International Orthopaedics (SICOT) (1989) 13: 21–28

International
Orthopaedics
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Rotational acetabular osteotomy in congenital dysplasia of the hip

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Summary. *Rotational acetabular osteotomy was carried out in 127 patients (147 hips) with acetabular dysplasia, some of whom showed early or progressive degenerative changes. Complications occurring during and after operation were transient lesions of the lateral femoral cutaneous nerve in 20 patients, of the femoral nerve in 2, fracture of the acetabulum in 1, inadequate rotation of the acetabulum in 11, and infection in 3 patients. Later complications were breakage of Kirschner wires in 3, ectopic bone formation in 2 and acute chondrolysis in 3 patients. Sixty-six patients (69 hips) were followed for an average of 5 years and 4 months, and in most of them satisfactory results were achieved in spite of these complications.*

Résumé. *Une ostéotomie cotyloïdienne de rotation a été réalisée 147 fois sur 127 malades porteurs d'une dysplasie du cotyle, certains d'entre eux présentaient des lésions dégénératives débutantes ou évolutives. Les complications per et post-opératoires suivantes ont été observées: 20 atteintes transitoires du nerf fémoro-cutané, 2 du nerf crural, 1 fracture du cotyle, 11 rotations incorrectes du cotyle, et 3 infections. Les complications tardives ont été 3 ruptures des broches de Kirschner, 2 ossifications périarticulaires et 3 chondrolyses aigües. Soixante-six opérés (69 hanches) ont été suivis en moyenne pendant 5 ans et 4 mois, chez la plupart d'entre eux des résultats satisfaisants ont été obtenus malgré ces diverses complications.*

The uncertain prediction of further growth of the acetabulum after operations for congenital dysplasia of the hip makes assessment of the results of any procedure difficult, even if a good result has been achieved. Closure of the growth plates of the acetabular triradiate cartilage and of the capital femoral epiphysis occur at 12–13 years of age in girls, and 13–15 years in boys. Rotational acetabular osteotomy has been used after the completion of acetabular growth [10].

The operation follows out the acetabulum outside the capsule, and produces anterolateral displacement which covers the femoral head. Acetabular dysplasia and displacement of the femoral head are corrected at the same time, and nearly normal alignment is usually restored. The biological and mechanical aspects of the procedure seems reasonable, and we have used it to treat dysplasia of the hip since 1974.

The en bloc circumferential acetabular osteotomy is not difficult to carry out, provided that a sufficiently wide exposure is obtained, and certain basic principles are followed. There are several pitfalls, and we have experienced some errors and complications which we wish to report.

Material and method

One hundred and twenty-seven patients (147 hips) have been treated by rotational acetabular osteotomy between November 1974 and April 1987. This was consecutive series, and all the operations were done by one of us (H A).

The age of the patients at operation was from 12 to 54 years (average 28 years), with only 8 over 40 years. One hundred and twenty-one were female and six were male.

The diagnosis was congenital subluxation or dysplasia in every case, with 99 hips having both dysplasia and subluxation. Osteoarthritis was present in 48 and was graded as early in 30, progressive in 15 and late in 3.

All patients had pain in the hip which varied in severity and frequency.

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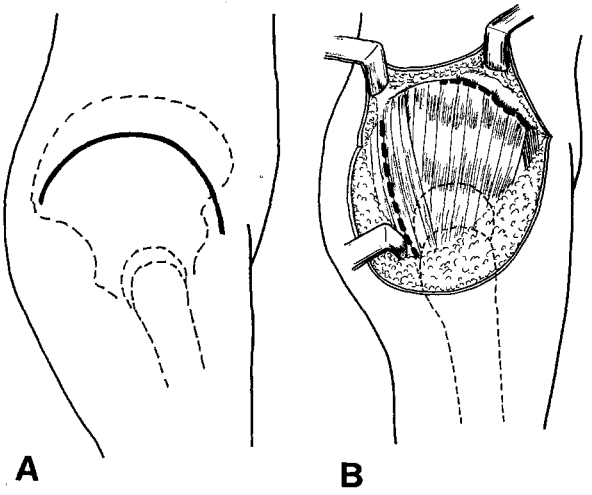

Fig. 1. **A** The skin incision; **B** The *dotted lines* show the anterior and posterior approaches

Surgical technique

The patient lies in the exact lateral position. A single skin incision, modified from Tagawa's original incision [8, 10], allows an anterior and posterior approach to the hip (Fig. 1). Gluteus medius and the tensor fasciae latae muscles are stripped from the iliac crest subperiosteally (Fig. 2A), and the lateral femoral cutaneous nerve is retracted medially. The two heads of the rectus femoris muscle are exposed, divided transversely, and retracted downwards. The reflected head is the landmark for the level of the joint. The iliopsoas is retracted medially to expose the pubic bone, and the iliopubic eminence is identified subperiosteally.

