ON THE ANATOMY AND PATHOLOGY OF THE HIP-JOINT

BY

POUL MORVILLE,

Head Surgeon, Department A, Copenhagen
County Hospital, Denmark.

A century ago *Cruveilhier* described the hip affection occurring in older individuals, which is later known under the name of malum coxæ senile or arthritis deformans coxæ. He pointed out that its anatomical basis is atrophy of the cartilage caused by wear of the joints, which he considered one of the many unavoidable phenomena of advanced age. This opinion seems to have prevailed until the beginning of the twentieth century.

At a congress in 1906 *Gourdon* reported 3 cases in which younger subjects presented symptoms of arthritis deformans coxæ, the x-ray examination, however, showing no trace of arthritis. In all 3 instances he found, however, that the acetabulum was *flat* and *steep*—that is, more vertical than normally—the caput femoris flattened and displaced upwards, and the collum was in a valgus position. In the families of the patients there had been cases of congenital hip luxations. *Gourdon* interpreted the flat socket as a hereditary congenital malformation and considered this the primary cause of the affection.

In 1907 *Preiser* showed through anatomical investigations that the socket is frequently directed more backwards or more forwards than is normally the case. With the femur in a normal position a great part of the articular area of the head will under these conditions be out of contact with the socket. The statics of the joint will be bad, with inadequately distributed pressure

on the head, resulting in trophic disturbances and, finally, in arthritis deformans.

These first communications, according to which the cause of the hip affections appearing later in life is sought in a congenital malformation of the acetabulum, do not seem to have attracted any greater attention. Not until 20 years later appear the works of *Murk Jansen* and *Calot,* both ascribing the cause of all the idiopathic affections in the hip-joint—those in children as well as those in adults—to the same congenital malformation, the flat socket. The writer has mentioned these works in one of his previous papers »The Incongruous Hip« (Acta Orthopædica Scandinavica, Vol. IV, Fasc. 2), to which those interested are referred.

The above-mentioned surprising hypothesis, according to which there should be a common cause of all the apparently widely different hip affections, is based on some previously unheeded details in the roentgen picture, and which the two authors have interpreted as signs of congenital abnormities. In my above-mentioned paper I suggested that this interpretation of the roentgen picture of the hip-joint of small children hardly stands a closer investigation; in other words, that the foundation of the above hypothesis is hardly correct. I have made some investigations in order, if possible, to prove that my view is right.

First some information as to the embryology of the joints. All the different parts of a joint, i.e. cartilage, bone, synovial membrane and fibrous capsule are, as we know, formed through differentiation of the same mesodermic somite. The head of the bone takes shape first and, *determined by the form of the head* the socket is developed later. The latter originates as a small excavation which later deepens. The margins of a socket are always originated as labrum glenoidale.

The x-ray examination of joints in new-born children and infants presents the difficulty that it is impossible without special measures to get detailed information as to the shape of the joint, as the epiphyses are not ossified and thus give no shadow.

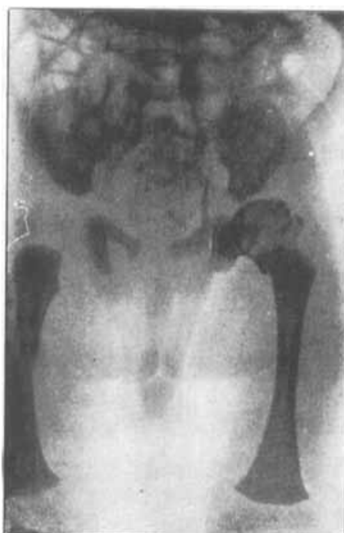


Fig. 1.
Hip-joints in new-born. Contrast substance injected into one of the joints.

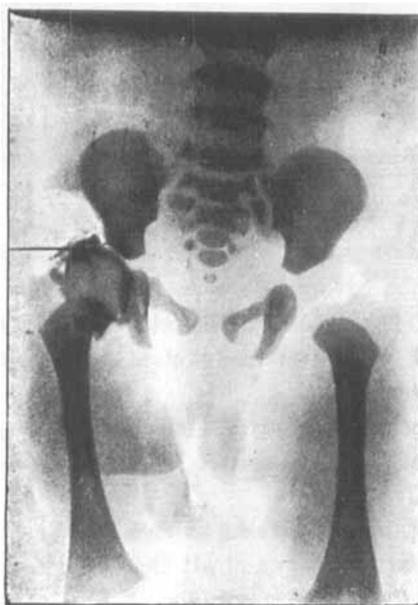


Fig. 2.
Hip-joint in new-born.

As regards the hip-joint the nucleus of the femoral head appears in the 10th month of life and not until about the age of 3 years is the whole epiphysis ossified and to its full extent visible in the roentgenogram.

In order to make the outlines of the caput in newborn children visible I have injected contrast substance into the joints of 12 full-term still-born children, before taking the picture.

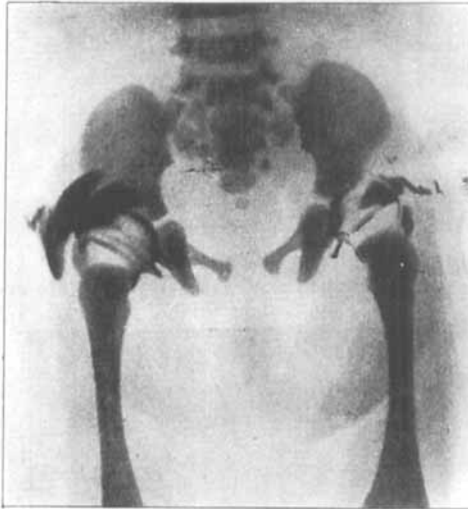


Fig. 3.
Hip-joint in new-born with contrast substance injected.

It is evident that the head is relatively large and well developed at birth, whereas the socket is just a small excavation in the pelvic bones.

Without injection of contrast substance the great distance between the neck and the socket reveals the disproportionate size of the epiphysis.

Exactly the same conditions as seen in Figs. 1, 2 and 3 are found in the roentgenograms of all the other new-born children examined.

Section was made of the hip-joints of all twelve children.

On account of the large cotyloid ligament the depth of the socket seemed not quite insignificant, but the osseous socket was, as seen in the roentgenogram, only a small excavation.

The photograph, Fig. 4, shows the hip of a new-born child whose socket has been sawn through saggittally. The acetabular roof is straight and steep as in the radiographs. The osseous socket is quite flat.

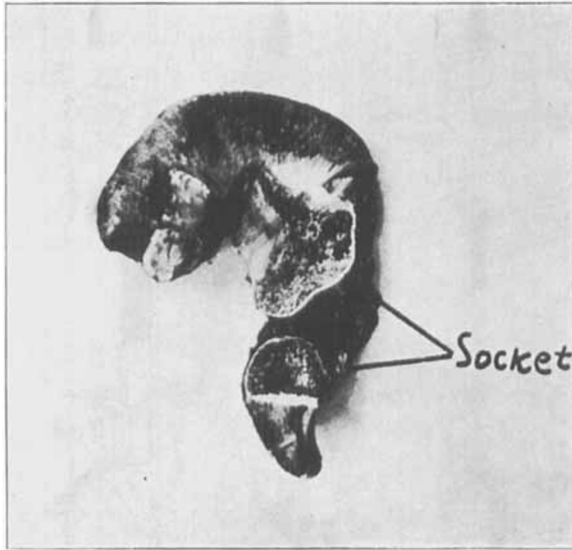


Fig. 4.
Mesial saggittal section through the hip in a new-born child.

The hip-joint has to undergo a thorough transformation and development during the first years of life, before it gets the shape found in adults. On Plate 1 this development is shown diagrammatically.

