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GROWTH DISTURBANCES OF THE PROXIMAL END OF THE FEMUR IN THE LIGHT OF ANIMAL EXPERIMENTS

By

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Epiphyseal injuries sustained during growth often give rise to characteristic deformities of the skeleton. The capital femoral epiphysis is the site of predilection for epiphyseal lesions. It is well-known that certain disorders of the capital epiphysis, such as congenital coxa vara, epiphyseolysis and Legg-Calvé-Perthes' disease, often bring about deformity of the proximal end of the femur. The epiphyseal lesion gives rise to coxa vara, irregularities of the femoral head and shortening of the femur (fig. 1). A similar deformity may be caused by trauma or pyogenic infection in the hip joint.

In planning orthopaedic treatment, the vulnerability of the epiphyses during the growth phase must be taken into consideration. In closed or operative treatment of congenital dislocation of the hip, injury to the capital epiphysis constitutes the commonest cause of a poor result. In operative treatment of epiphyseolysis or of Perthes' disease, injury to the epiphysis may also occur, a fact which has been pointed out by *Compere* et al., among others. In experiments on goats, these authors demonstrated that the animals developed typical deformities of the upper end of the femur after lesion of the capital epiphysis or of the epiphysis of the greater trochanter. But little attention has been paid in the literature to the fact that injury to the epiphysis of the greater trochanter produces a characteristic deformity in the form of coxa valga and a long neck of the femur.

During the last ten years, a large number of children with congenital dislocation of the hip have been treated with operative reduction at the Orthopaedic Hospital of the Invalid Foundation. During an earlier period, a bone-cartilage graft was removed at operation from the region

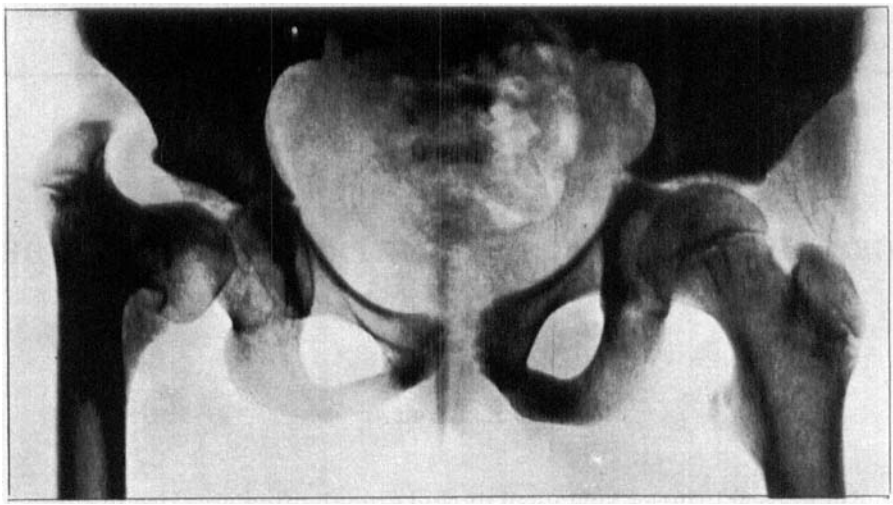


Fig. 1.
12 year old girl. Right congenital coxa vara. Typical deformity. Untreated.

of the greater trochanter and used to strengthen the acetabular roof (*F. Langenskiöld, Laurent*). In some of these cases a typical coxa valga deformity was seen to develop during the period of observation. Both in closed and in operative treatment of congenital dislocation of the hip severe injury to the capital epiphysis was sustained in a number of cases, with gradual development of coxa vara, deformity of the femoral head and a long greater trochanter. Since it is possible to reproduce lesions of the growing skeleton in animals, in which they may be studied in detail (*A. Langenskiöld*), a number of such experiments were made in order to gain further insight into these growth disturbances.

In some five day old rabbits the greater trochanter was removed together with its epiphyseal cartilage. After as little as two weeks a typical deformity, with coxa valga and a long femoral neck, occurred and was seen to be further accentuated eight weeks later. In figs. 2 and 3 this deformity in two experimental animals is compared with two cases of operatively treated congenital dislocation of the hip in which the greater trochanter was injured during the operation. Fig. 3 shows in the patient and the rabbit a dislocated piece of the trochanteric epiphysis which continued growing.

