

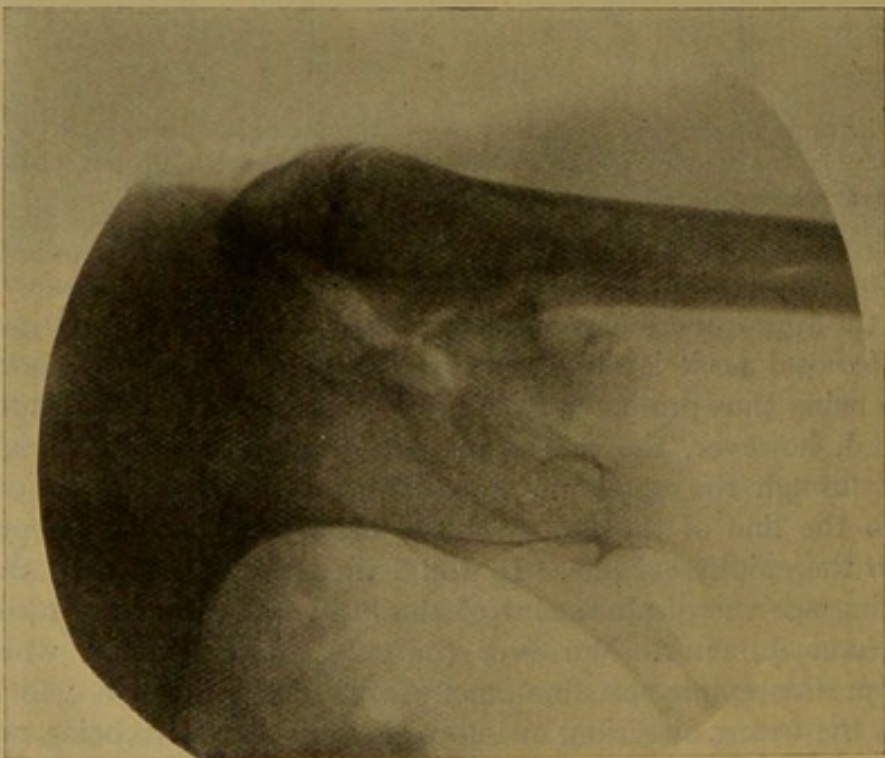


FIG. 18. Radiograph of a case of infantile Coxa vara in a girl aged 15 (bilateral), showing depression of the whole femoral neck, with a clear intersection due to fibrous tissue.

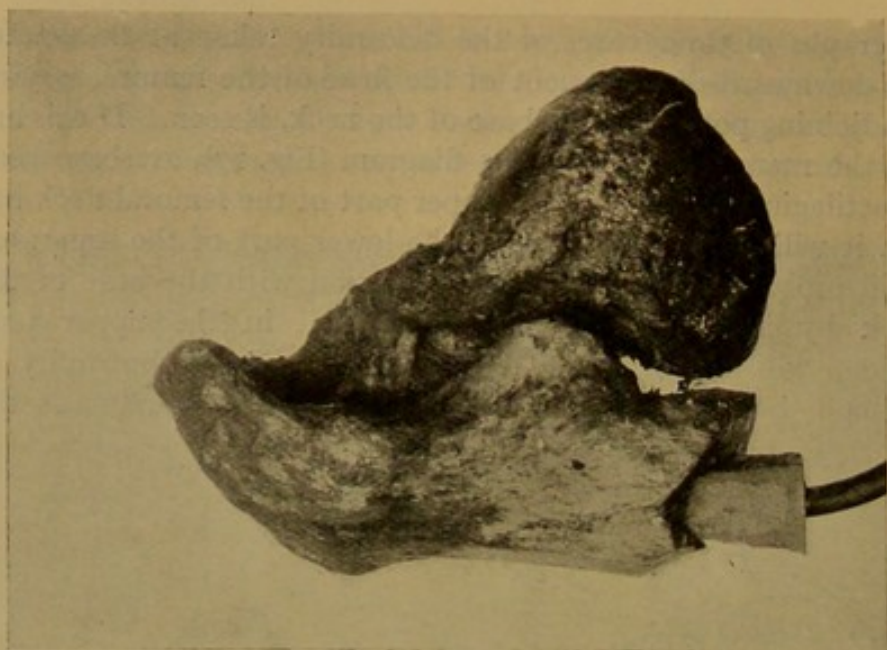


FIG. 19. The upper end of femur from a case of infantile Coxa vara in which resection was carried out by Mr. Robert Jones.

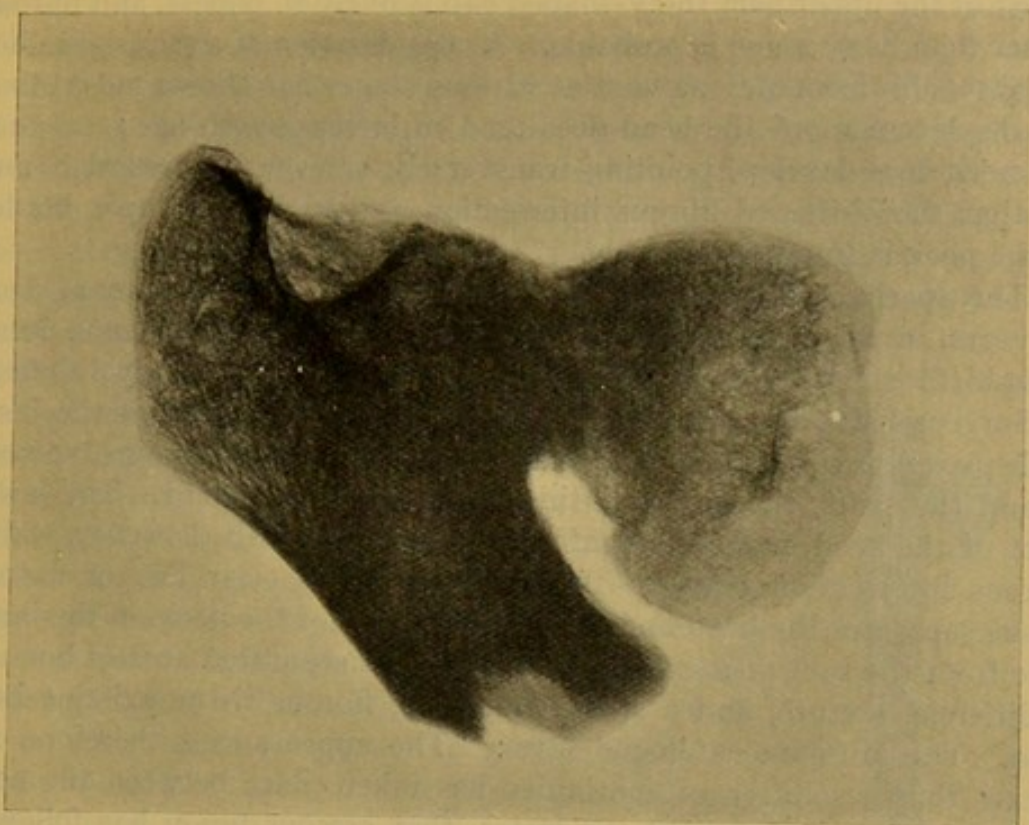


FIG. 20. Radiograph of the same specimen.