Plate 1 shows that this development is not finished until the age of about 5 years. The great changes taking place can be best understood by studying the different details illustrated by diagram in Plate 1.

1. The socket.

The osseous socket in new-born children is, as already men-

tioned, only a small excavation in the pelvic bones. Its floor is, therefore, thick.

Already at about 1 year of age a relatively strong growth

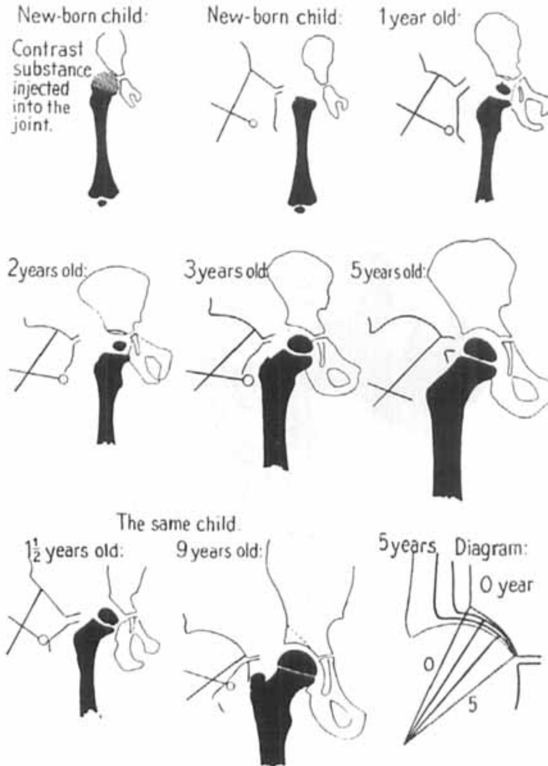
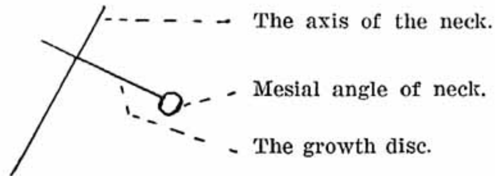


Plate 1.
Explanation of the diagrams:



The diagram shows the development of the acetabular roof and the displacement downwards of the collum axis, i.e. the socket extends out over the head, capping it like a hood.

has taken place in the upper part of the socket, which starts shelving outwards. At the age of about 2 to 3 years the roof of the socket grows and shelves beyond the femoral head, at 5 years we find the »normal« socket whose upper lateral outline slopes downwards over the head and ends in a beak-shaped prominence—the shelving roof is formed.

2. The femoral head.

Its dominating size in new-born children has already been mentioned. The major part of the head protrudes above and beyond the small socket, so that the projection of the collum axis (the position of the caput in the socket) points towards the upper angle of the acetabulum. Gradually, as the roof of the socket grows beyond the femoral head, the latter seems to move downwards in the socket so that at the age of 5 years the collum axis points towards the Y-cartilage: *the caput is placed in the centre of the socket.*

At the age of 1 year we have a distinct bone nucleus. Striking is the relatively stronger growth of the socket and neck during the first years of life as compared to that of the head.

3. The growth disc.

This is in new-born children at a right angle to the collum axis, from above downwards and mesially. Already at about 1 year of age the growth disc is horizontal, resulting from a more rapid growth of the lower part of the collum than of the upper part. It remains horizontal until the age of 5 to 8 years, then again turns somewhat downwards, forming once more approximately a right angle with the collum axis.

4. The mesial angle of the collum.

The roentgen picture of a new-born child shows the mesial angle of the collum separate from the pelvic bones. At the age of two years it reaches the shadow of os ischium, then glides in over the latter, approaching the »Thränenfigur« (Alban Köhler).

The shape of the mesial collum angle also undergoes characteristic changes. A very strong growth takes place here during the first years of life, resulting in a hypertrophical prominence, which from ½ to 2 years is lip-shaped and later chin-shaped.

This hypertrophy subsides gradually and is not seen after the age of 8.

5. The collum.

The characteristic of the remaining part of the collum is, as mentioned before, that it is very short at birth, then grows rapidly. The turning of the growth disc towards the horizontal and, later, back again is a sign of the more rapid growth of the lower mesial part of the collum during the first years of life and, later, the dominating growth of the upper lateral part of the collum.

The epiphyses of the great trochanter and small trochanter appear at much varying ages, between 3 to 8 years, the great trochanter first.

In the lower left corner of Plate 1 is seen a roentgenogram of a child, aged 1½ years. Then a picture of the same joint 8 years later, when the child was 9 years old. The formation of the acetabular roof, the turning of the growth disc and the gliding down of the head into the socket are clearly seen.

The diagram in the lower right corner of Plate 1 illustrates the development of the socket and the change in the direction of the axis of the neck taking place from 0 to 5 years.

Summed up these investigations show that the hip-joint of the new-born child has an embryonic form with a relatively large spherical head, the socket proper is undeveloped. During the first years of life the head is placed in the upper part of the socket. Not until the acetabular roof is formed at about three years, the head is placed in the centre of the socket. It is a mistake to talk of a congenital flat acetabulum as a malformation, the acetabulum being flat in all new-born children. A slight degree of »subluxation«, i.e., an excentric position of the head in the socket, is likewise physiologic during the first 2 years of life.

The writer has divided the idiopathic diseases of the hip-joint into two groups: the constructive and the structural affections. The first group comprises the congenital luxation, the

congenital subluxation and coxa valga, the second Calvé-Perthe's disease, slipping epiphysis and the acquired subluxation.

The constructive diseases and their relation to the formation and development of the hip-joint will be discussed first.

The frequent occurrence of *congenital luxation* specially in the hip-joint, is easily explained by the fact that the osseous socket is only being fully developed during the first years of

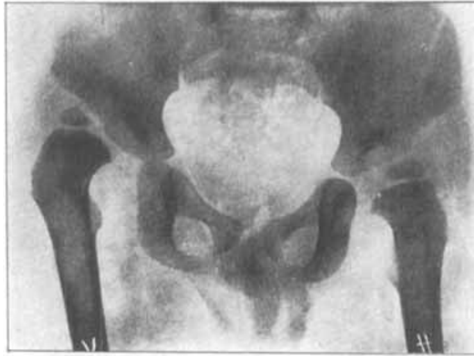


Fig. 5.
Boy, aged 4. Luxatio coxæ congen. sin. Subluxatio coxæ congen. dext.

life. The head has at birth hardly any osseous support, is only fixed by the cotyloid ligament and soft parts.

The cause of *the congenital subluxation* is a socket remaining flat during growth, which mode of expression is more correct than calling it a congenital flat socket. In order to understand how such a malformation can arise we must keep in mind that a bone in order to develop and grow in a natural way must have its epiphysis subjected to a certain pressure. We know, according to the Hüter-Volkmann law, that if this pressure is strongly increased above the physiological limit, growth decreases. Is the pressure somewhat below the physiological, growth may be stronger than normal; no pressure at all results in cessation of growth or malformation.

Fig. 5 shows a congenital luxation on left side and a congenital subluxation on right in a boy of 4 years. The luxation was reduced and 1 year later we see (cf. Fig. 6) that the

acetabular roof on left side is more developed and shelved because it has been subjected to pressure from the reduced caput. The subluxation on right side has in the course of the year become a luxation, the socket on this side rather seems to have become flatter, because the pressure on the roof has ceased.