Attention is next directed to the posterior approach. The piriformis, the short external rotator muscles and the proximal part of quadratus femoris are divided to expose the posterior capsule of the hip joint (Fig. 2B).

A special osteotome, designed by Tagawa, and curved to correspond to the curve of the acetabulum, is used. The line of osteotomy follows the attachment of the capsule to the pelvis one finger breadth above the acetabular ridge. The cut is made anteriorly and posteriorly around the circumference of the acetabulum, the osteotome being allowed to follow its own curve (Figs. 2A, 3A–D). The osteotome should not be allowed to penetrate the acetabular cartilage, although no harm results from penetration of the inner cortex of the floor.

Whe the osteotomy of the pelvis is completed, the capsule is the only soft tissue attachment to the acetabulum, which is rotated and transferred anterolaterally, and at the same time displaced caudally (Fig. 3B). In a hip with a high subluxation, the acetabulum is usually shallow throughout its whole extent, so the rotational displacement of the acetabulum should be lateral, rather than anterolateral. Excess bone should be removed from each side of the osteotomy (Fig. 3B). The rotated acetabulum provides a more horizontal weight-bearing area, and returns the subluxated femoral head to a more normal position (Fig. 3C).

A trapezoidal-shaped bone graft, its size and thickness determined by the size of the gap created by the osteotomy, is taken from the wing of the ilium and used to fill this gap. One or two Kirschner wires (2 mm in diameter) transfix the displaced acetabulum, the graft and the pelvis (Fig. 3D). Radiographs are taken to check the position of the femoral head and its cover.

The average operating time in our last 25 cases was 2½ hours, and the average blood loss was about 900 ml.

Plaster immobilisation is not used, and active movements are begun in the second week after operation. The Kirschner wires are removed through a small incision at the fifth or sixth week. Partial weight-bearing with crutches is then allowed.

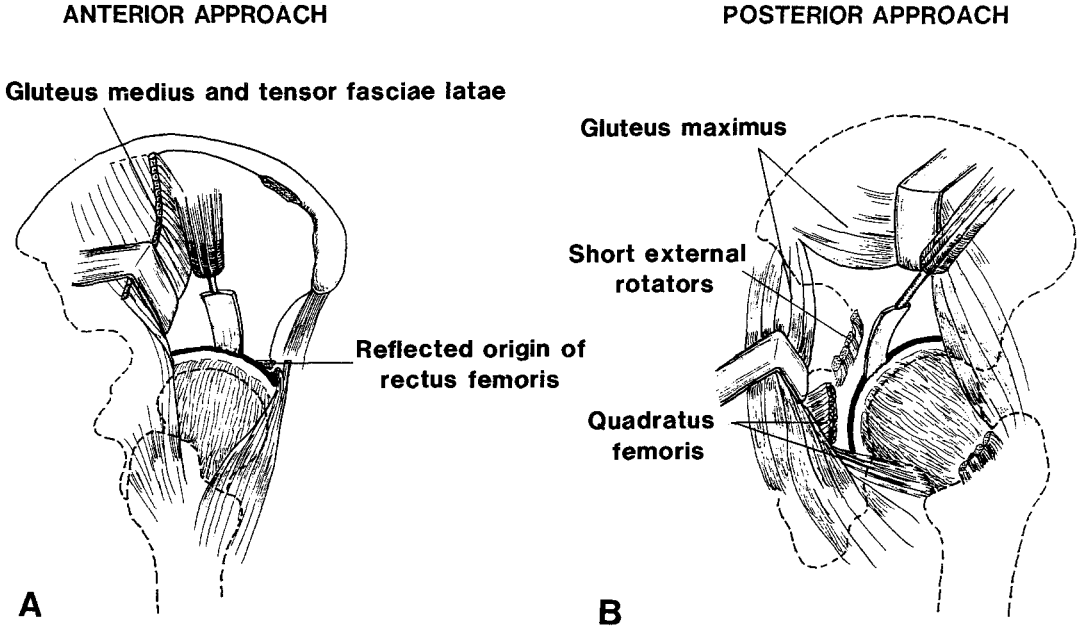

Fig. 2. **A** Gluteus medius and the tensor fasciae latae muscles have been stripped from the iliac crest. The reflected origin of rectus femoris is shown; **B** The gluteus maximus muscle has been split. The external rotators and part of quadratus femoris have been divided