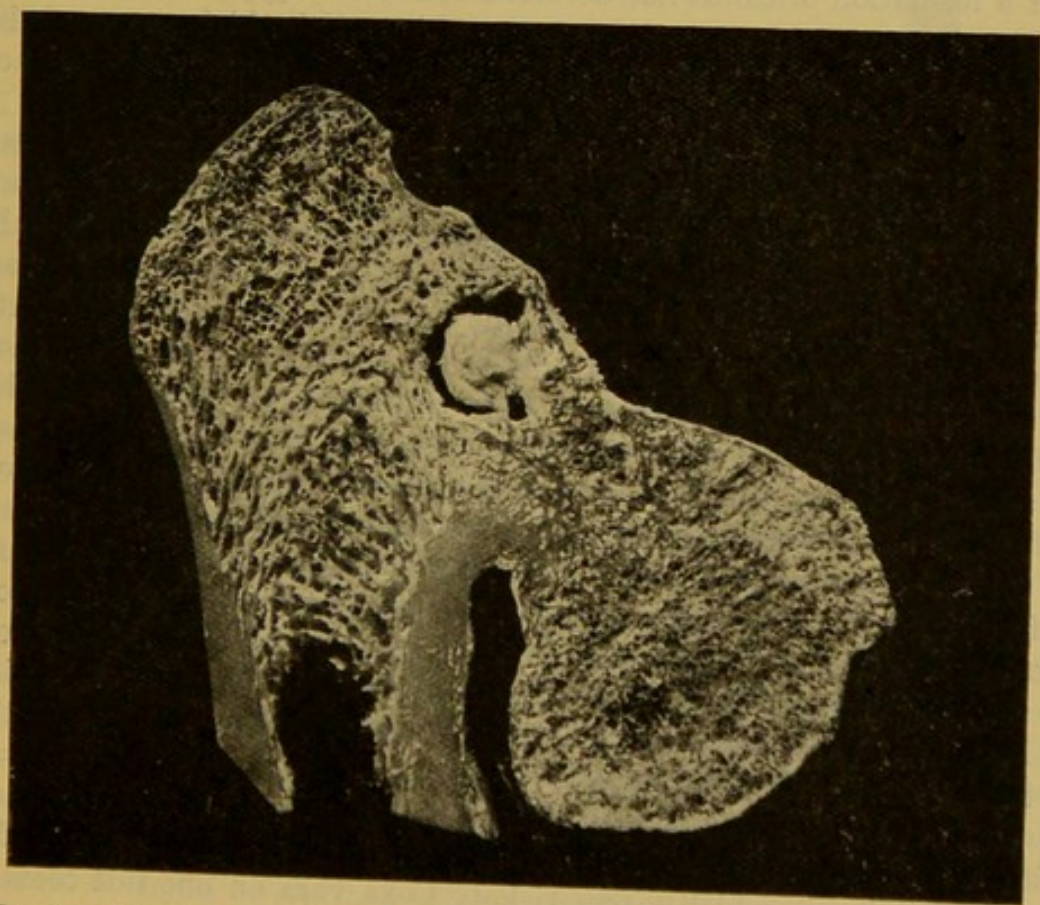


FIG. 21. A transverse section of the specimen, showing the appearances described in the text.

whilst in the upper part the V-shaped gap is likely to persist, and fibrous rather than bony union is probable. A consideration of a series of radiographs of this form of Coxa vara at various stages has shown me (1) that the displacement of the head does tend to increase with age; (2) that the neck does develop, pointing transversely or even downwards; and (3) that the V-shaped fibrous intersection or gap in the upper border of the neck is frequently visible.

The specimen resected by Mr. Robert Jones from a woman, aged 26 years, in whom both hips were affected, and whose symptoms dated from birth, shows very well the condition finally attained (Royal College of Surgeons Museum, Specimens 1785 *d* and *e*). The head of the bone is displaced downward, so that only a narrow interval remains between it and the shaft, the neck pointing downward and inward. The lower part of the head, neck and shaft are continuous, with, however, a fine fibrous intersection between them; above this a clear line of fibrous tissue separates the head and the adjacent part of the neck on the inner side from the root of the neck on the outer, a separated area of bone of a different texture, and a space containing fibrous tissue existing here also. The Museum catalogue says: 'The appearances, therefore, indicate that a solution of continuity has taken place between the neck and the head close behind the latter, that osseous union has followed between the opposed lower portion of the neck and the head (?), and that a formation of callus has occurred upon the exposed surface of the neck and occupies the interval between this and the higher part of the head.' The specimen already mentioned as existing in the museum of St. Bartholomew's Hospital shows a very similar condition.

Causation. Such, then, is the pathological anatomy of infantile Coxa vara. What factors take part in its causation? (1) Accident may undoubtedly directly cause the lesion; this is proved by Joachimsthal's case, and by other cases, in which the symptoms and radiographic appearances were identical with those in the non-traumatic cases. (2) Birth injury I have suggested as a possible factor, especially in the production of bilateral cases; it is, however, difficult to prove. (3) Rickets; this deformity is not an ordinary rickety curvature; so much is quite clear, but many children in whom it occurs are stated by their parents to have suffered from rickets in infancy, the disease leaving, however, no trace in any other part of the body. Probably the softening of the bone and defective ossification, in the first years of life permits the first displacement of the head. Then when all active rickets, indeed when all evidences of old rickets, have disappeared, the mechanical factor of the direction of pressure of the body weight serves to cause steady increase of the deformity of the hip or hips.

Rickets, as I shall presently mention, causes a form of Coxa vara, with a different pathological anatomy, but one case has come under my observation in which a true rickety Coxa vara on one side coexists with a typical infantile Coxa vara on the other side, the latter in the

radiograph showing all the appearances already described, including the V-shaped gap in the upper part of the neck.

