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Experimentally produced growth disturbance of the acetabulum in young rabbits

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The primary aim of this study was to clarify the influence of operations of the acetabular roof on the development of the hip joint in growing rabbits. The second objective was to discover if age had any role in the development of eventual acetabular growth disturbance. The animals were 3 and 8 weeks old at the time of the operation. A wedge-resection was performed on the acetabular roof through an extra-articular approach. In the control series only the soft tissues were operated, and the bony-cartilaginous roof was left intact. The growth of the hips was followed radiographically. In the rabbits operated at the age of 3 weeks acetabular dysplasia developed within a few weeks, associated with subluxation or luxation of the femoral head combined with other secondary changes of the joint. In the rabbits operated at the age of 8 weeks the dysplastic changes of the acetabulum were lesser or no abnormalities could be seen. In the control group the growth of the hip was normal.

Key words: acetabular dysplasia; experimental growth disturbance; hip.

The main growth of the acetabulum takes place in the triradiate cartilage and the outer border of the acetabulum, where the perichondrium changes to periosteum (Otte 1969). Acetabular development and the morphology of dysplasia have been followed in fetal studies of congenital hip dislocation (Dunn 1976b, Dega 1978, Ogden & Moss 1979). Disturbances in this area of growth have been observed in connection with acetabular fractures (Ljubosic 1967, Rodrigues 1973, Hallel & Salvati 1977) and severe hip infections (Gillespie 1973, Dias et al. 1980) in children. Furthermore, attention has been paid to the possible untoward late effects of certain surgical procedures, e.g. the Chiari osteotomy, when performed in young patients (Purath 1979). The aim of the present study was to clarify the effect of acetabular operations on the development of the hip joint.

Material and methods

The experimental material in this study comprised 21 growing rabbits of which 13 were 3 weeks and eight 8 weeks old. During the operation the animals were kept in a prone position. The dorsal upper aspect of the acetabulm was bared through a muscle-splitting incision in the gluteal region. An extra-articular wedge-shaped resection was made into the acetabular roof 5 mm medial to the acetabular rim. Care was taken not to enter the joint (Figure 1). The wedge was 10 mm in length, 2 mm in width, and 4 mm in depth. The long axis of the wedge was parallel to the outer border of the acetabulum. A metal marker was placed in the resection site for later reference. After closure of the wound a radiographic examination in the antero-posterior projection was performed and repeated at regular intervals. After they had reached maturity, the animals were killed and macroscopic specimens were prepared.

The first group comprised the 3-week-old rabbits. A wedge-shaped resection was made in 10 of these. In the three remaining rabbits of this group, the controls, only the soft tissue approach was performed but no resection. In the second group, comprising the 8-week-old animals, all had the resection operation.

Results

In the *3-week-old* rabbits, radiographic (Figure 2) and macroscopic (Figure 3) growth disturbances of the acetabulum were recorded in eight out of ten experiments. Acetabular dysplasia was associated with dislocation of the femoral head in seven animals and sub-

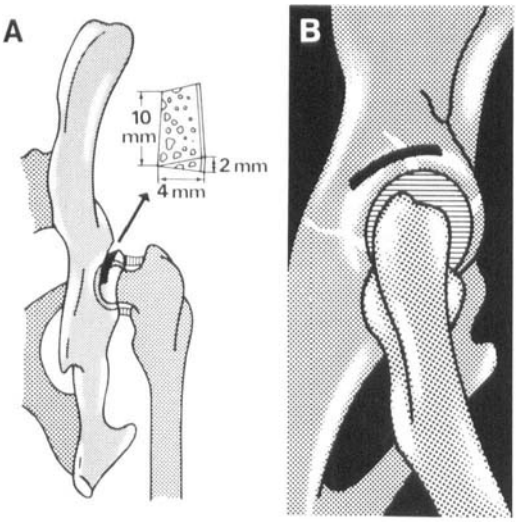

Figure 1. An extra-articular, wedge-shaped resection was performed on the acetabular roof. The long axis of the excised bony wedge ran parallel with the outer rim of the acetabulum. The joint cavity was not entered.

luxation in one animal. Of the remaining two animals one died 3 weeks after the operation, and in the other animal the resection was performed too low, i.e. just on the acetabular rim and without effect on acetabular growth.

Macroscopically, the acetabular cavity was shallow and sloping in the eight hips. The acetabular region was clearly thicker on the operated than on the unoperated side (Figure 3). Dislocation of the femoral head occurred within 3 months after the operation. Necrosis of the femoral head occurred in three hips, and in the majority of the animals there was also some deformation in the trochanteric region. A tendency to femoral neck anteversion was observed. In the control animals no growth disturbances of the hip region were seen.

In the *8-week-old* rabbits, dysplastic changes of the acetabulum were seen in six of the eight animals, in two animals with subluxation of the femoral head. The changes were definitely of a lesser degree than in the younger animals, but thickening of the acetabulum and supraacetabular ileum was a regular finding in the six affected animals.