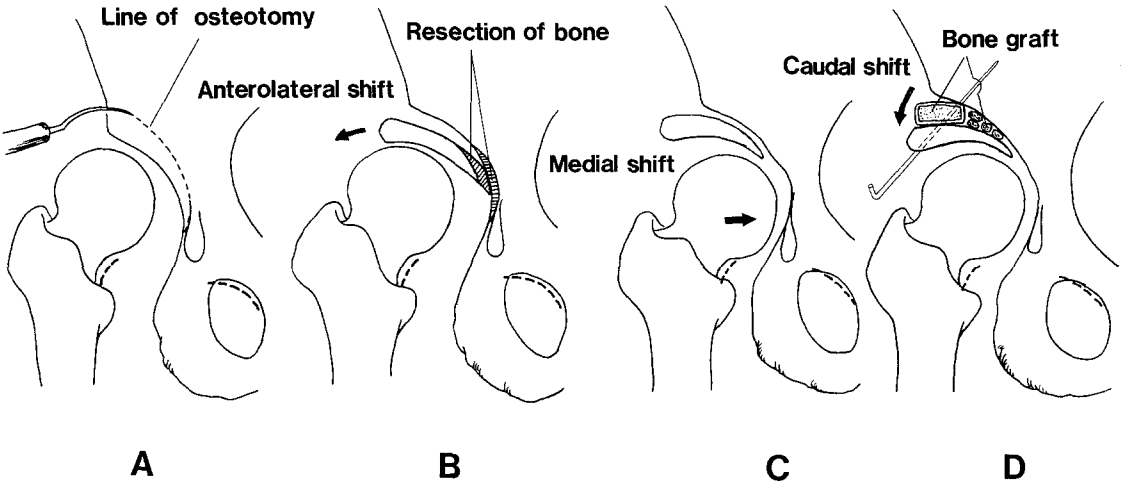

Fig. 3A–D. Diagrams showing the steps of the operation: **A** The line of the osteotomy; **B** The acetabulum is displaced and excessive bone is removed from each side of the osteotomy; **C** Medial displacement of the femoral head after removal of excessive bone; **D** A Kirschner wire secures the acetabulum, the bone graft and the pelvis. The improved acetabular cover and the improved position of the femoral head are shown (Shenton's line has been restored)

The crutches are discarded 4–5 months after operation, and most of our patients resume their normal activities within a year.

If satisfactory congruence between the acetabulum and the femoral head has not been achieved, the situation can be improved by a concomitant intertrochanteric varus or valgus femoral osteotomy or by distal transfer of the greater trochanter with or without femoral lengthening (Figs. 4 and 5).

Results

Sixty-six patients (69 hips) were followed up from 2½ to 12¾ years after operation (average 5⅓ years).

Pain

All patients had variable pain before operation, mild in 25, moderate in 30 and severe in 14. After operation, 58 patients (61 hips) were free of pain, 6 (6) had mild pain and 2 (2) moderate pain.

Gait

Before operation, 50 patients had a limp, 20 used a stick and 2 needed bilateral support. After operation, 39 did not limp, 21 had a mild, and 6 a moderate limp.

Activities of daily living

Improvement after operation was not remarkable, and some patients still had difficulty with putting on their stockings, cutting their toe-nails and making a Japanese style bow.

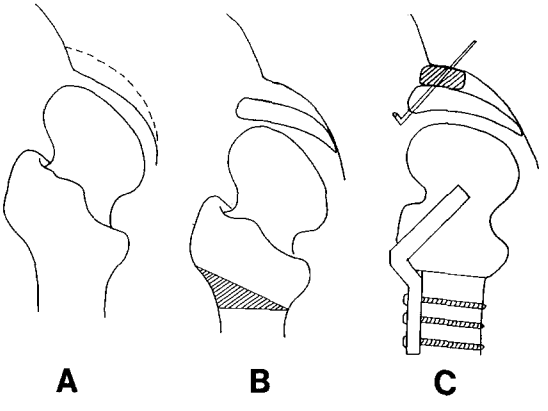

Fig. 4A–C. Combined operation with rotational acetabular osteotomy and intertrochanteric osteotomy; **A** Before operation; **B** When there is poor congruity after displacement of the acetabulum, an intertrochanteric osteotomy will improve the position; **C** Combined rotational acetabular osteotomy and valgus osteotomy

