ACETABULAR DYSPLASIA AND HIP DISLOCATION AFTER SELECTIVE PREMATURE FUSION OF THE TRIRADIATE CARTILAGE

AN EXPERIMENTAL STUDY IN RABBITS

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Premature fusion of the triradiate cartilage was obtained surgically in 10 three-week-old rabbits, and compared with isolated fusion of the ilio-ischial and of the ilio-pubic limbs of the triradiate cartilage in two further groups of 10 rabbits. Complete fusion caused acetabular dysplasia five weeks after operation in all animals and hip dislocation at nine weeks in half of them; ilio-ischial fusion had a comparable effect. Ilio-pubic fusion had only a minimal effect on acetabular development. The posterior position of the ilio-ischial limb in the acetabulum and its predominance in the formation of the triradiate cartilage in quadrupeds may have contributed to its decisive effect on acetabular development.

Premature fusion of the triradiate epiphysial growth plate in man causes dysplasia of the acetabulum and may cause subluxation or dislocation of the hip. Hallel and Salvati (1977) reproduced dislocation of the hip by experimental fusion of the triradiate cartilage in young rabbits. However, there are no experimental data on the effect of selective premature fusion of the different limbs of the triradiate cartilage and subsequent acetabular development. This investigation reports the influence of selective premature fusion of the ilio-ischial, ilio-pubic and ilio-ischio-pubic limbs of the triradiate cartilage on acetabular development in rabbits.

fusion of the ilio-ischial limb of the triradiate cartilage was performed using a dorsal extra-articular approach. In the third group fusion of all three limbs of the triradiate cartilage was performed using the ventral retroperitoneal approach (Hallel and Salvati 1977). The animals were anaesthetised with ketamine hydrochloride, 10 mg per rabbit, intramuscularly, and halothane. The fusion was performed by surgical exposure of the selected part of the triradiate cartilage and adjacent bone, bridging the cartilage plate by a homologous corticocancellous bone graft. One rabbit from each litter was set aside and killed, keeping the pelvic bone sterile for use as a bone graft in

Table I. Influence of selective fusion of the triradiate cartilage on acetabular development

Operative fusion	At 3 weeks (n = 10)		At 5 weeks (n = 8)		At 9 weeks (n = 6)	
	Dysplasia	Dislocation	Dysplasia	Dislocation	Dysplasia	Dislocation
Ilio-pubic	0	0	50% (4)	0	50% (3)	0
Ilio-ischial	0	0	100% (8)	0	100% (6)	66% (4)
All 3 limbs	0	0	100% (8)	0	100% (6)	50% (3)

MATERIALS AND METHODS

Thirty rabbits all aged three weeks were divided into three groups of 10 and operated on as follows. In one group a selective fusion of the ilio-pubic limb of the triradiate cartilage was performed, using the ventral retroperitoneal approach. In another group selective

its siblings. The bone graft was glued in place using Histoacryl. One acetabulum from each rabbit was operated on as described above, keeping the contralateral acetabulum as a control.

A pelvic radiograph was taken every two weeks. Two rabbits of each group were killed three weeks after the operation and two at five weeks (at the ages of six and eight weeks respectively); the remaining animals were killed at 12 weeks of age. The bony pelvis was removed, the hip joint opened, and the acetabula were inspected. The fusion of the different limbs of the triradiate cartilage was confirmed by inspection and by transacetabular histological section (Figs 1 and 2).

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Fig. 1

Fig. 2

Figure 1—Transacetabular section five weeks after operation (at eight weeks of age) in a rabbit with selective ilio-ischial fusion (arrow). Note the fused ilio-ischial limb while the other two limbs of the triradiate cartilage remained intact. Figure 2—Transacetabular section of the contralateral acetabulum of the same rabbit. (Haemotoxylin and eosin, $\times 15$.)

