

Total Hip Arthroplasty After Periacetabular Osteotomy

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abstract

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Patients with hip dysplasia often endure multiple surgical interventions, first in attempts to preserve their biologic hips and later for total hip arthroplasty (THA). Each different surgical approach traumatizes the musculoligamentous complex of the hip. These cumulative insults can significantly affect THA success.

We retrospectively reviewed 8 patients who underwent THA after previous periacetabular osteotomy via the same anterior approach. Acetabular bone stock required no augmentation for implant coverage. No complication occurred during surgery. All patients increased their functional score at last follow-up. No dislocation or implant loosening occurred. Leg length restoration was excellent.

Periacetabular osteotomy is a proven conservative procedure in dysplastic hips that can be realized through a Smith-Petersen incision. Restoration of the acetabular anatomy is achieved with limited muscle detachment. Good results have been achieved with periacetabular osteotomy; however, some patients develop increasing pain from progression of osteoarthritis and require a THA to allow relief of symptoms. The anterior-approach THA is a well-established procedure using the same Smith-Petersen interval as periacetabular osteotomy. Using this approach for both procedures optimizes the patient's immediate and ultimate functional recovery and hip stability. Instead of compromising subsequent THA, periacetabular osteotomy may improve THA results in dysplastic hips.

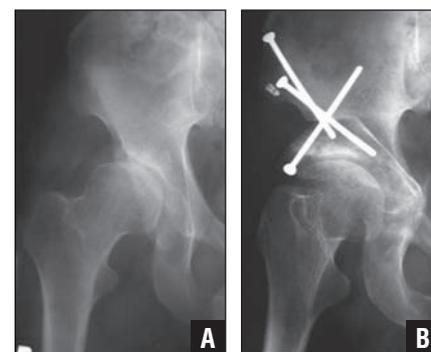


Figure:

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Drs Baqué, Brown, and Matta have no relevant financial relationships to disclose.

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Patients with hip dysplasia often endure multiple surgical interventions, first in attempts to preserve their biologic hips and later for total hip arthroplasty (THA). Each different surgical approach traumatizes the musculoligamentous complex of the hip. These cumulative insults can significantly affect the success of THA.

Periacetabular osteotomy is a proven conservative procedure in dysplastic hips that can be realized through a Smith-Petersen incision. Restoration of the acetabular anatomy is achieved with limited muscle detachment. Excellent clinical results can be achieved while also providing acetabular bone stock augmentation if future THA becomes necessary.

When a THA procedure is indicated for increasing pain or progression of osteoarthritis after periacetabular osteotomy, it is advantageous to use the same muscle-sparing approach. The anterior-approach THA is a well-established procedure using the same Smith-Petersen interval as periacetabular osteotomy. Using this approach for both procedures optimizes the patient's immediate and ultimate functional recovery and hip stability. Instead of compromising subsequent THAs, the periacetabular osteotomy may improve THA results in dysplastic hips, particularly if the Smith-Petersen interval is used for both procedures.

This study was designed to evaluate middle-term results and the technical aspects of anterior approach THA in patients with prior Smith-Petersen-approach periacetabular osteotomy.

MATERIALS AND METHODS

Beginning in 1987, the senior author (J.M.) performed periacetabular osteotomies on >250 patients for residual hip dysplasia. Patients who subsequently developed symptomatic osteoarthritis and presented requesting THA were retrospectively reviewed. Eight patients who had THA performed by the senior author after having a periacetabular osteotomy

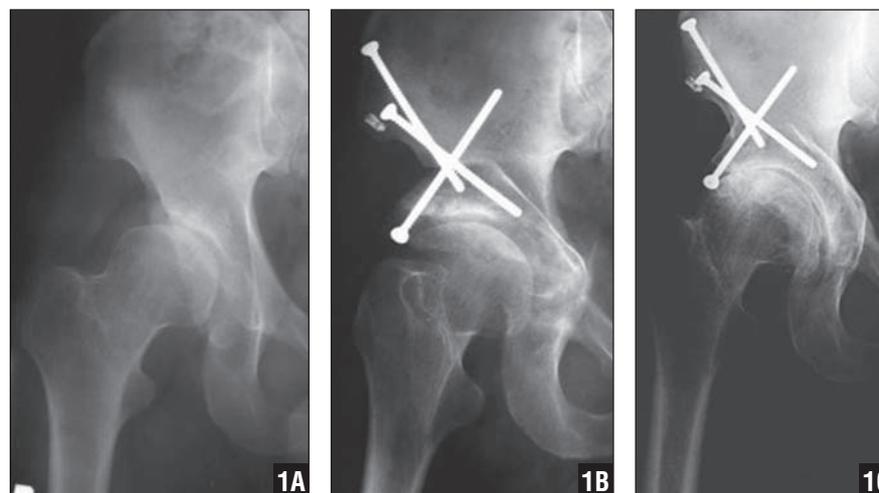


Figure 1:

were identified. All hip replacements were performed via the anterior approach described by Judet and Judet¹ and modified by the senior author.²