Discussion

There are several comprehensive studies on the pre- and perinatal development of the hip and the acetabulum (Dunn 1976a,b, Ogden & Moss 1978). The normal morphologic development of the acetabulum after birth has also

Figure 2. A. Radiograph showing wedge resection of the left acetabular roof in a 3-week-old rabbit.
B. The hip of the same animal 12 weeks after the operation. Pronounced acetabular dysplasia and dislocation of the femoral head are evident. Associated changes are seen in the femoral head, neck and trochanteric region.

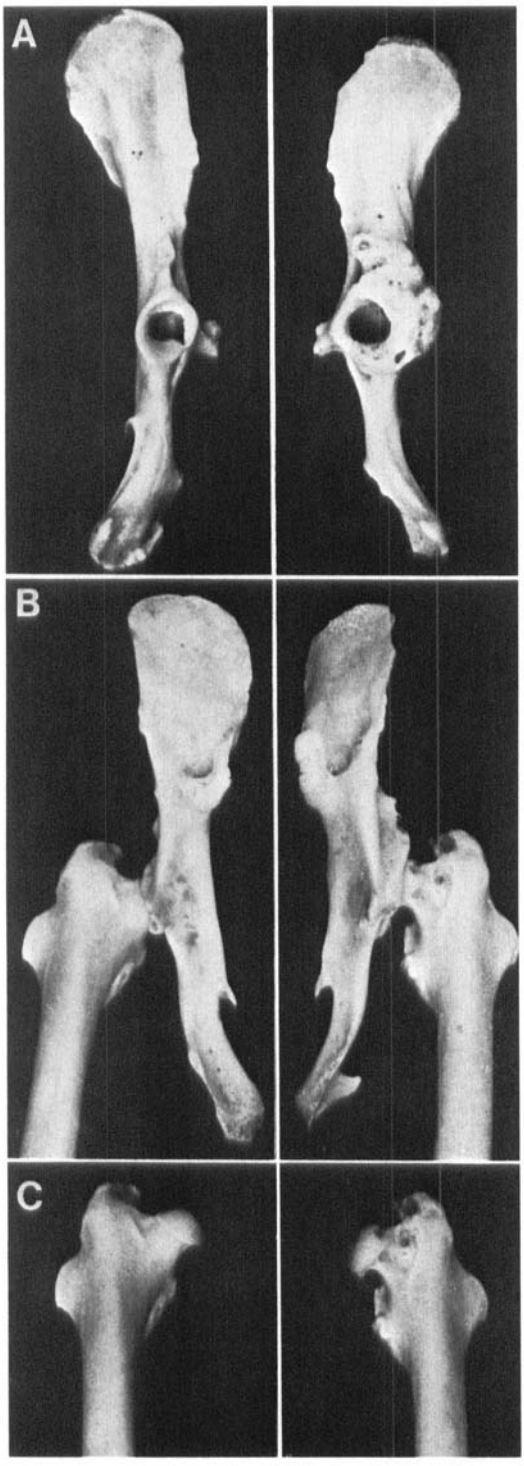

Figure 3. Macroscopic changes 12 weeks after wedge resection of the left acetabular roof in a 3-week-old rabbit.
A. The acetabular region is distinctly thicker on the operated left side than on the unoperated right side.
B. The acetabular roof is sloping and the acetabular cavity is shallow, resulting in subluxation of the left femoral head. The whole hemipelvis on the operated side is hypoplastic.
C. The left femoral head is flattened, and the femoral neck is shortened and anteverted.

been followed (Ponseti 1978a, b). Surprisingly, there are, nevertheless, only a few experimental studies on the growth and growth disturbances of the acetabulum despite the clinical importance of hip disease in early childhood. Earlier experimental studies have been mainly directed to analyzing changes in the acetabulum subsequent to provoked hip dislocation (Smith et al. 1958, Langenskiöld et al. 1962). The acetabular and femoral changes in these studies were very similar to those observed in congenital dislocation of the hip.

In our experiment, on the other hand, primary acetabular dysplasia was provoked surgically, followed by secondary subluxation and dislocation of the femoral head. The changes seen in the proximal femur are of an adaptive nature both clinically (Siffert 1981) and in our experiments and could be due to altered nutrition, circulation, muscle tone, and cartilage proliferation.

Little attention has been paid to the later consequences of acetabular surgery on the growth of the hip. Following experimental innominate osteotomy of the Salter type, Shim et al. (1981) found increased vascularity at the osteotomy site and also in the femoral head. The higher location of the osteotomy did not involve the triradiate cartilage and growth disturbances did not occur. Ieda (1977) studied the Chiari osteotomy experimentally in rabbits, mainly to clarify the coverage of the femoral head by the acetabular roof; less attention was paid to possible negative effects of the procedure. Purath (1979), however, in his clinical studies stressed the dangers of the Chiari osteotomy performed in young individuals; the acetabular growth disturbance produced by this type of osteotomy can lead to

a negative result, which he called the anti-Chiari effect.

Our experiment demonstrates that disturbance of the triradiate cartilage could have been the main factor causing deformation and associated subluxation. The practical conclusions on the basis of these results are to avoid injury to the triradiate cartilage when performing a Chiari osteotomy or not to perform the operation at such an early stage as to disturb normal growth and closure of the triradiate cartilage.

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