FROM THE DEPT OF SURGICAL TUBERCULOSIS OF ST. GÖRAN'S HOSPITAL, STOCKHOLM (CHIEF: HENNING WALDENSTRÖM)

THE FIRST STAGES OF COXA PLANA

BY

HENNING WALDENSTRÖM

It is now twenty-five years since coxa plana was first described as a typical deformity, by the French author *Sourdat* and by *the writer of the present article;* and in the following year other studies of the same subject were made and published by *Legg* in America, *Calvé* in France, and *Perthes* in Germany. The observations of these five authors, which were thus made at about the same time, were all correct, except with regard to the etiology of the disease, as to which each expressed a different opinion. *Legg* believed it to be due to some kind of staphylococcal infection, *Calvé* to rachitis tarda, *Perthes* to septic osteomyelitis, while to the *present writer* it represented a particularly benign form of tuberculosis. None of us were right, however; and the etiology of the disease is still an unsolved problem. In the meantime, it has been a subject of interest to many investigators, and a great deal has been written concerning it, notably by *Perthes* and his assistants. Among the various names that have been given it, those of Perthes' disease and osteochondritis deformans have been particularly used in Germany and Scandinavia. The former is ill chosen, however, as Perthes was not the first to describe the disease; and the latter is equally unfortunate, as it conveys a wrong idea—the disease being neither an osteitis nor a chondritis.

To show that, apparently, the description which I gave of the disease in 1909 still holds good, I quote here the following passage from my treatise published at that time.

»The caput retains its covering of cartilage all the time. The varus deformity of the neck is to a great extent illusory, and is caused by the destruction of the upper part of the collum, and by the aplanation of the caput, which becomes flattened out over the collum. The acetabulum changes its shape secondarily, and adapts itself to the more oval shape of the caput. The disease is benign in character, its progress slow, and healing takes place with conservative treatment, or even without any treatment whatever, in a rather satisfactory manner as regards the function of the joint.«

In 1920, I therefore suggested the name: coxa plana, as designation for the disease;—a name which, like coxa vara, takes no account of the etiology, but only of the appearance of the deformity: the flattened epiphysis. The term has since been generally adopted by Belgian, Dutch, English, French and Italian writers. I have continued, in subsequent papers, to contribute to our knowledge of the disease. Thus, in an article in the Acta Chirurgica Scandinavica, in 1923, I described its development; and in another, in the Acta Radiologica Scandinavica for 1922, its definite form. As regards the appearance of the hip-joint before the first signs of the future condition begin to appear, and the very earliest stages of the disease itself, our knowledge is still incomplete, however. In the present paper I shall try to throw some light on these two stages.

By many authors the name coxa plana is used as a designation only for the later stages of the disease, because they believe that only by then has the caput become flattened. This is not the case, however. I shall give here an account of my studies, which show that *the flattening of the epiphysis is the principal sign of the pathologic process in its very earliest beginning.* If one is careful always to bear in mind this important fact, I think it will be possible, by the aid of radiographs, to identify the coxa plana as soon as the first clinical symptoms from the hip-joint—the claudication and somewhat reduced mobility—become perceptible; and I further think that it will then be possible, when this claudication has lasted for a month or so, to distinguish the coxa plana from a tuberculous coxitis. The latter disease often begins in the same manner, but it usually takes a long time before it gives a characteristic roentgenologic picture.

The development of coxa plana is very slow, and it takes a long time, from the first stages of the disease, before the upper part of the femur has assumed its definite shape. In a paper published in 1923, I attempted to divide into periods this development, which takes from three to four years. The first of these periods, which, as a rule, extends over two to three years, I called the period of evolution; and this I again divided into two stages: the *inital stage,* lasting from six months to one year, and the *stage of fragmentation,* lasting from two to three years. In the present paper I propose to deal only with the initial stage, and also with another, new one, which I would call the *pre-coxa-plana stage.*

The real cause of coxa plana is still unknown. Our knowledge of the disease is chiefly gathered from radiographs taken at short intervals, which, when chronologically arranged, give an almost cinematographic impression of its development. This method is still the most important one, but anatomical examination has shown that the transformation visible in these radiographs is caused by an aseptic necrosis of the bone. In the medical literature we find descriptions and illustrations of specimens obtained by autopsy or resection in such cases. The latter can only be regretted, however, in spite of the information they give us. Resection, in the case of coxa plana, could be made only by one unacquainted with the comparatively benign development of that disease. The condition in which the ultimate stage of that development leaves the patient will, in any case, be better than the result of a resection.

About the *pathological findings* in coxa plana a great deal is known from anatomical specimens that have been carefully examined and described. All these have represented the more advanced stages of the disease, however. The most interesting ones are those of *Riedel* and *Konjetzny.*[1]) I will give only some details from the descriptions furnished by these two authors, and will then try to give, for comparison, an anatomical explanation of the changes to be seen in my radiographs. *Konjetzny* has kindly placed his original films at my disposal, and of

[1]) See Acta chir. scand. 1934.

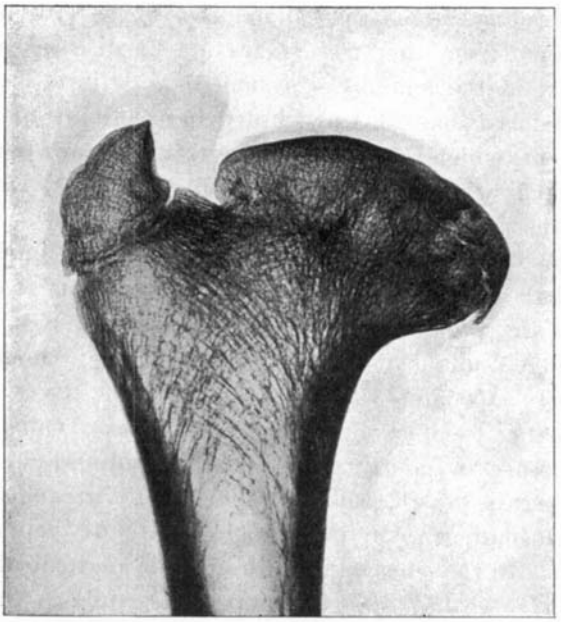
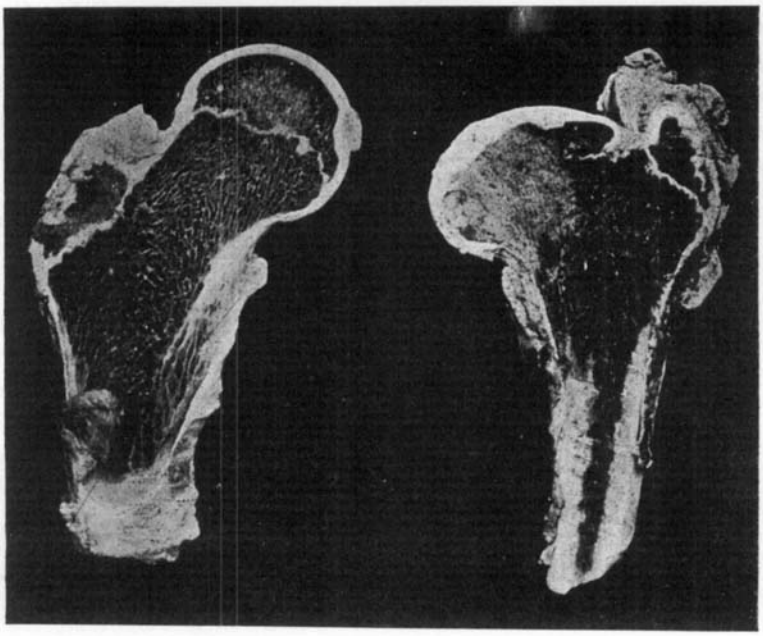
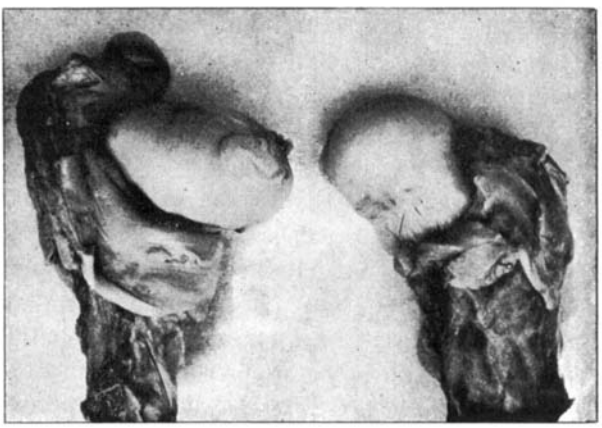


Fig. 1.