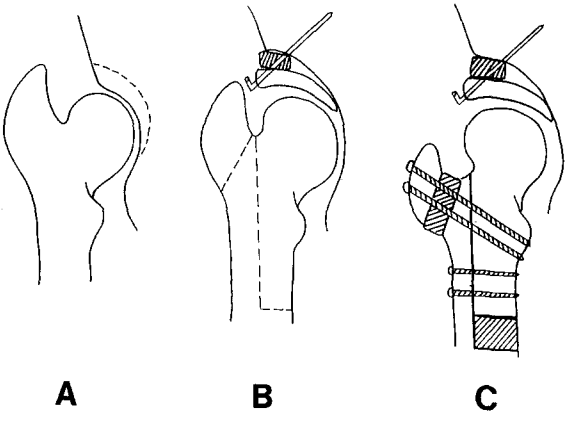

Fig. 5A–C. Combined rotational acetabular osteotomy, distal transfer of the greater trochanter and femoral lengthening: **A** Before operation. There is marked overgrowth of the greater trochanter with shortening of the leg; **B** *Dotted lines* show the femoral osteotomy; **C** The result of the combined operation

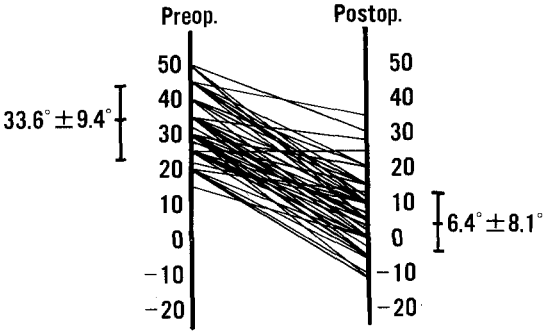

Fig. 6. The pre- and postoperative obliquity of the acetabular roof (n = 69)

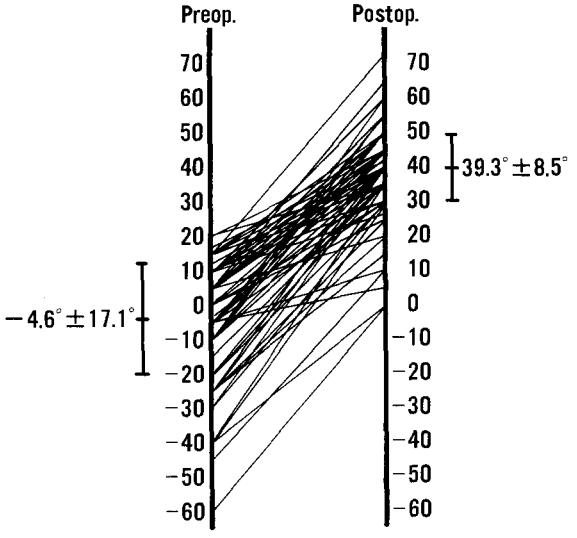

Fig. 7. The pre- and postoperative CE angle (n = 69)

Movement

All hips, except one, had a full or only slightly limited range before operation with over 100° of flexion. After operation, 63 hips maintained the same range of flexion, one showed no change and 5 lost some movement, with a range between 60° and 100°. Other directions of movement showed a similar trend. About 90% of the range achieved at operation was preserved in most cases.

Overall results

The results were compared using the hip function rating system and classification of osteoarthritis according to the Japanese Orthopaedic Association [9]. A group of patients with no osteoarthritic changes improved from 78.7 to 95.7 points after operation. Those with early osteoarthritis improved from 74.3 to 82.8 points and those with progressive changes from 65.5 to 85.1 points.

Radiographic measurements

The angle of obliquity of the acetabular roof improved from 33.6° ± 9.4° before to 6.4° ± 8.1° after operation (Fig. 6).

The CE (centre-edge) angle ranged from −60° to 20° (average −4.6° ± 17.1°) before operation. After operation, the angle in all but 5 hips was more than 20° (average 39.3° ± 8.5°) as shown in Fig. 7.

Pitfalls and complications

Peripheral nerve lesions

Twenty patients had a lesion of the lateral femoral cutaneous nerve with loss of sensation to light touch, but none had severe pain or paraesthesiae. Two had lesions of the femoral nerve, but recovered well within a year from the operation, apart from slight residual sensory disturbance.

Fracture of the acetabulum

One patient had a large acetabular cyst before operation, and a fracture occurred during the osteotomy.