A few cases of Coxa vara arising in early childhood show clinical symptoms of a moderate degree of deformity of the infantile type above described, but the neck is found to be longer and stronger, and there is no fibrous intersection. A specimen of this type of the deformity is in the museum of St. Bartholomew's Hospital; unfortunately it was found in a dissecting-room subject, and is without history. These are probably cases of the infantile type of Coxa vara in which the displaced head has become united to the shaft by bone, and a stout neck has then developed in a more or less horizontal direction, the architecture of the bone adapting itself to the unusual pressure conditions. Additional evidence of this view is found in the occurrence of cases in which it is difficult to say with which of these two types of the infantile variety of the deformity a case should be classed. In addition, a case referred to later in which osteotomy of the femur was performed appears to have developed as the result of the alteration in the line of pressure from a typical case of the first class into a case of the second class, with a strong bony neck.



FIG. 22. Photograph of a specimen of infantile Coxa vara, in which there is a strong bony neck without any fibrous intersection.

Rickety Coxa vara. I turn next to rickety Coxa vara. At the age at which rickets is usually active, i. e. in the first and second years, the femoral neck is very short, has a wide angle, and is largely cartilaginous. This serves to explain the fact that the depression of the femoral neck is not common as the result of infantile rickets. In those rarer cases, however, in which the rhachitic processes in the bones continue after infancy (continued, late, or recrudescent rickets) depression of the neck is commonly found when a radiograph is taken. The anatomical condition, however, is a depression of the whole neck, usually with an antero-external convexity in the adjoining part of the femoral shaft, and unaccompanied by any displacement of the epiphysis. The symptoms present are lordosis, a waddling gait, and sometimes limitation of movements of extension, abduction, and inversion of the hip-joint. Save for the lordosis, however, the symptoms are not very evident, and are usually overshadowed by those of other deformities present. The fact that this special form of Coxa vara is found constantly in these, the very worst cases of rickets, is very strong evidence that infantile and adolescent Coxa vara, which have a totally different pathological anatomy, cannot be ascribed to a purely rhachitic origin.

Congenital Coxa vara. The deformity of Coxa vara as a rule only

becomes evident when the child begins to walk; it is on this account very difficult to prove that in any case the deformity was truly congenital. It is quite possible that some cases classed as infantile Coxa vara have the deformity at birth. I have indeed suggested that an injury at birth

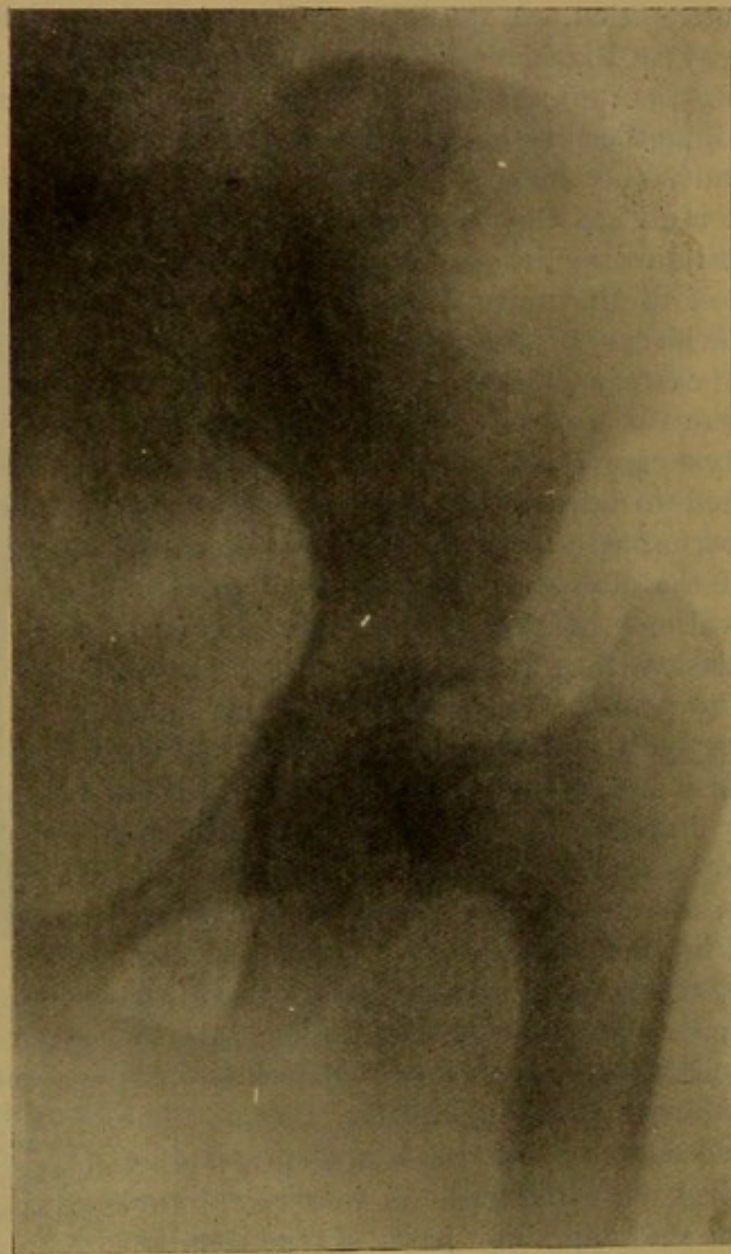


FIG. 23. Radiograph of a case of Coxa vara of the infantile type with a strong bony neck at right angles to the shaft.

may be one of the factors in the production of this deformity. However, occasionally congenital imperfections of the upper epiphysis of the femur do occur, there being as a rule other associated defects of the limb. In five cases which have come under my notice there was defective growth of the femur in four, there being great shortening in each case, and in one case also a considerable degree of obliquity of the condyles

of the femur, so that in these cases apparently the upper and lower epiphyses of the femur were both affected. In the fifth case there was Coxa vara on both sides, congenital talipes on one side, and a diminutive paralysed hand on the other. Anatomically these cases are of the cervical type—that is, the neck is depressed at its root as in infantile cases. There is, however, a strong although short neck and no fibrous intersection. The secondary adaptive changes in the bone are considerable, the architecture being altered and the articular surface extending further