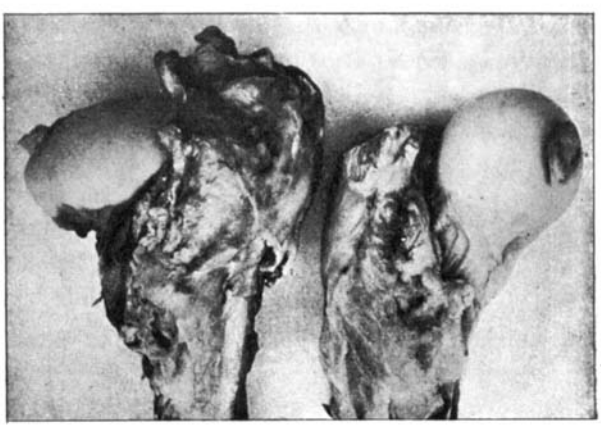


A *Fig. 2.* B

these I reproduce here (Figs. 1—4) some anatomical preparations from a boy who died from pulmonary tuberculosis at the age of seventeen. He had then been under treatment for his hip



B *Fig. 3.* A



B *Fig. 4.* A

disease for eight years. The disease had entered the stage of fragmentation already by the time he was first examined. If we compare the radiographs of the upper part of the femur (Fig. 1) and of the photograph of the diseased hip sawn through

(Fig. 2 B) with the normal hip sawn through (Fig. 2 A), we see very plainy that the collum, especially in its upper portions, has disappeared almost completely, and that the rest has increased very much in thickness, we see also that the caput is flattened. Of the upper half of the cartiliginous epiphyseal line, only a small part remains (Fig. 2), and in this place alone is there a clear demarcation between the epiphysis and the metaphysis. Instead of the regular structur of the cancellous tissue there is for the most part a confusion of bone, cartilage and fibrous tissue, with a necrosis medially in the caput, which has not yet become resorbed. The thickness of the articular cartilage is on the whole increased, but not evenly over the whole surface of the caput; in the upper part the cartilaginous covering is even thinner than normally. As a result of the partial disappearance of the inner substance of the collum and of the caput, and the flattening of the latter, its top has sunk considerably, and does not reach a level higher than the point of the trochanter. In both the radiographs taken in anteroposterior projection (Fig. 3), one observes a fold in the articular cartilage over the upper part of the caput. When comparing them with the radiographs taken in a posteroanterior direction (Fig. 4), one sees that the posterior part of the articular surface of the caput is more normal in shape and size, than the anterior one, where the distance from the ligamentum teres to the edge of the caput is very much shortened. This is due to the fact that the necrosis and the consecutive resorption involve the posterior part of the epiphysis to a lesser degree than the anterior;—compare the radiographs taken in anterior and lateral projection of Cases II and III, in which it is plainly seen that the destruction chiefly affects the anterior parts of the epiphysis and metaphysis.

The studies of wich I shall now give an account have been made on ten cases of coxa plana, selected from among those which I have treated personally during the last twenty-five years. Of those ten, eight came under my observation at so early a stage of the disease that they have enabled me to demonstrate the beginning of the coxa plana. The two others, and one of those already mentioned, have later become bilateral, but at the

time when I first examined them one hip-joint was still normal. By the aid of these three cases, I shall try to show that the coxa plana begins in a hip-joint primarily normal. From the radiographs of all these cases—which include not only the first pictures taken, but a whole series from each case—the reader will be able to verify the correctness of the diagnosis, by studying the development from its very beginning; in other words, they constitute a complete »picture book« of coxa plana. Eight of the patients are boys, two are girls. The youngest, a girl, was three years and nine months old when the disease began, the oldest nine years; the average age for the beginning of the disease, in the ten cases, six years and a half.

The first symptom of the disease is limping, sometimes associated with pains in the hip or, more commonly, toward the knee. In the beginning, these symptoms appear only after some strong exertion, and disappear when the patient has rested a while. I have questioned the parents closely as to the time when they first noticed any slight change in the gait of their child, and have tried to fix the duration of the disease counting from that moment. The value of the information thus gathered naturally depends, on the interest which the parents take in their children and the precision of their observations; but, at any rate, it should be possible in this way to get an indication of the shortest time the disease can have existed before the case is first examined. I found that, five of my patients had been limping for one month, two for from two to three months, and none of the other three for more than five months. The information obtained with regard to the patients in Cases I and II would seem to be the most valuable, judging from the intelligence of their parents, and the concern they showed for their children. We shall later find these cases the most interesting from the point of view that they were the ones in which the changes shown by the radiographs taken at the first examination were the least pronounced.

It is quite natural that these cases of coxa plana should at first be regarded as tuberculous coxitis: they limp, and the mobility is reduced. When the patient first comes to

CASE I.

B. N., boy, aged 6 years. Admitted 14th May, 1927. Occasional limping observed during the six weeks preceding.

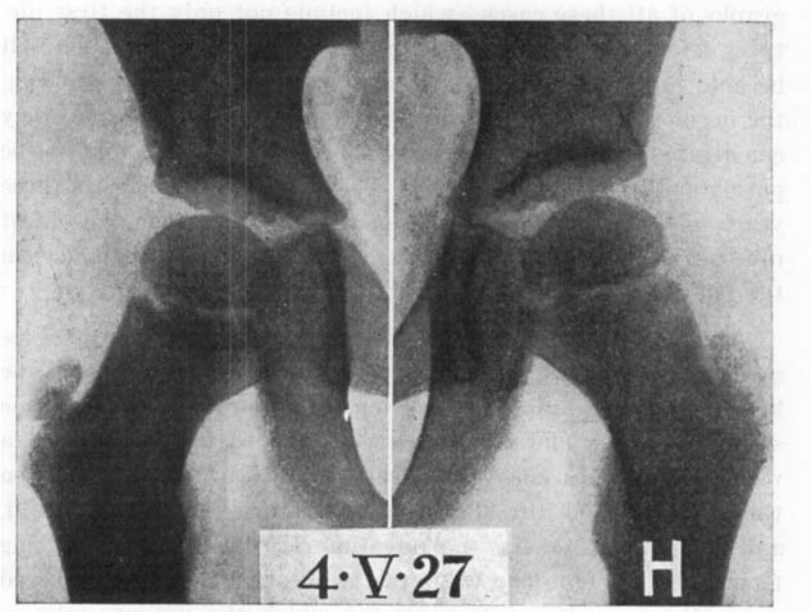


Fig. 5.

Fig 5 shows condition at the time of admission. The picture has been made by first roentgenographing the two hip-joints symmetrically on the same film, and then cutting out the middle portion of the latter and approaching the two joints as closely to each other as possible, for the sake of better comparison. It is then seen that the part of the epiphysis of the right side (marked H) latterally from the summit shows a very slight flattening. The structure of the spongiosa is normal,—that is, similar to to that in the left side,—except for a thread-like line of greater density in the outline of the epiphysis at the point just indicated. There is a very slight displacement of the caput upwards and outwards within the acetabulum, as a result of which the distance from the medial part of the epiphysis to the bottom of the acetabulum has become somewhat increased. This is best seen if one looks at the position of the epiphysis in relation to the lateral line of the u-shaped figure. This formation was first described by the Austrian authors *Reiner* and *Werndorff* (Zeitschr. f. Orhtoped. Chir., 1913). It was called by them the »tear-drop« formation, and they explained it as being conditioned by the the bottom of the fossa acetabuli (see Fig. 5 H). The lateral line of demarcation is formed by the densified surface toward the fossa acetabuli, the medial line enters into the formation of the wall of the pelvis minor. Below, the two lines unite and form a smooth curve corresponding to the acetabular notch where the fossa acetabuli unites with the wall of the small pelvis in the upper part of the obturator foramen.

CASE I.

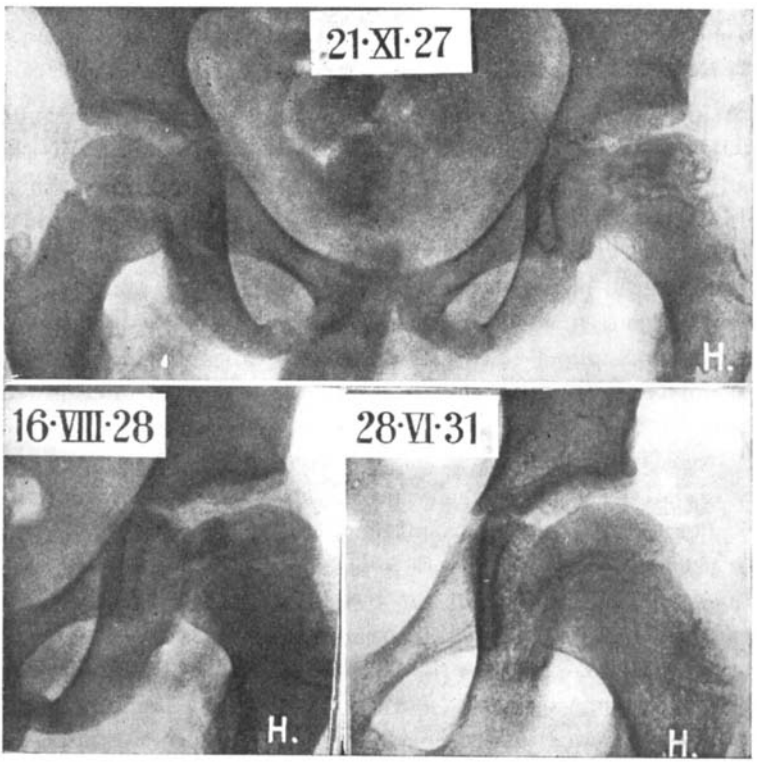


Fig. 6.

