A Modified Periacetabular Osteotomy with Use of the Transtrochanteric Exposure

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Background: Periacetabular osteotomies are technically demanding surgical procedures. We developed a modified technique that uses a transtrochanteric approach. Our goal was to facilitate surgical exposure without compromising the results of surgery. The purpose of the present study was to review the early results in our initial group of patients who had this procedure.

Methods: We retrospectively reviewed the results of a modified periacetabular osteotomy in thirty-eight consecutive patients (forty-six hips) at an average duration of follow-up of 4.2 years. The average age of the patients was thirty-one years (range, eighteen to fifty-eight years) at the time of surgery. We evaluated the results with use of serial radiographs and the Merle d'Aubigné and Postel hip-scoring system.

Results: All osteotomies healed. Preoperatively, the average lateral center-edge angle was 3° (range, –15° to 12°), the anterior center-edge angle was 0° (range, –20° to 5°), the acetabular angle of Sharp was 57° (range, 50° to 68°), and the femoral head coverage was 53% (range, 40% to 66%). Postoperatively, the average lateral center-edge angle was 35° (range, 23° to 45°), the anterior center-edge angle was 32° (range, 20° to 55°), the acetabular angle of Sharp was 40° (range, 37° to 45°), and the femoral head coverage was 92% (range, 85% to 100%). The average amount of medialization of the femoral head was 6 mm. At the latest follow-up examination, improvement in the grade of osteoarthritis was noted in eight hips, while progression of osteoarthritis was seen in five hips. Functionally, the average Merle d'Aubigné and Postel hip score improved from 13.2 points preoperatively to 17.0 points postoperatively. No patient had a neurovascular complication.

Conclusion: Our early experience with a modified periacetabular osteotomy showed encouraging results in terms of the technical ease of the technique and the outcome in our patients.

Level of Evidence: Therapeutic study, Level IV (case series [no, or historical, control group]). See Instructions to Authors for a complete description of levels of evidence.

The rationale for performing a periacetabular osteotomy in the treatment of adult hip dysplasia is to reposition the dysplastic acetabulum into a more anatomic orientation and thus prevent the need for total hip arthroplasty in these relatively young patients. In 1984, Ninomiya and Tagawa[1] reported their experience with rotational acetabular osteotomy in skeletally mature patients with symptomatic hip dysplasia. Their procedure was a modification of the circumacetabular osteotomies described by Eppright[2] and by Wagner[3]. While the results reported by Ninomiya and Tagawa were satisfactory[1,4], the design of the osteotomy tended to leave the teardrop in its original position and technical errors such as intra-articular penetration or osteonecrosis of the acetabular fragment have raised concerns about the difficulty of performing this procedure well in a consistent manner[5].

The Bernese periacetabular osteotomy has become popular since it was first described by Ganz et al.[6], in 1988, and several authors have reported encouraging results[7-10]. However, it is a technically demanding procedure. The polygonal shape of the osteotomy can create osseous gaps when the fragment is repositioned, especially when a large correction is needed[11,12]. Also, the classic Smith-Petersen exposure originally used by Ganz et al. carries a high risk of postoperative abductor weakness[13]. Although the use of the modified Smith-Peterson exposure, the ilioinguinal exposure, and, recently, the direct anterior exposure to spare the abductor dissection have been proposed, we believe that these approaches are still difficult and that surgical exposure can be improved with an alternative approach[13,14].

To improve exposure, we modified the techniques described by Ninomiya and Tagawa[1] and Ganz et al.[6]. We now propose the use of a transtrochanteric approach because it provides a sufficiently wide exposure to the osteotomy sites and because it is a familiar approach used by most orthopaedic surgeons. Our goal was to adhere to the basic principles of adequate repositioning of the dysplastic acetabulum while avoiding or minimizing the known complications of the rotational acetabular osteotomy.

Materials and Methods

Forty-six hips in thirty-eight consecutive adult patients with hip dysplasia were treated with use of this method at our institution and were followed for an average of 4.2 years (range, twenty-four to sixty months). The average age of the patients at the time of surgery was thirty-one years (range, eighteen to fifty-eight years). There were thirty women and eight men.