During the period of observation, 10 weeks, there occurred in the experimental animals an insignificant shortening of the femur by some mm. due to the injury to the trochanteric epiphysis. By means of ortho-

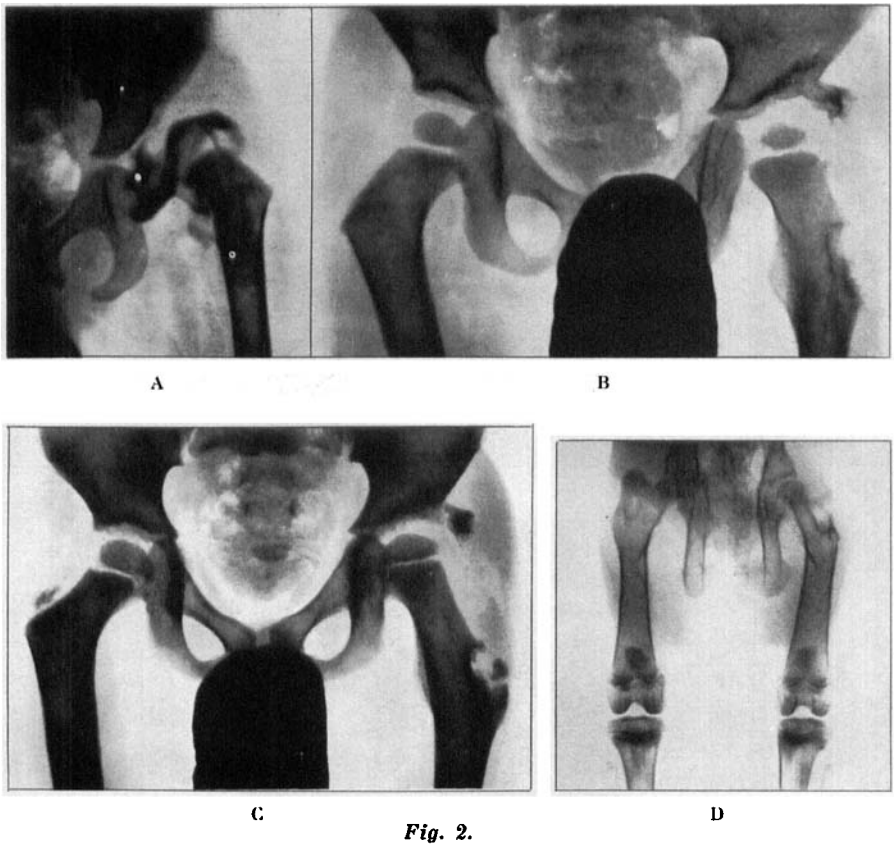
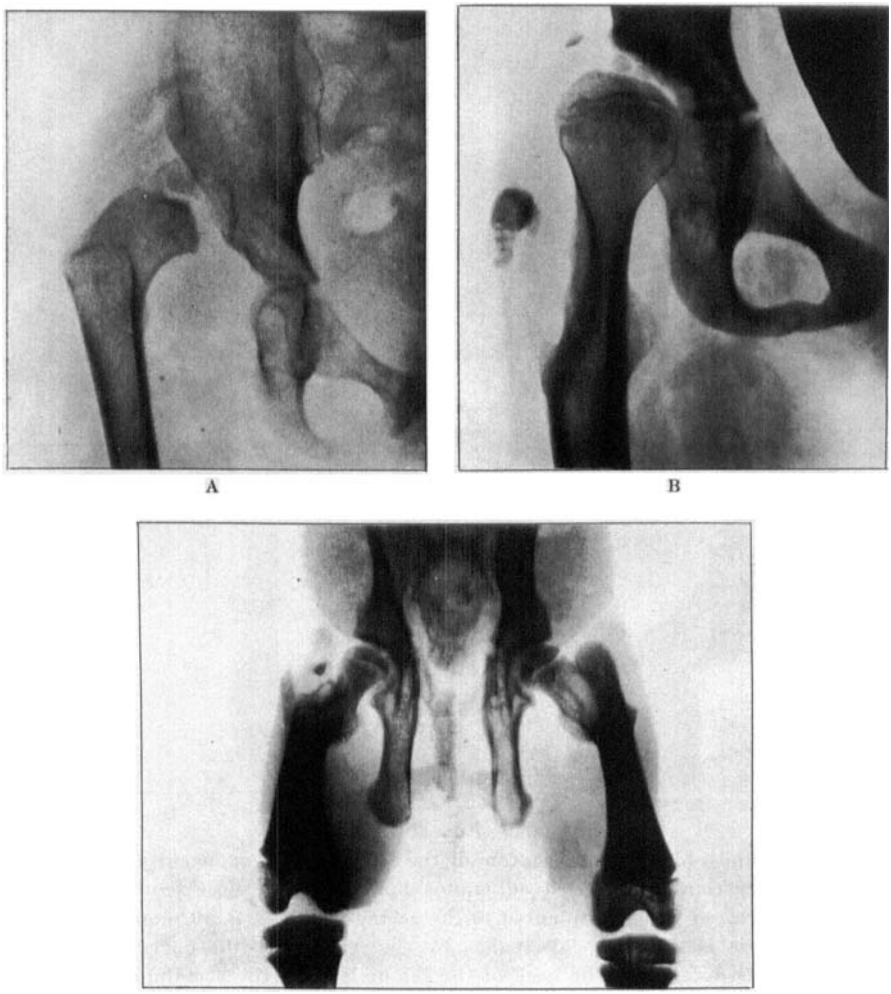


Fig. 2.

