SUBSPECIALTY PROCEDURES

ROTATIONAL ACETABULAR OSTEOTOMY

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Abstract

Background: Hip dysplasia is a common cause of secondary osteoarthritis. To prevent the early onset of secondary osteoarthritis, rotational acetabular osteotomy has been proposed¹.

Description: The approach combines the anterior iliofemoral and posterior approaches through a single skin incision. The pubic bone is cut independently, and the ilium and ischium are cut in continuity. The rotation of the acetabulum provides a more horizontal weight-bearing area and, at the same time, returns the superiorly subluxated femoral head to a more normal position.

Alternatives: The Ganz periacetabular osteotomy involves the same concept as a rotational acetabular osteotomy with a different surgical approach. The rate of major complications, such as intra-articular osteotomy, nerve palsy, loss of fixation, malreduction, and symptomatic heterotopic ossification, is lower in rotational acetabular osteotomy (0% to 18%)² than in periacetabular osteotomy (6% to 37%)³. Because of a wide surgical exposure, osteotomy can be performed under direct vision in rotational acetabular osteotomy.

Rationale: Rotational acetabular osteotomy for osteoarthritis secondary to hip dysplasia can alter the position of the acetabulum en bloc and cover the femoral head with cartilage. For the unstable hip with dysplasia, the surgical procedure is needed for the prevention of osteoarthritis.

Introductory Statement

Rotational acetabular osteotomy¹ not only alters the direction of the acetabulum but also correctly positions the femoral head with an adequate operative field (Video 1).

Video 1 Demonstration of the rotational acetabular osteotomy.

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Indications & Contraindications

Indications²

- An age of <60 years.
- A center-edge angle of <20°.
- Pre-osteoarthritis or early-stage osteoarthritis.
- Improved femoral head coverage and joint congruency on preoperative anteroposterior radiographs of the hip in abduction (Fig. 1).
- A grade-A or B joint congruency, according to the 4-grade system of Yasunaga et al. (Fig. 2)^{3,4}, is an optimal indication and grade C is a relative indication for surgery.

Contraindications^{2,3}

- Joint congruency is not improved or there is no widening of the joint space on preoperative anteroposterior radiographs of the hip in abduction (grade-D joint congruency) (Fig. 2)⁴.
- End-stage osteoarthritis.

Fig. 1

Fig. 2

Figs. 1-A and 1-B Preoperative radiographic evaluation of a 50-year-old woman with early-stage osteoarthritis. **Fig. 1-A** Anteroposterior pelvic radiograph showing superior-lateral migration of the femoral head of the left hip, with a wider medial joint space in the left hip than in the right hip. **Fig. 1-B** With the left hip in the abducted position, the femoral head is medialized and joint congruency is improved.

Fig. 2 The classification of joint congruency. (Reproduced, with modification, from: Yasunaga Y, Ikuta Y, Kanazawa T, Takahashi K, Hisatome T. The state of the articular cartilage at the time of surgery as an indication for rotational acetabular osteotomy. *J Bone Joint Surg Br.* 2001 Sep;83(7):1001-4. Reproduced with permission of The Licensor through PLSclear.) A: Excellent (the subchondral plates of the acetabulum and the femoral head are parallel, and the joint space is uniformly maintained). B: Good (the subchondral plates of the acetabulum and the femoral head are not parallel, but the joint space is maintained). C: Fair (partial narrowing of the joint space). D: Poor (minimal residual joint space).

Step 1: Incision

Position the incision on the lateral aspect of the hip.

- Place the patient in the lateral decubitus position with the extremity draped free on the table (Fig. 3).
- Begin the incision with a scalpel at the apex of the ilium and curve the incision downward and posteriorly to a distance of 4 cm distal to the base of the greater trochanter (Fig. 4).
- Elevate the skin flap subcutaneously and posteriorly with use of electrocautery (Fig. 5).

Fig. 3

Fig. 4

Fig. 5

Fig. 3 The position of the patient. The chest, back, and waist are fixed, but the pelvis is free because of the intraoperative radiographic confirmation.

Fig. 4 The skin incision for rotational acetabular osteotomy of the left hip.

Fig. 5 The skin flap is elevated in a posterior direction.

Step 2: Anterior Approach

Use the Smith-Petersen approach between the tensor fascia latae and the sartorius (Fig. 6).

- Identify and preserve the lateral femoral cutaneous nerve.
- Expose the origin of the rectus femoris and cut it.
- Elevate the anterior part of the gluteus medius subperiosteally from the iliac wing.
- Elevate the iliac muscle, and expose the bursa of the iliopsoas tendon and incise it (Fig. 7).
- Retract the iliopsoas tendon anteriorly and expose the ilipubic eminence at the site of the osteotomy of the pubic bone (Fig. 8).

Fig. 6

Fig. 7

Fig. 8

Fig. 6 The anterior approach between the tensor fascia latae and the sartorius.