Fig. 7.

Fig. 8.

Fig. 6, taken 21st November, 1927, shows a distinct flattening of the right epiphysis (H). whose margin, in the six months since Fig. 5 was taken, has become uneven, and its design spotty owing to focal resorption of spongy tissue.

Fig. 7, taken 16th August, 1928, shows incipient healing; but a remnant of focal resorption still exists.

Fig. 8, taken 28th June, 1931, shows the shape of the caput after the process of alteration has terminated. In the mildest forms of coxa plana, the caput retains this appearance. It is flatter and broader. The acetabulum, whose shape was normal in the beginning (see Fig. 5), has now adapted itself to the shape of the caput. The distance between the epiphysis and the bottom of the acetabulum, which becomes steadily greater as the resorption in the epiphysis progresses (see Figs. 5, 6 and 7), has now become normal again, since the acetabulum has become altered so that it shape corresponds to the definite shape of the caput.

the doctor, the limping is often so slight that it is not noticeable to the eye; thougt, when he is made to walk across the floor with his shoes on, it may often be *heard.* Beside the limp, there was in all my cases a pathologic restriction of the mobility, sufficiently distinct to be measured in degrees when compared with the sound hip.

As it will be seen from the following description, I found deviations from the normal, typical of coxa plana, in the roentgenologic picture of all those cases in which the patient had been limping for a month or more. They may not be noticed at once, but with my description as a guide one will be able to find them even in the accompanying reproductions, though these cannot, of course, be so distinct as the original films. Of all the cases of coxa plana that I have treated since 1907, there has been only one in which the first roentgen examination showed nothing of a pathologic nature whatever. This patient (Case VI) had been limping only a week. It seems quite likely that the necrosis of the epiphysis may give symptoms already from the first beginning, and the roentgenologic picture at that early time yet be normal. *There can be no characteristic signs in the radiographs before the normal structure of the cancellous tissue begins to be resorbed.* The radiograph of Case VI it not clear enugh to exclude the possibility of the actual existence of minor changes. It was taken in 1907, and at that time the standard of radiography was not very high. In the cases from later years, with first class radiographs, I have always been able, on careful examination, to find typical changes. The photographic work has to be done with extreme care, with both hip-joints symmetrically exposed on the same film, one exposure in sagittal projection and another from the side (with the joint in Lauenstein's flexion- abduction position), so that the joint may be studied in two perpendicular planes. Unfortunately, some of my cases were not examined in the latter manner, which is the most suitable one for this purpose. In two or three instances this made the first diagnosis somewhat uncertain, and only a second examination, in Lauenstein's position, showed the existence of the coxa plana. As the deformity is

much more visible in the lateral view (see Figs. 9 b and 13 b), it seems probable that there may be cases of incipient coxa plana in which the deformity can be observed only in films in the latter projection.

I now proceed to the description of the initial changes in my cases of coxa plana, and will deal with the first three of these (nos. I, II and III) together. In all of them, the symptoms had been present less than three months. The changes to be observed in the radiographs taken at this stage are very slight, and it requires a minute comparison of the two hip-joints to discover them. Let us begin with Figs. 5 and 9, a and b. In order to make it easier to get a simultaneous view of both joints in these cases, I have cut away the central part of a film on which the hip-joints and pelvis have been photographed symmetrically, and have placed the two joints side by side, as close to each other as possible. It may now be seen that the form of the two sockets is identical, and the appearance of the acetabulum the normal one for a subject of the patient's age. If we compare the epiphyses on the two sides, we find that the texture of the bone is clearly visible in both. *The epiphysis* on the right side (Figs. 5 and 9 a) *is lower, and shows a distinct flattening of the part facing the roof of the acetabulum.* In the radiographs taken in Lauenstein's flexio-abduction position, this flattening is still more apparent. The lower part of the epiphysis is of normal shape. When these inequalities have once been observed they are clearly recognised, but it is impossible to measure the degree of the differences with a pair of compasses, especially on films taken in sagittal projection. The reason for this lies in the impossibility of finding exactly corresponding points; and, consequently, differences as slight as the ones revealed by these radiographs cannot be measured exactly. To obtain a reliable measurement of the decrease in the height of the right epiphysis, I made copies of the films of each hip-joint separately. These I placed one over the other, and, holding them against the light, arranged the corresponding points of the femur and the pelvis so that they were exactly covering each other. I thus got two shadows, one superimposed upon the other.

CASE II.

A. M., boy, aged 9 years. Admitted 6th September, 1932; at which time he had been limping very slightly for three months.

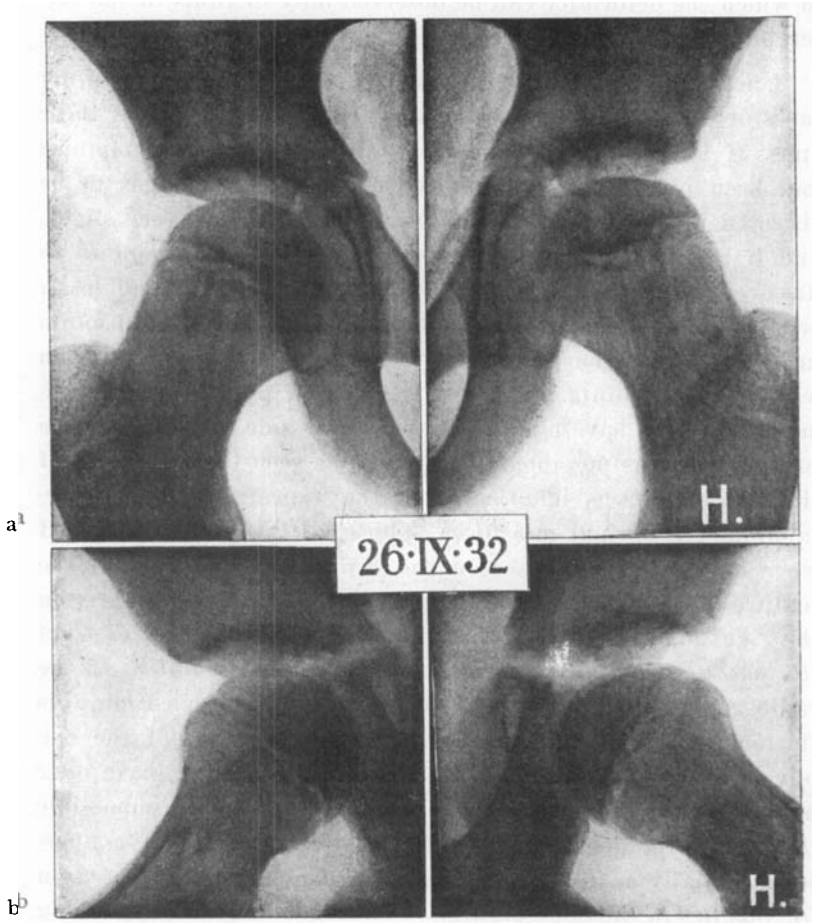


Fig. 9.

Fig. 9 shows pictures, taken at the time of admission, of both hip-joints, both from the front (a) and from the side (b), all taken symmetrically, with both hip-joints on the same film, as described under Case 1, and placed in close juxtaposition for the sake of easier comparison between the normal left hip and the right one (H) with its incipient coxa plana. The anterior view Fig. 9 a shows a normal left hip, and in comparison with this the right one shows a somewhat flattenned epiphysis, which also, on the whole, appears somewhat lower. The structure

of the spongiosa is normal. The lateral view, Fig. 9 b, shows that the inferior part of the right epiphysis (H)—corresponding to the posterior part when the leg is in extended position—is of normal shape and size, but that the upper part—corresponding to the anterior part of the epiphysis when the leg is in extended position—is lower. The periphereal portion of the epiphysis seems here to have disappeared, as if it had been

CASE II.

