We describe a method of intertrochanteric osteotomy with posterior rotation of the femoral head and neck. We analysed 45 hips in 44 children and adolescents aged from six to 18 years with residual dysplasia after conservative (35) and operative (10) treatment of developmental dysplasia of the hip complicated by avascular necrosis of the femoral head. In ten, femoral osteotomy was combined with a variety of pelvic procedures.

Thirty-seven hips (36 patients) were available for follow-up at a mean of 4 years 5 months (2 to 15 years). Excellent results were obtained in nine, good in 17, fair in seven and poor in four.

The prevention and treatment of early osteoarthritis after conservative and operative treatment for developmental dysplasia of the hip (DDH) remain a problem. An important cause of incongruity of the hip is deformity of the femoral head and neck caused by avascular necrosis. The use of femoral rotational osteotomy has been reported for the treatment of avascular necrosis in adults and for Perthes' disease in children.

We review our experience of this technique in children and adolescents with residual hip dysplasia after treatment for DDH.

Patients and Methods

Between 1970 and 1997 we performed 73 rotational osteotomies for various hip conditions in children and adolescents aged between 3 and 18 years. Of these, we were able to review 44 patients (45 hips) who underwent surgical treatment for residual deformity of the hip after conservative (35) and surgical (10) treatment for DDH. The mean age of the patients at the time of operation was 11 years and 2 months (6 to 18 years); nine were less than ten years old.

The earliest clinical symptoms of tiredness and limp appeared at the age of six to eight years. All patients older than ten years complained of pain in the hip after prolonged walking. The Trendelenburg test was positive in 19. Limb-length discrepancy ranged from 0.5 to 3.5 cm. The range of flexion was between 90° and 120°; abduction and rotation were more severely restricted.

Radiological examination and CT revealed various multiplanar deformities of the femoral head and neck, as a result of segmental damage to the head and growth plate. The severity of the deformity was assessed according to the quotients described by Heyman and Herndon. The femoral head was usually flattened and broadened (coxa plana) and the joint surface irregular. The mean preoperative epiphyseal quotient was 52 (28 to 89). The value of the neck-diaphyseal and epiphyseal-diaphyseal angles varied within a range of 10° to 20°. Epiphyseal antversion, rarely retroversion, reached 50° in some cases. When medial physeal damage had occurred we observed medial angulation of the femoral head and neck and the lower border of the neck was short and concave. The mean neck-shaft angle in these patients (30 hips) was 106° (70 to 120).

Premature closure of the growth plate led to marked shortening of the femoral neck with an epiphyseal-neck quotient on the affected side of 47 to 50. This was associated with shortening of the limb and relative overgrowth of the greater trochanter. In 36 hips we noted gradual upward migration of the greater trochanter, measured by the articulotrochanteric distance which was zero or had a negative value in 24 hips.
Acetabular dysplasia was characterised by a decrease in the depth of the acetabulum. The mean acetabular quotient was 80 (70 to 84) which indicated reasonably satisfactory development of the acetabulum. Often, however, it could not contain the flattened and enlarged femoral head. As a result the acetabulum-head quotient ranged from 60 to 71 and in 28 hips the centre-edge (CE) angle of Wiberg ranged from -15° to +15°.

A wide variety of deformity was seen in these dysplastic hips in adolescence. Radiographs revealed early signs of osteoarthritis in most cases. In three hips which had had previous surgical intervention we observed necrosis of the weight-bearing area of the femoral head similar to idiopathic avascular necrosis in adults. According to the modification of Severin’s assessment system by Zionts and MacEwen five joints were classified as class III, 39 as class IV and one as class V.

We resorted to posterior rotational osteotomy only after detailed clinical and radiological examination, when other methods would not provide adequate correction. The aim of the operation was to improve centralisation of the femoral head and the congruity of the articular surfaces. A marked increase in epiphyseal height on the radiograph in the Lauenstein position compared with that on a standard anteroposterior radiograph was a good indication for rotational osteotomy. One requirement for the operation was an adequate range of hip movement in the sagittal plane. A mild hip flexion contracture of 15° to 20° was not a contraindication to posterior rotational osteotomy in this study.