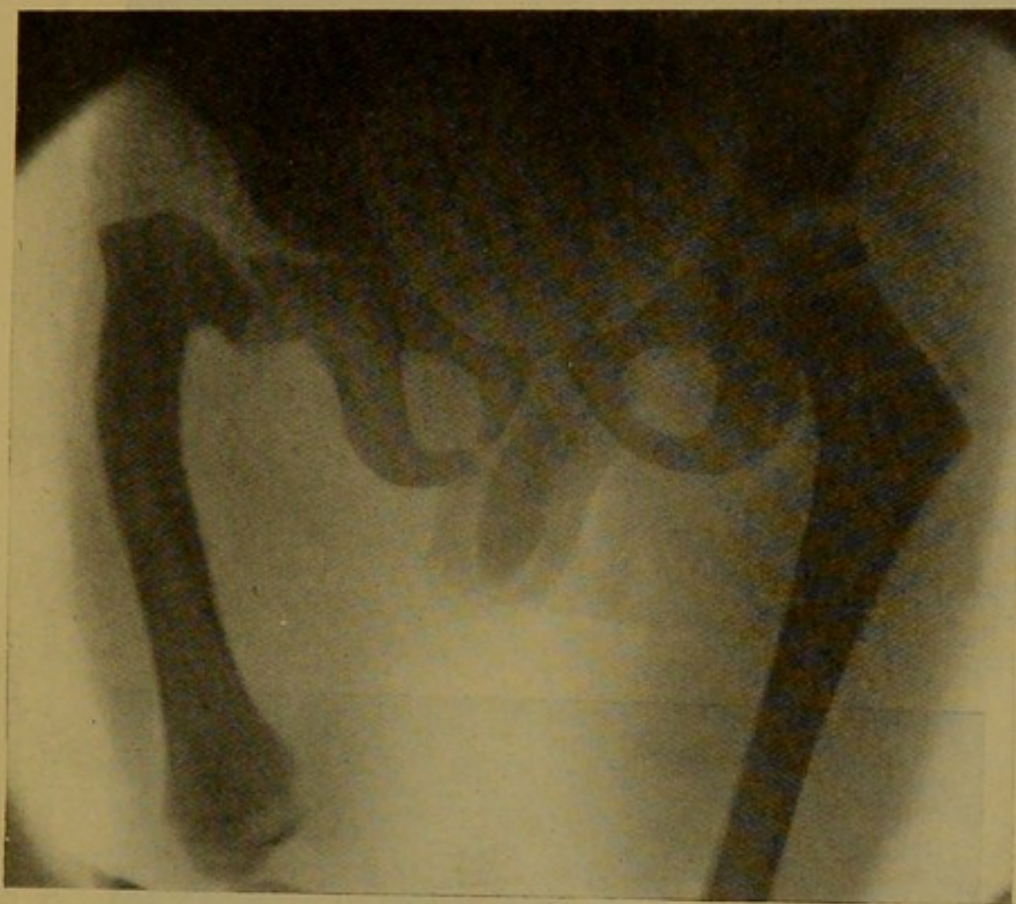


FIG. 24. Radiograph of a case of congenital Coxa vara with defective growth of the femur.

outwards than usual over the upper part of the head, so that anatomically these congenital cases are most like those described in the second class of infantile cases.

PATHOLOGICAL CONCLUSIONS

Coxa vara is a deformity, then, of the upper epiphyseal region of the femur, and varies in its anatomy as it comes on: (1) before birth, when a strong neck pointing in an abnormal direction results; (2) during the first five or six years of life, whilst the neck of the femur is largely cartilaginous, when the depression is at the root of the neck of the femur, with usually a fibrous intersection across the neck; (3) during adolescence,



FIG. 26. Radiograph of the same case.

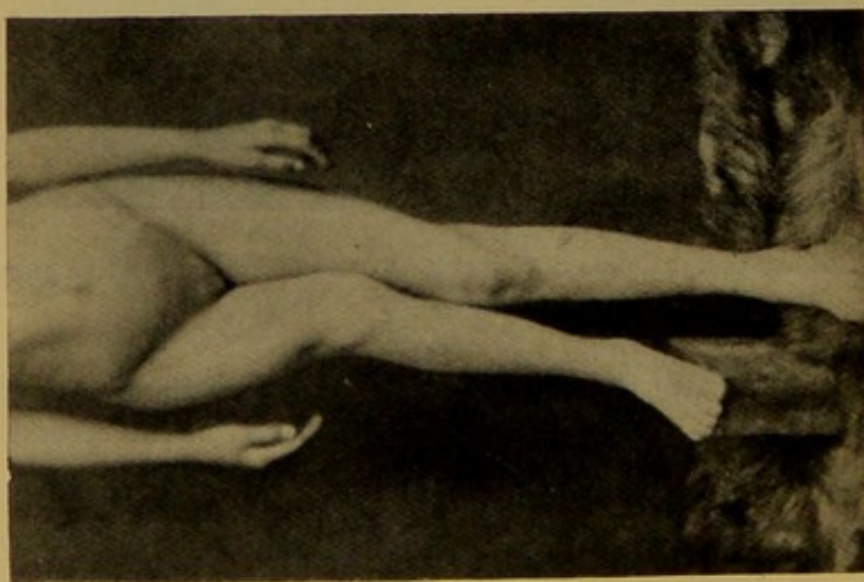


FIG. 25. Photograph of a case of congenital Coxa vara in which there was defective growth of the femur.

when there is a slipping downwards and backwards of the epiphysis. This deformity is undoubtedly due often to accident; there is a difference of opinion among authors as to whether the more usual accident in childhood is a displacement of the epiphysis or a fracture of the