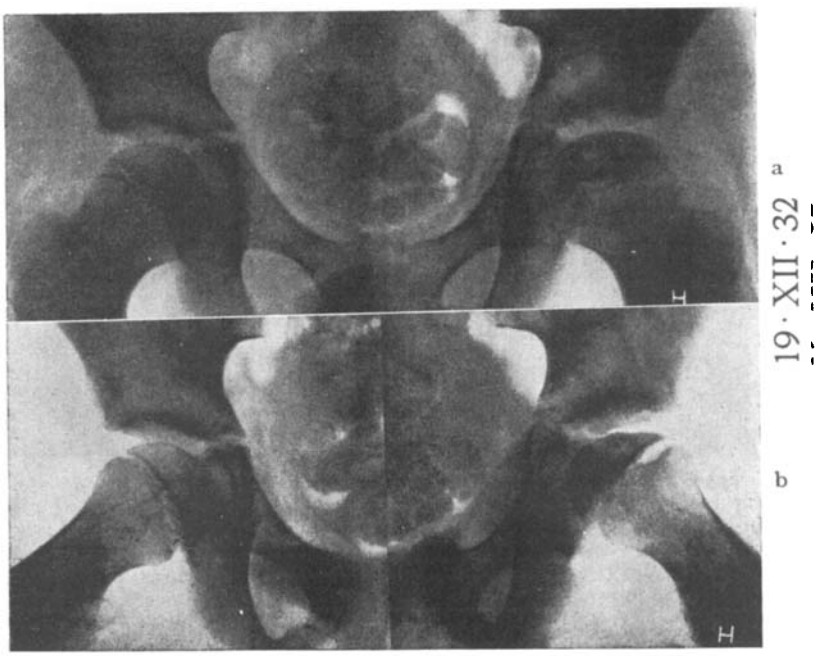


Fig. 10.

worn away. If one looks more closely, one finds in this place a thin line, corresponding to the articular cartilage, which has been pressed in upon it. Both in the pictures a and b the caput is seen to have been displaced somewhat upwards and outwards within the acetabulum, whereby the distance between the epiphysis and the bottom of the former has become increased. This is best noticed if one looks at the position of the epiphysis in relation to the lateral curve of the tear-drop figure. The acetabula of the two sides are alike.

Fig. 10 a—b. 19th December, 1932. The epiphysis is lower and denser; in the metaphysis is seen a zone of resorption extending to the epiphyseal line. The distance between the epiphysis and the bottom of the acetabulum is greater.

CASE II.

Fig. 11.

Fig. 12.

Fig. 11 a—b. 3rd April, 1933. The epiphysis is lower and denser. In the metaphysis, the resorption is more pronounced; in the anterior part it is seen as a rounded focus in the collum.

Fig. 12 a—b. 30th November, 1933. In the anterior view, the shape of the epiphysis is rounder. In the side view, the posterior part of the epiphysis still appears intact; it has evidently not become necrosed.

In the darker portion both shadows of the epiphysis coincide, while in the thinner, semilunar, upper portion we have only the shadow of the larger, i. e. the normal epiphysis; and the size and shape of this thinner portion thus gives a picture of the degree of flattening,—or, in other words, the form of the depression. By making a mental synthesis of the figures 9 a and 9 b, one is able to imagine the real shape of the whole circumference of the epiphysis. One realizes that the flattening mainly involves the upper, anterior part, while the posterior part has retained its normal shape. This is due to the fact that only the anterior part is necrotic. If we look more closely at Fig. 9 b, we

find at the top—that is, in the upper part of the epiphysis, where it looks as if something had been worn away—a thin, hardly distinguishable line, concentric with the epiphysis. This narrow strip shows the position of the cartilage of the joint. It is visible on the radiograph only because a narrow edge of the bone has not become resorbed, and is therefore still in its place, close to the cartilage. Underneath this strip is a bright zone, caused by a subchondral resorption of necrotic bone. The cartilage of the joint has thus lost its natural support, and has been pressed together. The same thing is seen in Fig. 13 b. If we look at the series of lateral views from Case II, we find that the resorption begins along the anterior surface of the epiphysis slowly progressing and leaving the posterior surface quite intact.

As already mentioned, the density of the necrotic spongiosa, and its transparency in the film, are the same as those of the normal bone. When its resorption begins, its structure breaks here and there, and the cancellous fibres become pressed into each other. Thus, the number of these fibres per superficial unit is increased, and, in consequence, the epiphysis looks increasingly denser on the film as the normal structure disappears. Illustrations of this may be seen in Case II. In Fig. 9 a, where a superficial resorption in the epiphysis has just begun, there is as yet no visible change in the transparency, but in Fig. 10 a we observe a decided increase in the density of the epiphysis. During the three months between the taking of these two pictures, the cancellous fibres have become partly resorbed and, in consequence, weakened and pressed together. Fig. 11, taken after another four months, shows the appearance of light spots in the epiphysis and metaphysis, indicating a resorption of the necrotic tissue in those places. Three pictures from Case IV, represeting the development during one year, show how the increased flattening results in an increasing density of the epiphysis. Already in the first picture (Fig. 16) the latter is somewhat lower and denser. Nine months after (Fig. 17), these changes have become more marked, and circumscribed foci of resorption appear in the epi- and metaphysis; and in the last picture (Fig. 18) the flattening and density of the epiphysis are yet

CASE III.

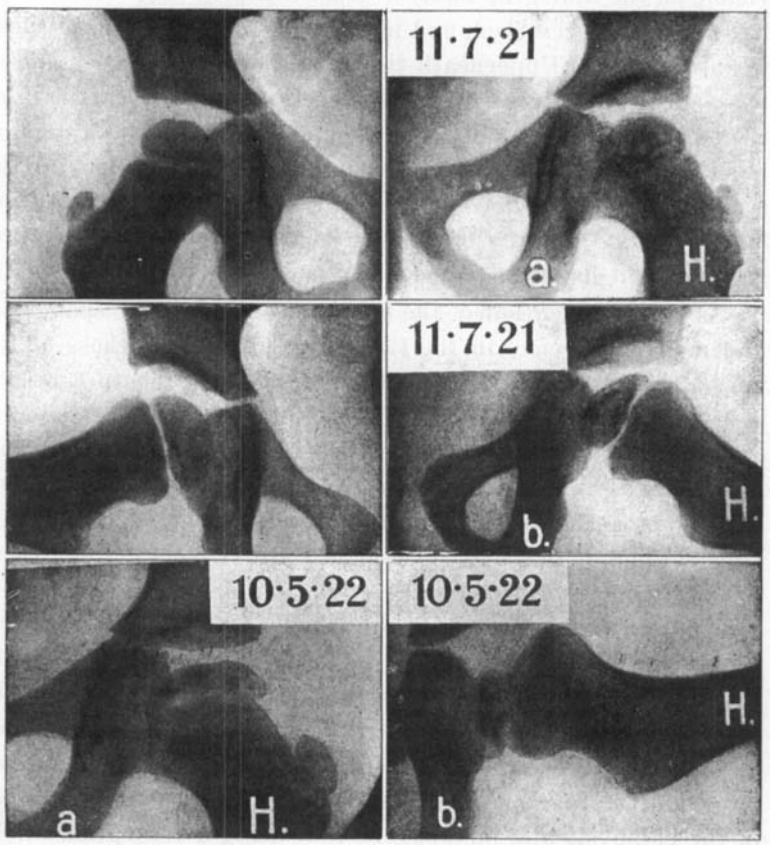


Fig. 13.

Fig. 14.

E. A.—k, girl, aged 4 years. Admitted 11th July, 1921. Occasional limping and pains in the knee for about a month past. Roentgenograph, front view *(Fig. 13 a)*, shows a very slight flattening of the epiphysis, which is also somewhat denser and spotted. The side view *(Fig. 13 b)* shows that the flattening has involved chiefly the anterior part of the epiphysis.

Fig. 14 a, 10th April. 1922, shows fragmentation of the epiphysis. In the side view, *Fig. 14 b*, the anterior part of the latter is seen to have become almost completely resorbed.

CASE III.

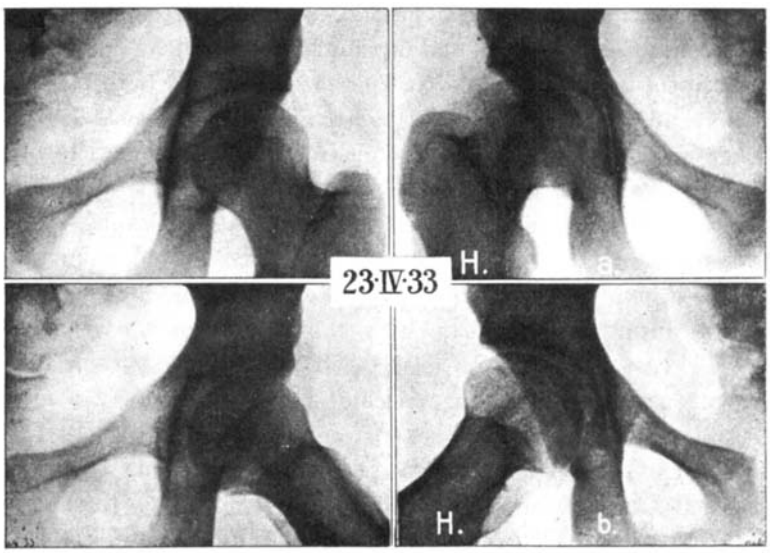


Fig. 15.