**Operative technique.** All the operations were performed by the senior author (AMS) or under his supervision. Our early experience was similar to that described by Kempf et al in 1981. In the standard procedure the proximal fragment is rotated so that its cortex is in contact with the distal fragment. This leads to delay in bony union and the risk of nonunion. We therefore modified the procedure to avoid this problem.10

**Modified procedure.** A lateral approach to the upper femur is made and the bone exposed subperiosteally. The greater trochanter is osteotomised at its base and retracted proximally (Figs 1a and b).

The longitudinal axis of the femoral neck is identified and used for the insertion of an osteotome into the proximal femur. The blade of a 130° blade plate is inserted into the femoral neck with the distal plate portion orientated at 90° posteriorly to the femoral shaft (Fig. 1b).

An incomplete femoral osteotomy is performed in the intertrochanteric region using an oscillating saw and leaving the posterior femoral wall intact. The plane of the osteotomy is parallel to the long axis of the femoral neck (Fig. 1a).

The joint capsule, gemelli, piriformis, obturator internus, obturator externus and the posterior circumflex femoral artery are preserved. The iliopsoas tendon is divided at its insertion onto the lesser trochanter.

The proximal fragment is then rotated posteriorly around the longitudinal axis of the femoral neck, so that it is in contact with the angled cut surface of the distal femoral fragment. The fragments are fixed by securing the plate to the distal femoral fragment with screws and reattaching the greater trochanter with a screw or wires (Figs 1c and 1d).

The wound is irrigated and closed after inserting one or two drains. A plaster boot is applied to hold the limb in a position of slight internal rotation. The drains are removed 24 to 48 hours after the operation. The patients are mobi-
lisé on crutches at two to three weeks and are non-weight-bearing for 4 to 4.5 months. Full weight-bearing is allowed at 5 to 6 months if the radiographs are satisfactory (Fig. 2).

In those hips which showed marked acetabular dysplasia and a centre-edge angle of less than 20° rotational osteotomy was combined with pelvic surgery. We performed four triple osteotomies of the pelvis, three Salter osteotomies, two Chiari osteotomies and one acetabuloplasty. Salter’s pelvic osteotomy was performed in patients under ten years of age, triple osteotomy in adolescents, and Chiari osteotomy in those hips with severe articular changes. Four of the ten procedures were performed in two stages.

Lengthening of 2 cm was achieved in two patients by inserting a bone graft obtained from the base of the greater trochanter between the proximal and distal femoral fragments.

Results

Eight patients (eight hips) were lost to follow-up leaving 36 (37 hips) available for review. The mean follow-up period was 4 years 5 months (2 to 15 years). Pain was present in 36 of the 37 hips before operation. After operation 30 hips were free from pain, four had occasional pain and three persistent pain. Trendelenburg’s test was positive in 21 hips before operation; after operation nine hips had a positive test. A degree of limb-length discrepancy was present in all patients preoperatively. After operation, it was present in only six and ranged from 0.5 to 1.5 cm. A range of movement in the sagittal plane of at least 90° to 100° was preserved; rotation and abduction rarely improved. The clinical results were graded according to McKay’s system, as modified by Zionts and MacEwen.

Before operation, 34 hips were grade III and three grade IV. After operation, four were grade I, 24 grade II, five grade III and four grade IV.

In order to measure the radiological quotients described by Heyman and Herndon the contralateral hip must be normal. This was not possible in three patients at follow-up. The mean epiphyseal quotient increased from 52 before operation to 83 at follow-up. The change in the spatial position of the femoral head and neck resulted in an increase in the epiphyseal head-neck quotient from 62 before to 88 after operation. Rotation of the femoral head to restore sphericity in the weight-bearing area did not necessarily restore the acetabulum-head quotient to normal. After operation, its mean value was 88 (77 to 105) and the mean neck-shaft angle was 133° (125 to 140). In 31 of 36 hips the position of the greater trochanter was restored to normal. In one hip it was normal before operation.

Shenton’s line was restored to normal in 35 of 37 hips. The mean centre-edge (CE) angle of Wiberg which was below 20° in 30 of the 37 hips before operation was restored to 20° or above (20 to 43) in all except two hips after operation.

Remodelling of the bone in the femoral neck in accordance with Wolff’s law was first seen nine to 12 months after operation and continued for at least two to three years.