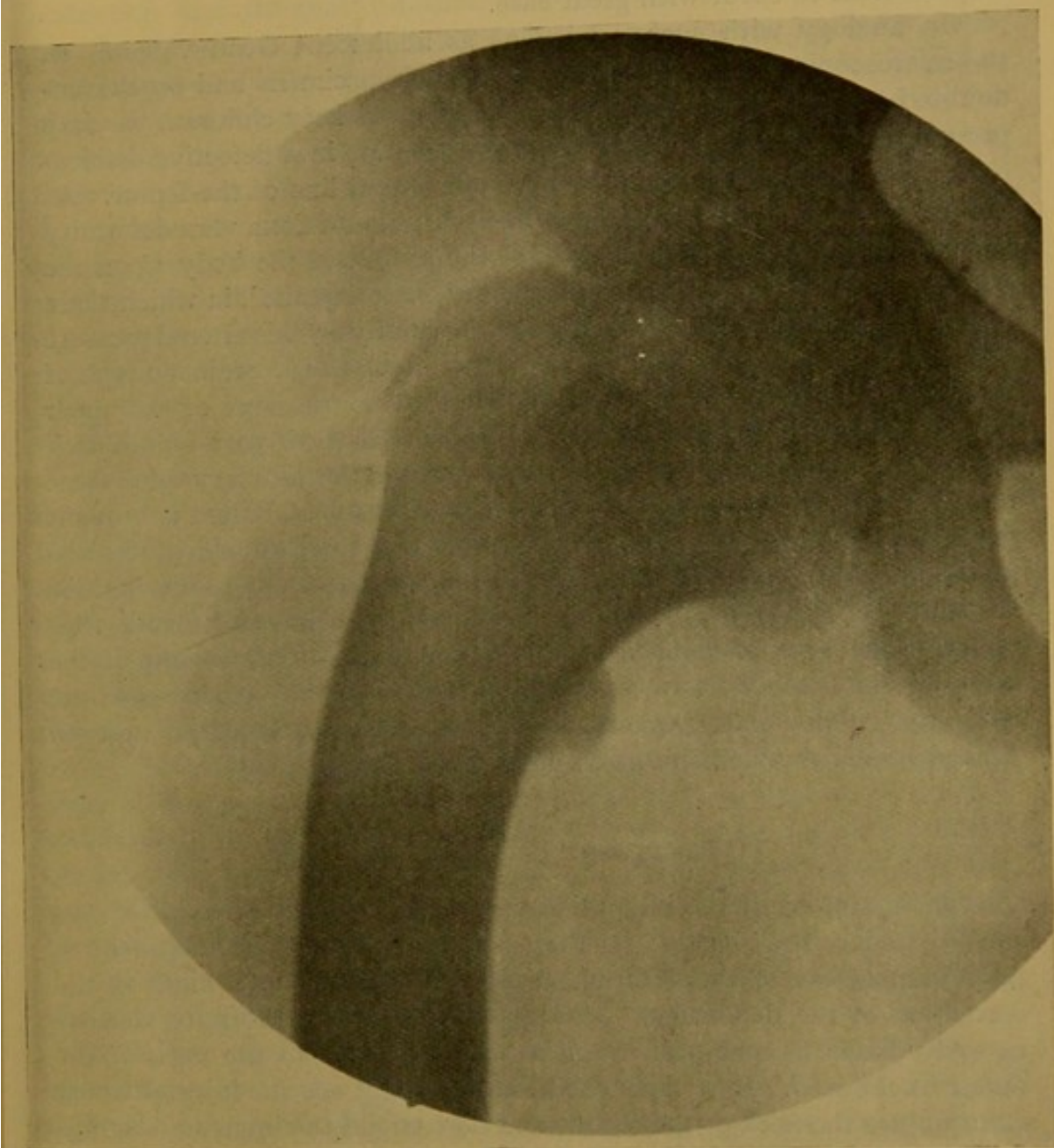


FIG. 27. Radiograph of a case of ricketsy Coxa vara.

neck; the truth, I believe, is that during the earlier years of life, before there is a well-shaped neck, the accident is a fracture of the neck; later, when there is a well-formed neck and a transverse epiphyseal line separating it from the head, the injury is a separation of the epiphysis. We find, therefore, that the Coxa vara of young children is cervical in type, the Coxa vara of adolescence is epiphyseal. Accident will not account for all cases, but we know that the non-traumatic cases have the same

pathological anatomy as the traumatic cases occurring at the same age-period, we must presume, therefore, that in them there is the same displacement, but that there is no definite injury to produce this, that some local pathological condition of the bone exists which enables such displacement to occur with great ease.

On analogy with such conditions as adolescent Genu valgum, on the microscopic findings in cases of resected specimens and on the undoubted occurrence of infantile Coxa vara in rickety children, we may presume that this pathological condition consists in a defective ossification of the bone formed at the upper epiphyseal line of the femur. As has already been briefly indicated, the occurrence of Coxa vara deformity alters the direction of the pressure of the weight of the body upon the neck of the femur. In those cases, such as the congenital, in which there is a strong neck and no displacement of the epiphysis, this altered pressure will not tend to greatly increase the deformity. In the ordinary type of infantile case, however, this alteration brings the pressure of the upper margin of the acetabulum directly across that weak part of the neck which contains the fibrous intersection, and in the ordinary adolescent form similarly the pressure of this margin of the acetabulum is brought directly across the region near the epiphyseal line, at which the displacement of the head of the femur has taken place. As a result, in these two forms of Coxa vara, when once a moderate degree of deformity has arisen, there is a mechanical factor in the shape of the weight of the body acting through the acetabulum which will tend to increase the deformity, quite apart from the existence of any pathological process. This mechanical point is of great importance in treatment.

TREATMENT OF COXA VARA

The treatment of the idiopathic varieties of Coxa vara may be considered under three heads: (1) Preventive treatment; (2) Treatment to prevent progress of the deformity; (3) Treatment which aims at the correction of the deformity. The prevention of the deformity consists in early diagnosis and proper treatment of injuries to the neck of the femur in children. Now that we know how slight are the injuries which can fracture the neck of the femur, and how trivial the immediate symptoms may be, we should, for safety's sake, radiograph all possible cases. Such injuries to the neck of the femur must be treated in full abduction. This method, so strongly urged by Whitman, will effectually prevent many severe subsequent deformities.

The prevention of the increase of deformity in an established case of Coxa vara can only be carried out by relieving the limb of weight-bearing. The simplest method of doing this is to fit the hip with a Thomas calliper splint, of such a length that the heel is well clear of the bottom of the boot. The hip-joint is thus relieved of pressure without being immobilized; the latter is an important point, for to completely im-

mobilize the hip in a case of Coxa vara is to run the risk of getting much subsequent stiffness.

The deformities requiring correction are, in infantile cases, limitation of abduction and of full extension; in adolescent cases, limitation of abduction and internal rotation. In infantile Coxa vara correction may be carried out by osteotomy or by resection of the hip-joint, or in some cases possibly by forcible abduction, refracturing the neck. Division of the abductor muscles may be necessary in addition to any of these operations. In adolescent Coxa vara forcible abduction under an anæsthetic may be used to separate the head of the femur and replace it upon the neck in the correct position. Reposition can also be obtained by gradual abduction on a rack splint. In later stages, when the deformity is more fixed, it can be corrected by osteotomy or an attempt can be made to increase the mobility of the hip-joint by removing the spurs or ridges of bone from around the head.

It will be well now to take the different varieties of deformity at their different stages, and indicate the most appropriate treatment.