The indication for the procedure was progressive hip pain in adult patients with early or moderate osteoarthritis secondary to dysplasia. All patients had pain in the involved hips, especially after walking a long distance. Most patients had a limp of varying severity and frequency. We considered advanced osteoarthritic change to be a contraindication to this procedure. We also excluded hips with a false acetabulum or with a severe deformity of the femoral head that precluded a congruent correction with a periacetabular osteotomy.

Four radiographic indices were used to evaluate the preoperative and postoperative anteroposterior radiographs. They were the lateral center-edge angle of Wiberg[15] (normal, >25°), the acetabular angle of Sharp[16] (normal, <42°), the percentage of femoral head coverage[17] (normal, >75%), and medialization of the femoral head as measured by the change in the distance between the symphysis pubis and the medial border of the femoral head. In addition, we recorded the relationship of the femoral head to the Shenton line, the anterior center-edge angle (normal, >20°) of Lequesne and de Seze[18], and the severity of hip arthritis according to the classification of Tönnis[19].

The clinical outcome was assessed preoperatively and at the latest follow-up examination with use of the scoring system of Merle d'Aubigné and Postel for the evaluation of pain, walking ability, and range of motion[20]. The radiographic and clinical results were evaluated by an independent observer (P.-C.L.) who was not involved in the index surgery.

Surgical Technique

After general anesthesia has been administered, the patient is placed in the lateral decubitus position. The involved leg is prepared and freely draped so that it can be mobilized during the procedure. A lateral skin incision is made 10 cm proximal to the tip of the greater trochanter and is carried distally along the longitudinal axis of the femur, ending at the base of the greater trochanter. After dividing the fascia lata in a straight midlateral line along the entire length of the skin incision, the anterior and the posterior borders of the gluteus medius are identified at its insertion into the greater trochanter. A peri-