Excessive rotational displacement

This was recognised in the anteroposterior radiographs and occurred in 11 hips, and most of these

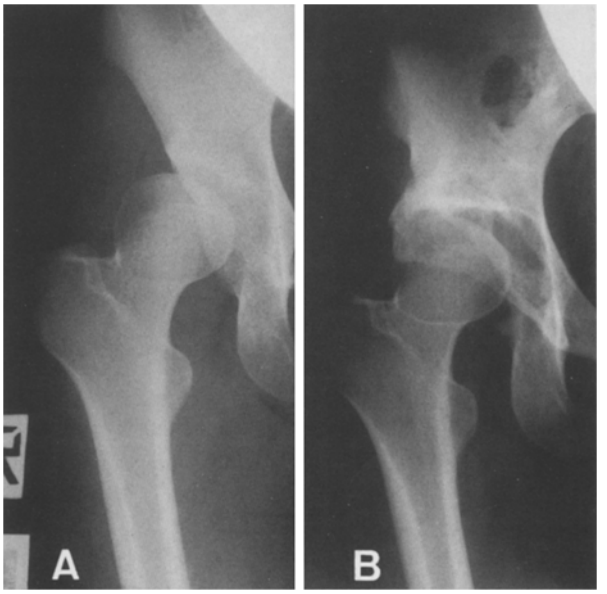

Fig. 8A, B. Radiographs of the hip of a 21-year-old woman. **A** Before operation; **B** Three and a half years after operation. The femoral head is displaced laterally because insufficient bone has been resected from the osteotomy site

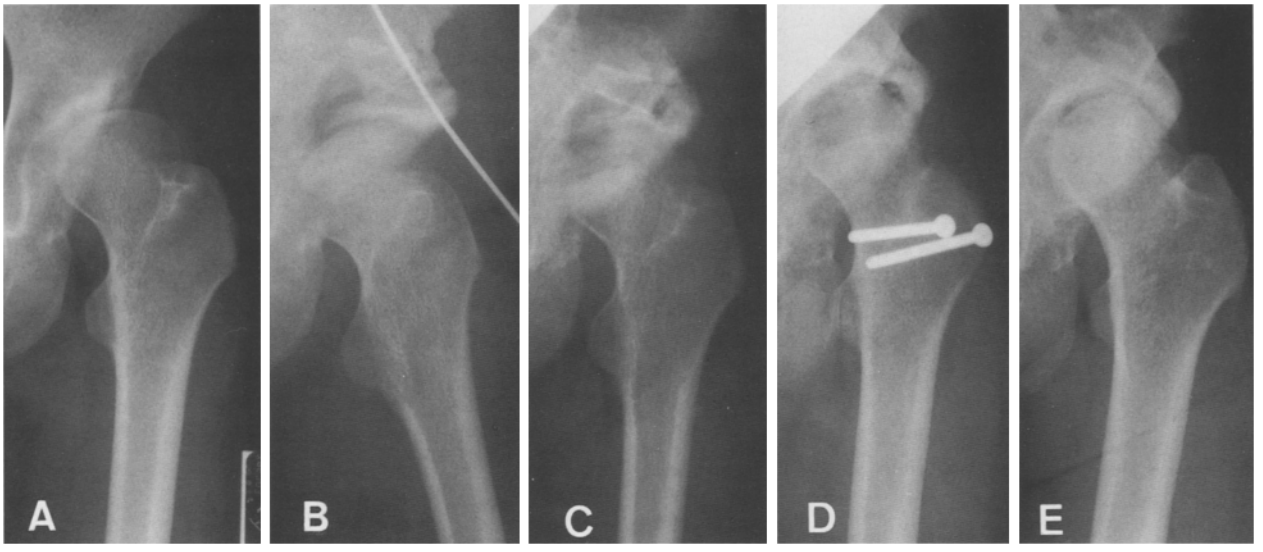

Fig. 9A–E. Radiographs of the hip of a 21-year-old woman. **A** Before operation; **B** One month after rotational acetabular osteotomy. There has been improved in the position of the femoral head and acetabular cover. The joint space is narrowed; **C** Four months after operation. The femoral head has moved upwards as a result of absorption of the acetabulum. The joint space is further narrowed. These changes are due to deep infection; **D** At 8 months after operation and 3 months after closed irrigation; **E** Five years after operation. Upwards and lateral displacement of the femoral head persists, but the configuration of the joint is well preserved

Fig. 10A–D. Radiographs of the hip of a 27-year-old woman. **A** Before operation; **B** One month after operation. Rotational acetabular osteotomy with distal transfer of the greater trochanter and femoral lengthening (performed at the same time); **C** At 1 year 9 months after operation. Ectopic bone (15 mm × 30 mm) shown by an *arrow*; **D** Three years and two months after the first operation and one year and 4 months after removal of ectopic bone

also had an excessive lateral displacement confirmed in the lateral radiograph. The clinical results are satisfactory so far, apart from slight restriction of flexion.

