Total Hip Arthroplasty With Shortening Osteotomy in Congenital Major Hip Dislocation Sequelae

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**abstract**

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We retrospectively evaluated the postoperative results of total hip arthroplasty (THA) in patients presenting with Crowe group IV dislocated hips. Overall, results were compared with regard to the type of osteotomy performed (Z or oblique) to define the correct indications for surgical technique and choice of prosthetic implant. Thirty-three subtrochanteric shortening and derotational osteotomies in primary THA were performed in 26 patients secondary to congenital hip dislocation. A Z osteotomy was performed in 14 cases and an oblique osteotomy in 19. The surgical approach was direct lateral, and surgery was aimed at restoring the anatomic hip center. Femoral and acetabular fixation was uncemented. The most used stem was the S-ROM (DePuy, Leeds, United Kingdom), and the couplings used were ceramic-ceramic (7 cases), ceramic-polyethylene (3 cases), metal-polyethylene (15 cases), and metal-metal (3 cases). Mean follow-up was 88±45 months. According to the Merle D’Aubigné score, the overall clinical results were good in 23 cases, satisfactory in 6, and fair in 4. Union of the osteotomy occurred in 97% of cases, and the mean time required for osteotomy union was 6±2 months without significant differences between Z and oblique osteotomies.

At last follow-up, there was loosening of 1 cup and 1 stem, and revision was necessary. Twelve percent of patients experienced postoperative dislocation and 9% developed neuropraxia of the femoral nerve. The clinical and radiological results were similar in both groups, with a high rate of pain relief, an improvement in limb-length discrepancy, and reduced limping, leading to a smaller or no insole. Currently, the more complex Z osteotomy has been abandoned, because a modular stem prosthesis with metaphyseal sleeve allows the oblique osteotomy to be used with an easier and shorter surgical procedure.

Figure: Radiograph at 3 months after THA and oblique subtrochanteric osteotomy.
Many patients with untreated high developmental hip dislocation require hip replacement surgery, especially in the fourth and fifth decades of life. Total hip arthroplasty (THA) in these patients is a technically demanding operation because of associated anatomic abnormalities. The true acetabulum is hypoplastic and usually deficient anteriorly, laterally, and superiorly, thus making it difficult to obtain sufficient bony coverage of the cup; acetabular bone density is often low because of the lack of stress remodeling; the femoral canal is narrower, and the femur commonly has excessive anteversion and a valgus neck-shaft angle and a posterior location of the greater trochanter; and the leg is shortened and soft tissues surrounding the joint are frequently contracted because of the chronicity of the dislocation.

The literature suggests that the best results are achieved when THA is performed to bring the center of rotation to the level of the true acetabulum, and the rotational deformities of the femur are compensated. Several techniques could be used to allow joint replacement: THA and lengthening the leg in a single stage (leg lengthening should be kept to < 4 cm to avoid neurological complications); lowering and THA in 2 stages with external fixation or skeletal traction; and lowering and THA in 1 stage with shortening osteotomy. Femoral shortening osteotomy was described by Klisic and Jankovic and adapted by Sponseller and McBeath to include simultaneous THA. Different subtrochanteric osteotomy geometries for leg lengthening and THA, including transverse, oblique, Z, and chevron shapes, can be used.

Total hip arthroplasty and cup positioning in the true acetabulum in a single stage allows the correction of the femoral axis and a rational recovery of the limb-length discrepancy, with reduced risk of infection in comparison with procedures that use trans-skeletal Kirschner wires or external fixation systems.

This article describes our experience in lowering and THA in major hip dysplasia by single-stage metaphyseal shortening osteotomy, and the overall results are compared with regard to the type of osteotomy performed (Z or oblique) to define the correct indications for surgical technique and choice of prosthetic implant. Another aim of this study was to understand if it was possible to obtain the same good results by a simpler surgical technique (oblique osteotomy) than the more complex Z osteotomy.

**MATERIALS AND METHODS**

From 1990 to 2004, we performed 33 subtrochanteric shortening and derotational osteotomies in primary THA in 26 patients (7 bilateral) secondary to congenital hip dislocation. The study group comprised 20 women and 6 men with a mean age at surgery of 52 ± 10 years (range, 34-66 years). All cases were type IV according to Crowe’s classification. The indications for THA were severe pain and/or considerable difficulty with walking and performing activities of daily living.