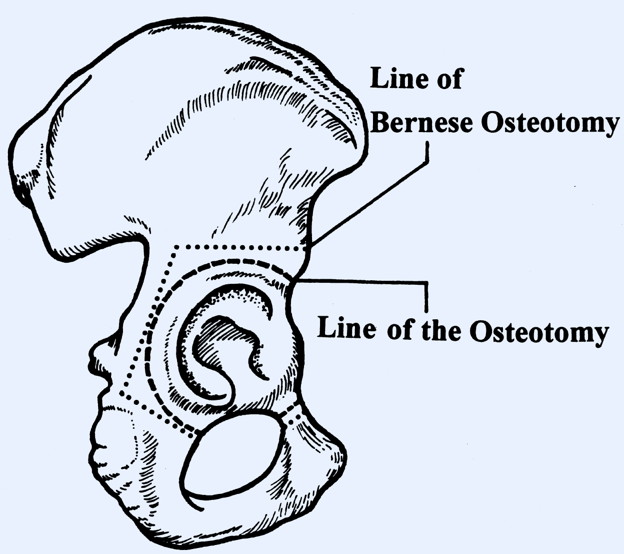

Fig. 1-A

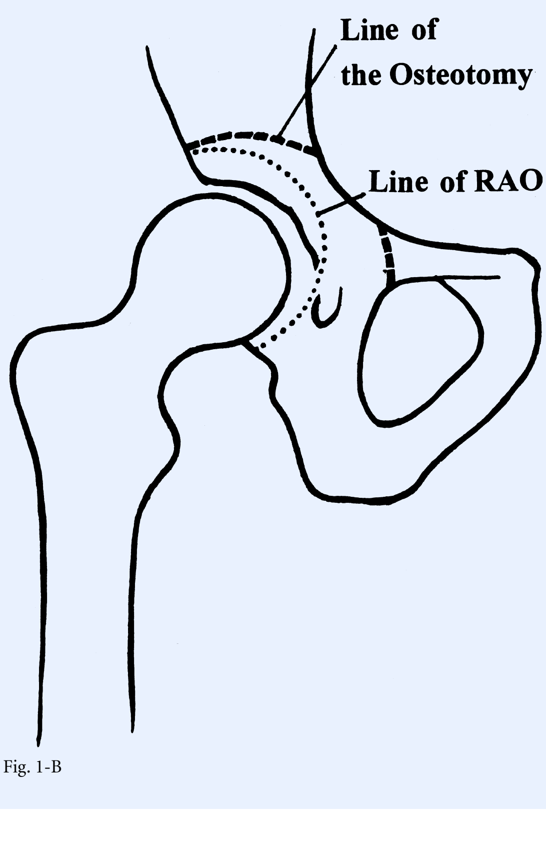

Fig. 1-B

Diagrams showing the lateral (Fig. 1-A) and anterior aspects (Fig. 1-B) of the modified periacetabular osteotomy. Note the differences between this osteotomy and the Bernese osteotomy and the rotational acetabular osteotomy (RAO).

osteal elevator is placed between the gluteus medius and minimus muscles and the joint capsule to allow extracapsular dissection. The greater trochanter is osteotomized with use of a Gigli saw and is reflected upward with the attached gluteus medius and minimus muscles. The osteotomy should end 0.5 cm proximal to the vastus lateralis ridge so that detachment of the vastus muscle is not required.

To free the joint capsule from the osteotomized trochanter, the piriformis and the proximal part of the conjoined tendon of the short external rotators are divided. Only the proximal part of the short external rotators should be dissected to prevent injury to the medial femoral circumflex artery, which is the main blood supply of the femoral head. The anterior, superior, and posterosuperior aspects of the capsule are then visualized. At this time, a T-shaped capsulotomy is always made, first, by a longitudinal incision in the anterolateral aspect of the joint capsule and, second, by a transverse incision along the acetabular rim. The flaps are retracted for direct inspection of the joint.

To proceed with the anterior exposure, the reflected head of the rectus femoris muscle is detached from the joint capsule to expose the anterior rim of the acetabulum. Through the plane between the iliocapsularis muscle, which is adherent to the anterior part of the capsule, and the psoas muscle, one can palpate bone medially and distally to the level of the base of the superior pubic ramus. Blunt dissection is performed deep to the rectus femoris and iliopsoas muscles to avoid injury to the neurovascular bundle that lies anterior to the iliopsoas. This dissection is made easier if the hip is flexed.

With use of a curved osteotome, the osteotomy is begun at the superolateral portion of the ilium, 1.5 cm from the acetabular ridge. We extend the osteotomy anteriorly and posteriorly around the circumference of the acetabulum (Figs. 1-A and 1-B). Our method differs from the rotational acetabular osteotomy described by Ninomiya and Tagawa[1] in that it penetrates the inner pelvic table rather than the medial part of the acetabular wall. Thus, the risk of creating an intra-articular osteotomy is virtually eliminated. In addition, we create a larger acetabular fragment that includes the inner pelvic table, decreasing the potential complication of osteonecrosis.

After the osteotomy of the ilium and the ischium is completed, the fragment is connected to the pelvis only at the pubis. The osteotomy at the base of the superior pubic ramus is made easier with the leg flexed. It is safe to perform the pubic osteotomy through the plane between the flexor muscles and the joint capsule, and the location and the direction of the pubic osteotomy can be confirmed with an intraoperative anteroposterior radiograph.

When the osteotomy is completed, the surgeon controls the fragment with a bone hook to redirect the acetabulum. The main corrective displacement is by anterior and lateral rotation, but the fragment can also be shifted more medially (Fig. 2). Because the fragment is smooth and round, the correction is usually obtained without creating gaps at the osteotomy site.

After temporary fixation of the site of the osteotomy with two Kirschner wires, the range of motion of the hip is tested. A radiograph is always made to confirm the amount of correction. The fragment is fixed to the ilium with three or four 3.5-mm cortical screws. The freed greater trochanter is then reduced and stabilized with two 6.5-mm cancellous screws. The joint capsule, the origin of the rectus femoris muscle, and the short external rotators are repaired. Suction drains are placed anterior and posterior to the capsule.