The study group comprised 3 men and 5 women with a mean height and weight of 168 cm (range, 155-180 cm) and 82 kg (range, 68-90 kg), respectively. Mean patient age at the time of periacetabular osteotomy was 45 years (range, 31-59 years). The average interval from periacetabular osteotomy to THA was 7.5 years (range, 1.2-13.9 years) and mean follow-up after THA was 2.3 years (range, 6 weeks to 5.1 years). The underlying diagnosis was acetabular dysplasia for all patients. Two patients had congenital dislocation, 1 was treated by reduction and cast before age 1, and 1 was treated by surgical open reduction in childhood. Another patient had previous surgery involving a femoral intertrochanteric osteotomy 1 year before his periacetabular osteotomy.

All periacetabular osteotomies and THAs were performed by the senior author using the Bernese technique³ with a Smith-Petersen approach for the periacetabular osteotomy and a muscle-sparing anterior approach for the THA using a portion of the same periacetabular osteotomy incision.⁴ The follow-up data were collected prospectively. All patients were

examined with radiographs annually after the periacetabular osteotomy or THA.⁴ The Merle d'Aubigné score was used for clinical analysis.⁵ Outcomes were categorized as excellent or good, fair, and poor. Patient satisfaction was determined by telephone interview and graded as very satisfied, satisfied, or not satisfied.

Radiological evaluation was undertaken with standardized AP and lateral hip radiographs. Radiographs taken preoperatively, immediately postoperatively, and at most recent follow-up were reviewed (Figure 1). The amount of correction for the 8 patients after periacetabular osteotomy was estimated from the THA preoperative radiographs by measuring the lateral center-edge angle of Wiberg,⁶ the acetabular index of the weight-bearing zone, and the anterior center-edge angle using the Lequesne false profile.⁷ The mean lateral center-edge angle was 40° (range, 24°-55°), the mean acetabular index of the weight-bearing zone was 9° (range, 3°-18°), and the mean anterior center-edge angle was 25° (15°-35°).

The mean lateral subluxation distance, measured between 2 parallel lines, the first through the ilioischial line and the second through the center of the femoral head, was 34 mm (range, 31-40 mm). Leg length discrepancy before THA was cal-

culated using preoperative radiographs by comparing the lesser trochanters. For pelvic reference the tear drop was not used because its anatomical position is changed by periacetabular osteotomy; instead we measured against a line drawn between the inferior points of the 2 sacroiliac joints. The severity of arthritis, defined by the classification of Tönnis and Brunken,⁸ was stage 3 in 6 patients and stage 2 in 2.

Hybrid prostheses were used in 3 cases (cemented stem and uncemented cup) and uncemented stem and cup prostheses were used in 5. Surgical duration and estimated blood loss were collected according to the operative report. The position of the implants was evaluated postoperatively and at last follow-up. The cup abduction was measured as an angle between the ischial line and the major diameter of the ellipse represented by the rim of the acetabular cup. The sine of the anteversion angle was calculated as the length of the transverse width of the center of the acetabular ellipse divided by the length of the major diameter. Lateral subluxation was measured from the center of the femoral head prosthesis and the ilioischial line.

Loosening of the THA stem at last follow-up was defined radiographically according to Engh et al.⁹ The acetabular components were evaluated for bone-prosthesis radiolucencies and osteolysis in the zones described by DeLee and Charnley.¹⁰ The acetabular component was radiographically considered to be loose if it had migrated >5 mm, tilted >10°, or demonstrated circumferential radiolucent lines. The wear of the implant and the mean femoral head penetration were not calculated in this study. Heterotopic ossification was classified according to Brooker et al.¹¹ Surgical time and estimated blood loss were recorded at the time of surgery and retrieved from the patient record.