**Clinical Evaluation**

The patients were reviewed with regard to correction of the center of rotation and limb-length recovery, osteotomy healing, component loosening or dislocation, pre- and postoperative pain, limp, and range of motion according to the Merle D’Aubigné classification modified by Charnley. This scoring method includes an evaluation of pain, ability to walk, and mobility, with each parameter scored on a scale from 1 (pain, severe also at rest; walking, impossible; mobility, flexion < 15°) to 6 points (pain, absent; walking, normal; mobility, flexion > 90°, abduction > 15°). Pre- and postoperative leg length was measured clinically with the patient standing using a spacer block under the shorter extremity and verifying the level of the iliac crest by palpation. In addition, the height of the iliose used preoperatively was also evaluated by comparing it with the one that was sometimes used postoperatively.

Mean follow-up was 88 ± 45 months (range, 26-183 months).

**Radiographic Evaluation**

The patients were assessed preoperatively by standard anteroposterior (AP) and lateral radiographs of the pelvis and hip, lumbosacral spine, and lower limbs. The pelvis and femur were scanned by computed tomography (CT) to assess the total discrepancy between the 2 limbs and the rise of the femoral epiphysis, the torsion axis and diameter of the femoral diaphysis, and the depth, thickness, and medialization of the true acetabulum. The rise of the epiphysis was defined as the distance between the center of the femoral epiphysis and the center of the true acetabulum; this allowed measurement of the amount of lengthening required to bring the center of rotation back to the anatomic acetabulum. Thus the extent of lowering to bring the center of rotation back to its native site could be found.

The radiographic results of the hip prosthesis were assessed using the Gruen method and the DeLee method for the stem and cup, respectively. Osteotomy healing was assessed using postoperative radiographs at 6 weeks and 3, 6, and 12 months. Criteria for union of the osteotomy included callus and no pain at the osteotomy site; restoration of cortical continuity between proximal and distal fragments on the AP or lateral radiograph, and no progressive migration or gapping at the osteotomy site on serial radiographs.

Heterotopic ossification was evaluated according to the Brooker classification.

**SURGICAL TECHNIQUE**

The surgical approach to the hip was direct lateral in all cases. Surgery was aimed at restoring the anatomic hip center.

The elongated hypertrophic joint capsule was resected, and the small fibrous fatty tissue-filled acetabulum was identified. The abductor muscles were left un-
touched, the piriformis tendon was sectioned, and the psoas tendon was partially released. The fibers of the gluteal muscles were released proximally and their direction was changed to become more vertical, thus facilitating surgery. The true acetabulum was exposed and its bone stock was evaluated. If the true acetabulum was insufficient, a new acetabulum was created around the rudimentary original one.

If the estimated cup coverage was between 60% and 80%, structural autografting from the resected femoral head was performed. If cup coverage was <60%, the so-called cotyloplasty technique was used in combination with autologous grafting to reduce the area of cup supported by the structural graft. When necessary, we used screws to increase cup stability. If cup coverage was <40%, we used a cup with iliac fixation combined with autologous grafting. Cotyloplasty, when performed, was done by using patient femoral epiphysis or (when autologous tissue is not available) an epiphysis from the bone bank.

When the femoral neck sections were low, trochanteroplasty was often performed to avoid impingement between the trochanter and iliac wing. In particular, part of the posterior part of the greater trochanter or occasionally part of the anterior part of the greater trochanter was resected. In some cases, some of the lesser trochanter had to be removed, as it was too big. This did not influence walking or the Trendelenburg sign mainly because the gluteal muscles were always carefully reconstructed.

In all cases, acetabular fixation was uncemented. Oblique (n=19) (Figure 1) or Z (n=14) (Figure 2) subtrochanteric shortening and derotational osteotomy was performed. In all cases, femoral fixation was uncemented. Laxity of the vastus lateralis, due to the femoral shortening osteotomy, was corrected by advancing the posterior half of the muscle to a more proximal insertion in the region of the greater trochanter.

Statistical analysis was performed using SPSS version 12.1 software (SPSS, Inc, Chicago, Illinois). Data are reported as mean±standard deviation at a significance level of \(P<.05\). Student \(t\) test was performed to verify significant differences between the Merle D’Aubigné parameters.