RESULTS

Three weeks after surgical fusion of the whole or any part of the triradiate cartilage, no radiological changes in acetabular development were seen. Five weeks after ilio-pubic fusion, four of eight rabbits showed radiological evidence of acetabular dysplasia; the other two groups (ilio-ischial fusion and fusion of all three limbs) showed acetabular dysplasia in all animals, but no hip dislocation was seen. Nine weeks postoperatively the ilio-pubic fusion group showed acetabular dysplasia without dislocation in three out of six rabbits, while the ilio-ischial fusion group showed acetabular dysplasia in all six animals and hip dislocation in four; fusion of all three limbs of the cartilage resulted in acetabular dysplasia in all animals and hip dislocation was observed radiologically in three out of six rabbits (Table I). All cases developing hip dislocation showed subluxation after seven weeks, and full dislocation nine weeks after surgical fusion (Fig. 3). There was no significant difference in the acetabular dysplasia or hip dislocation resulting from fusion of all three limbs of the triradiate cartilage or from selective fusion of the ilio-ischial limb. Gross inspection of the acetabula confirmed that those which were dysplastic radiologically were shallow and that those with dislocated hips were filled with soft tissue.

DISCUSSION

The triradiate cartilage growth plate is of particular interest as it provides for growth of three bones simultaneously with the formation of the acetabulum. Premature fusion of this physal cartilage, resulting in acetabular dysplasia with progressive subluxation and dislocation, has been reported in man and demonstrated in animal experiments (Lujubosic 1967; Rodrigues 1973; Hallel and Salvati 1977; Ponseti 1978; Blair and Hanson 1979; Dias, Tachdjian and Schroeder 1980; Bucholz, Ezaki and Ogden 1982). In an effort to obtain more information on the role of this physis in acetabular

Fig. 3

Sequential radiographs of the pelvis of a rabbit taken three (top), five and nine weeks after ilio-ischial fusion of the left hip. Note the fusion of the ilio-ischial limb and the beginning of dysplasia at five weeks followed by dislocation at nine weeks.

development we studied the effect of selective fusions of parts of the triradiate cartilage in the rabbit. No difference was found between the effect of isolated fusion of the ilio-ischial limb of the triradiate cartilage and the fusion of its three limbs. All animals in these groups developed

acetabular dysplasia, while 50% to 66% of them also showed hip dislocation. On the other hand, isolated fusion of the ilio-pubic limb had only a minimal effect on acetabular development and there was no evidence of dislocation. We were not able to perform selective fusion of the ischio-pubic limb because of its extremely small size.

In a separate study a direct transacetabular radiograph of the normal innominate bone of a six-week-old rabbit was compared with the human transacetabular view published by Bucholz *et al.* (1982). In the human, the ilio-ischial limb is twice the size of the ilio-pubic limb, while in the rabbit it is three times the size (Fig. 4). The predominance of the ilio-ischial limb of the triradiate cartilage in quadrupeds such as rabbits may be responsible for the decisive effect of its premature fusion on acetabular development. Bucholz *et al.* (1982) demonstrated in their schematic drawing of a neonatal hemipelvis the continuity of the acetabular hemisphere of articular cartilage and the triradiate cartilages. Growth at the junction of the ilium, ischium and pubis, which must also be responsible for acetabular development and growth, occurs at both the triradiate cartilage and at the acetabular hemisphere.

The ilio-ischial limb forms a considerable part of this composite physis in the rabbit, and its fusion probably has the same effect as fusion of the whole triradiate cartilage. The fusion of the triradiate growth plates on the outside of the acetabulum leaves the living articular cartilage and its growth potential intact and this continues to develop. The acetabulum therefore is displaced laterally and becomes shallower, resulting first in dysplasia and then in subluxation and dislocation of the hip.

The position of the ilio-ischial limb of the triradiate

cartilage in the upper posterior part of the acetabulum may also contribute to its importance in acetabular development. Deficiency in the development of the posterior rim of the acetabulum may cause dysplasia and eventual subluxation and dislocation of the hip. Dias *et*

Fig. 4

Drawing of a transacetabular radiograph of a six-week-old rabbit acetabulum. Note the large size of the ilio-ischial limb in comparison with the ilio-pubic limb.

al. (1980) reported a case of dislocation after septic arthritis of the hip in infancy with no improvement of the acetabular dysplasia after reduction. An isolated fusion of the posterior part (ilio-ischial) of the triradiate cartilage was demonstrated. In view of our results, it could be anticipated that an isolated ilio-pubic fusion would have had a less deleterious effect on acetabular development.

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