Adolescent Coxa vara, in the majority of cases, even if untreated, does not progress to form a severe deformity. Very occasionally the limitation of abduction or the eversion of the foot become considerable, but often the worst part of the eventual disability is the stiffness of the joint, resulting from treatment by fixation, therefore the evident line of treatment indicated in recent cases of adolescent Coxa vara is the protection of the hip-joint from pressure, without limiting its movements. This principle, as already explained, is best carried out by the use of the calliper splint. The other question arising in these recent cases is whether it is advisable in commencing treatment to secure full abduction of the hip. The evident method of securing this is to abduct the hip-joint forcibly under an anæsthetic, in the expectation that the head of the femur will remain in the acetabulum, and that the neck will be replaced accurately upon it.

The following case illustrates that this replacement is a possibility, but it also indicates that it is accompanied by a risk.

R. B. was admitted to St. Bartholomew's Hospital at the age of 14, after an injury to the left hip. He had fallen about four or five feet on to the pavement, striking his hip; on getting up he was able to walk. He had about five weeks before fallen on the same hip, but took no notice of the accident, although he walked a little lame after.

On admission to the hospital he had the typical deformity of adolescent Coxa vara, and a radiograph showed a separation of the epiphysis of the head of the femur. A fortnight later, under an anæsthetic, the hip was forcibly abducted and inverted and fixed on a splint. A radiograph showed that the epiphysis had been completely and accurately replaced. The splint was kept on for a month, the patient then being allowed to walk.

Three and a half years later he was readmitted to the hospital on

account of pain in the right hip, following a strain a fortnight previously. At this time the left hip was ankylosed, the limb adducted and everted, and $\frac{3}{4}$ inch shorter than the right. A radiograph showed absorption of the head of the femur and bony ankylosis. The right hip showed the characteristic deformity of adolescent Coxa vara, and a radiograph showed the usual appearances of displacement of the epiphysis. An extension was applied to the right limb, and a subtrochanteric osteotomy was performed to the left to correct the adduction and eversion.

The result in this case was probably due to the conversion of a partial separation of the epiphysis into a complete one, the nutrition of the

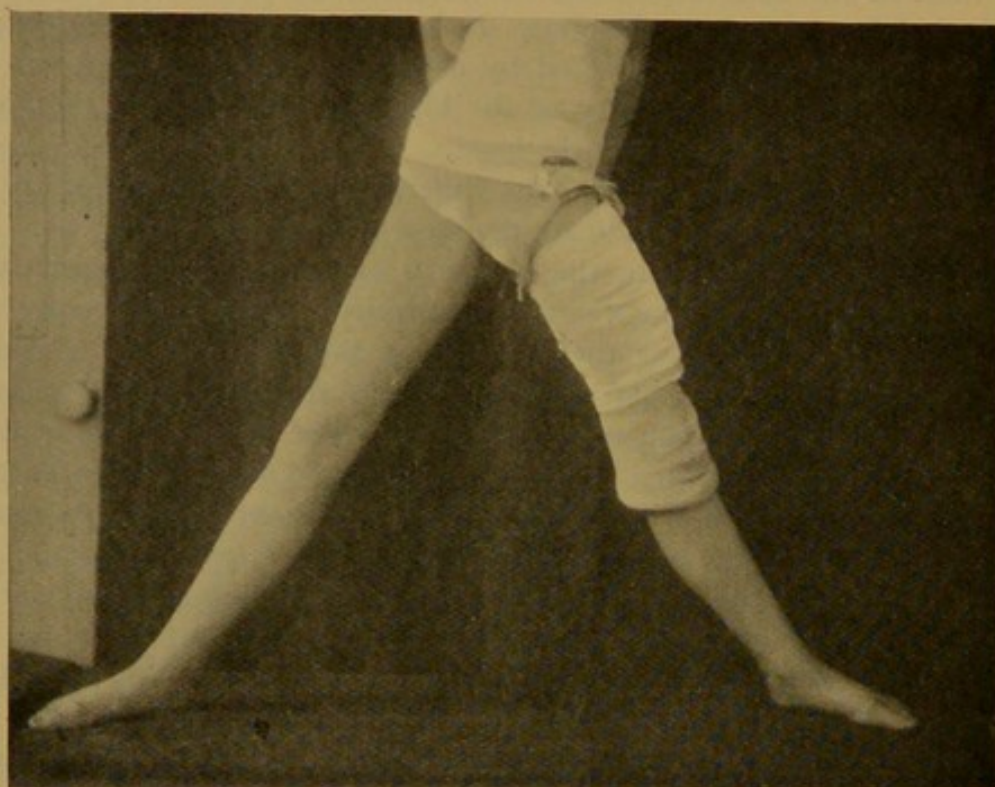


FIG. 28. Photograph of a case of adolescent Coxa vara fully abducted in a rack splint incorporated in plaster-of-paris bandages which surround the pelvis and thigh.

head of the femur being interfered with. It is of course possible in this case to ascribe ankylosis to a lack of proper after-treatment, but in untreated Coxa vara ankylosis never occurs; this case, therefore, makes one hesitate to employ such a method for correction of a deformity, the late stages of which we know not to be very severe. It occurred to me that it might be possible to obtain replacement of the head upon the neck by a more gradual abduction on a splint with a rack situated opposite the hip-joint. Although I have not as yet been able to obtain such a complete reposition, as evidenced by radiographs, yet I have shown that by such a rack splint I can in the course of a few weeks obtain full abduction of the limb. I therefore consider that recent cases of adolescent Coxa vara should be treated by such an abduction rack until full abduction is

obtained, and then fitted with a calliper splint to protect the hip-joint. The period for which this splint must be worn is a difficult one to decide; it would appear better to continue it until after the epiphysis has united, but this may prove tediously long in some cases. In a good radiograph an indication that it is safe to omit the splint may sometimes be seen in the formation of a well-marked group of pressure lamellæ, radiating upwards and inwards from the side of the lower margin of the neck to that part of the head which is in contact with the upper surface of the acetabulum. These pressure lamellæ are very well shown in a radiograph of an old case of adolescent Coxa vara in the museum of St. Bar-

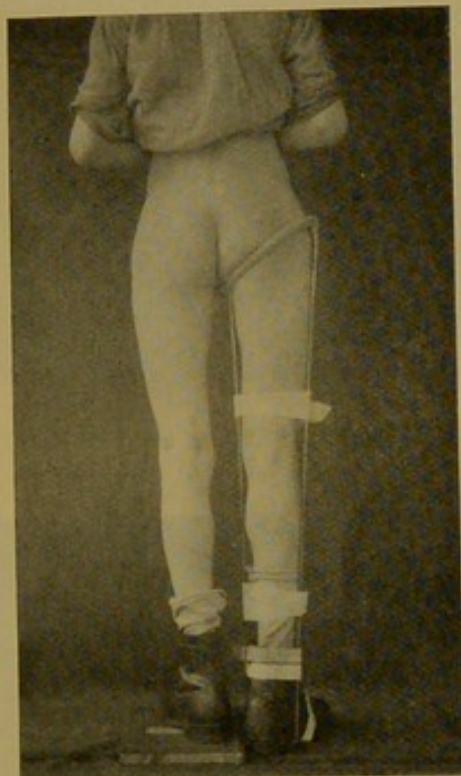


FIG. 29. Photograph of a case of adolescent Coxa vara fitted in a calliper splint of such a length that the heel does not reach the bottom of the boot. Note the book placed under the sound foot to equalize the length of the splint and the sound limb.

tholomew's Hospital. They indicate that the architecture of the bone has adapted itself to the altered conditions, and that the deformity is therefore not likely to increase further.