Postoperative Care

As no cast is required, active range-of-motion exercises are begun immediately. The patient is managed with use of crutches and partial weight-bearing after the pain has subsided, usually on the fourth or fifth postoperative day. After six weeks, the patient is allowed to walk with one cane. The cane is usually discarded three months postoperatively when osseous healing is evident radiographically. We do not use indomethacin for prophylaxis against heterotopic bone formation.

Results

For the forty-six procedures, the average operative time, including postoperative plain radiographic imaging, was 3.3 hours and the average blood loss was 700 mL. Labral lesions were found in one-third of the hips. These included a torn labrum in eight hips, an intra-articular ganglion in five hips, and a separated bone fragment, or os acetabuli, in two. All of the unstable tissues were excised.

The osteotomies of the pelvis and greater trochanter healed in all of the patients. The preoperative and postopera-

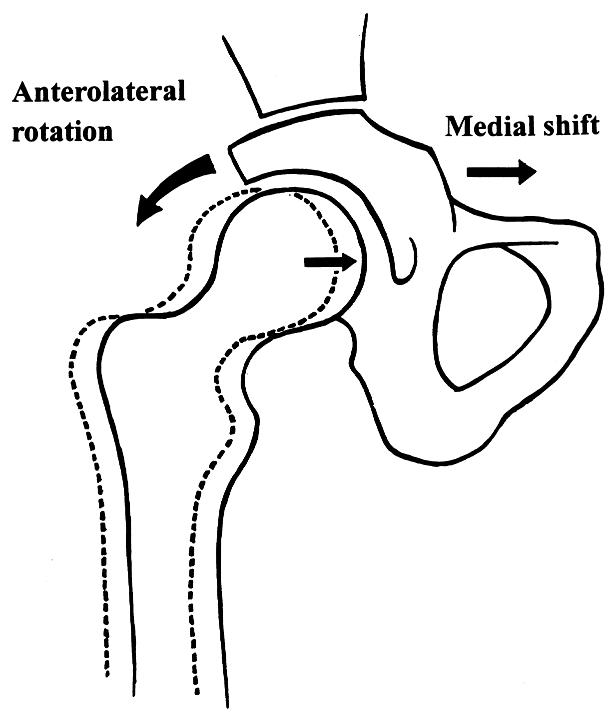

Fig. 2

Diagram showing the corrective displacement. The acetabular fragment should be rotated anterolaterally. Sometimes a medial shift is required.

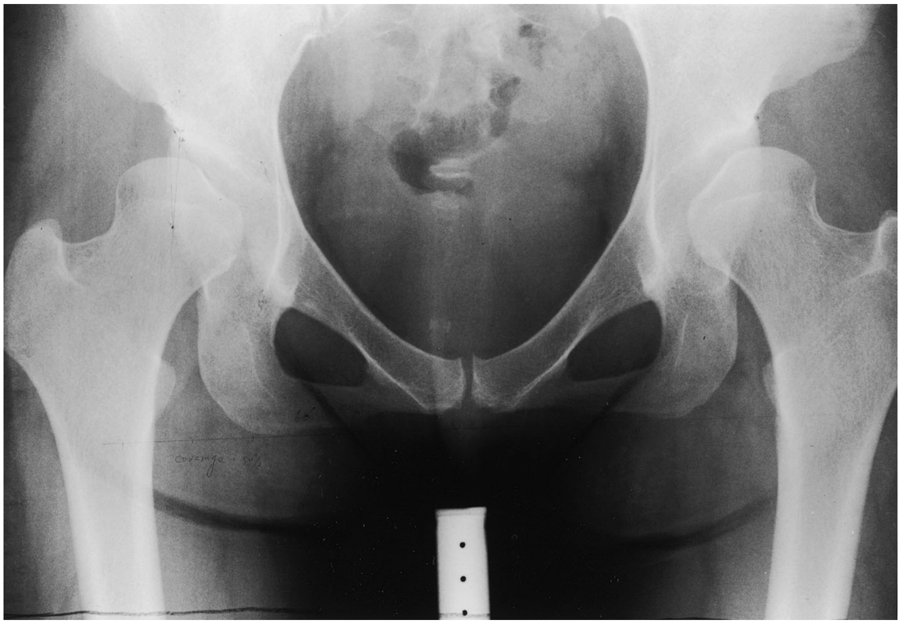

Fig. 3-A

Figs. 3-A, 3-B, and 3-C A twenty-six-year-old woman who had painful dysplastic hips. **Fig. 3-A** Preoperative anteroposterior radiograph.