Gradual improvement and growth of the femoral head were seen from 10 to 12 months to 3 to 5 years after the operation. We also observed improvement in the joint space. Unfortunately, the development of the acetabulum

Fig. 2

Case 25. Radiographs showing A) residual subluxation of the left hip with severe deformity of the femoral head (coxa plana) and relative overgrowth of the greater trochanter (Severin class IV), B) after 90° posterior rotational osteotomy with improvement in joint congruity and C) follow-up at ten months. The osteotomy is united and the hip graded as Severin class I.
often remained retarded and led to a gradual deterioration of the acetabulum-head quotient. The overall radiological results according to the Severin classification as modified by Zions and MacEwen were as follows: nine hips were class I, 17 class II, seven class III and four class IV. There were no hips in class V or VI.

Complications. Most occurred at or soon after operation. Three hips developed aseptic necrosis and one chondrolysis. In one further hip the postoperative result was excellent for two years but aseptic necrosis developed after removal of the blade plate. Careful review of this case showed that the tip of the blade plate had been positioned in the subchondral zone of the weight-bearing area.

In two hips loss of correction of the neck-shaft angle was noted after fixation of the fragments with pins. They required revision by valgus osteotomy. In three hips inadequate fixation of the greater trochanter was complicated by upward migration, but this did not significantly affect the function of the joint and further surgery was not required. One patient developed a deep wound infection.

Discussion

This type of rotational osteotomy of the femoral neck is rarely undertaken in children or adolescents. Anterior rotational osteotomy as described by Sugioka is a complicated and demanding procedure. Posterior intertrochanteric rotational osteotomy is also technically demanding. We consider an angled blade plate to be the best method of fixation even in children. Fixation with pins is not sufficiently rigid. The problem of fixation of the greater trochanter has not been completely solved. The strength of the gluteal muscles is increased as a result of the relative lengthening of the femoral neck and distal transfer of the trochanter, and fixation by screws and wire is not always sufficient. Hanslik and Scholz proposed a new form of fixation, but it has not been widely accepted. Recently, we have been using the Weber technique for fixation of the greater trochanter.

Some authors are concerned about the growth of the greater trochanter after rotational osteotomy and closure of its epiphysis. Gage and Cary reported that trochanteric epiphysiodesis in children with avascular necrosis due to Perthes’ disease occurring at an average age of six years did not significantly affect the final shape of the femoral head and neck. Preoperative and postoperative radiological examination in the Lauenstein position may show disparity between the size of the acetabulum and femoral head of up to 20% because of enlargement of the femoral head or failure of acetabular development. This should not be considered as a contraindication to posterior rotational osteotomy if congruence can be obtained within the joint.

In ten hips with significant acetabular dysplasia a variety of pelvic procedures was performed either at the same time or as a second-stage procedure.

A range of movement of at least 90° to 100° was preserved in the sagittal flexion/extension plane but abduction and rotation were rarely improved.

Anterior rotational osteotomy is considered to be dangerous because of the possibility of interference to the blood flow in the proximal femoral area. We believe like Kempf et al that posterior rotational osteotomy is less likely to affect the posterior circumflex artery and the blood supply to the femoral neck. Three hips, however, developed aseptic necrosis at or soon after surgery and in one it occurred after a delay of two years.

The age at which rotational osteotomy should be undertaken is debatable. Sugioka recommended operation in patients with Perthes’ disease after the age of ten years. In our series the mean age at operation was 11 years and 2 months (6 to 18 years). Keret and MacEwen have described the radiological changes in the femoral head and neck in conservatively treated hips after vascular insult before closure of the proximal femoral physis. Our patients showed improvement in the epiphyseal head-neck quotient and the acetabular-head quotient postoperatively consistent with continued remodelling after surgery. We were able to restore and preserve the normal joint space as has been reported by Kempf and Padovani.

In conclusion we feel that rotational osteotomy should be considered in some patients who have residual subluxation and deformity of the femoral head after treatment for DDH. The operation cannot eliminate the defects of the femoral head but allows maximal use of its intact segments. It can improve centralisation of the femoral head in the acetabulum and articular congruence. Angular deformities of the femoral neck can be corrected and leg-length discrepancy significantly improved. In patients with marked acetabular dysplasia a pelvic procedure may also be necessary either at the same time or at a second stage.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


