INJURIES OF THE ACETABULAR TRIRADIATE CARTILAGE AND SACROILIAC JOINT

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Four patients with injuries of the acetabular triradiate cartilage are presented. In three of them premature fusion of the cartilage occurred; two of these developed acetabular deformity and subluxation of the hip. In all patients the sacroiliac joint also was injured; in two, the joint was completely disrupted, leading to fusion and growth disturbance of the ilium.

As injury of the triradiate cartilage is easily missed on the initial radiograph, it is advised that all patients with pelvic trauma should be followed clinically and radiographically for at least one year.

The acetabular triradiate cartilage is the composite growth-plate of the iliac, ischial and pubic bones. Premature closure of this physis is an infrequent complication of pelvic injury, septic arthritis and pelvic surgery (Rodrigues 1973; Halle and Salvati 1977; Wientroub, Lloyd-Roberts and Fraser 1981; Bucholz, Ezaki and Ogden 1982). When it occurs in early childhood, disruption of acetabular growth with thickening of the medial acetabular wall and subluxation of the hip may result. Usually the subluxation is mild, the function of the hip is not affected and, during childhood and adolescence, the patient experiences little or no pain. In addition, growth disturbance of the ilium may be caused by premature fusion of the sacroiliac joint (McDonald 1980).

We report four children, each of whom was run over by a truck or a bus, injuring the triradiate cartilage and one or other sacroiliac joint, leading to disproportionate pelvic growth. The spectrum of growth disturbances after premature fusion of the triradiate cartilage and fusion of the sacroiliac joint are discussed.

CASE REPORTS

Case 1. A nine-year-old boy had arrived at a local hospital in a state of deep shock. Multiple lesions were diagnosed: a fracture-dislocation of the right hip with a Salter-Harris Type V physeal injury, a right sacroiliac dislocation with lumbar plexus injury, fractures through the pubic and ischial rami and symphysiolyis (Fig. 1). An attempted closed reduction of the dislocated hip was unsuccessful. The pelvis was stabilised with a tension-band wire through the symphysis.

Three weeks after injury the patient was transferred to our hospital where an open reduction was performed. A posterior-rim fracture of the acetabulum was found, as well as multiple osteochondral lesions. Postoperatively the patient was treated in suspended traction, and after six weeks, was mobilised in an Atlanta brace. Two months after injury the right triradiate cartilage had fused (Fig. 2), leading to progressive growth disturbance of the acetabulum. At present six years later, skeletal growth is nearly complete. Fusion of the sacroiliac joint has not occurred and the lumbar plexus injury has recovered spontaneously. There is subluxation of the femoral head and an acetabular shelf has formed, probably caused by the fusion of a posterior wall fragment with the acetabulum (Fig. 3). A scan (Fig. 4) revealed extensive irregularity and thickening of the medial acetabular wall. The patient is painfree but walks with a severe limp. The right leg is 3 cm shorter than the left with 20° of fixed flexion, 25° of fixed medial rotation and 20° of fixed adduction, for which a corrective intertrochanteric femoral osteotomy is planned.

Case 2. A seven-year-old girl had sustained fractures through the right pubic and ischial rami, an anterior dislocation of the left sacroiliac joint without plexus injury and extensive soft-tissue lesions of both legs (Figs 5 and 6). Open reduction and screw fixation of the superior ramus was performed and the sacroiliac dislocation was reduced. Injury to the triradiate cartilage was not considered. However, one year after the initial injury, a slowly progressive fusion of the right triradiate cartilage was noticed, with thickening of the medial acetabular wall and lateralisation of the femoral head (Figs 7 and 8). Partial fusion of the left sacroiliac joint had led to relative shortening of the ilium (Fig. 7). Four years later, at last review, the patient was painfree, hip mobility was normal except for 10° of limitation of medial rotation, and the right leg was 1 cm short. Depending on the rate of progression of the acetabular deformity, a pelvic osteotomy or shelf procedure will be performed. Retrospectively, this was judged to be a Type V physeal injury.