Fig. 3-B

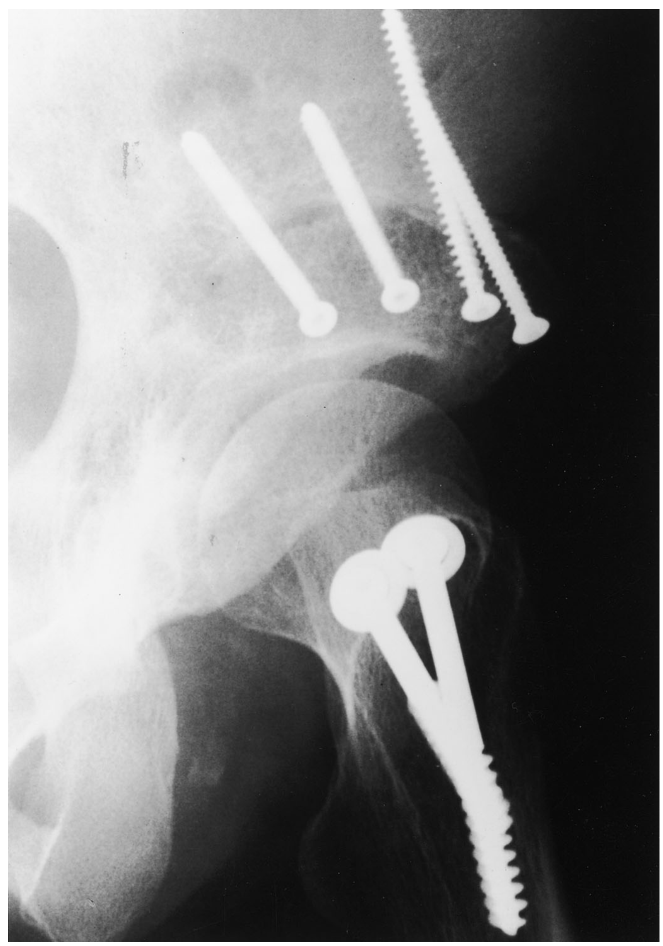

Fig. 3-C

Anteroposterior (Fig. 3-B) and lateral (Fig. 3-C) radiographs of the left hip made four years after the periacetabular osteotomy, showing solid osseous union and good joint congruity as well as good lateral and anterior coverage of the femoral head.

TABLE I Radiographic Results for the Forty-six Hips

Radiographic Parameters	Preoperative	Postoperative
Lateral center-edge angle* *(deg)*	3 (–15-12)	35 (23-45)
Anterior center-edge angle* *(deg)*	0 (–20-5)	32 (20-55)
Acetabular angle of Sharp* *(deg)*	57 (50-68)	40 (37-45)
Femoral head coverage* *(%)*	53 (40-66)	92 (85-100)
Medialization of femoral head*† *(mm)*	91 (82-95)	85 (78-92)
No. *(%)* of hips with an intact Shenton line	12 (26)	40 (87)

*The values are given as the mean, with the range in parentheses. †Measured as the distance between the symphysis pubis and the medial border of the femoral head.

TABLE II Grades of Osteoarthritis, According to the Classification System of Tönnis[19], in the Forty-six Hips*

	Grade 0	Grade 1	Grade 2	Grade 3
Preoperative grade	12 (26%)	30 (65%)	4 (9%)	0
Postoperative grade	16 (35%)	26 (57%)	3 (6%)	1 (2%)

*Grade 0 indicates no evidence of osteoarthritis; Grade 1, sclerosis of the femoral head or the acetabulum with slight narrowing of the joint space; Grade 2, the presence of small cysts in the femoral head or the acetabulum with moderate loss of the joint space; Grade 3, the presence of large cysts in the femoral head or the acetabulum with severe narrowing or obliteration of the joint space, with or without deformity of the femoral head.

tive radiographic measurements are shown in Table I. On the average, the femoral head was medialized 6 mm (range, 0 to 11 mm) (Figs. 3-A, 3-B, and 3-C).