Periacetabular osteotomies were performed as described by Ganz et al³ with the patient in the supine position on a radiolucent table. Fixation was usually achieved with 1 or 2 small fragment screws. THAs

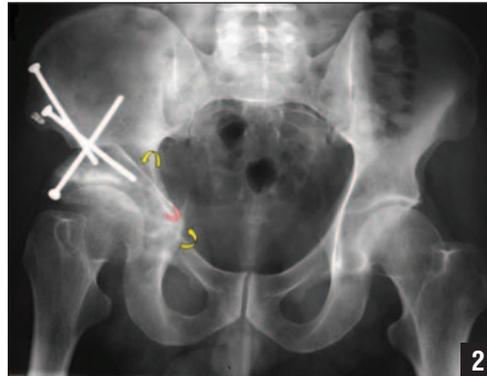
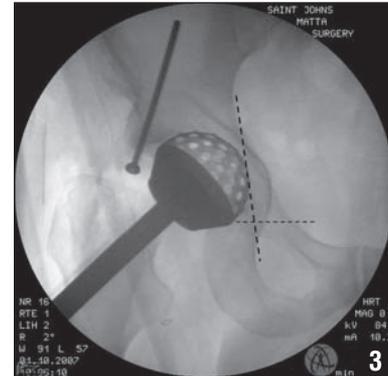


Figure 2:
Figure 3:



were performed using the senior author's standard technique for anterior-approach THA. The approach was a short Smith-Petersen, using the distal half of the previous incision for periacetabular osteotomy and occasionally extending distally.

The periacetabular osteotomy crest screws were routinely removed either percutaneously or through extension of the incision. After capsulotomy, the head was dislocated. Reaming was then done under fluoroscopic guidance in all patients. The dysplastic socket, even when reoriented, had a large radius of curvature and was dishlike. The surgeon should not attempt to match the radius or curvature of the prosthetic acetabulum to the native radius. Instead, a new hemisphere of lesser radius was reamed into the subchondral bone "dish."

In standard THA, visualization and/or palpation of the medial wall and inferior margin of the acetabulum are relied on for cup positioning. After periacetabular osteotomy, these major anatomic landmarks are changed. Indeed, the correction achieved by the periacetabular osteotomy is lateral and anterior rotation of the roof and anteversion of the whole socket. The center of rotation of the hip is moved more distal and medial. This changes the inferior margin of the acetabulum to a place more medial, proximal, and posterior than usual. Moreover, the medial wall of the acetabulum is tilted (Figure 2).

Using only these altered landmarks for reference in positioning the cup can lead

to errors. To avoid such errors, reaming of the acetabulum was done using image intensification. The radiographic landmark for medialization of reaming for preparation of the cup position was not the medial wall of the acetabulum, but the unaltered ilioischial line. The cup was kept lateral to the ilioischial line. Similarly, the inferior landmark for the cup was not the inferior margin (radiographic tear drop), but the superior extent of the obturator foramen, best referenced fluoroscopically in the AP view (Figure 3). Fluoroscopic guidance was also helpful to control the abduction angle and anteversion of the cup as the prosthesis was sequentially seated.

The femoral exposure was aided by the orthopedic table. Trial reduction was done once broaching was complete. The leg lengths and offset were compared intraoperatively using the image intensifier. In cases of dysplasia, the target leg length after THA could be the contralateral hip or the preoperative length of the operative hip. An image of the reference hip was obtained and printed. The operated reduced hip with trial component was then imaged and printed, and 2 two images were compared by overlying the transparencies (Figure 4). Once the trial components were chosen, they were removed, the femoral prosthesis was inserted, and the hip was reduced.

Patients were allowed weight bearing as tolerated immediately postoperatively, and there were no postoperative restrictions to movement or position. Walking with the

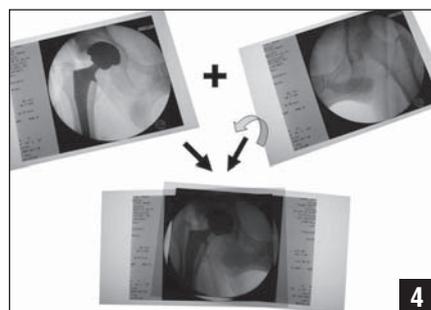


Figure 4:

aid of a crutch, cane, or walker was based on patient ability, and physical therapists instructed gait training and stair ambulation during each patient's hospital stay.

RESULTS

Clinical Results

The mean Merle d'Aubigné functional hip score was 17 ± 0.5 points (range, 14-18 points) at last follow-up vs 13.7 ± 4 points (range, 12-15 points) preoperatively (Wilcoxon rank test, $P < .001$). At last follow-up, 7 hips were rated excellent or good and 1 was rated fair. All patients were satisfied or very satisfied, according to subjective evaluation.

Radiographic Results

The mean abduction angle of the socket was $44^\circ \pm 4^\circ$ (range, 40° - 53°). The mean anteversion angle was at $26^\circ \pm 7^\circ$ (range, 14° - 34°). According to the study's criteria, no cup or stem was considered loosened at last follow-up. Leg-length discrepancy was 5 ± 4 mm (range, 1-11 mm) preoperatively. After THA, leg length restoration was excellent, with an average postoperative leg length discrepancy of 2 ± 1 mm (range, 0-3 mm). Stage 1 heterotopic calcification was present in 2 patients before hip replacement, and no progression occurred after THA. A cracked calcar was the only intraoperative complication that occurred. This healed without problems after 1 month of limited weight bearing. No cases of infection, hematoma, dislocation, or nerve dysfunction had occurred by last follow-up.