Deficient resection of bone from the osteotomy site

This error was frequently made in the past so that the femoral head was left in a lateral position (Fig. 8). The clinical results remain excellent.

Infection

Superficial sepsis occurred in two patients, and healed after debridement and chemotherapy. One deep infection occurred in which the acetabulum was progressively absorbed and the femoral head displaced upwards. The joint space became narrowed and there was some destruction of the femoral head. After 5 months, closed irrigation of the joint was carried out and the infection was gradu-

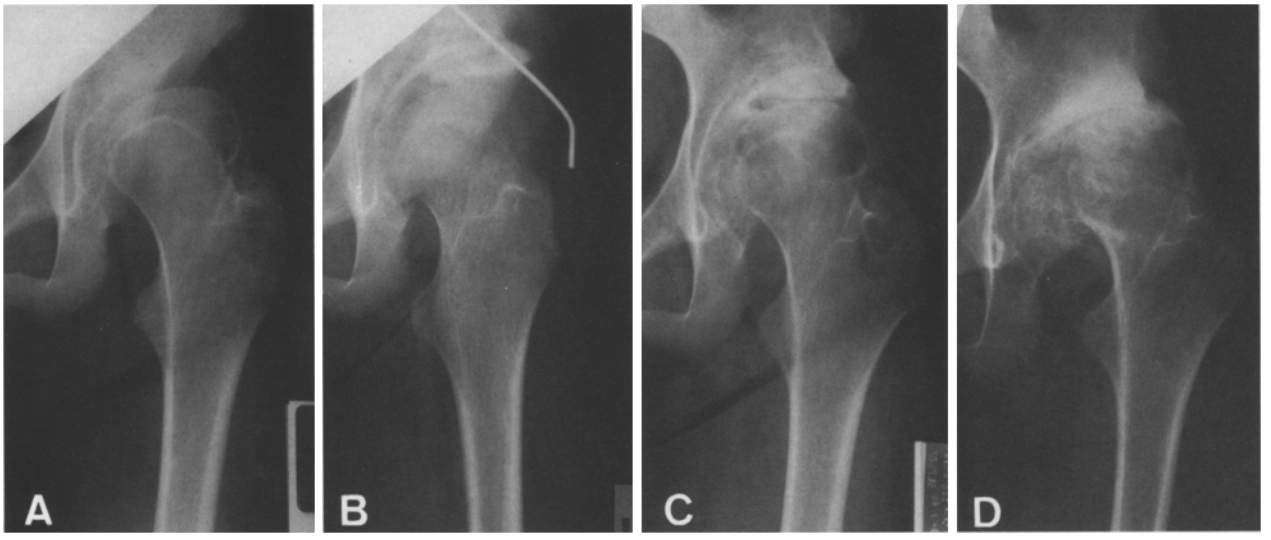

Fig. 11A–D. Radiographs of the hip of a 15-year-old girl. **A** Before operation; **B** Immediately after operation; **C** Ten months after operation. Narrowed joint space with sclerosis of the acetabulum; **D** Four years after operation. Advanced osteoarthritis with displacement of the femoral head

ally controlled. The narrowed joint space became wider and the bony changes were repaired. Five years later, the patient has some limitation of movement, but has no difficulty doing her housework (Fig. 9).

Breakage of Kirschner wires

The wires broke in 2 cases about 4 and 5 weeks after the operation, respectively. They were removed routinely at 6 weeks after operation.

Ectopic bone formation

Moderate ectopic bone formation was seen in 2 hips. In one, the bone was in the re-attached rectus femoris tendon; tenderness and movement improved after its removal (Fig. 10). In the other case, the new bone was in the anterior part of the acetabulum and was seen in the radiographs 8 weeks after operation. Flexion was restricted, the bone was excised 4 months after the first operation. It recurred, but to a lesser extent, and there was only slight restriction of flexion and internal rotation.

Chondrolysis

This developed in 2 cases in which the osteotome accidentally penetrated the acetabular articular cartilage. Osteoarthritis developed 5 and 10 months later, respectively. At 2 and 4 years after operation, neither patient has pain, but there is marked restriction of hip movement due to progressive osteoarthritic changes (Fig. 11).