Fig. 7 The bursa of the iliopsoas tendon is shown.

Fig. 8 The site of the osteotomy of the pubic bone (ilipubic eminence) is exposed.

Step 3: Posterior Approach

Use the conventional posterior approach.

- Divide the external rotator muscles from the greater trochanter.
- Expose the posterior wall of the acetabulum subperiosteally.
- Place Hohmann retractors at the greater sciatic notch and the most inferior part of the ischium (Fig. 9).
- Expose iliac bone under the gluteus medius subperiosteally.

Fig. 9

Fig. 9 The arrow shows the osteotomy line of the posterior wall of the acetabulum. A needle has been inserted in the joint.

Step 4: Decide on the Placement of the Osteotomy Line

Decide on the osteotomy line in the ilium and ischium, and cut the outer cortical bone of the ilium and ischium with an air drill.

- Identify the joint space below the anterior inferior iliac spine.
- Draw the osteotomy line from the anterior point at 1 and 1/2 finger breadths cephalad to the joint space to the mid-portion of the ilium posteriorly and horizontally under the gluteus medius (Fig. 10).
- At the posterior wall, draw the osteotomy line superiorly from the base of the ischium.
- At the greater sciatic notch, draw the osteotomy line at the point midway between the posterior joint space and the sciatic notch (Fig. 9).
- Ultimately, connect the anterior line and the posterior line under the gluteus medius.
- Arthroscopic evaluation of articular cartilage. The arthroscope (30° oblique) is inserted at the anterior capsule with leg traction by an assistant (Fig. 11).
- Cut the outer cortex of the ilium (Fig. 12) and ischium (Fig. 13) with an air drill along the osteotomy line.

Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 10 The osteotomy line at the anterior part of the ilium is shown.

Fig. 11 Arthroscopic evaluation of articular cartilage is shown.

Fig. 12 The outer cortical bone of the ilium is cut with an air drill.

Fig. 13 The outer cortical bone of the posterior wall of the acetabulum is cut with an air drill.

Step 5: Osteotomy

Cut the pubic bone independently, and cut the ilium and ischium in continuity and outside the joint capsule (Fig. 14).

- Cut the pubic bone at the iliopubic eminence with a flat osteotome.
- Cut the ilium from the anterior portion (Fig. 15) to the posterior wall and to the ischium (Fig. 16) with a curved osteotome.
- Pay careful attention to the sound of the hammer as it permits the surgeon to detect when the tip of the osteotome has reached the inner cortex of ilium because of previously cutting the outer cortex with an air drill, thereby avoiding too much penetration into the intrapelvic space and intra-articular osteotomy.

Fig. 14

Fig. 15

Fig. 16

Figs. 14-A and 14-B The osteotomy. **Fig. 14-A** The osteotomy line is shown (Reproduced from: Yasunaga Y, Ochi M, Terayama H, Ryuji T, Yamasaki T, Yoshimasa I. Rotational acetabular osteotomy for advanced osteoarthritis secondary to dysplasia of the hip. Surgical technique. J Bone Joint Surg Am. 2007 Sep;89 Suppl 2 Pt.2:246-55.) **Fig. 14-B** The chisel is inserted 30° caudally at the anterior part of the ilium and approximately perpendicularly at the posterior wall of the ilium.

Fig. 15 The osteotomy of the anterior part of the ilium is shown.

Fig. 16 The osteotomy of the posterior wall of the acetabulum and ischium is shown.

Step 6: Rotation of the Acetabulum

Rotate the acetabulum to provide a more horizontal weight-bearing area with a target of a 0° acetabular roof angle while returning the superiorly subluxated femoral head to a more normal position, and when medialization of the femoral head is needed, thin the intrapelvic portion of the rotated acetabulum and resect any excess bone from the pelvic side.

- Place the hook at the osteotomy site in the pubis and the osteotome at the osteotomy site in the anterior part of the ilium (Fig. 17) and abduct and externally rotate the hip, thereby facilitating rotation of the acetabulum in an anterolateral direction (Fig. 18).
- Harvest 1 or 2 trapezoidal bone grafts (2 cm wide by 3 cm long) from the outer cortex of the iliac wing, fill the space between the ilium and the newly repositioned acetabulum, and temporarily fix with a Kirschner wire.

Fig. 17

Fig. 18

Fig. 17 The manipulation of rotation of the acetabulum is shown.

Fig. 18 The acetabulum is rotated in an anterolateral direction.

Step 7: Fixation of the Acetabulum

Before fixation of the acetabulum, radiographically confirm the acetabular position and note that acetabular retroversion should be avoided for the prevention of femoroacetabular impingement.