Fig. 15, taken in 1933, shows the definite shape, with very slight flattening (front and side views).

more pronounced. The resorption of the necrotic bone is in rapid progression, and the epiphysis is soon divided into small bits. The stage of fragmentation has begun. This evolution is also clearly seen in Case V. The first picture (Fig. 19) shows a somewhat flattened and in its entirety condensed epiphysis, with a zone of resorption in the metaphysis and a bordering zone of increased density. Ten months later (Fig. 20), the necrotic epiphysis has become largely resorbed, only the basal portion and some fragments remaining. The degree of the necrosis varies in the different cases, from such in which only small foci of resorption appear (Cases I and VI), to those in which both the epiphysis and great parts of the metaphysis are almost entirely broken up (Figs. 23 and 37). The necrosis and subsequent resorption seem to begin in the anterosuperior part of the epiphysis, and possibly also in the anterior part of the metaphysis, as, for instance, in Cace II (Fig. 11 b). The later development may run one of two courses: either the posterior part of the epiphysis remains intact, as in Case II, or the greater part of the epiphysis is resorbed as in Cases VII and VIII. There may be total resorption of the epiphysis, but this is rather unusual; in most cases some posterior portions still remain. (Figs. 12 b and 14 a and b). The smaller the necrotic part of the epiphysis, the slighter the flattening. The limit of the the latter is set by the height of the part of the epiphysis which remains. Thus, in the last picture of the series from Case II we see the completed aplannation of the caput, viewed in anteroposterior direction. The side view shows how the degree of the flattening depends upon the height of this surviving posterior part.

When one examines the radiographs of these incipient cases of coxa plana, one notices a constant change in the hip-joint, consisting in an increase of the distance between the epiphysis and the bottom of the acetabulum,—or, to put it more clearly, from the epiphysis to the lateral leg of the U-shaped figure,[1])— as compared with the normal side. If one looks closely, this

[1]) See the text to Case I.

CASE IV.

E. A., boy., aged 6 years. Admitted 15th September, 1924, at which time he had been limping for a month.

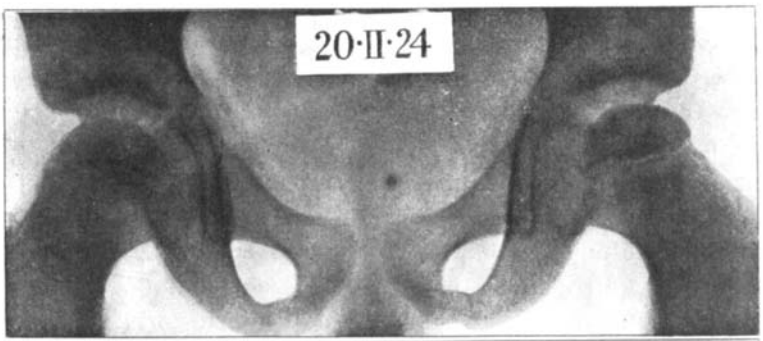


Fig. 16.

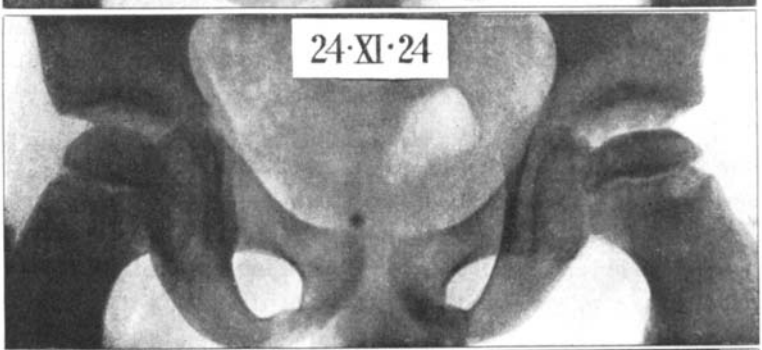


Fig. 17.

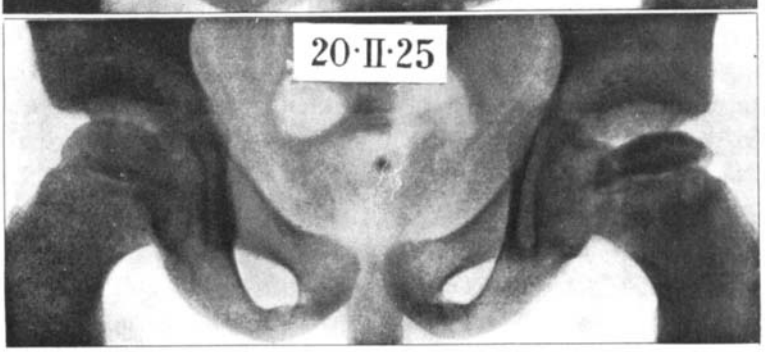


Fig. 18.

Fig. 16, at the time of admission, shows a very slight flattening and condensation of the epiphysis, and a distinct increase of the distance between the latter and the bottom of the acetabulum. In the following pictures, *Figs. 17 and 18*, the development of a coxa plana can be followed during one year: increasing flattening and condensation of the epiphysis, the appearance of foci of resorption even in the collum, and increase of the distance between the epiphysis and the bottom of the acetabulum.

may be observed in Figs. 5, 9, 13, 16, and many of the other pictures. Most distinct does it become if we place the films of the right and the left side over each other, in the manner I have already described. As the epiphysis gradually shrinks, this distance between it and the bottom of the acetabulum steadily increases, as may be clearly seen in the series of three pictures, Figs. 16, 17 and 18, from Case IV. In my opinion, the explanation of this phenomenon is the following. On radiographs of coxa plana in its first stages, the acetabulum is of normal shape, and alike on both sides. The cause must therefore be found in the caput-collum part of the hip. The muscles of the hip-joint press the caput against the roof of the acetabulum. Upwards, the caput finds the firm roof the socket; downwards, the latter is for a great part filled with soft tissues in the fossa acetabuli. With decreasing volume of the caput, the intra-articular pressure is falling. This is compensated by an increase in the blood supply and a resulting swelling of the soft tissues in the fossa, until the pressure is again normal. The interspace between the caput and the acetabulum becomes filled with these tissues, which support the inferior part of the caput and prevent any loose working of the joint.—The increase in the distance between the epiphysis and the bottom of the socket may also be observed in another way. On radiographs of the hip in anteroposterior projection, the posterior margin of the acetabulum—belonging to os ischii—is always seen as a curved line intersecting the caput in its medial part. The extent of this coïncidence of the os ischii with the caput is smaller on the side where the coxa plana exists, than in the opposite, sound hip (see, for instance, Figs. 5, 9 a and 16).

This change in the position of the epiphysis in relation to the acetabulum has been observed by *Murk-Jansen,* who would explain it by assuming a congenital variation in the shape of the acetabulum, which he calls: "a wide hip-socket"; and this, according to him, should be the cause of coxa plana. The radiographs which he reproduces in support of his theory are, however, from cases in which the process, at the time they were taken, was too far advanced to allow of any hypothesis being based upon them with regard to the primary or secondary nature of

the changes. My radiographs, on the other hand, represent the earliest stages of coxa plana of which any pictures have as yet been published; and they permit us to conclude that at the beginning the size and shape of the socket are normal (see Figs. 5, 9, 13 and 16). There is no "wide hip-socket" in the initial stage of coxa plana. The condition described by *Murk-Jansen* under that name is the result of the changed position of the epiphysis in relation to the acetabulum; or, to express it as cautiously as possible: it is the outline of the epiphysis on the radiograph that, leaves the bottom of the socket; but the form of the latter remains normal.

Of the fact that the transformation of the acetabulum follows secondarily upon that of the caput, forther proof is found in many of my cases; for instance in Case IV, where it may be seen that the socket, in spite of the steadily increasing deformation of the caput, retained its normal shape for a whole year. The deformation of the caput produces a corresponding change in the form of the socket,—and we may then speak of a "wide hip socket", as a secondary adaptation to the altered caput;—but such a change does not take place until the deformation of the epiphysis has been in progress for a long time. In pronounced cases the acetabulum, with its sloping roof, presents an appearance very similar to what is seen after a subluxation (Figs. 18, 29, 36). If one has seen radiographs only of this terminal stage, one may easily persuade oneself that the sloping roof is the primary process and the real cause of the deformation of the caput. *Calot* has made that erroneous conclusion, and has called the coxa plana: *une subluxation congénitale méconnue.* When the caput shrinks it travels upwards and outwards in the acetabulum; that is, in the same direction as in the case of a subluxation; but these changes have nothing to do with the socket.

