ROTATIONAL ACETABULAR OSTEOTOMY FOR SEVERE DYSPLASIA OF THE HIP WITH A FALSE ACETABULUM

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We have divided Severin group-V severely dysplastic hips with a false acetabulum into three subtypes, based on the height and shape of the socket. We performed rotational acetabular osteotomy (RAO) in 19 hips in 17 young adults with a type-1 ‘low’ false acetabulum which had direct contact with the true acetabulum. This is a periacetabular osteotomy which gives acetabular coverage with articular cartilage and produces a nearly normal position of the head. Concomitant osteotomies of the proximal femur were carried out in 11 hips. We reviewed the patients clinically and radiologically at a mean of ten years (6 to 18) after operation. Of the 19 hips, 15 showed very good or good results.

This operation is indicated in young adults with a dysplastic hip and a type-1 low false acetabulum. Subclassification of Severin group V is a convenient way of defining those patients who would benefit from the procedure.

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The management of young adults with a severely dysplastic hip and a false acetabulum, classified as Severin group V, is controversial. Anatomical correction by an operation such as proximal femoral osteotomy, a shelf procedure or pelvic osteotomy, is extremely difficult. Variations of pelvic osteotomy include the Salter procedure (Salter and Thompson 1979), the triple osteotomy of Steel (1973) or Tönnis (1982), the double innominate osteotomy of Sutherland and Greenfield (1977) and the Chiari osteotomy (Chiari 1974).

The anatomical characteristics of a severely dysplastic hip vary between individuals and this causes difficulty in assessing the effectiveness of a particular procedure. We have attempted to clarify the indications for a particular operation and its efficacy by dividing the hips in Severin group V into three types, namely those with a ‘high’ false acetabulum (Fig. 1) which has no connection with the true acetabulum, and two types of ‘low’ false acetabulum in contact with the upper lip of the true acetabulum (Fig. 2). Type-1 low false acetabulum has no or only minimal osteophyte formation in its lower lip and shows a nearly

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**Fig. 1**
Diagram showing ‘low’ and ‘high’ false acetabula. In the low type the rim of the false acetabulum contacts the upper lip of the true acetabulum and in the high type, the false acetabulum has no such contact.

**Fig. 2**
Diagram showing types 1 and 2 of the low false acetabulum. In type 1 there is no osteophyte formation in the lower lip, but in type 2 there is a marked bony prominence with osteophyte formation forming a boundary with the true acetabulum.
linear inclination through the two acetabula with a slight bony prominence at the boundary. Type-2 low false acetabulum has marked osteophyte formation which produces a bony prominence with a clear boundary at its lower margin. In type 2, the false acetabulum is easily recognised as an isolated joint with more distinct separation than in type 1. The crucial differences between the types are the presence of the bony prominence dividing the true and false acetabula and the depth of the false articular concavity.

Rotational acetabular osteotomy (RAO) is a peri-acetabular osteotomy which provides satisfactory cover for the head with true articular cartilage in a nearly normal position. It has been reported to be useful in young adults with no dislocation but mild or moderate subluxation (Ninomiya and Tagawa 1984; Azuma and Taneda 1989), but has not always been satisfactory in severely dysplastic hips with a false acetabulum in young adults.

We have attempted to define the indications and limitations of the procedure in young adults with type-1 low false acetabulum in dysplasia of Severin group V.

PATIENTS AND METHODS

We operated on 19 hips in 17 patients (15 women and 2 men) all with the type-1 low false acetabulum of the Severin group-V classification. The femoral heads were articulating with a false acetabulum which was in contact with the upper portion of the true acetabulum. Their mean age at operation was 20.6 years (14 to 47) and the mean follow-up was 10 years (6 to 18).

We staged osteoarthritis of the hip from I to IV according to the radiological appearances. Stage I showed no osteoarthritic change, stage II had slight narrowing of the joint space associated with sclerosis of the subchondral bone, stage III marked narrowing of the joint space with many cystic lucencies and small osteophytes in the femoral head and acetabulum, and stage IV disappearance of the joint space with marked osteophyte formation at its margin. Before operation there were nine hips (mean age of patients 18.6 years) in stage I, seven (mean age of patients 31.3 years) in stage II, three (mean age of patients 37.0 years) in stage III and none in stage IV.

Radiological indices included the CE angle of Wiberg, the acetabular roof obliquity (ARO) (Massie and Howorth 1950), the acetabular head index (AHI) (Heyman and Herndon 1950) and the head lateralisation index (HLI) (Hijikata, Tagawa and Toyoshima 1985) which was calculated by two lengths both from the centre of the femoral head to the tip of the teardrop and between bilateral teardrops (Fig. 3).