The way in which the neck grows is also rather instructive. During the first years of life the head, as already mentioned,

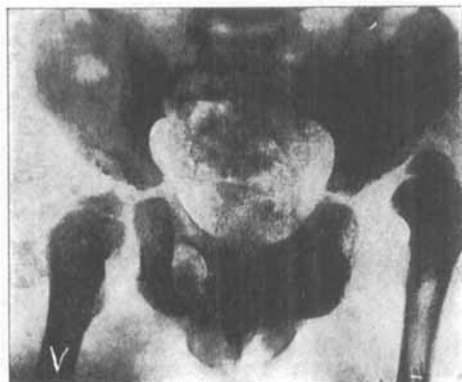


Fig. 6.
Same case 1 year after reduction of left hip-joint. Development of acetabular roof. On right side the subluxation has become a luxation. Acetabular roof somewhat more flat than in Fig. 5.

presses against the upper part of the socket; thus the area of contact on the head is only a small part of its upper lateral surface and to this the body weight is transferred through the pelvic bones. The pressure will therefore be abnormally strong on this small area, whereas it will be less than normal on the mesial part of the epiphysis; thence decreased growth in the lateral part of the epiphysis and increased growth mesially. This condition manifests itself in the turning of the growth disc towards the horizontal, the mesial half of the collum growing more than the lateral. Another manifestation is the first lip-shaped, later chin-shaped hypertrophy of the mesial angle of the neck. The former shape is seen at the age of ½ to 2 years and is considered typical of rachitis; the latter is most pronounced from 3 to 8 years and is by *Murk Jansen* and other

authors considered a characteristic of the incongruence of the joint and the initial symptom of the Calvé-Perthe's disease. Both shapes are physiologic stages of the transformation the hip-joint undergoes during childhood. When the shelving of the acetabular roof is developed, the pressure is distributed more equally over the head, the irregular growth ceases and it is now seen that the growth disc turns from the horizontal plane downwards towards its former direction and the mesial hypertrophy of the collum disappears.

If the development of the acetabular roof does not take place until later, the increased growth of the mesial part of the collum may reach such a degree as to result in a *coxa valga* which becomes permanent.

The growth disc is, as is known, assumed to be the growth zone. According to *Harris* nobody, however, has ever succeeded in demonstrating here, in man, the cell division, which is the primary condition of growth. From the recent investigations by Harris, however, we see, that he has succeeded in finding cartilage cells in division in the human foetus. They are only found in the epiphysis, arranged in a ring, the mitotic ring. In all directions around this ring there are found older cells of which those close to the middle of the epiphysis are calcified, forming the bone nucleus, whilst the cells growing downwards are calcified in the zone below the epiphyseal line. The relatively stronger growth occurs, as is known, while the epiphysis still partly consists of cartilage. As the growth zone proper is ring-shaped, as already mentioned, it is easily understood that an increased excentric pressure on the head must result in a deforming growth.

When the socket does not develop normally, this may be due to the fact that the head in the infant glides higher up in the flat socket than normal, perhaps as a result of decreased muscle tonus in the child. As the head gets no support here, neither the head nor the socket is thus subjected to the physiologic pressure. The result is, as mentioned above, that the growth ceases. The same happens after reduction of a con-

genital luxation, if the head fails to be placed sufficiently deeply in the socket. The result will then be a subluxation.

Even if the caput is placed in the centre, however, a flat socket may now and then be found—a presumably inexplicable atavism.

As regards the above mentioned affections, *the congenital luxation, the congenital subluxation* and *coxa valga,* the flat socket may presumably be considered the only or, at all events, the principal cause of these lesions. Therefore, I have called these diseases *the constructive affections of the hip.*

The conditions are far more complicated if we look at the other group of the idiopathic hip affections, those I have called the *structural affections.*

The characteristic of the latter affections is that at a certain age and during a shorter or longer period the articular surfaces undergo a transformation. Is the period of short duration the transformation is accompanied by structural changes visible in the x-ray picture. A period of plasticity of the bone tissue is noted in these affections. The solidity of the bones depends, as we know, on the deposit of lime salts. Therefore, plasticity is ascribed either to a decrease in the amount of lime salts or to depositing of other calcium compounds of lesser firmness.

Plasticity of bone tissue is a wellknown phenomenon in several affections: rachitis, osteomalacia, etc., but the time is over when these bone changes were considered specific of these affections and only connected to same.

In my paper, »The Incongruous Hip«[1]) I have discussed these conditions more closely, and here it will suffice to recall the fact that plasticity may be experimentally produced in *sound* bones by exposing them to excessive strain.

The plasticity is in early childhood localized to the most sensitive tissue, i.e., the growth zones, and occurs specially in those bones which are mostly subjected to mechanical influence.

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[1]) Acata Orthopaedica Scand., Vol. IV, Fasc. 2.

It is thus more pronounced in the lower than in the upper extremities.

The Calvé-Perthe's disease is one of the affections where the plasticity of the bones is most evident. As is known, the pathogenesis of this disease is rather disputed. The writer just wants to remind of the fact that both *Murk Jansen* and *Calot* believe that the cause also of this disease is anatomic, namely a flat socket.

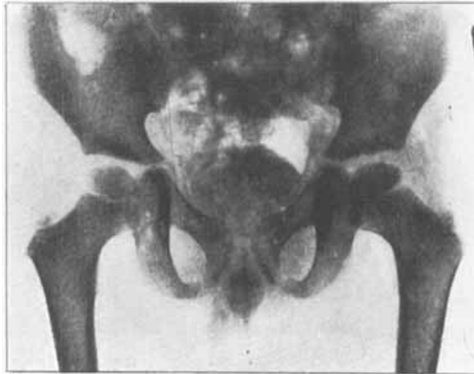

Fig. 7.
Boy, aged 6. Calvé-Perthe's disease.

Fig. 7 shows the hip-joints of a 6-year-old boy having had pains in right hip for 3 months and now and then a slight limp.

There is no definite difference to be seen in the two hip-joints. The socket seems to be of normal depth, the lateral part of its upper outline slopes downwards as normal, the head is centred accurately, there is no displacement upwards, no trace of subluxation.

According to *Murk Jansen* this hip presents the following abnormities:

a) The growth disc is almost horizontal, it should be (according to *Murk Jansen*) at a right angle to the axis of the neck.

b) The chin-shaped eminence of the mesial angle of the neck is a sign of incongruence of the joint.

c) The head is too remote from the mesial part of the socket, it is displaced too much outwards from the »Thränenfigur«, so that a gap is formed here.

d) The socket is too flat as compared to the caput.

Murk Jansen has personally given me this description of above x-ray picture.

As pointed out already, my investigations on the development of the normal hip-joint show that these »abnormities« are physiologic stages in the development of the hip during childhood.

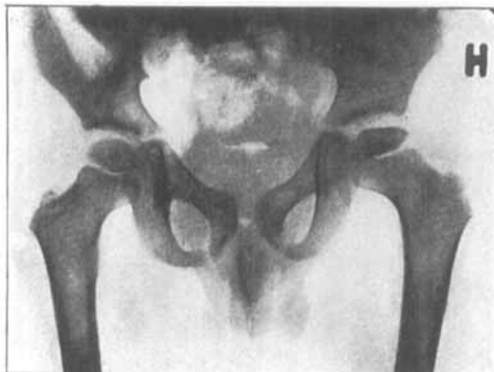

Fig. 8.
Same case as in Fig. 7 10 weeks later. Flattening of the epiphysis, neck slightly bent.

Fig. 8 is taken 10 weeks after Fig. 7. The head on right side is flattened and it is obvious that it has been flattened through the weight of the body. It is also clearly seen that the pressure has bent the upper part of the collum somewhat downwards. This plasticity of the bone tissue may, as previously mentioned, be due either to a decrease in the lime salts of the bones, or to the fact that the lime salts enter into other compounds than normally.