In all my cases of coxa plana, the distance between the epiphysis and the bottom of the acetabulum has always been increased, no matter how small the changes in the epiphysis. The question now arises: How was the condition before the beginning of the coxa plana? The only possible way of solving this problem, so far as I can see, must be by means of radiographs of the hip

CASE V.

L. L-n, boy, aged 6 years. 8nd March, 1927. Occasional limping and pain in the hip for about six months past.

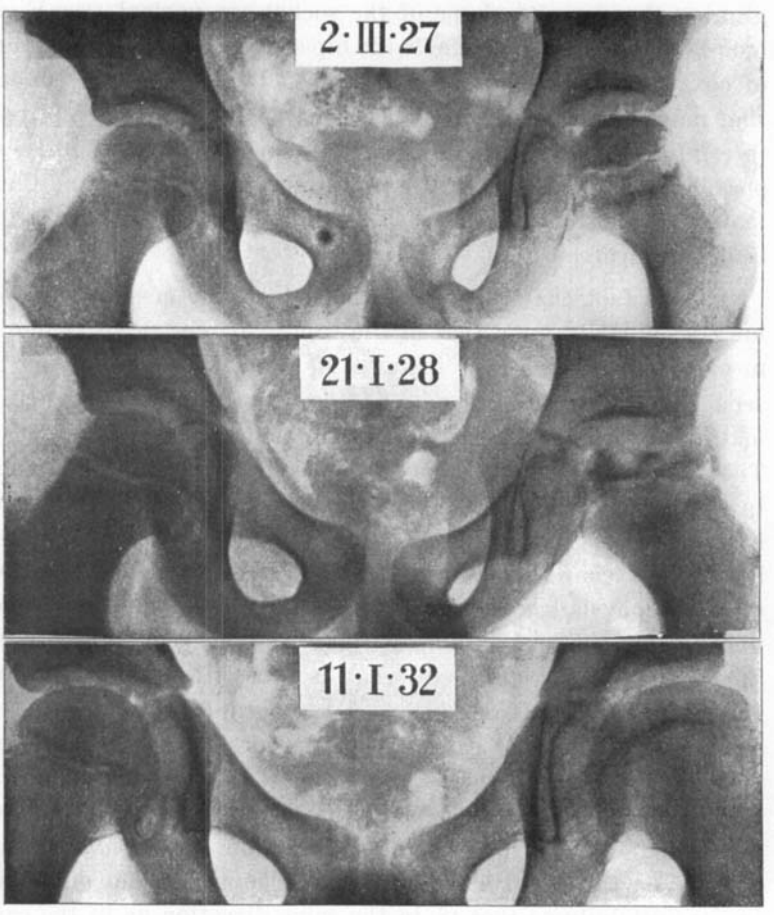


Fig. 19

Fig. 20.

Fig. 21.

Fig. 19 shows a somewhat flattened and condensed epiphysis. Distinct rarefication in the metaphysis, bounded inferiorly by a condenced zone. Increased distance between the epiphysis and the bottom of the acetabulum.

Fig. 20, taken 21st January, 1928, shows the entire upper part of the epiphysis resorbed, the rest broken up into small bits (stage of fragmentation). The distance between the epiphysis and the bottom of the acetabulum still further increased.

Fig. 21, taken 2nd January, 1932. Caput and collum enlarged and flattened. The acetabulum has udapted itself to the altered shape of the caput. The distance between the epiphysis and the bottom of the acetabulum is therefore beginning to get normal again.

taken a long time—not less than a year—before there are any symptoms from the joint, and where a new film shows typical signs of coxa plana. That possibility only exists with patients in whom the process is bilateral. I have therefore gone through my material, picked out the bilateral cases for a careful study, and among them I found three answering the claims that have been proposed. All three cases had a unilateral coxa plana at the first examination. In two of them the malady was in its initial stage, in the third case in the stage of fragmentation. The joint of the opposite side was normal in all cases. All these previously normal hip-joints have developed a coxa plana a long time,—more than a year—afterwards. *Coxa plana thus arises in a joint primarily normal.*

For reasons which I have stated abowe, I have had to reproduce in these pages some radiographs also of the final stage of coxa plana; and, in conclusion, I wish to add a few words about the definite stage of that disease, to what I stated in my paper in the Acta Radiologica Scandinavica, 1923. The degree of the deformity varies enormously,—from the most severe cases, where no semblance of the normal hip-joint remains, to the slightest, where the deformity is quity inconspicuous and can be detected only by comparison with a normal joint. These final forms of the disease may be divided into three groups, according to the degree of the deformation. In the *first group,* the size of the caput and collum is increased, the shape of the latter—normally globular—has become ovoid, the surface of the joint is evenly rounded, and the joint may still be regarded, functionally, as a ball-joint. In my cases of this group, the degree of the deformation varies. It is slightest in Case VI, more pronounced in Case I, greatest in Case V. When the process has come to a standstill, the patient walks without limping, and the mobility is only slightly reduced. A *second*—intermediate—*group* is represented by Case IX. The surface of the joint is still smooth and of ovoid shape, but the deformation has developed to such an extent that the mobility is decidedly reduced; the patient frequently limps, and strong exercise is followed by pains. The *third group* is that of the severest deformities; the

(Continued in page 28).

CASE VI.

M. B., girl, aged 6 years. Admitted 5th February, 1907. Had been limping for a week.

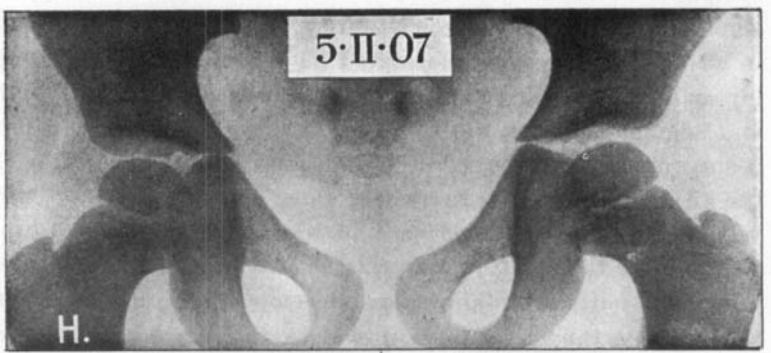


Fig. 22.

Fig. 23.

Fig. 24.

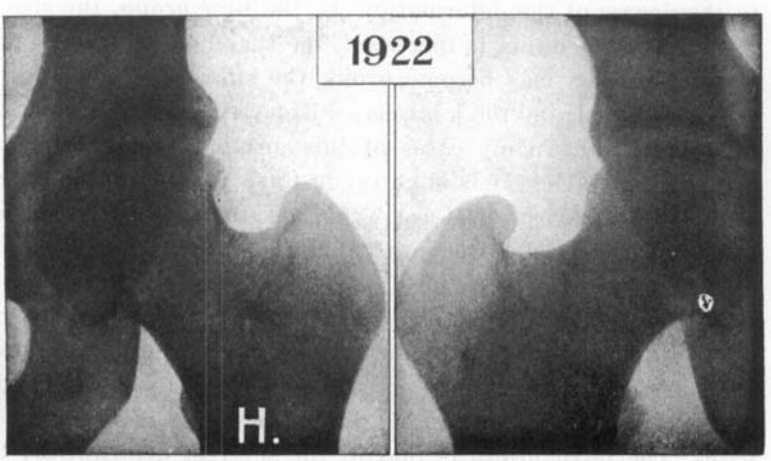


Fig. 25.

Fig. 22. Epiphysis and istance between the latter and the bottom of the acetabulum normal. *Fig. 23.* 23rd August, 1907, shows a slight rarefication in the outer park of the epiphysis. *Fig. 24.* 15th February, 1909. Flattening of the epiphysis. *Fig. 25.* 1922. Definitive shape, with very slight deformation of the caput.

CASE VII.

A. M., boy, aged 7 years. Admitted 15th September, 1921. Had at that time been limping occasionally for three months past.