In another case, acute chondrolysis developed 15 months after operation. Prior to this the postoperative course had been uneventful.

Discussion

Various operative procedures have been advocated for congenital dysplasia of the hip, such as osteotomy of the pelvis and/or the proximal femur, and acetabuloplasty.

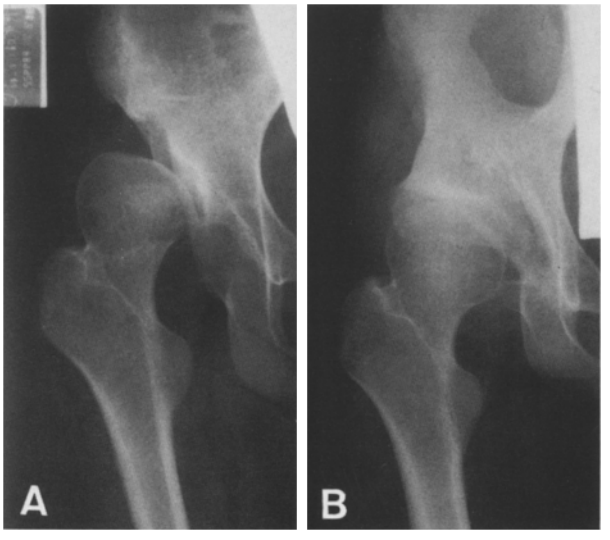

Fig. 12A–B. Radiographs of the hip of a 21-year-old woman. **A** Before operation; **B** At two years after operation. Equalisation of leg lengths was restored as shown by the intact Shenton's line