We must not be misled by the fact that the x-ray does not show any decrease in lime salts. From the treatment of fractures we know that the firmness of the fracture and the deposition of lime salts in the callus are not necessarily parallel. It

is also worth while remembering that marble and chalk give the same density in the x-ray picture. The first thing we can establish in the Calvé-Perthe's disease is thus plasticity of the bone tissue.

Six months later we find the so-called fragmention stage of the head, cf. Fig. 9. A great part of the lime salts in the

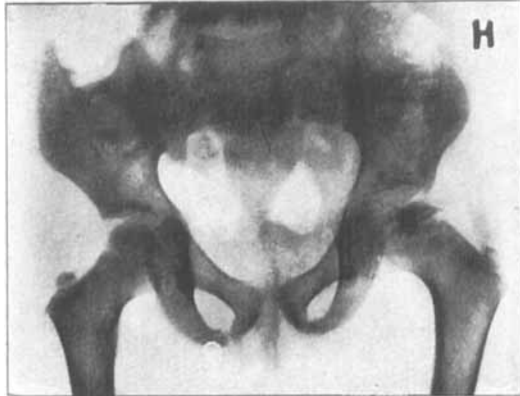

Fig. 9.
Same case as in Fig. 8, 6 months later. Fragmentation stage. The remaining epiphysis shows denser structure. Outline of socket somewhat effaced. Beginning lateral subluxation of head.

head have disappeared, the remainder lies in different parts whose density in the x-ray picture is more pronounced than that of the surrounding bone tissue. The seeming division—fragmentation—of the epiphysis may frequently be more marked than in this instance, so that of the head there will remain only separate small particles of great density. Distinct changes are also seen in the socket. The bone structure is somewhat effaced and the outlines hazy. Furthermore, in comparison with the left side, *a beginning subluxation of the femur is noticed, the head is about to be displaced outwards in the socket.*

After the last x-ray picture was taken the healing began, resulting finally—2 years later—in the typical transformation, i.e., a flat head spread out over the upper part of the neck

towards the trochanter, the socket broad and flat but not steep, the head subluxated laterally but not displaced upwards.

In order to throw some light upon the question, whether a deformation of the socket is also the cause of slipping epiphysis,

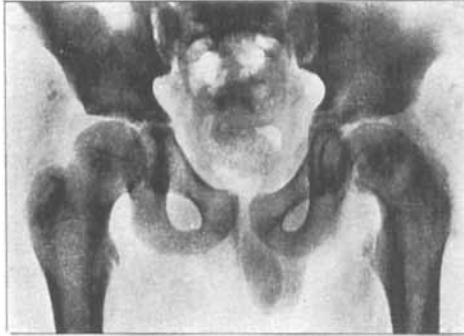

Fig. 10.
Boy, aged 10. Slipping epiphysis. Clearings and density in collum. Outline of acetabular roof indistinct.

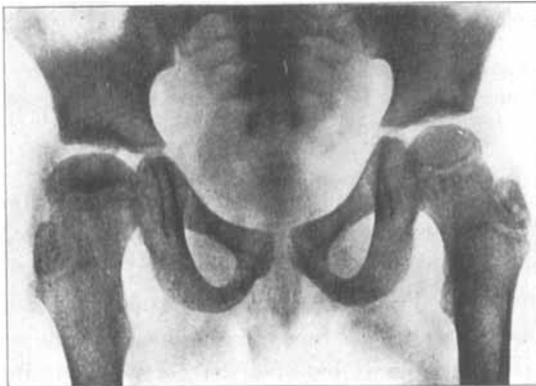

Fig. 11.
Coxa valga sin. Large dark spot in the epiphysis.

as has been maintained, it is probably sufficient to show a typical roentgenogram of the latter affection. Fig. 10.

Apparently nothing is wrong with the form and depth of the socket, nor with the position of the head. It is worth notic-

ing, however, that the structure of the acetabular roof cannot be made out and the upper outline of the joint is nearly effaced. The picture of the socket is very much like the one (Fig. 9) illustrating the Calvé-Perthe's disease. Also in the collum there are seen clearings and structural changes of quite the same kind as in the Calvé-Perthe's disease. Similar clearings, i.e., localized rarefaction of lime salts may also be seen in coxa valga, as shown in Fig. 11, a condition which will be discussed later.

Even though the idiopathic hip affections appearing during childhood are not exceptional, they are far less important than those occurring in adults. The latter bear the equally misleading names of arthritis deformans coxæ or malum coxæ senile.

In order to find out whether there is any hold for the assumption that a congenital flat socket is the cause of arthritis deformans, the writer has in the Invalidity Insurance Court examined 100 cases, where invalidity benefit was applied for on account of arthritis deformans coxæ.

I found that in only 16 of these instances the arthritis had developed in an anatomically normal hip-joint. There were in these cases the classical signs of arthritis, namely diminished joint gap, osteophytes along the margins of the socket and of the articular surface of the head, forming an osteophytic enlargement of the margins. This is the form which can rightly be called arthritis deformans plastica.

From the anamneses it was evident that in 12 of the 16 instances the hip affection was either only a link in a polyarthritis or there was a traumatic or infectious cause of the arthritis.

According to the information in hand one would thus in only 4 out of the 100 cases examined assume the occurrence of an idiopathic hip affection in an anatomically normal joint, and it is then hardly too unreasonable to assume that with still more complete information also the last 4 cases might have been eliminated. The remaining 84 cases showed anatomically

abnormal conditions. It was, however, apparent that the deformations could without difficulty be divided into two types, widely different from each other. Cf. Plate 2. I have called one *subluxatio coxæ congenita,* the other *subluxatio coxæ acquisita.*

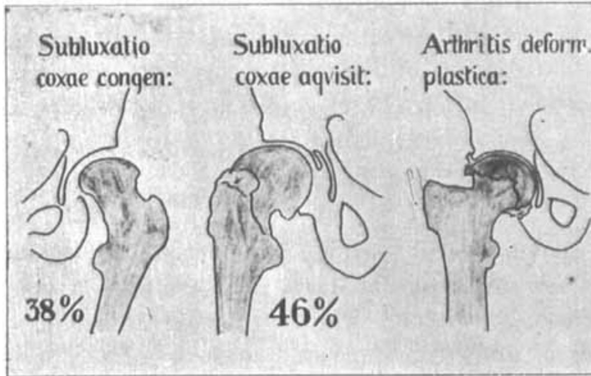

Plate 2.

	Sublux. coxæ congenita	Sublux. coxæ acquisita	Arthritis deform. plastica
Socket	Flat, steep	Broad, flat, double floor	Normal shape
Caput	Buffer shaped	Flat, spread-out over collum towards trochanter	Normal shape
Subluxation	Upwards	Outwards	None
Osteophytes	None	Few	Numerous, osteophytic marginal enlargement
Collum	Long, (Caput) valgum	Short	Normal

Subluxatio coxæ congenita is the deformity primarily described by *Gourdon,* later in Germany by *Klapp,* who calls it *coxa valga luxans.* The acetabulum is in this disease extraordinarily flat and steep, the »Thränenfigur« points almost mesially instead of bending, as normal, outwards below the lower part of the femoral head. The head is deformed in an

equally typical and constant form, buffer form, flattened on the upper side. A great part of it, as a rule one-fourth to one-third, projects laterally beyond the angle of the socket. It is subluxated upwards, which is most easily seen by interruption of Shenton's line. The head is bent upwards, is in the valgus position. The generally long collum has a bending upwards.