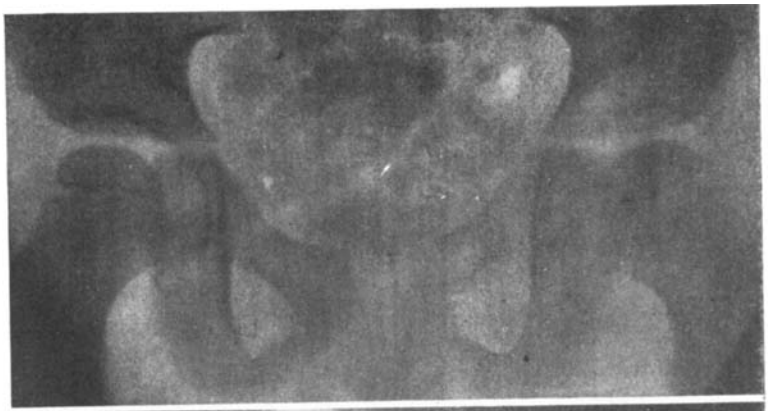


Fig. 26. 16·9·21

Fig. 27. 21·11·21

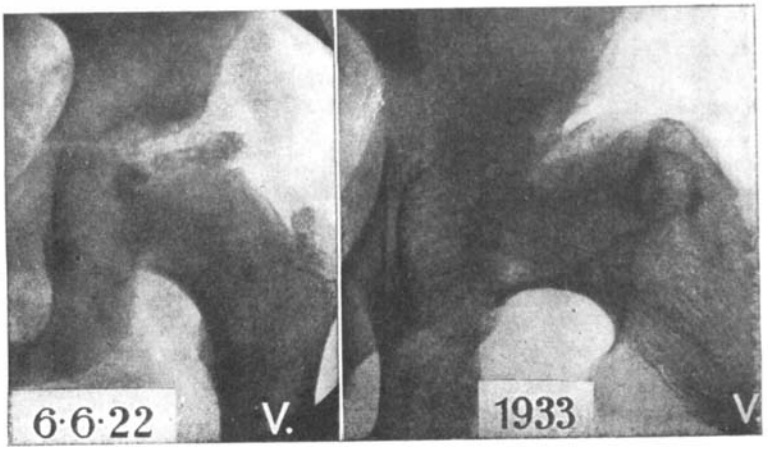


Fig. 28. *Fig. 29.*

Fig. 26 shows the epiphysis somewhat flattened and condensed.

Fig. 27, taken 21st November, 1921. Epiphysis denser, with beginning resorption.

Fig. 28, taken 6th June, 1922. The greater part of the epiphysis resorbed; the remainder broken up (fragmentation). These three pictures also show increasing distance between the epiphysis and the bottom of the acetabulum.

Fig. 29, shows definitive shape, with strong deformation.

CASE VIII.

J. A., boy, aged 8 years. Admitted 4th June, 1919. Had then been limping for a month past.

CASE VIII.

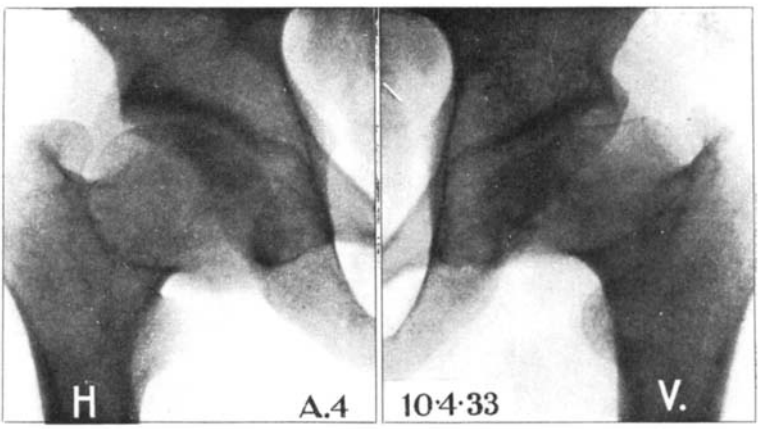


Fig. 33.

Fig. 30, taken 4th June, 1919, shows the left hip-joint normal, the right one somewhat flattened and condensed. Distance between epiphysis and bottom of acetabulum increased.

Fig. 31, taken 5th October, 1920,—sixteen months later,—shows the left hip-joint still normal. Left epiphysis in state of fragmentation.

Fig. 32, taken 4th May, 1922, shows distinct coxa plana in left hip-joint.

Fig. 33, taken in 1933, shows the definitive shape of both hip-joints. The left, which was attacked last, shows the greatest changes (group 3). the right (group 2).

CASE IX.

S. M., boy, aged 8 years. Admitted 14th November, 1912. Had been limping for a month.

Fig. 34.

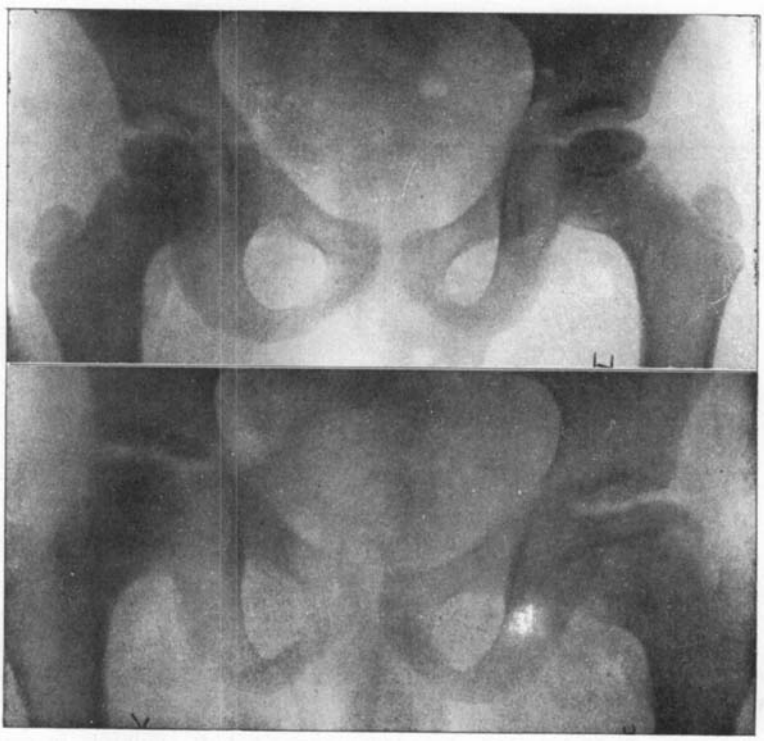


Fig. 35.

Fig. 34 shows a normal left hip-joint and an incipient coxa plana on the right (flattened epiphysis and increased distance between the epiphysis and the bottom of the acetabulum).

Fig. 35, 19th April, 1914. Nearly eighteen months after, incipient coxa plana also on the left.

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surface of the joint is uneven, the caput projects into the socket as a tap. Sometimes, as in Case X, there are corpora libera in the joint. The latter is no longer a ball-joint; it has but one axis, so that the mobility is confined to flexion only. The patient limps, and physical exercise invariably produces pain. Cases VII, and X belong to this group. Seemingly, the bilateral cases showed more severe degree of deformation than the unilateral ones.

CASE IX.

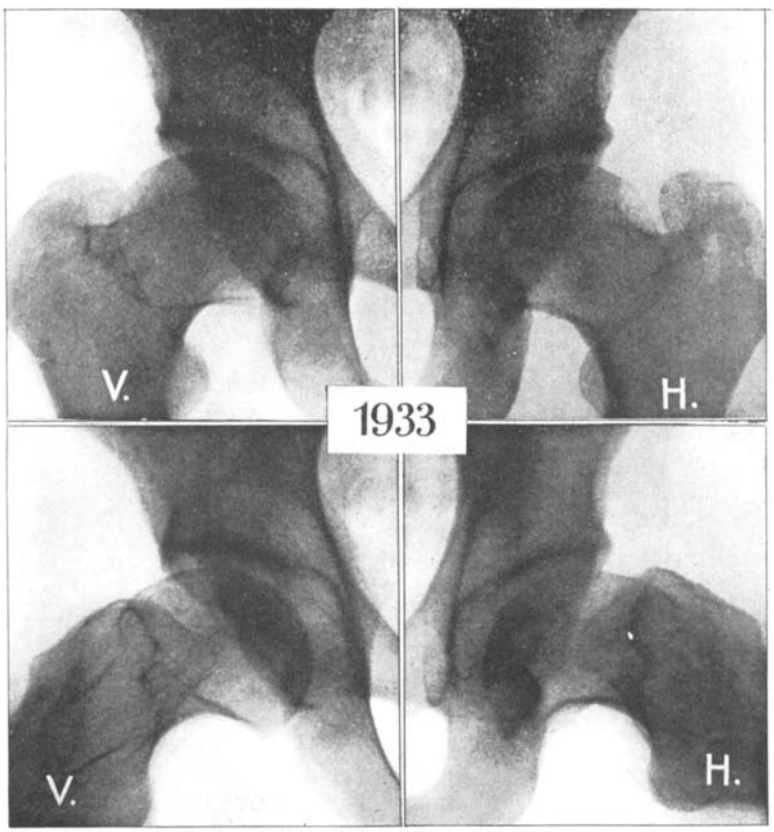

Fig. 36.

Fig. 36, 1933, shows the de initive stage of coxa plana, with medium degree of deformation (group 2). Films both in anteroposterior and in lateral projections.

The question arises, whether it is possible to prognosticate the future development from the radiographs of the early stages. It seems likely that the extent of the necrosis and the subsequent resorption must be the determining factors in that respect. This is also usually the case. If the resorption in the epiphysis is quite insignificant, the case will, in its definite stage, belong to

CASE X.