The preoperative and postoperative grades of osteoarthritis according to the classification system of Tönnis are shown in Table II. Eight hips had improvement in the grade of osteoarthritis. Five hips had osteoarthritic progression, with a change from Grade 0 to Grade 1 in two hips, from Grade 1 to Grade 2 in two hips, and from Grade 2 to grade 3 in one hip.

Functionally, the most impressive finding was the relief of pain. No patient in this series required pain medication at three months after the operation. Overall, there was a slight decrease in the range of hip motion. The range of hip flexion was reduced from a preoperative mean of 121° (range, 100° to 130°) to a postoperative mean of 116° (range, 95° to 120°). Hip abduction was reduced from a preoperative mean of 38° (range, 30° to 50°) to a postoperative mean of 32° (range, 30° to 50°). The average Merle d'Aubigné and Postel hip score improved from 13.2 points (range, 10 to 15 points) preoperatively to 17.0 points (range, 15 to 18 points) postoperatively (Table III). Most, but not all, patients had no limp.

No patient had an injury to the great vessels or major nerves. Dysfunction of the lateral femoral cutaneous nerve, which is a frequent complication of other surgical approaches[13], was not seen in our series. There was no infection, deep-vein thrombosis, or heterotopic bone formation. The only complication was a symptomatic, but reducible, groin hernia that occurred three months after the operation in an obese female patient. The cause of this unusual occurrence was thought to be excessive anterior dissection that weakened the transverse abdominal muscle at the iliopubic tract.

TABLE III Clinical Results, According to the Scoring System of Merle d'Aubigné and Postel[20], at 4.2 Years After the Operation

Clinical Evaluation	Preoperative*	Postoperative*
Total score *(points)*	13.2 (10-15)	17.0 (15-18)
Pain	3.2 (2-5)	5.8 (5-6)
Walking ability	4.4 (3-6)	5.9 (5-6)
Range of motion *(deg)*	5.6 (5-6)	5.4 (4-6)
Flexion	121 (100-130)	116 (95-120)
Abduction	38 (30-50)	32 (30-50)

*The values are given as the mean, with the range in parentheses.

Discussion

The goal of periacetabular osteotomy is to achieve optimal coverage of the femoral head and optimal congruency of the hip joint by reorienting the acetabulum. The Bernese osteotomy and the rotational acetabular osteotomy are two specially designed techniques that are capable of correcting the anatomic deformity of the dysplastic acetabulum. However, they are technically demanding procedures, and a slow rate of mastery has been reported in association with both[1,6,8,11,12]. Our goal was to modify these procedures and use an easier approach, the transtrochanteric exposure, to provide a safe and easy exposure. With our osteotomy, the osseous cuts are near the acetabulum so that a large correction in the acetabular orientation is achieved without altering the shape of the true pelvis, a benefit that allows young female patients to have a normal delivery of a baby. In addition, maintaining the continuity of the posterior column offers reliable stability of the pelvis for fixation of the fragment. Therefore, early postoperative mobilization is allowed without adverse effects on osseous union.

Our osteotomy is spherical in shape, which is similar to the design of the rotational acetabular osteotomy[1]. The smooth, rounded surface allows easy mobilization of the fragment in all directions without impingement, and it provides a large area of contact that results in rapid and predictable bone-healing. In contrast, the polygonal shape of the Bernese osteotomy can result in large gaps, especially when a large corrective displacement is required. Furthermore, nonunion or delayed union has been reported in other studies involving the Bernese osteotomy[6,8,11,12].

The rotational acetabular osteotomy described by Ninomiya and Tagawa uses osseous cuts around the joint capsule and leaves the teardrop in continuity with the pelvis, making the osteotomy intra-articular. As a result, injury to the intra-articular structures has been a serious complication[1]. To avoid producing an intra-articular osteotomy, we create a larger fragment by penetrating the inner pelvic wall.