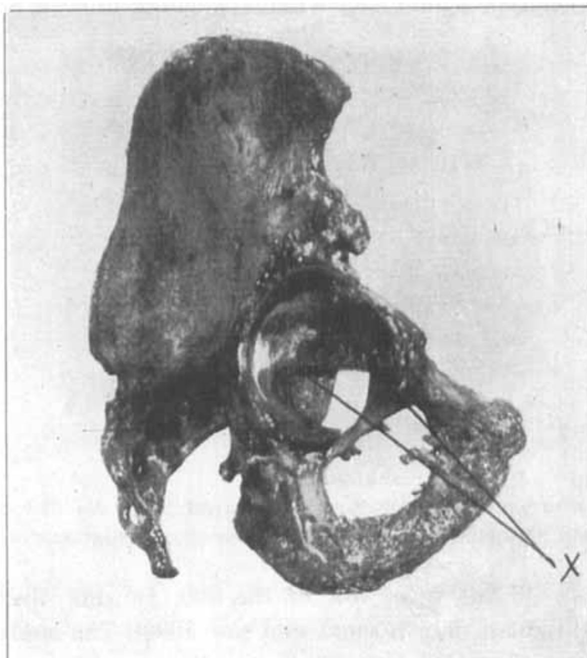

Fig. 12.
Socket with double floor, marked X. A slip of paper is introduced between the original and the double floor.

The collo-diaphytic angle is, on the contrary, most often normal, so it is no coxa valga in the stricter sense of the term.

This deformity has undoubtedly developed on the basis of the congenital flat acetabulum. It is not until the age of about 30 to 50 years that there occur real arthritic changes in the form of atrophy of the articular cartilage and regressive changes in the bone structure, most frequently as cyst-like clearings in the cancellous tissue under the cartilage. There is no

osteophyte formation worth mentioning. The deformity may give symptoms already during childhood, temporary pains in walking and a limp, so it is often diagnosed many years before the arthritis occurs. Among the 100 instances from the Invalidity Insurance Court there were no less than 38 of this kind.

The other type which I have called *subluxatio coxæ acquisita*

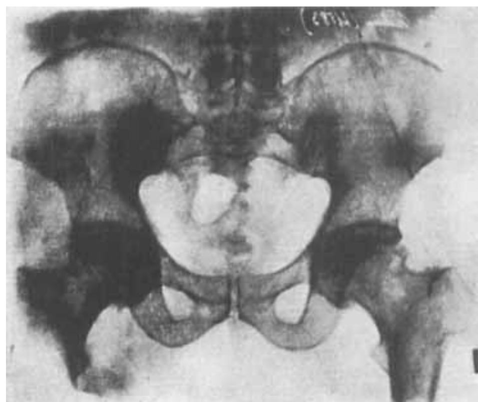

Fig. 13.
Arthritis deformans plastica. Normally shaped joint. No dislocation of caput. Osteophytes and marginal osteophytic enlargement.

occurred in 46 instances out of the 100. In this disease the socket is broader than normal and not steep. The subluxation of the caput, therefore, is no displacement upwards worth mentioning but a displacement laterally, so that it is removed far from the »Thränenfigur«. Frequently, the head gets another support mesially through the formation of the so-called double floor, which may vary from a small osteophytic prominence to a broad lamina of bone, which from the fossa acetabuli grows downwards parallelly to the »Thränenfigur« (cf. Fig. 12). The head is broad and flattened, it is spread out beyond the upper surface of the collum and nearly reaches the trochanter. The collum has in this deformity no typical form, it may be in a slight valgus or slight varus position but is, contrary to what is the case in the congenital subluxation, generally short. This

deformity is nearly identical with the transformation of the joint seen as the end stage in the Calvé-Perthe's disease, but otherwise it never occurs in young individuals. Secondarily, the subluxation leads to the same arthritic changes as the congenital subluxation.

Duvernay has pointed out that arthritis deformans plastica

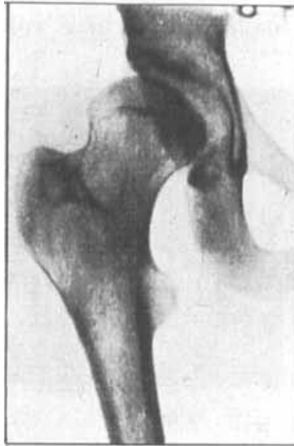

Fig. 14.
Subluxatio coxæ congen. Displacement upwards 1 cm., caput valgum. No arthritis.

and subluxatio coxæ are two absolutely different affections, one does not develop on the basis of the other, and it is my opinion that subluxatio congenita and subluxatio acquisita are equally characteristic and of each other independent affections.

It is the current belief that it is »the arthritis« that leads to deformity of the articular surfaces, but I wish to maintain that it is undoubtedly the deformity—the subluxation—that is primary but for years giving no symptoms, until the arthritic changes occur and with them the symptoms. The following facts speak in favour of my view:

1. The described deformity may very often be found without arthrosis, a condition which is common on the sound side in unilateral affections.

2. Even if the arthritic changes are very pronounced and

extensive in the head, neck and socket, the same typical deformity is maintained, the deformity is thus not developed concurrently with or proportionally to the arthrosis.

3. In an arthritis deformans without subluxation a detailed anamnesis nearly always reveals a previous affection, for inst. an infectious, traumatic or neuropathic arthritis—a polyarthritis—or the patient has had a slipping epiphysis in childhood.

The acquired subluxation does as a rule not develop until

Fig. 15.
Subluxatio coxæ congen. On right side 1½ cm. displacement upwards. secondary arthritis with cyst-like clearings in caput and acetabulum.

at about 40 years. The symptoms are rarely very pronounced until the age of 50, when the secondary arthrosis appears.

The following roentgenograms illustrate the two types of idiopathic hip affections in adults.

For comparison is shown, in Fig. 13, an arthritis deformans plastica in a patient suffering from polyarthritis.

The caput is seen quite at the bottom of the acetabulum. There is perfect adjustment between the head and the socket, no displacement upwards or laterally of the head. The joint gap is narrowed, there are considerable osteophytes and pronounced marginal swelling of the head.

Fig. 14 shows a subluxatio congenita in a woman of 18 years. More than one-third of the caput protrudes beyond the acetabulum. The acetabulum is flat and steep, the caput flattened and buffershaped, bent upwards in a valgus position. There is

a displacement upwards of 1 cm. measured at the interruption of Shenton's line. There is no trace of arthritis.

Fig. 15 shows a subluxatio coxæ congenita. On right side pronounced arthritic changes, the joint gap nearly eliminated. Both in the head and socket there are seen cyst-like clearings; the head is displaced upwards 1½ cm.; one-fourth of it protrudes beyond the socket, caput valgum, long collum. No osteophytes. On left side no arthritis, flat socket but no subluxation.

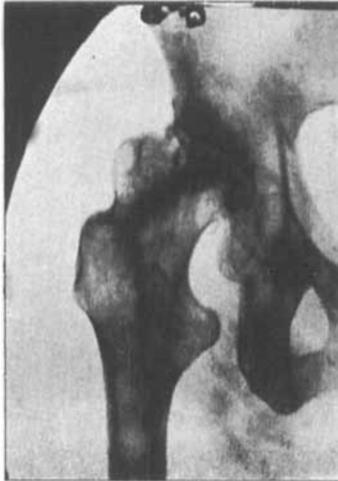

Fig. 16.

Subluxatio coxæ congen. 2 cm. displacement upwards. In spite of excessive secondary arthritic changes typical shape remains.

In Fig. 16 we see excessive arthritic changes, extensive cyst-like clearings quite down in the collum, one-third of the head protrudes beyond the socket, there is a displacement upwards of 2 cm. In spite of these violent secondary arthritic changes the typical form is still retained.

Fig. 17 shows a subluxatio coxæ acquisita in a man of 46 years. The socket is broad and flat, there is a clearly visible double floor. The head is flattened and spread out over the upper surface of the neck towards the trochanter. The head is subluxated laterally but not upwards. No secondary arthritis,

no diminution of joint gap. No structural changes in the bones.