A. 1 year 8 month old boy. Arthrogram of the left hip shows congenital dislocation. Operative reduction was carried out and a bone-cartilage piece from the greater trochanteric region was transplanted to the acetabular roof. *B.* 19 months after the operation there is incipient coxa valga. *C.* 4½ years after the operation, marked coxa valga has developed. The neck of the femur is long, the acetabular roof well-developed. *D.* Rabbit in which the greater trochanter together with its epiphyseal cartilage was removed at the age of 5 days. 45 days after the procedure, there is typical coxa valga and a long femoral neck.

radiography it was demonstrated that in five children with unilateral dislocation of the hip, a lengthening of the femur on the operatively treated side had taken place during the period of observation, which averaged six years. The lengthening was 5 to 28 mm., the average being 13 mm. In these cases, rotation osteotomy had further been carried out, the increased growth probably being the effect of stimulation. **These observations indicate that the epiphysis of the greater trochanter does not contribute to the growth in length of the femur.**



A B C

Fig. 3.

A. 2½ year old girl with congenital dislocation of the hip. At operative reduction, the epiphysis of the greater trochanter was damaged. *B.* 7 years after the operation there was coxa valga and a long slender femoral neck. A dislocated piece of the greater trochanter continued growing. *C.* Rabbit with a similar deformity, operative injury to the trochanteric epiphysis having been carried out 60 days previously.

In experiments in which the hip joints of rabbits a few days old were dislocated, dysplasia of the acetabulum and hypoplasia of the capital epiphysis of the femur could be observed after some weeks (*A. Langenskiöld* and *O. Sarpio*). If closed reduction was then carried out on the