Case 3. A nine-year-old boy had been struck by a bus. Clinical investigation and radiographs revealed a dislocation of the right sacroiliac joint, a lumbar plexus injury and fractures through the left pubic and ischial rami (Fig. 9). Injury of the right triradiate cartilage was not considered at the time of injury, but two months later premature fusion was noticed; this did not, however, lead to disproportionate pelvic growth (Fig. 10). The patient recovered completely from the plexus injury. At present, eight years later, he has no pain and the function of the hip is completely normal. Retrospectively, this was judged to be a Type V physeal injury.

Case 4. A two-year-old girl had sustained severe disruption of the left hemipelvis with a dislocation of the sacroiliac joint, symphysiolyis, a

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Case 1. Figure 1 - A fracture-dislocation of the right hip with a Type V triradiate physeal injury and dislocation of the sacroiliac joint. Figure 2 - Two months after injury there is premature fusion of the right triradiate cartilage with lateralisation of the femoral head. Note also the obvious inefficiency of the tension-band wire. Figure 3 - Six years later there is gross deformity as well as extensive irregularity and thickening of the medial acetabular wall. Lateralisation of the femoral head has progressed. Note the spontaneous acetabular shelf formation, and the almost complete fusion of the right triradiate cartilage. Figure 4 - A scan taken at last review shows extensive irregularity and thickening of the medial acetabular wall.

Case 2. Figure 5 - A radiograph taken on admission during intravenous pyelography. Fractures through the right pubic and ischial rami are present. Injury of the (right) triradiate cartilage was not considered. Figure 6 - Anterior dislocation of the left sacroiliac joint as seen on a CT scan. Figure 7 - Four years later there is premature fusion of the right triradiate physis, thickening of the medial acetabular wall and lateralisation of the femoral head. The left sacroiliac joint has fused. Note that the left ilium is short. Figure 8 - A CT scan of the acetabular region. Fusion of the right triradiate cartilage has occurred, and the thickening of the medial acetabular wall is clearly visible.
Case 3. Figure 9 - A radiograph taken on admission shows displacement at the right sacroiliac joint and fractures through the left pubic and ischial rami. Injury of the triradiate cartilage was not considered. Figure 10 - Two months later premature fusion of the right triradiate cartilage was observed. However, further pelvic deformity did not occur.

Case 4. Figure 11 - In this radiograph, taken on admission, the left hemipelvis is displaced upwards and the left sacroiliac joint is grossly disrupted. A Type I triradiate physeal injury can be seen. The ischiopubic fragment is rotated. Figure 12 - The resulting pelvic deformity 19 years later: the left sacroiliac joint has fused, with shortening of the ilium. The pubic and ischial bones are still rotated and shortened. The acetabulum has developed normally.

Type I triradiate physeal injury, extensive genito-urinary injuries and soft-tissue lesions of the legs (Fig. 11). A laparotomy was performed to repair the genito-urinary lesions and to stabilise the pelvis using a tension-band wire. During follow-up, disproportionate pelvic growth was observed, with fusion of the left sacroiliac joint and shortening of the pelvic bones (Fig. 12). The acetabulum developed normally. Now, 19 years later, she is painfree and has normal hip function, although there is a leg-length inequality of 2 cm.

DISCUSSION

The large acetabular cartilage complex is composed of a hemispherical cup-shaped cartilage and the triradiate cartilage; the former fills the outer two-thirds of the acetabular socket and is continuous with the triradiate cartilage medially (Fig. 13). The physis within the cartilage is bipolar and its intrapelvic side is covered by perichondrium and thick fibrous tissue (Ponseti 1978).