Fig. 18 shows a subluxatio acquisita on both sides. On right side extensive regressive changes in the caput, which is dislocated *2 cm. laterally*. The socket is broad but not steep. The joint gap narrowed. Medially in the socket there is a long and solid double floor. The gap between the double floor and the

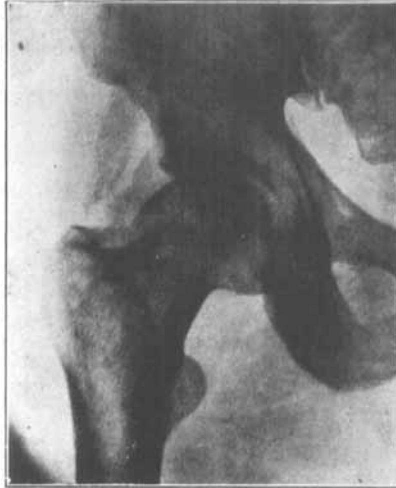

Fig. 17.
Subluxatio coxæ acquisita. Caput subluxated laterally. Double floor. No arthritis.

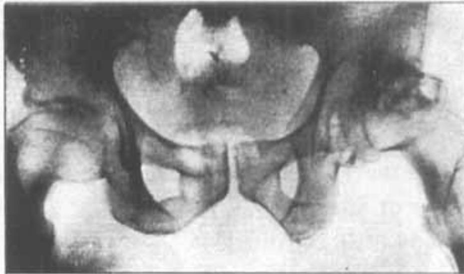

Fig. 18.
Subluxatio coxæ acquisita. On affected side violent regressive changes. *Lateral* displacement of 2 cm. Double floor. On sound side same deformity in milder degree: broad, flat socket, large, flat head; signs of lateral displacement but no arthritis.

original mesial wall of the socket is distinctly seen. It is interesting to note that the same deformity in a milder form is found on the sound side, the caput being extended almost to the

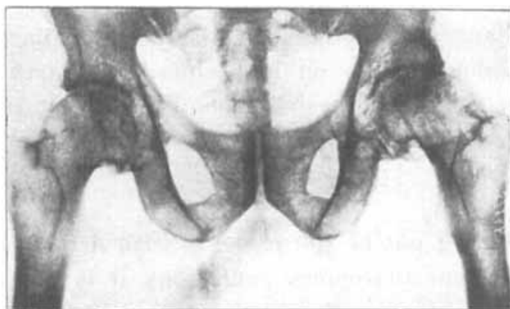

Fig. 19.
Subluxatio coxæ acquisita on both sides. Caput displaced laterally 2 and 1 cm. respectively. Arthritic changes most pronounced on left side.

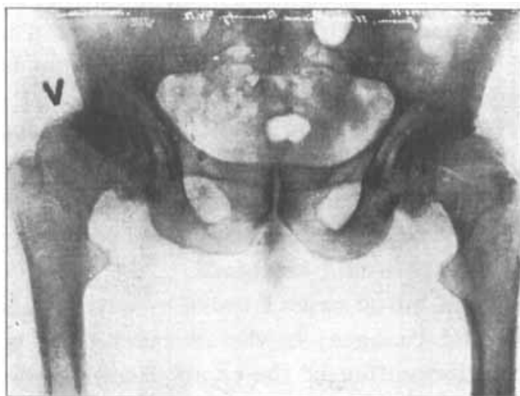

Fig. 20.
Bilateral subluxatio coxæ acquisita. Pronounced arthritic changes.

trochanter; the socket is broad and flat, there is a beginning of a double floor in the form of a little osteophyte from the fossa acetabuli. The head is moderately displaced laterally. No secondary arthritis.

Fig. 19 shows an instance of bilateral subluxation. The caput is on right side displaced laterally 2 cm., on left side 1 cm.

No upward displacement. The head is flattened and extended towards the trochanter; double floor on both sides; arthritic changes most pronounced on left side.

Fig. 20 shows another bilateral subluxation with pronounced arthritic changes on both sides, the head displaced laterally 1 to 2 cm., double floor on both sides. The parrot-bill-shaped eminence of the lower mesial part of the caput is not rarely seen in this deformity.

When finding out of 100 patients with arthritis deformans 84 with abnormal anatomical conditions, it is quite natural to ask oneself: are these malformations not to be found or developing so frequently in older subjects that their pathogenetic importance will thus be doubtful?

In order to make this point clear the writer has examined the roentgenograms of 30 patients admitted at the Rigshospital, Department C, for hypertrophy of the prostate. Their average age was 65 years. On the pictures taken of the bladder and prostate region one has a full view of the mesial part of the socket and the femoral head. It is of course no ideal control examination, but the picture shows enough to make it possible to recognize a subluxation of the head upwards or laterally, and in most instances so much is seen of the head that the typical changes in its shape would be noted.

Only in one of the 30 cases I found a congenital subluxation without arthritic changes; in the 29 cases there was no subluxation or malformation of the caput. These findings do thus not go against the subluxation as the cause of the arthritis.

DISCUSSION

According to the foregoing, a congenital flat acetabulum—or, more correctly, an acetabulum *remaining flat*— must be considered the cause of *the constructive hip affections* i.e., *luxatio coxæ congenita, subluxatio coxæ congenita* and *coxa*

valga. The structural affections i.e. *Calvé-Perthe's disease, slipping epiphysis* and *subluxatio coxæ acquisita,* on the contrary, develop in anatomically normal hip-joints. The characteristic of the latter affections is a transformation of the articular surfaces occurring during a longer or shorter period at a time when the bones are plastic—not solid enough to answer to the enormous mechanical demands on the bones of the hip-joint.

The plasticity is due to abnormal conditions in the deposition of lime salts in the bones and it is natural to look for the cause of these affections in factors influencing the calcium metabolism, i.e., inadequate nutrition with a deficiency of lime salts and phosphorus, lack of vitamins A and D, dysfunction of endocrine organs (the parathyroids, thyroid, hypophysis, and genital organs), changes in the phosphatase activity of the organism, etc.

The appearance of structural affections within a limited period of age and their partial relation to sex and family seem to point in the direction of a hormonal influence, which to some degree is confirmed by the fact that patients with slipping epiphysis very often show signs of constitutional anomalies, mostly in the form of dystrofia adiposo-genitalis.

There is nothing unlikely in the thought that generally acting factors, such as want of vitamins, hormonal and enzymatic influences, etc. manifest themselves exclusively in the hip-joint. They may bring about a slight decrease in the strength of the bones, and that this enfeeblement primarily and perhaps exclusively leads to affections in the hip-joint may be naturally explained thereby that functional mechanical influences are stronger here than in any other joint.

Even in an anatomically normal hip-joint the roentgenogram shows, as a rule, a densification of the subchondral bone tissue of the acetabular roof, forming an eyebrow-shaped density above the upper outline of the socket. This densification is due to excessive strain and can thus be produced experimentally. It is not found in other joints.

Some new views concerning calcification, decalcification and ossification published in 1934 by *Watson Jones* and *Roberts*

are interesting with regard to localized bone affections. These authors point out that bone formation is no specific quality of the cells called osteoblasts. Bone-producing is all mesodermic tissue where inorganic salts can be deposited, absorbed, redeposited and reabsorbed, and this takes place through local enzymatic influence under endocrine control. All mesodermic tissue which is dedifferentiated can be rebuilt as bone tissue: muscles, fibrous tissue, cartilage, etc.