A. P., boy, aged 8 years. Admitted in 1908. Right hip-joint normal, left with coxa plana fragmentation.

In 1932, both hip-joints greatly deformed (group 3). Coxa plana in both hip-joints.

1908

Fig. 37.

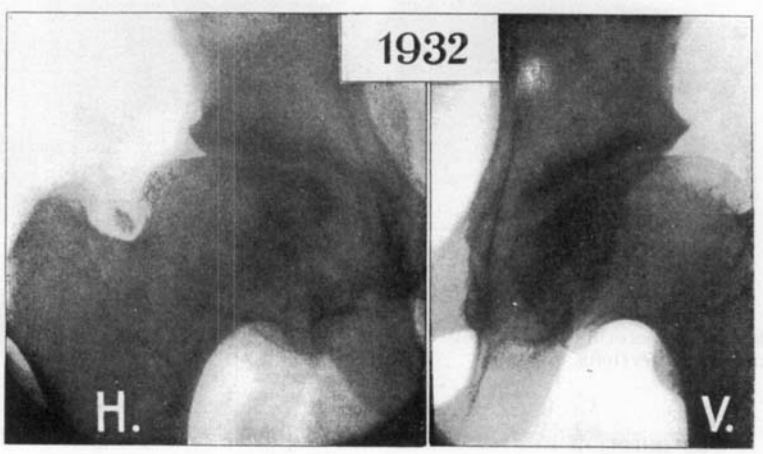

Fig. 38.

Group I (Cases I and V). If the epiphysis is completely resorbed, or if there are only small pieces left, and the upper part of the collum is resorbed, one may know that the deformity will,

in the course of time, become so severe as to place the case under Group III. Almost total resorption of the epiphysis does not always lead to a final stage of extreme deformation; as may be seen by comparing Cases V and VII, which are entirely similar during their development (see Figs. 20 and 28), but very different in the final result; Case VI (Fig. 21) belonging to Group I, Case VII (Fig. 29) to Group III.

SUMMARY

1.—Coxa plana develops in a hip-joint previously normal. This is proved by my bilateral cases. Fig. 30 shows incipient coxa plana in the right hip-joint, while the left hip-joint is normal. Fig. 31 shows the left hip-joint still normal sixteen months later; after another eighteen months there is typical coxa plana in this hitherto normal joint (Fig. 32).

2.—The clinical symptoms—a slight limp and a trifling reduction of the mobility—probably make their appearance before any evidence of the change becomes visible in the radiologic picture. Fig. 19 shows a normal hip, at a time when the clinical symptoms had been present for a week.

3.—The most important diagnostical indication of coxa plana in its earliest stages is the flattening of the epiphysis, which may be observed when the clinical symptoms have been present only a month.

4.—This flattening of the epiphysis is seen most clearly in the radiographs in lateral projection (flexion-abduction position), because the aplanation chiefly concerns the anterosuperior part (Cases II and III).

5.—In all cases of coxa plana, the distance between the epiphysis and the bottom of the acetabulum is greater than normal from the very beginning of the disease (Figs. 5, 9, 16). This distance is best measured from the medial part of the epiphysis to the bottom of the socket; that is, to the lateral leg of the U-shaped figure. It increases steadily with the progression of the disease (Case IV). Its cause is the flattening of the caput and

the resulting displacement of the latter, sideways and upwards in the acetabulum.

6.—At first, there is no change in the shape of the acetabulum (Case VIII, IX, X). The change in the latter takes place secondarily, as an adaptation of the socket to the deformed caput, and only after some time. When the caput has assumed its final shape, this adaptation of the socket is completed (Fig. 21), and, as a consequence, the distance from the epiphysis to the bottom of the acetabulum is once more normal; the caput fits into the socket again (Case VI).

ZUSAMMENFASSUNG

1) Coxa plana entwickelt sich in vorher normalen Hüften. Dies lässt sich durch meine doppelseitigen Fälle beweisen. Fig. 30 zeigt eine beginnende coxa plana in der rechten Hüfte, während das linke Hüftgelenk normal ist. Fig. 31 zeigt, dass das linke Hüftgelenk 16 Monate später immer noch normal ist; nach weiteren 18 Monaten findet man eine typische coxa plana in diesem bisher normalen Gelenk (Fig. 32).

2) Die klinischen Symptome des Leidens — ein leichtes Hinken und eine minimal herabgesetzte Beweglichkeit des Gelenks — sind möglicherweise schon vorhanden, bevor irgendwelche pathologischen Veränderungen auf den Röntgenbilde sichtbar werden. Fig. 22 zeigt eine normal aussehende Hüfte zu einem Zeitpunkt, in dem die klinischen Symptome bereits eine Woche bestanden haben.

3) Das wichtigste diagnostische Kriterium ist für die frühesten Stadium des Leidens die Abflachung der Epiphyse, die schon zu einem Zeitpunkt beobachtet werden kann, wo die klinischen Symptome erst einen Monat lang bestanden haben.

4) Diese Abflachung der Epiphyse sieht man am deutlichsten auf Röntgenbildern, bei deren Aufnahme die Projektionsrichtung die Epiphyse medial-lateral durchläuft (während die Hüfte in Flexion und Abduktion liegt), weil die Abflachung besonders

den vordersten obersten Teil der Epiphyse betrifft (Fälle II und III).

5) In allen Fällen von coxa plana findet man den Abstand zwischen der Epiphyse und dem Boden des Acetabulums gleich vom ersten Beginn des Leidens an grösser als normal (Fig. 5, 9, 16). Dieser Abstand wird am sichersten vom medialen Rand der Epiphyse bis zum Boden des Acetabulums gemessen, d. h. zum lateralen Schenkel der Tränenfigur. Diese Abstandsvergrösserung nimmt im Verlaufe der weiteren Entwicklung des Leidens zu (Fall IV). Die Ursache hierfür ist die zunehmende Abplattung des Caput und in deren Folge seine Verschiebung im Acetabulum nach oben und aussen.

6) Im Anfangsstadium finden sich keine Veränderungen in der Form des Acetabulums, sondern diese stellen sich erst sekundär ein als eine Anpassung der Form der Gelenkpfanne an das deformierte Caput, und auch das erst nach Verlauf einiger Zeit. Wenn das Caput seine endgültige Form erreicht hat, ist auch diese Anpassung der Form der Gelenkpfanne vollendet (Fig. 21), und infolgedessen ist der Abstand zwischen der Epiphyse und dem Boden des Acetabulums wieder normal geworden; das Caput passt wieder in die Gelenkpfanne hinein (Fall VI).

RÉSUMÉ

1) La coxa plana se développe dans des hanches préalablement normales. Ce fait se laisse constater à l'aide de mes cas bilatéraux. La fig. 30 montre une coxa plana droite débutante, tandis que l'articulation coxale gauche est normale. La fig. 31, radiographie prise 16 mois plus tard, présente l'articulation coxale gauche toujours normale; après encore 18 mois on voit une coxa plana typique dans cette articulation jusqu'alors normale (fig. 32).

2) Les symptômes cliniques de la lésion — un boitement léger et une diminution à peine appréciable de la mobilité de l'articulation — existent peut-être avant qu'aucune altération pathologique ne soit démontrable par radiographie. La fig. 19

présente une hanche apparemment normale à un moment où les symptômes cliniques existaient depuis une semaine.

3) Le critérium diagnostique le plus important de l'affection dans ses premiers stades, c-'est l'aplatissement de l'épiphyse, qu'il est possible de constater à un moment où les symptômes cliniques ne datent que d'un mois.

4) Cet aplatissement de l'épiphyse s'observe le plus distinctement sur des radioscopies prises de manierè que les rayons perpendiculaires à la plaque passent l'épiphyse dans la direction médiale-latérale (la hanche étant placée en flexion et en abduction) ; c'est que l'aplatissement atteint surtout la partie antérieure-supérieure de l'épiphyse (cas II et III).

5) Dans tous les cas de coxa plana on trouve, dès le premier début de 'affection, que la distance entre l'épiphyse et le fond de l'acétabule est plus grande que normalement (fig. 5, 9, 16). Cette distance se mesure le plus exactement à partir du bord médial de l'épiphyse et jusqu'au fond de l'acétabule, c'est à dire jusqu'à la branche latérale de la figure en U. Cette augmentation de distance s'accroît pendant l'évolution de la lésion (cas IV). La cause en est l'aplatissement progressif du caput, et son glissement vers le haut et vers le dehors dans l'acétabule.

6) Au commencement on ne constate pas d'altérations de la forme de l'acétabule (cas IV) ; celles-ci ne se produisent qu' après un certain temps. C'est un processus secondaire: l'adaptation de la cavité articulaire à la déformation du caput. Le caput ayant pris sa forme définitive, cette adaptation de la forme de la cavité articulaire se sera aussi complétée, et par conséquent la distance entre l'épiphyse et le fond de l'acétabule sera redevenue normale; le caput est de nouveau conforme à la cavité articulaire (fig. 21).