For clinical assessment we used the system of Merle d’Aubigné and Postel (1954) graded from 0 to 6 for relief of pain, restoration of mobility, and improvement in walking. By adding the scores for pain and walking a functional grade was assigned as very good (11 to 12 points), good (10 points), medium (9 points), fair (8 points), and poor (7 points or less).

Operative technique (Fig. 4). A curved skin incision is made along the entire length of the wing of the ilium. The iliac origin of tensor fascia latae, the anterior portion of gluteus medius and gluteus minimus are detached subperiosteally to expose the anterior and lateral aspects of the hip. The posterior aspect is visualised by mobilising the piriformis and the short rotator muscles from the greater trochanter after separating gluteus maximus by blunt dissection. An osteotomy is performed using a special curved osteotome, starting just outside the joint capsule and deepening towards the inner wall of the ilium, the base of the pubis and the ischium. When the acetabulum has been mobilised it is rotated en bloc anterolaterally and medio-caudally to a position in which maximum coverage of the femoral head is obtained. A bone graft is placed in the gap to maintain position and stabilised with two or three Kirschner wires. No other fixation is used. Partial weight-bearing is started about six weeks after operation after removal of the Kirschner wires.

With severe acetabular dysplasia two additional procedures are needed. A strut graft of relatively large bicortical bone blocks taken from the iliac crest is positioned to stabilise the osteotomy and the inferior portion of the joint.

CE Angle (a) and Acetabular Roof Obliquity (ARO) (β)

Acetabulum Head Index (AHI)

AHI = \frac{A}{H} \times 100

Head Lateralisation Index (HLI)

HLI = \frac{1/2 T}{H} \times 100

Fig. 3

Radiological indices of the hip.
capsule is incised and released to allow the osteotomised portion to rotate to its proper position.
In our series valgus osteotomy (9 hips) and varus osteotomy (2 hips) of the proximal femur and transposition of the greater trochanter (2 hips) were also carried out either simultaneously or secondarily to obtain adequate joint congruency.

RESULTS
The radiological indices before and after operation are shown in Table I. Improvement was seen in the CE angle, the ARO and the AHI and the values after operation almost reached the normal figures for Japanese women (Ninomiya 1989).

The functional grading of the hips before and after operation is shown in Table II. Marked improvement was seen after operation and this was substantially maintained in those who were followed up for longer periods.

Figure 5 shows the changes in the radiological signs of osteoarthritic changes over the period of follow-up.

| Table I. Mean (± sd) acetabular indices before and after operation |
|------------------------|------------------------|------------------------|
| Acetabular               | Before operation       | After operation        |
| CE angle in degrees     | -16.8 ± 14.8           | 28.5 ± 13.6            |
| ARO in degrees          | 43.5 ± 6.6             | 12.8 ± 9.4             |
| AHI                    | 34.8 ± 11.8            | 83.5 ± 20.5            |
| HLI                    | 82.6 ± 10.9            | 72.3 ± 16.7            |

Fig. 4a
Diagrams showing the anterior (a) and lateral (b) aspects of rotational acetabular osteotomy.

Fig. 4b

Fig. 5
The progression of osteoarthritic changes over the period of follow-up.
osteoarthritis in the hips over the period of follow-up. Most remained unchanged but both improvement and deterioration were seen in the remainder.

Illustrative cases

Case 1 (Fig. 6). A 14-year-old girl with slight pain and a limp had an RAO in 1987. Before operation stage-II osteoarthritis was present and her hip score was 9 points. Eight years later she has no pain and only a slight limp. The hip score has increased to 11 points.

Case 2 (Fig. 7). A 25-year-old woman had mild pain and a limp with stage-II osteoarthritis. We performed RAO in 1983. The Trendelenburg sign persisted and two years later distal and lateral advancement of the greater trochanter was undertaken. She now has no pain and only a slight limp two years after the first operation. Her hip score has improved from 9 to 11 points.

Case 3 (Fig. 8). A 36-year-old woman had severe pain in the right hip and a type-I low false acetabulum with a small curtain osteophyte. She had stage-III osteoarthritis and her hip score was 9. RAO and concomitant valgus osteotomy were undertaken but she still had mild pain with a moderate limp and the osteoarthritic changes progressed to stage IV. Bipolar hip arthroplasty was carried out four years after the first operation.