- Secure the rotated acetabulum with 2 poly-L-lactic acid (PLLA) screws (Gunze) (Figs. 19 and 20).
- Pack bone chips in the space between the ilium and the rotated acetabulum.
- The operative time is usually from 90 to 120 minutes, and the bleeding loss is from 500 to 800 mL.
- Osteotomy, rotation of the acetabulum, and fixation are shown with a sham bone (Fig. 21).

Fig. 19

Fig. 20

Fig. 21

Fig. 19 The acetabulum is fixed with 2 poly-L-lactic acid (PLLA) screws.

Fig. 20 The postoperative radiograph shows that the coverage and position of the femoral head and the joint congruency are substantially improved compared with the preoperative radiograph in Figure 1.

Figs. 21-A, 21-B, and 21-C Osteotomy, rotation of the acetabulum, and fixation of the acetabulum with a sham bone. **Fig. 21-A** Anterior view. **Fig. 21-B** Lateral view. **Fig. 21-C** Posterior view.

Step 8: Postoperative Care

Allow the patient to use a wheelchair and touch-down weight-bearing as tolerated after 1 day of bed rest, and then advise the patient to start partial weight-bearing at 3 to 5 weeks and full weight-bearing at 4 to 6 months postoperatively.

- Neither postoperative traction nor cast immobilization is used.
- After 1 day of bed rest, the patient is allowed to use a wheelchair along with touch-down weight-bearing, as tolerated.
- Partial weight-bearing is begun at 3 to 5 weeks after surgery according to the state of articular cartilage evaluated with an arthroscope.
- Full weight-bearing is started 4 to 6 months after surgery, after resolution of the Trendelenburg sign.

Results

Between 1987 and 2001, we treated 21 patients (27 hips) with pre-osteoarthritis (the follow-up rate was 84%) and 110 patients (118 hips) who had early-stage osteoarthritis (the follow-up rate was 82%)⁵. The mean age at the time of surgery was 22 years in the pre-osteoarthritis group and 38 years in the early-stage group. The mean duration of follow-up was 21 years in the pre-osteoarthritis group and 20 years in the early-stage group.

Major complications such as necrosis of the acetabulum, intra-articular penetration by the osteotome, delayed union, and pulmonary embolism were not observed. Eight patients (9 hips) with early-stage osteoarthritis preoperatively underwent total hip arthroplasty at a mean duration of 20 years after rotational acetabular osteotomy. Radiographic indices were improved after surgery in both groups. Radiographic progression of osteoarthritis occurred in 24 patients (25 hips). Kaplan-Meier survivorship analysis, with radiographic signs of progression of osteoarthritis as the end point, predicted survival of 96% at 10 and 20 years in the pre-osteoarthritis group. For the early-stage group, survivorship was found to be 89% at 10 years and 78% at 20 years.

Pitfalls & Challenges

- Intra-articular perforation by the osteotome, which leads inevitably to the progression of osteoarthritis, should be avoided.
- Identify and preserve the lateral femoral cutaneous nerve to prevent lateral femoral cutaneous nerve palsy.
- Avoid malreduction (a deficiency or an excess of femoral head coverage).
- Intraoperative arthroscopic evaluation of articular cartilage, which we have done from 1994 to the present, is recommended because, even when the radiographic stage is early, grade-4 degeneration of the articular cartilage, according to the Outerbridge classification system, can be observed⁴. For these patients, partial weight-bearing should be started 5 weeks after surgery.
- Intra-articular treatments with multiple drillings at the acetabular fossa, which we have been using since 2001, are recommended when appropriate (Fig. 22-A). We have observed spontaneous medial and lateral extension of the subchondral bone of the acetabulum after rotational acetabular osteotomy, which suggests an enlargement of the weight-bearing area⁶. Multiple drillings at the acetabular fossa can induce early joint remodeling⁷. For patients with cartilaginous metaplasia and ossification at the acetabular fossa, this procedure is not necessary. In addition, intraoperative treatment with microfracture (Fig. 22-B), which we have used from 2008 to the present, for lesions with Outerbridge grade-4 degeneration of the articular cartilage can reduce the T2 mapping value after rotational acetabular osteotomy, which suggests the regeneration of cartilage (Fig. 23).

Fig. 22

Fig. 23

Figs. 22-A and 22-B Intra-articular treatment may include multiple drillings at the acetabular fossa (**Fig. 22-A**) or microfracture of the degenerated cartilage of the femoral head (**Fig. 22-B**).

Fig. 23 The mean T2 values (and standard deviation) of the articular cartilage of the femoral head in hips that were treated with microfracture for degenerated cartilage (Outerbridge grade 4). The T2 values decreased significantly at 6 months, 1 year, and 2 years after surgery compared with the preoperative values. Normal T2 value is 37 msec. *P < 0.05.

- The use of delayed gadolinium-enhanced magnetic resonance imaging (MRI)⁸, MR arthrography⁹, or T2 mapping MRI¹⁰ for the preoperative evaluation of articular cartilage provides a potentially more precise operative indication than plain radiographs.

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