In recent cases no other treatment than that above described should be necessary, except possibly division of the adductor tendons. In old-standing cases, particularly those in which the epiphysis has joined, correction of the deformity by other means may be necessary.

Osteotomy has been widely advocated and practised. I believe in many cases it might have been replaced by slighter measures. It is, however, a reasonable operation, in a severe case, in which adduction or eversion require to be corrected. As a rule, subtrochanteric osteotomy

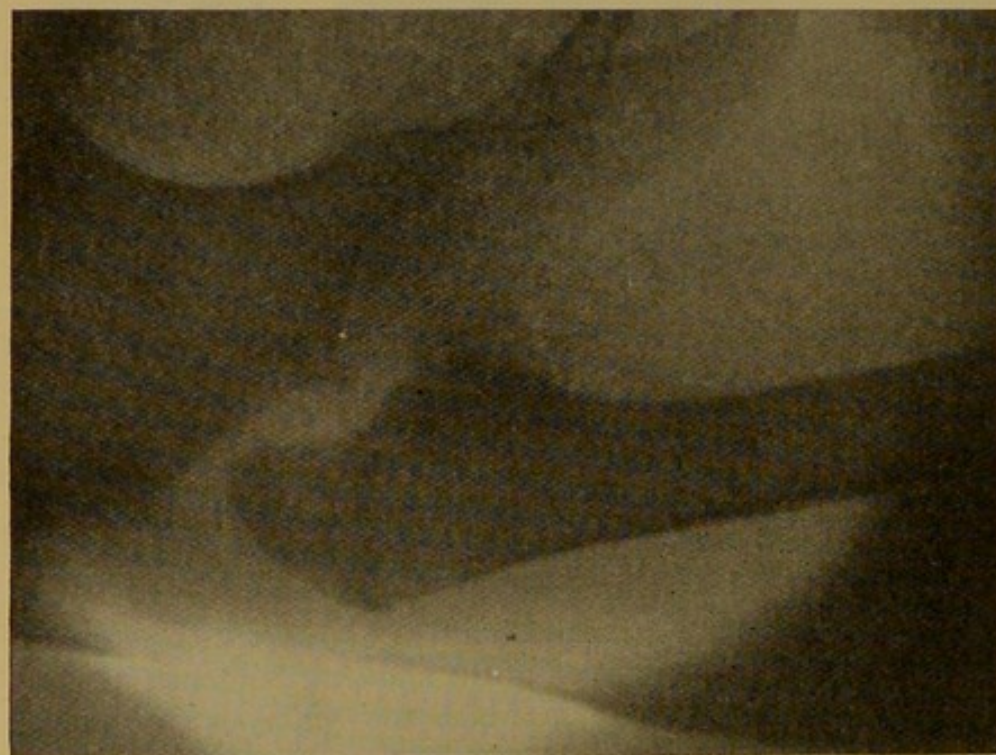


FIG. 30. Radiograph of the patient R. W., at the age of 13, before treatment.

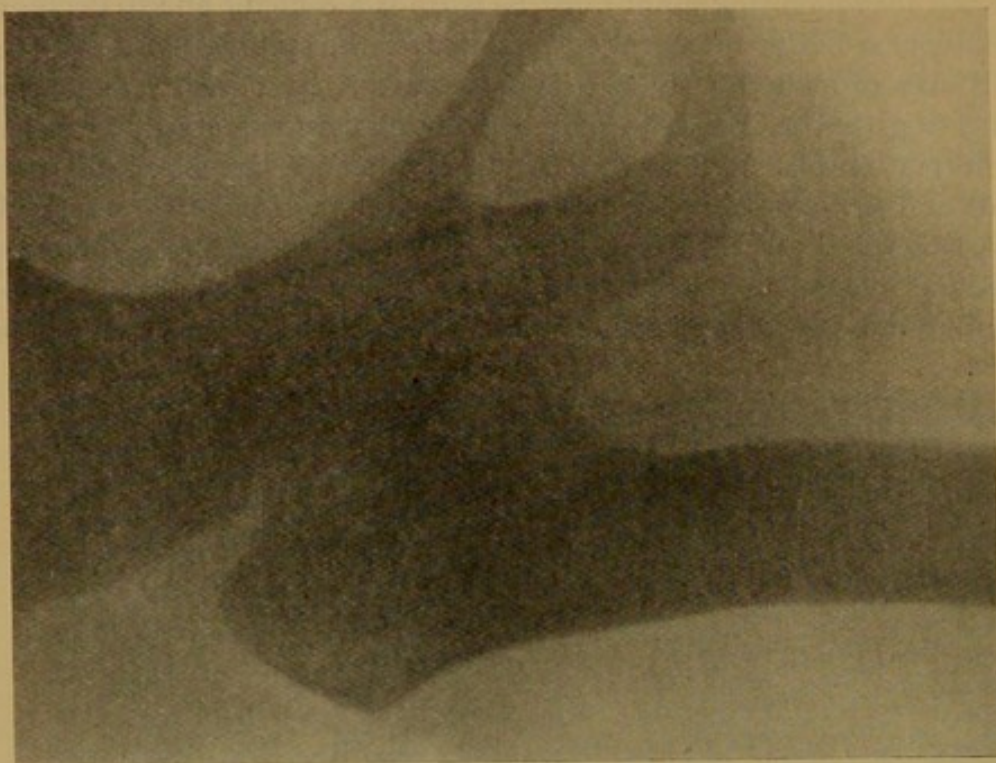


FIG. 31. Radiograph of the same patient $6\frac{1}{2}$ years after osteotomy.

has been performed, sometimes with a removal of a wedge. Jones's trans-trochanteric osteotomy does not seem to have been used, although it would seem to be a very suitable operation. The limitation of abduction and of internal rotation of the hip, in old-standing cases, is often due to a spur on the upper surface of the neck of the femur and a ridge running down its anterior surface; these have already been described under pathological anatomy. It is quite possible to remove these with a chisel after opening the hip-joint through an anterior incision. The range of the movement of the hip may thus be somewhat enlarged.