Osteonecrosis is another potential complication of the rotational acetabular osteotomy[1,4-6]. The acetabulum is supplied superiorly by the superior gluteal artery, posteroinferiorly by the inferior gluteal artery, and medially and anteriorly by the obturator artery[21,22]. By leaving the teardrop in its original position, the rotational acetabular osteotomy may compromise the acetabular blood supply except for that coming from the capsule. Ninomiya indicated that osteonecrosis of the acetabular fragment could occur when the fragment was too thin[4]. Itokazu et al. showed that, to avoid development of osteonecrosis after the rotational acetabular osteotomy, it is important to preserve the acetabular branch of the obturator artery, which supplies the acetabulum through the acetabular notch[22].

We observed bleeding from the acetabular fragment in all of the hips at the time of surgery, and none have had osteonecrosis of the osteotomized fragment. We believe that osteonecrosis was avoided because of the thickness of the acetabular fragment and because the attached blood supply of the inner pelvic table was maintained. Also, there was no dissection from within the pelvis, which is associated with a risk of injury to the blood supply. Furthermore, because a reliable blood supply to the acetabular fragment is preserved at the time of the osteotomy, a simultaneous arthrotomy can be performed without devascularizing the fragment.

Currently, many centers prefer to perform the periacetabular osteotomy with use of a modified Smith-Petersen approach to minimize abductor dissection[6-8,10,13]. A high rate of injury to the lateral femoral cutaneous nerve and a cosmetically unacceptable scar are common problems with this approach[12,13]. Alternatively, the ilioinguinal exposure has been used to decrease abductor morbidity[13]. However, this exposure is associated with other problems, e.g., it makes the assessment of intra-articular disease difficult, increases the likelihood of vascular injury, requires a longer operative time, and makes manipulation of the fragment difficult[12,13]. The direct anterior exposure advocated by Murphy and Millis is also an abductor-sparing approach[14]. The main concern, however, is the vulnerability of the femoral nerve when dissection proceeds medial to the iliopsoas muscle. In one report, two of five patients in whom the direct anterior exposure was used sustained femoral nerve palsies[13]. Importantly, these surgical exposures are all anterior approaches so that the ischial osteotomy must be performed blindly, requiring extensive anatomic knowledge and experience[9].

The transtrochanteric approach through a single lateral incision, which was used in the present series, has several advantages. First, it is a familiar technique to most orthopaedic surgeons and provides sufficient exposure, including the posterior column of the hemipelvis. Second, the periacetabular osteotomy can be done from outside the pelvis with no more dissection of important structures than is absolutely necessary. Third, there is no change in the length of the abductors, and the abductor mechanism can be securely restored by bone-to-bone healing. Finally, this approach allows for an arthrotomy of the hip joint to directly assess the intra-articular disease, which has been considered an important cause of residual symptoms[23].

Complications of trochanteric osteotomy include increased operative trauma, blood loss, and bursitis, but the most commonly noted serious complication is nonunion[24-26]. This complication is frequently seen in patients following total hip replacement when the blood supply in the trochanteric area has been altered by the insertion of a femoral stem and the osteotomized trochanter can only be fixed by cable systems or wires[27]. In our patients, however, fixation was performed with two cancellous screws and bone-healing was uneventful in all of them.

Although a comparison of our preliminary results with the long-term outcome after other procedures is beyond the scope of this study[1-10,14,28,29], we showed that this technique is capable of achieving excellent correction of the dysplastic acetabulum and good initial clinical results with a very low rate of complications.

In conclusion, an ideal technique of periacetabular osteotomy for the treatment of hip dysplasia in adults should be safe and easy to perform, provide reliable stability and predictable correction with use of a minimum of postoperative external support, allow the surgeon to address the intra-articular abnormality, and have a low prevalence of complications. Our early experience with the modified osteotomy with use of the transtrochanteric exposure seems to fulfill all of these requirements. We emphasize that this is a study of our initial patients who were managed with the technique, and it demonstrates the technical ease and reproducibility of this modified method. Further study is obviously necessary to determine the long-term efficacy of the procedure in preventing the onset of secondary osteoarthritic changes and to compare our method with other reconstructive procedures for residual dysplasia in the adult hip. ■

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