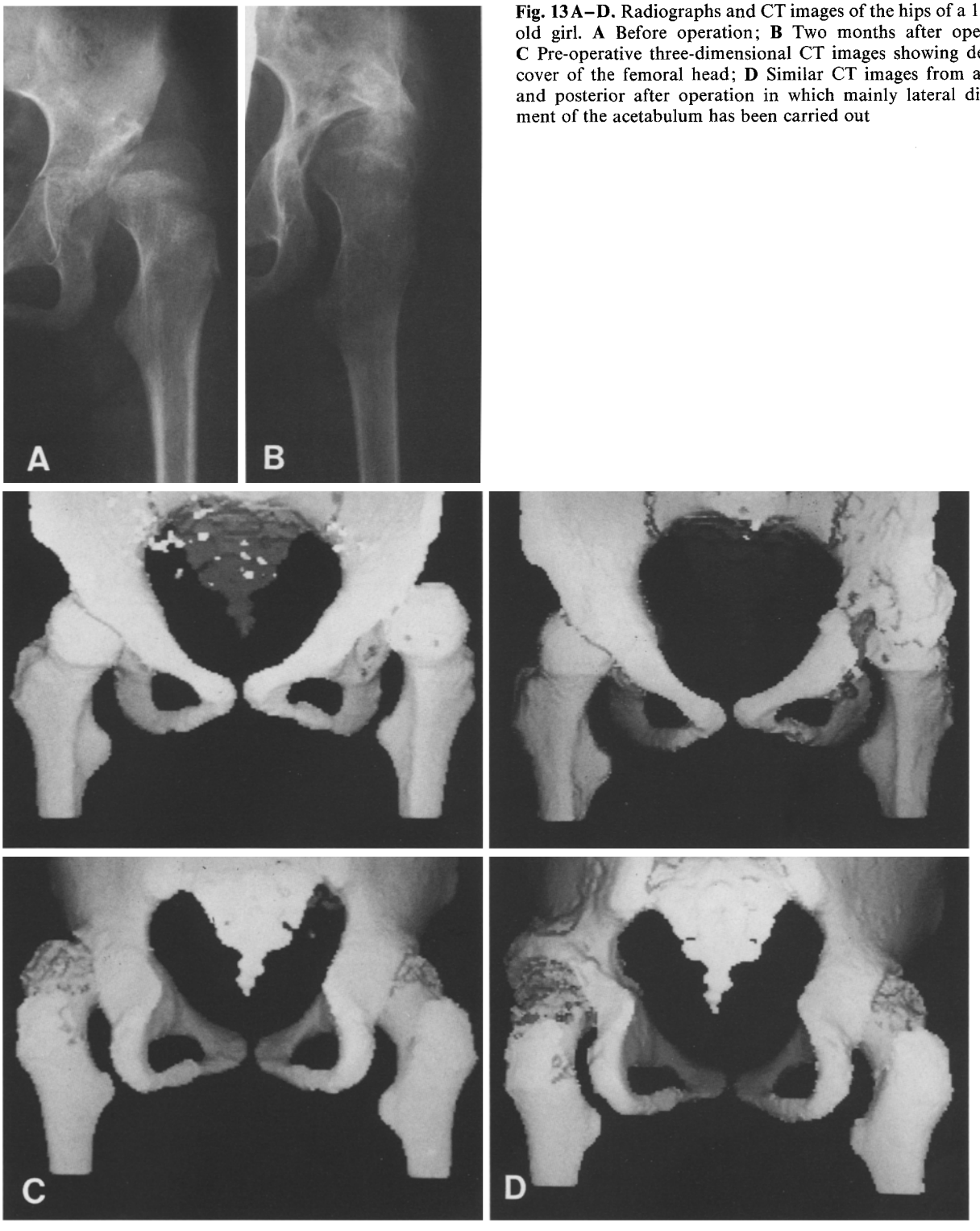

Fig. 13A–D. Radiographs and CT images of the hips of a 12-year-old girl. **A** Before operation; **B** Two months after operation; **C** Pre-operative three-dimensional CT images showing deficient cover of the femoral head; **D** Similar CT images from anterior and posterior after operation in which mainly lateral displacement of the acetabulum has been carried out

Rotational acetabular osteotomy is an extra-articular circumferential en bloc osteotomy of the acetabulum which is basically identical to Blavier's osteotomy [1], Wagner's spherical acetabular osteotomy [11] and Eppright's dial osteotomy [4]. The method has biological and biomechanical advantages in the treatment of the dysplastic hip. It provides sufficient cover of the femoral head by rotational displacement of the acetabulum with its intact cartilage, the weight-bearing part is en-

larged by better alignment of the joints surface, and shearing forces are lessened by the decrease of the acetabular inclination and by the reduction of the resultant force applied to the femoral head as a result of its medial displacement. In cases of high subluxation, it may be possible to make the legs the same length by the downward displacement of the femoral head and the restoration of Shenton's line (Fig. 12).

The indications for rotational acetabular osteotomy are wide in respect to both age and the stage of osteoarthritis. The age may vary from 12 to 13 years in girls (13 to 15 years in boys), to middle age and over. Osteoarthritis may be absent, or from slight to progressive changes may be present. Excellent results have been obtained, but the various pitfalls and complications need to be taken into consideration.

We did not encounter damage to intrapelvic structures or large vessels, but the femoral nerve may be injured when the iliopsoas is being retracted medially, although this should be avoided if care is taken. The lateral femoral cutaneous nerve should be identified and preserved before stripping the muscles from the iliac crest, but variations in its course have been reported [2]. A lesion occurred in 16% of our cases; in most the nerve had not been identified at operation.

Acetabular cysts occur in osteoarthritic hips and are in a plane beneath and posterior to the anterior inferior iliac spine. This is near to the site of the osteotomy, and there is a risk of fracture if due care is not taken.

At the beginning of our series, technical errors in 11 patients produced an incorrect rotational displacement. This involved either excessive anterolateral displacement of the acetabulum or was caused by insufficient resection of the medial part of the acetabulum. Three-dimensional reconstruction of CT-images is a valuable way of considering the direction and degree of rotational displacement, especially in the hip with a high subluxation (Fig. 13). It will be possible in the future to use a computerised surgical simulation system so that the operation can be rehearsed on a threedimensional image of the bone.

The cause of ectopic bone formation is not yet known, but we attempt to wash out all bony debris during the operation.

The acute chrondrolysis which occurred in two of our patients appeared to be due to penetration of the articular cartilage by the osteotome. Recent studies have suggested that in closed nailing of a slipped capital femoral epiphysis, penetration of the joint is a possible cause of chondrolysis and the early onset of osteoarthritis [6]. Ingram et al. [5] agree with Mankin et al. [7] that chondrolysis is an immunological disorder occurring in genetically susceptible individuals. The late development of chrondrolysis in our third patient with this condition needs to be studied further.

Rotational acetabular osteotomy is a major procedure, but it restores the position of the femoral head and provides good acetabular cover in congenital dysplasia of the hip. We have emphasised the errors and pitfalls which must be avoided if a successful result is to be achieved.

Acknowledgments. The authors wish to thank Dr Mutsuhisa Fujioka for his assistance in preparing the three-dimensional CT-imaging, and Dr Shiro Ukawa for his English translation.

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