Pathologic calcification is seen in tissue with insufficient blood supply. We observe it in necrotic granulation tissue in tuberculous or syphilitic processes, in poorly nourished tissue in tumors, for inst. in fibromyomas and cysts. We observe it in the walls of the vessels in arteriosclerosis. The syphilitic exostoses are sclerotic on account of the decreased supply of blood resulting from the syphilitic endarteritis.

It is observed in fractures with detached fragments that their greater amount of lime salts strongly contrasts with that of the fragments healing up. The first thing noticed in a roentgen picture of a healing fracture is a strong decalcification of the ends of the fractured bone. If a fragment keeps its amount of lime salts—its density—as compared to the adjacent bone tissue, this suggests that it is avascular—not healing up.

Increased blood supply, hyperæmia, leads, on the contrary, to decalcification. This is seen, as already mentioned, in fractures beginning to heal up, where the blood supply is specially abundant. It occurs most rapidly in acute inflammations of the bones, acute osteomyelitis. Chronic osteomyelitis, however, when the hyperæmia is followed by a subnormal blood supply, leads to the sclerotic sequestrum capsule. Also traumata are followed by hyperæmia and rarefaction of lime salts in the bones. The phosphatase activity is supposed to be dependent on the blood supply.

Applying above views to the structural hip affections, the writer wants in this connection to remind of the fact that the hip-joint is at birth far behind in development. It undergoes, as no other joint, an enormous development and transformation during the first years of life in order that it may be able to

fill its function—the upright posture in walking. It is strikingly obvious that the human hip-joint is not created for this function. Its subsequent shape, tolerably fit to the peculiarity—unique among the mammals— exclusively to use the hind legs in walking, is developed laboriously.

Throughout life, and by far most pronounced during the years of growth, a breaking-down and a rebuilding of bones normally takes place. From the foregoing it is natural to suppose that this takes place in a particular degree in the hip bones. This condition demands an *ample supply of blood to these bones* and the unfavourable statics result in a stronger functional bruising of the articular surfaces, which in turn leads on to an increased supply of blood. From some occasional cause or other, endogenous or exogenous, the hyperæmia may then reach such a degree as to alter the calcium content of the caput, making the bone tissue plastic, as seen in the aforementioned instance of the Calvé-Perthe's disease, where the epiphysis was flattened after a short time.

That such an acute flattening of the epiphysis must have unfavourable consequences for the nutrition is obvious, as the vessels here run in preformed, normally unyielding canals not permitting the vessels to escape the pressure. The result is the peculiar picture called the fragmentation stage, where the lime salts are partly absorbed, partly remain as small particles giving a denser shadow than the surrounding bone tissue. The absorption is a result of the initial hyperæmia, the sclerotic remainders are due to the hypæmia brought about by the compression of the blood vessels.

It is obvious that on account of a trauma the already previously ample blood supply may occasionally reach such a degree as to cause a decalcification. It is equally obvious that endogenous factors in enfeebling the bones may cause the hyperæmia to bring about pathologic changes. No wonder that the cause of the Calvé-Perthe's disease has been sought in widely different conditions and that it has been possible to find some evidence in support of many of them.

That a purely traumatic hyperæmia may lead to changes in

the femoral epiphysis, quite like those observed in the Calvé-Perthe's disease, is seen in children where a congenital hip luxation has been reduced. These changes may then be seen to occur in the epiphysis shortly after the reduction or when the child starts walking after the bandage treatment is at end.

As is known, *the slipping epiphysis* in the hip is not considered a traumatic affection. It is most probable that the slipping nearly always takes place successively during a longer period. *Wandering epiphysis* would thus be a better name. As is known, the slipping takes place below the epiphyseal line, in the preparatory calcification zone, the same place where the rachitic changes occur. The resulting enfeeblement here is undoubtedly due to a localized decalcification of the same kind as that in the epiphysis in the Calvé-Perthe's disease.

The deformity I have called *subluxatio coxæ acquisita* does not appear until long after the termination of the period of growth. The breaking-down and the rebuilding of bones after this period take place much more slowly, but the unfavourable statics of the hip will still demand a relatively abundant blood supply. Increasing fatness will further raise the functional demands, increase the hyperæmia of the bones and on certain occasions cause some plasticity of the bone tissue leading to a slowl flattening and spreading out of the head and, parallelly therewith, a flattening of the socket. After the articular areas have lost their spherical form, the fixation of the head in the socket is less solid, and through the body weight it will by and by be pushed, subluxated, laterally.

The secondary arthrosis which, as mentioned, starts with degenerative changes in the bone tissue beneath the cartilage and, later, causes atrophy of same, is probably the final result of the steady influence of the factors which primarily led to the deformity.

Even though constitutional conditions in many cases play a greater or lesser part with regard to the appearance of the structural affections, their occurrence especially in the hip-joint shows the importance of the local peculiarities of this joint, consisting not in properly abnormal anatomical conditions but in an unfavourable and unfit shape of the joint.

It is worth noticing that affections leading to deformation, what the Germans call »Umbaukopf«, appear specially in joints with a well developed socket, where the head is firmly anchored and where it presumably just for this reason is specially injured when in function. Where the socket is flat no change of shape takes place; the head is structurally at rest.

The idiopathic hip affections are among others the price we have to pay for the boldness of prehistoric man in his habituation to the upright walk.

Therapy.

The importance of the above pathogenetic views to the treatment of the idiopathic hip affections will merely be mentioned briefly.

As regards the treatment of *the congenital luxation* one will from the picture given of the development of the socket understand the importance of reducing and fixing the head deeply in the socket as, otherwise, the roof will not be formed.

Further, it is the writer's opinion that when children suffering from a congenital luxation are admitted for treatment, the most favourable time for treatment is in reality most often passed. I believe it would be worth while trying, whether reduction and abduction posture could not be carried out already in the first year of life. The greatest difficulty will of course be to make the diagnosis so early. It is also obvious that children ought not to be taught to walk as early as possible.

The uncomplicated *coxa valga* hardly ever needs any treatment, nor any special measures for the future.

The prognosis given in the *Calvé-Perthe's disease* was previously good in nearly all cases, and the treatment was limited to a direction to spare the leg. Now, however, we know that already at an early age a secondary arthritis may quite frequently appear. The Calvé-Perthe's disease has only been known for about 20 years. When, later on, we will be able to follow a larger number of patients, having had this disease in their childhood, until the age of 40 or 50, then I believe we whall see that a considerable number of them get an arthritis.

The treatment to be followed must be not to expose the leg

to any stress as long as there are any pains at all. During the years when the joint is being transformed, the best thing would be as much as possible to move about outdoors on a bicycle.

The frequently disappointing results from treating a *slipping epiphysis* with reduction and plaster of Paris will be more easily understood when it is borne in mind that the slipping is presumably a gradual displacement, often developed during a long time. It is not surprising that a minute x-ray examination undertaken in two planes shows that a real reduction succeeds only in very few instances. That the considerable trauma caused by an attempt to reduce the epiphysis may have unfortunate consequences is easily understood in this case, where there is already previously an enfeeblement of bone. If there is a total dislocation, a reduction is of course indicated.

As so many of the arthroses in the hip joint are developed on the basis of a *congenital subluxation* the indications for treatment of this affection surely ought to be extended further than is generally the case. As mentioned before, this malformation often gives symptoms in childhood or youth long before the development of the secondary arthritis. A shelf operation gives the head the wanting support and is but a small and extra-articular operation.

The secondary arthrosis, whether developed on the basis of a congenital or an acquired subluxation, seems to be the most favourable object of *Duvernais'* palliative »fourage« operation.

In the more radical operations it is undoubtedly worth while taking into consideration the before mentioned anatomical conditions.

The flat socket of a congenital subluxation does not lend itself to arthroplasty, as it will generally not afford sufficient support for the collum stump.