Case 4 (Fig. 9). A 47-year-old woman had severe pain in the right hip, with stage-III osteoarthritis. Her hip score was 9. We performed RAO with concomitant valgus osteotomy. She now walks without a stick and with no pain or limp. Her hip score is 12 points and the osteoarthritic changes have not progressed.

DISCUSSION

Severe hip dysplasia in young adults inevitably progresses to osteoarthritis with increasing age. Although total hip arthroplasty can provide a durable and relatively painless hip for the lifetime of more elderly patients, the long-term durability of the procedure in younger individuals is uncertain. To prevent progression of osteoarthritic changes, a more efficient operation is desirable. Harris and Enneking (1995) have presented histological evidence to show that an appropriate osteotomy could provide durable regeneration of articular cartilage with remodelling of subchondral bone.

Anatomical correction for a severely dysplastic hip with a false acetabulum is extremely difficult by any conventional operative procedure (Steel 1975; Sutherland and Greenfield 1977; Wagner 1978; Salter and Thompson 1979; White and Sherman 1980; Tönnis 1982; Reynolds 1986;
Høgh and Macnicol 1987), since it is difficult to control the required transposition of the acetabulum to a position which would provide a congruent hip.

The variations in the anatomy of hips which have been placed in Severin group V are too great to enable an accurate assessment of the possible outcome of an operation. We divided false acetabula classified as Severin group V into three types, high and two variations of low, depending on their level and radiological appearance. Correction of the high position is beyond the technical possibilities of the RAO operation, but the procedure may be successful in some of the low hips. We have classified the low acetabula into types 1 and 2 (Fig. 3), and all 19 hips on which we performed the RAO procedure were all type-1 low acetabula.

We suggest that the type-1 low false acetabulum originated from severe subluxation in a high position and was usually classified as Severin group IV in infancy since it was displaced in the superolateral direction to the same position as true Severin group V. The false acetabulum may be covered with original hyaline cartilage, regardless of having some degree of degeneration, and may be able to maintain favourable articular function in the long term if a near anatomical relationship to the femoral head can be obtained. Type-2 low false acetabulum, however, may originate from complete dislocation and will usually be classified in Severin group V in infancy. The secondary acetabulum has a marked articular concavity, and a bound-
ary with an osteophytic prominence just above the true acetabulum. It may be covered only with fibrous tissue which would not be suitable for a functional joint even if appropriate anatomical repositioning could be undertaken. Thus from a biological viewpoint type 1 is more likely to be suitable for the RAO procedure. Using the Merle d’Aubigné and Postel (1954) grading system, 15 of our 19 hips (78.9%) achieved a very good or good result at a five- to ten-year follow-up, which is better than that obtained with other procedures (Eppright 1975; Wagner 1978; Reynolds 1986; Høgh and Macnicol 1987) and may justify this hypothesis.

Ninomiya (1989) reported findings using the same procedure in dysplastic subluxated or dislocated hips including both Severin groups IV and V; he had 31 excellent or good results (75.6%) in 41 operated hips after a mean of 7 years and 9 months using the clinical assessment of modified Severin grading.

With the RAO procedure anatomical reduction and acetabular coverage of the femoral head can be obtained relatively easily, although it may be necessary to undertake proximal femoral osteotomy or advancement of the greater trochanter at the same time. The surface of the osteotomised acetabulum is covered with original hyaline cartilage, it is relatively easy to manipulate the freed portion to an ideal position and the osteotomised bony surface is in such wide contact that union is easily secured. The operation does have limitations which are influenced by the age of the patient, the stage of osteoarthritic change, the congruency of the joint and the position of the false acetabulum. Case 3 (Fig. 8) suggests that if there is a deformed head in addition to severe dysplasia it is difficult to obtain appropriate congruency of the joint. In case 4 (Fig. 9), however, in which there was an almost round femoral head, a good result was obtained in an older patient with advanced osteoarthritic change.

The most important limiting factor may be joint congruency, which is determined by the shape of the femoral head and of the acetabulum. The procedure is not indicated in patients who have marked deformity of the femoral head with an incongruent joint which cannot be adjusted by additional proximal femoral osteotomy.

In patients with high displacement, including our type-2 ‘low’ false acetabulum, we have combined a modified RAO procedure with a modified Codoville-Colonna arthroplasty after pulling down the femoral head (Azuma, Taneda and Igarashi 1994).

We have found that RAO, with concomitant osteotomies of the proximal femur, is an efficient way of preventing progression of osteoarthritic change in young adults with a low false acetabulum originating from a severely subluxated hip in infancy, and that it has favourable long-term results.

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REFERENCES