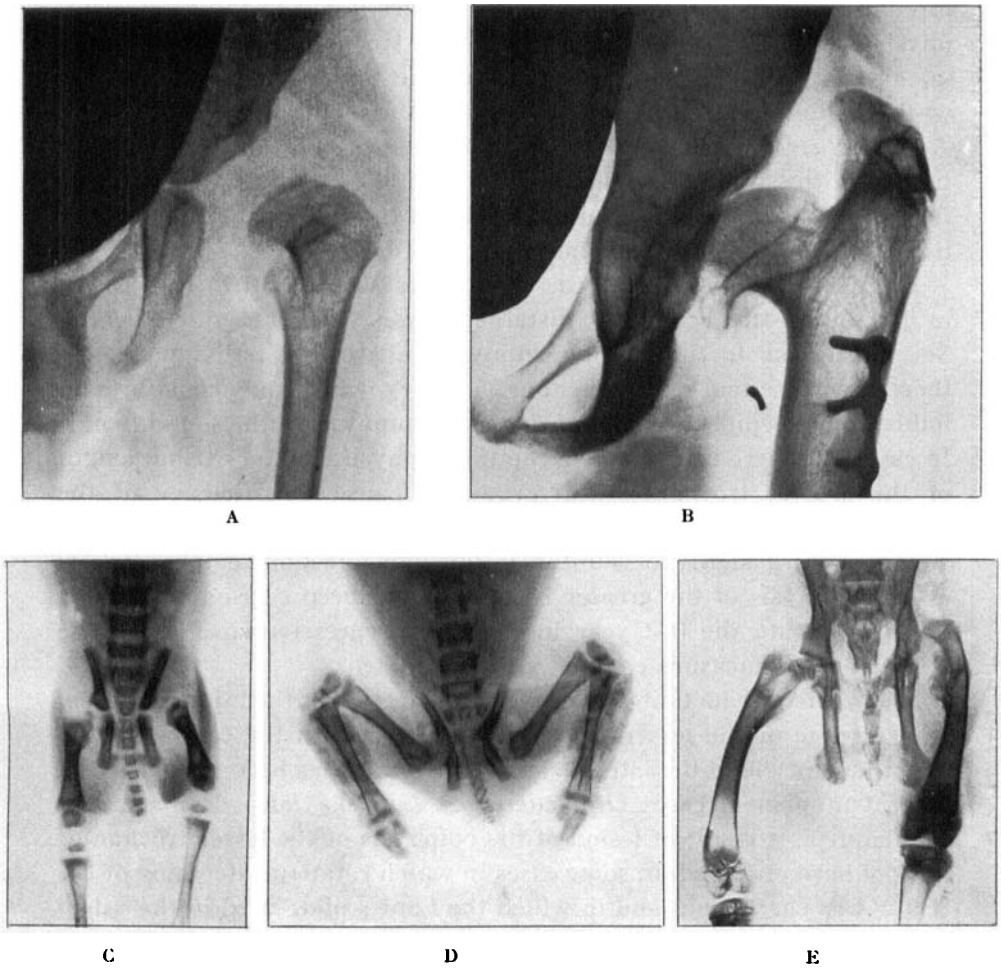


Fig. 4.

A. Congenital dislocation of the hip, persistent subluxation and damage to the capital epiphysis after unsuccessful closed abduction treatment. Operative reduction and rotation osteotomy were carried out. *B.* 10 years later there is coxa vara, deformity of the head and neck of the femur and a long greater trochanter. *C.* Rabbit in which the left hip was dislocated 10 days previously. Dysplasia of the acetabulum and hypoplasia of the capital epiphysis. *D.* The hip was reduced. *E.* Abduction treatment caused severe damage to the capital epiphysis. The femoral head is missing, while the greater trochanter continued growing. There is extreme coxa vara. (Fig. C–E reproduced by courtesy of *A. Langenskiöld, J.-E. Michelsson* and *O. Sarpio*).

hip and an abduction splint applied, a severe lesion of the capital epiphysis occurred in some cases. The greater trochanter continued growing and the result was extreme coxa vara with a long trochanter. There was simultaneously marked shortening of the femur (*A. Langenskiöld, J.-E. Michelsson* and *O. Sarpio*). In fig. 4 the deformity in a rabbit treated in this way is compared with a case of congenital dislocation of the hip in which, owing to failure of closed treatment, operative reduction and rotation osteotomy had been carried out.

The capital femoral epiphysis contributes 30 per cent to the growth in length of the bone, the distal epiphysis 70 per cent (*Blount*). Severe damage to the capital epiphysis in growing individuals may therefore cause marked shortening of the leg, which may constitute an indication for epiphyseodesis of the distal epiphysis of the sound femur. In cases of severe injury to the capital epiphysis, the increasing length of the greater trochanter will gradually cause insufficiency of the gluteus medius and minimus muscles and there will be a positive Trendelenburg sign. To counteract this phenomenon, epiphyseodesis of the epiphysis of the greater trochanter has been carried out in this hospital during the last year in cases of progressive coxa vara. The results of this measure cannot yet be evaluated.

At operative reduction in congenital dislocation of the hip in children, transference of the lesser trochanter together with the tendon of the ileopsoas muscle to the lateral side of the femur has been performed in a great number of cases (*Rohlederer, F. Langenskiöld*). Deformity of the femur as a result of lesion of the epiphysis of the lesser trochanter has not been observed. In some cases in which rotation osteotomy of the femur was carried out and in which the Lane's plate used in the osteosynthesis was subsequently removed, the displaced ileopsoas tendon was explored. In these cases the tendon had become distally displaced as a result of the growth in length of the femur.

CONCLUSIONS

Damage to the capital epiphysis of the femur in growing individuals gives rise to deformity of the femoral head, a short neck, coxa vara, a long greater trochanter and both real and functional shortening of the femur.

Damage to the epiphysis of the greater trochanter causes a typical deformity, with coxa valga and a long slender neck of the femur. This lesion does not affect the growth in length of the femur.

Clinical observations indicate that lesion of the epiphysis of the lesser trochanter does not give rise to deformity of the femur.

The deformities described could be reproduced in rabbits in a short time.

SUMMARY

The characteristic deformities developing in the proximal femoral end after injury to the capital femoral and greater trochanteric epiphyses are described. The deformities could be experimentally reproduced in animals in a short time.

RESUME

Description des déformités caractéristiques qui se développent dans l'extrémité proximale du fémur après une lésion de la tête fémorale et des épiphyses trochantériennes. Les déformités peuvent être reproduites expérimentalement chez les animaux dans un délai rapide.

ZUSAMMENFASSUNG

Die charakteristischen Deformiteten, die nach Beschädigung der Epiphysen des Femurkopfes und grossen Trochanters im proximalen Femurende auftreten werden beschrieben. Die Verbildungen konnten bei Tieren experimentell in einer kurzen Zeitspanne hervorgerufen werden.

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