When an arthrodesis in the hip-joint sometimes fails, contrary to what is the case for inst. in the knee-joint, it lies in the fact that the articular areas after removal of the cartilage become still more incongruent giving bad contact and hence unfavourable healing conditions. When the socket is flat it is necessary, as indicated by *Albee,* to make the resection hori-

zontal both in the head and in the socket. The tendency of the arthritis to become bilateral, limits, however, the use of the arthrodesis.

Even though the arthroplastic resection presumably ought to be used somewhat more frequently in hip arthroses than is the case, the age and general state of health of most patients with this affection excludes, however, such a radical operation. It may be appropriate to remind that the findings in the x-ray picture must not be decisive when choosing the kind of treatment to be followed. The symptomatic treatment will remain the most common but, of late, an encouraging improvement of same has been found in the relatively safe palliative operations. Now as previously, however, the alpha and omega of the treatment will be prevention, eventually treatment of contractions—specially adduction, which often develops insidiously and unnoticed by the patient and strongly furthers the development of the morbid processes.

In this golden age of vitamin and hormone research, it will presumably be within the limits of the possible to find measures of increasing the strength of the bones so that those of the hip-joint will answer to their function without leading to deforming affections.

SUMMARY

1. The hip-joint shows at birth an embryonal character, a relatively very large head but only a small and very flat osseous socket.

2. During the first years of life, there occurs a considerable transformation of the joint. The acetabular roof is formed and grows beyond the head, which at birth seemed subluxated.

3. This transformation demands a considerable blood-supply which, in connection with the fact that the shape of the joint is unfit for its function, may lead to disturbances in the deposition of lime salts in the bones and may contribute to affections such as slipping epiphysis and Calvé-Perthe's disease.

4. Disturbances and irregularities of growth may cause that the acetabular roof will not be formed, which leads to the con-

genital luxation and the congenital subluxation. Coxa valga is developed through excessive growth of the lower mesial part of the neck. These malformations are called the constructive affections of the hip.

5. The »deforming« arthritis in adults is either developed on the basis of a congenital subluxation or an equally typical malformation, where the caput is subluxated laterally, and which is called subluxatio acquisita.

6. In both forms of subluxation the arthrosis is secondary; also the acquired subluxation is developed long before there are any signs of arthrosis. As a rule, these signs appear at about the age of 40, and the principal cause of the arthrosis is supposed to be the excessive functional demands on the bones of the hip-joint.

7. The subluxatio coxæ acquisita, the Calvé-Perthe's disease and the slipping epiphysis are called the structural affections of the hip.

8. The cause of an arthritis with a pronounced formation of osteophytes, but without any deformation of the head or socket, is nearly always of an infectious, neuropathic, constitutional or traumatic nature. This disease is called arthritis plastica and does not belong to the idiopathic affections of the hip.

9. A short survey is given of the therapeutic importance of the above pathogenetic views.

ZUSAMMENFASSUNG

1. Bei der Geburt weist das Hüftgelenk einen embryonalen Charakter auf: einen verhältnismässig umfangsreichen Gelenkkopf aber eine sehr kleine und flache knöcherne Pfanne.

2. Während der ersten Lebensjahre verändert sich das Gelenk erheblich. Das Dach der Gelenkpfanne bildet sich und wächst über den Gelenkkopf, der bei der Geburt subluxiert schien, hinaus.

3. Diese Umbildung erfordert eine beträchtliche Blutzufuhr, die ihrerseits, zusammen mit dem Umstand, dass das Gelenk infolge seiner Form unzweckmässig ist, zu Störungen der Kalksalzablagerung in den Knochen führen und Erkrankungen wie

Epiphysenlösung und die Calvé-Perthe'sche Krankheit verursachen kann.

4. Störungen und Unregelmässigkeiten des Wachstums können auch zur Folge haben, dass die Gelenkpfanne sich nicht entwickelt, was zu angeborener Luxation und angeborener Subluxation führen kann Durch übermässiges Wachstum des unteren Teils des Knochenhalses wird Coxa valga entwickelt. Diese Missbildungen werden die konstruktiven Hüfterkrankungen genannt.

5. Die Arthritis deformans bei Erwachsenen entwickelt sich entweder auf Grund einer angeborenen Subluxation oder einer anderen, ebenso typischen Missbildung, bei welcher der Gelenkkopf seitlich verschoben ist, und die Subluxatio acquisita genannt wird.

6. In beiden Formen der Subluxatio ist die Arthrose nur sekundär; auch entwickelt sich die erworbene Subluxatio lange bevor irgendwelche Anzeichen von Arthrose auftauchen. In der Regel machen sich diese Anzeichen im Alter von etwa vierzig Jahren bemerkbar; als Hauptursache der Arthrose wird übermässige Beanspruchung der Hüftgelenkknochen angenommen.

7. Die Subluxatio coxae acquisita, die Calvé-Perthe'sche Krankheit und die Epiphysenlösung werden die struktuellen Hüfterkrankungen genannt.

8. Die Ursache einer Arthritis mit ausgesprochener Bildung von Osteophyten, jedoch ohne irgendwelche Deformation des Gelenkkopfes oder der Gelenkpfanne, ist fast immer infektiöser, neuropathischer, konstitutionneller oder traumatischer Natur. Diese Krankheit wird Arthritis plastica genannt und gehört nicht zu den idiopathischen (primären) Hüfterkrankungen.

9. Über die therapeutische Bedeutung der oben angeführten pathogenetischen Gesichtspunkte wird ein kurzgefasster Überblick gegeben.

RÉSUMÉ

1. A la naissance, l'articulation de la hanche montre un caractère embryonnaire, une tête relativement très large, mais un cavité cotyloide osseux très étroit et très plat.
2. Durant les premières années de la vie, il se produisit une

transformation considérable de cette articulation. Le toit acétabulaire est formé et croît derrière la tête, qui semblait subluxée à la naissance.

3. Cette transformation demande un apport considérable de sang et, étant donné que, de par sa forme, l'articulation est impropre à ses fonctions, ceci entraîne des troubles dans le dépôt de sels calcaires dans les os et peut ainsi contribuer à causer des affections telles que l'épiphyseolysis et la maladie de Calvé-Perthe.
4. Des troubles et des irrégularités de croissance peuvent etre cause que le toit acétabulaire ne se forme pas, ce qui conduit à la luxation congénitale et à la subluxation congénitale. Coxa valga est développé par une croissance excessive de la partie inférieure du col. Ces malformations sont appelées les affections constructives de la hanche.
5. L'arthrite »déformante« chez les adultes se développe soit sur la base d'une subluxation congénitale, soit à la suite d'une malformation également typique, la tête étant subluxée latéralement, phénomène désigné subluxatio acquisita.
6. Dans les deux formes de subluxation, l'arthrose est un facteur secondaire; la subluxation acquise se développe, elle aussi, longtemps avant qu'aucun signe d'arthrose ne soit constaté. En règle générale, ces signes apparaissent vers l'âge de 40 ans et la principale cause de l'arthrose est supposée être l'emploi fonctionnel excessif des os de l'articulation de la hanche.
7. La subluxation coxæ acquisita, la maladie de Calvé-Perthe et l'épiphyseolysis sont appelées les affections structurales de la hanche.
8. La cause de l'arthrite avec formation prononcée d'ostéophytes, mais sans aucune déformation de la tête ou du cavité cotyloide est presque toujours de nature infectieuse, neuropathique, constitutionnelle ou traumatique. Cette maladie est appelée arthritis plastica et n'appartient pas aux affections idiopathiques de la hanche.
9. Il est donné un aperçu sommaire de l'importance thérapeutique des points de vue pathogénétiques indiqués ci-dessus.