Three of the many secondary centres of ossification which develop in the pelvis appear after the age of eight years in the cartilage surrounding the acetabular cavity: the iliac and pubic centres of ossification constitute major portions of the superior and anterior wall of the acetabulum (Fig. 13); the left ischial centre is very small and rarely seen (Ponseti 1978). Growth of the acetabulum and pelvic bones is very complicated: interstitial growth within the triradiate cartilage is responsible for the growth in height and width of the acetabulum and also contributes to growth in length of the pelvic bones. The depth of the acetabulum increases during develop-
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Fig. 13

A diagram of the left innominate bone (left) and an oblique schematic view demonstrating the continuity of the hemispherical and triradiate cartilages (right). The acetabular cartilage complex is composed of a hemispherical cartilage (HC) and triradiate cartilage (TC). Three secondary centres of ossification appear in the cartilage surrounding the acetabular cavity: the os acetabuli (OA) of the pubis, the acetabular epiphysis (AE) of the ilium and the ischial epiphysis (IE). (Figures modified from Ponseti 1978 [left] and Bucholz et al. 1982 [right]).

ment as a result of the interstitial growth in the hemispherical cartilage and of appositional growth of the periphery of this cartilage (Ponseti 1978). The concavity of the acetabulum develops in response to the presence of a spherical head.

Growth in the height and width of the ilium, ischium and pubis is essentially like growth in tubular bones: the physeal plates at the ends are responsible for growth in length, the peristeme for growth in width (Ponseti 1978). The general effect of trauma on the epiphysis and growth-plate has been described by Siffert (1977). Acute trauma to a portion or to the entire plate which destroys the germinal cell layer or its vascularity results in partial or total growth arrest. When only a portion of the plate is damaged, the unaffected segment continues to grow. The progressive deformity that may occur depends on the future growth potential of the unaffected segment of growth cartilage: the younger the patient, the longer the period of growth and the greater the possible deformity. However, why the deformity occurs in some patients with triradiate cartilage injury while not in others is still not clearly understood. A Type V physeal injury was always associated with deformity in the series of Bucholz et al. (1982), as well as in two of our patients (Cases 1 and 2), but in Case 3 there was no progressive deformity.

The patient's age at the time of injury is important: severe deformity has not been described with injury after the age of 11 years (Bucholz et al. 1982). Experimental investigation in the rabbit has demonstrated that selective fusion of all three limbs of the triradiate cartilage or fusion of only the ilioischial limb caused acetabular dysplasia; this was associated in 50% with dislocation of the hip. Iliopubic fusion had only a minimal effect on acetabular development (Gepstein, Weiss and Hallel 1984). This may be explained by the predominance of the ilioischial limb, which is twice the size of the iliopubic limb.

Injury of the triradiate cartilage can be easily missed at the initial radiographical examination. In two of our patients (Cases 2 and 3) the diagnosis could not be made on the initial radiograph, and only retrospectively was it ascertained that both had sustained a Type V physeal injury.

If traumatic fusion of the triradiate cartilage occurs without damage to the hemispherical cartilage, the latter continues to grow and eventually displaces the acetabulum laterally. This creates the typical thickening of the acetabular wall. Damage to the metaphysis adjacent to the growth-plates may inhibit the growth in length of the pelvic bones (Ponseti 1978).

Injury of the sacroiliac joint may cause fusion, leading to a shorter ilium (McDonald 1980): this occurred in two of our patients (Cases 2 and 4). In the remaining two patients only minor sacroiliac displacement occurred and there was no growth disturbance.

The general management of triradiate cartilage injuries should not differ from that of other pelvic fractures. Theoretically, any subsequent osseous bridging can be resected and replaced by fat, but the surgical difficulties encountered with this procedure limit its practical use (Langenskiöld 1975). When subluxation is severe and the patient is symptomatic, a pelvic osteotomy may be necessary. However, there are very few reports on this in the literature. Blair and Hanson (1979) reported treating such a patient with a Chiari osteotomy, but the result was not recorded. It is important to perform clinical and radiographical follow-up examinations for a period of at least one year in order to detect a post-traumatic deformity at its earliest stage.

REFERENCES