Infantile Coxa vara. The deformity of the ordinary variety of infantile Coxa vara is more severe than that of the adolescent form, and it is certainly more difficult to suggest an appropriate treatment. To secure a complete anatomical cure is out of the question; the deformity is usually of old standing when the case is first seen, the growth of the neck is defective, and there is, at least very frequently, that fibrous intersection which forms such a weak spot. It is, however, possible, by means of an osteotomy combined with division of the adductors, to secure full abduction. The following case illustrates that after this operation the altered condition of pressure bringing the line of weight at a right angle to this weak fibrous line, may result in the subsequent development of a firm bony neck. So that an osteotomy performed in early life may give eventually an excellent result.

R. W., a girl aged 13, was admitted to the Metropolitan Hospital in 1907 with a history of deformity of the hips dating from early childhood. There was no history of any accident or illness.

Clinically she presented the characteristic signs of Coxa vara of the infantile or cervical type, the fibrous intersection in the neck showing clearly in the radiograph. Tenotomy of the adductor muscles was carried out, followed a week later by subtrochanteric osteotomy on each side.

In 1913, six and a half years after the operation, the legs are equal in length, the hip movements are free in all directions, abduction being possible to an extent represented by a separation of twenty-four inches between the malleoli, and the gait being practically natural.

The radiographs at present show a short strong neck to the femur, without any fibrous intersection; the neck is about at a right angle to the shaft; the head of the bone has spread out, and presents an unusually broad articular surface. The upper part of the shaft in the region below the trochanters is a little thickened.

In some cases it may not be possible to perform this operation with success, particularly if the patient is seen when the growth is nearly complete. The following was such a case.

J. S., a girl aged 13½ years, was first seen by me at St. Bartholomew's in 1906; she then presented clinically the signs of a severe degree of Coxa vara of the infantile or cervical type. This deformity had come on gradually after a fall at the age of three years. The radiograph at

that time showed depression of the femoral neck to less than a right angle, with a fibrous intersection through it.

At the age of $15\frac{1}{2}$ the patient felt something give way in the hip; this happened without any accident; afterwards she was unable to walk. A radiograph showed that the head of the femur had slipped almost completely off the root of the neck, the separation having occurred through the region of the fibrous intersection. The shortening in the limb had increased to $1\frac{1}{2}$ inches.



FIG. 32. Radiograph of the patient J. S. at the age of $15\frac{1}{2}$, showing complete displacement of the head of the femur from the neck.

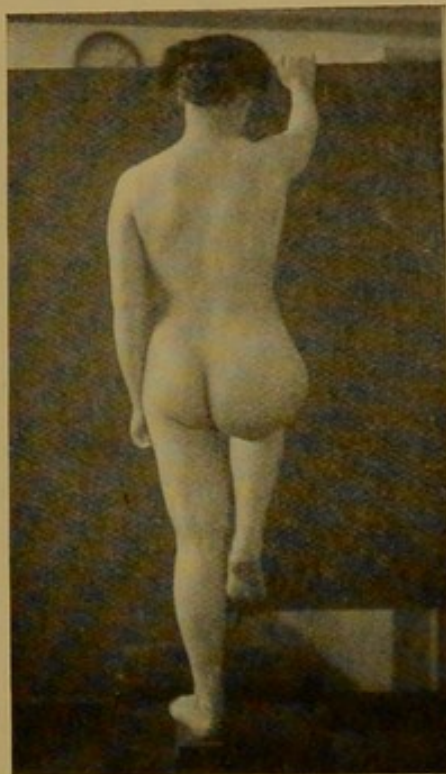
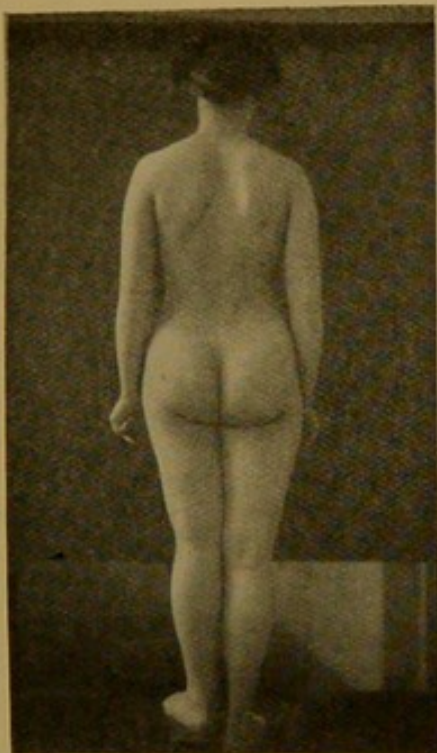
The head of the femur was excised through a posterior incision; as soon as the wound was healed the hip was fixed in an abducted position in a plaster spica, which was retained for nine months, the patient being allowed to walk.

Two years later the patient walked perfectly, with a high boot with $1\frac{1}{2}$ inches of cork, the hip was quite strong and freely movable. The deformity was much less than it had been before the final accident.

Here the head was practically detached from the neck of the femur,

but by tethering the latter completely restricted the movement of abduction of the hip-joint. The removal of the head of the femur at once relieved this restriction, and the subsequent use of the plaster spica enabled a firm false joint to form, so that, except for the shortening, the patient is hardly lame at all. Such a limited resection of the head of the femur is, I believe, the best treatment in extreme cases.

Congenital Coxa vara and those cases in which there is a firm bony neck may be considered together. I have not attempted to carry out



FIGS. 33 and 34. Photographs of the patient J. S., two years after excision of the head of the femur; 33, standing on both legs; 34, standing on the affected leg, to show the stability of the resulting joint.

any remedial treatment on any of these cases that have come under my observation, nor do I know of any so treated. In congenital cases the associated defective growth of the femur makes it impossible to get a really good limb. The patients have permanently to wear some form of appliance, and unless the adduction is severe, it seems hardly advisable to carry out any operative treatment.

On general grounds, however, an osteotomy to secure good abduction may be confidently recommended whenever necessary, and should give at least as good result as in cases of the ordinary infantile type.

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