DISCUSSION

Periacetabular osteotomy was developed in the early and mid-1980s and was described in 1988 by Ganz et al.³ Many studies report good results with this technique for conservative treatment of dysplastic hips, especially in the early stages of arthrosis.¹² Periacetabular osteotomy allows acetabular reorientation in all necessary planes, including anterolateral coverage as well as medialization to improve hip joint mechanics.³ This technique, realized by a single anterior approach, leaves the posterior column intact and maintains a sufficient vascular supply to the acetabular fragment. It increases the bone stock anterolaterally, allowing improved coverage of the femoral head with hyaline cartilage. It restores the anatomy and the biomechanics of the hip while sparing the subchondral bone.

The goals of surgical treatment include medialization of the hip joint center and reorientation of the acetabulum to increase the deficient coverage of the femoral head. Ultimately this may provide more normal joint mechanics and prevent secondary osteoarthritis.^{4,13} Good results have been achieved with periacetabular osteotomy; however, some patients develop increasing pain from progression of osteoarthritis and require a THA to allow relief of symptoms. Periacetabular osteotomy allows restoration of head coverage in the dysplastic hip while maintaining anterior and posterior walls.³ This optimizes bone stock and facilitates later component placement and fixation of the THA. This circumferential bone restoration is an important predictive factor for socket fixation and durability.¹⁴

Few studies report the results of THA after periacetabular osteotomy. Ganz et al³ reported the results of 41 patients who had THA after periacetabular osteotomy, with a follow-up of 6 to 9 years.¹⁵ They reported that THA can be done safely in patients with a previous periacetabular osteotomy and should provide excellent results. In their study, THA was done

through a transtrochanteric or Hardinge approach. They report some complications such as dislocation, greater trochanter detachment, heterotopic ossification, and component loosening.

Our study had no dislocations or revisions after THA. No radiological signs of implant failure were present at last follow-up. All components were implanted in good bone and had good primary fixation and coverage. All periacetabular osteotomies were healed, and no bone grafting was necessary at the time of THA.

After the osteotomy heals, the radiographic anatomy of the hemipelvis is changed. The rotation of the acetabulum, when performed by the periacetabular osteotomy, causes elevation, medialization, and posterior rotation of the inferior margin of the acetabulum corresponding to the teardrop of the obturator foramen. These anatomical changes can alter the landmarks normally used for judging cup implantation height and medialization. Moreover, the medial wall of the acetabulum is tilted and medialized during rotation of the acetabulum. These changes increase the risk of excessive inclination of the cup.

The anterior approach as described by Judet and Judet¹ is performed in the supine position on the orthopedic table.² Direct visualization of the acetabulum and precise fluoroscopic control make accurate and secure cup placement possible. Fluoroscopy provides immediate information regarding acetabular position, including reaming depth and acetabular component positioning. Leg length equalization of the dysplastic THA is a challenge. Direct comparison of the operative hip with trial components and the nonoperative hip by overlying the 2 printed images is useful to adjust femoral length and offset before implantation of the prosthesis.

Multiple approaches around the hip are well known to compromise the function of THA.^{16,17} Musculotendinous integrity is essential for hip stability, strength, and flexibility. Scarring or disruption of these

structures can thereby contribute to dislocation, limping, and limitation of motion. Periacetabular osteotomy is done through a Smith-Petersen incision with minimal violation of the abductors and posterior soft tissues.⁴ By using the same anterior approach performing THA, new capsulo-ligamentous lesions that may compromise the hip prosthesis stability and gait are avoided. The dissection of scarred tissues does not raise particular difficulties because it is guided by the former muscular structures. Because periacetabular osteotomy is an extra-articular intervention, femoral head dislocation is not more difficult than normal.

Our retrospective study has inevitable weaknesses inherent to its small size and short duration of follow-up. Therefore, it is impossible to make conclusions about the survival of THA after periacetabular osteotomy. However, it is possible to support the idea that when THA becomes necessary, a previous periacetabular osteotomy can improve acetabular bone stock and facilitate replacement. It is likely that when both procedures use the same muscle-sparing approach, hip function is enhanced, risk of instability minimized, and results of THA in the dysplastic hip improved. Anterior-approach THA seems to be a particularly safe and reproducible

technique in cases of THA after periacetabular osteotomy because it facilitates accurate positioning of the implants and leg length restoration. Studies with sufficient population and follow-up are necessary to confirm these results. 

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