**RESULTS**
**Correction of the Center of Rotation and Recovery of the Discrepancy**

In the 33 cases studied, the mean epiphyseal proximal migration was \(70±20\) mm (range, 40-110 mm).

An attempt was made to place all acetabular components at the anatomic hip center. The mean lowering of the center of rotation (true acetabulum—secondary acetabulum) was \(68±22\) mm (range, 10-100 mm). The mean osteotomy resection was \(36±13\) mm (range, 20-55 mm); average leg shortening postoperatively was \(31±15\) mm (range, –10±60 mm). Nineteen of 33 cases (58%) used an insole preoperatively, with a mean height of \(60±10\) mm (range, 20-80 mm). Postoperatively, 12 of 33 patients (36%) still used an insole with mean height of \(30±10\) mm (range, 10-50 mm).

**Osteotomy and Muscular Tightening**

A Z osteotomy was performed in 14 cases (Figure 3) and an oblique osteotomy in 19 (Figure 4). Union of the osteotomy occurred in 32 of 33 cases (97%); a painful nonunion was found in 1 case where oblique osteotomy was performed, but 3 years postoperatively, the patient elected not to undergo further surgery, despite having pain after prolonged weight bearing.

The mean time required for osteotomy union was \(6±2\) months (range, 4-12 months). No differences were observed between the time for union of the Z osteotomy (6±2 months; range, 4-12 months) compared with the oblique osteotomy (6±1 months; range, 5-7 months).

The gluteus medius was usually partially disconnected in its anterosuperior portion and then sutured under tension, thus restoring its physiological obliquity and, accordingly, a suitable lever arm. In 5 cases, a muscular split of the gluteus medius was performed; it was allowed to ride up a bit, and then it was sutured to the remaining attached gluteus medias.

**Components and Fixation**

Different types of prostheses were used, both for the cup and for the stem. In 5 cases, a stemmed cup was used. The median size of the acetabular component was 42 mm (range, 36-48 mm).

The most widely used stem (20 cases) was the S-ROM (DePuy, Leeds, United Kingdom). It was used in all cases of oblique osteotomy and in 1 case of Z osteotomy.
The other stem types used are summarized in Table 1. In the 4 cases where the Wagner stem (Zimmer, Warsaw, Indiana) was used, a more marked limping was observed objectively because it has a smaller offset.

The femoral head size was 22 mm in 15 cases, 26 mm in 1 case, 28 mm in 16 cases, and 38 mm in 1 case. In 21 cases, screws were used as additional anchorage for the cup, and in 13 of these cases, autogenous bone grafts were used to increase the cup coverage.

The coupling used was ceramic-ceramic in 7 cases, ceramic-polyethylene in 3, metal-polyethylene in 15, and metal-metal in 3. The coupling was often determined by the small diameter of the cup implanted. In small diameter cups where it is not possible to use the ceramic-ceramic coupling, small 22-mm polyethylene heads are used.

The mean length of the stems used was 150±20 mm (range, 110-190 mm) with a mean diameter of 13±2 mm (range, 7-16 mm).

**Clinical Evaluation**

Clinical results are summarized in Table 2. Significant differences were found for pain (P<.0005), walking (P<.0005), mobility (P<.05), rise (P<.0005), and limb discrepancy (P<.0005) parameters between pre- and postoperatively. The Trendelenburg sign was marked in all patients (100%) preoperatively and was present in 21 of 33 cases postoperatively. In 13 of these patients it was evident, and in 8 patients it was slight. Concerning patient satisfaction, 23 patients were satisfied with the result, 6 were reasonably satisfied, and 4 were unsatisfied. Of these patients, 1 had a nonunion at the subtrochanteric osteotomy, and 3 were affected by femoral nerve neuropathy, which later partially recovered.

**Complications**

At last follow-up, there was a loosening of 1 cup and 1 stem, after 45 and 120 days, respectively, and revision was necessary. In 1 case, a radiolucent line of <1 mm was observed in the ABC acetabular area (according to Gruen [16]) at 96-month follow-up; however, revision was not necessary.

Four patients (12%) experienced postoperative dislocation. All dislocations were treated with closed reduction and brace for 4 weeks and did not require revision surgery.

Three cases (9%) developed neuropathy of the femoral nerve. In 2 patients it partially recovered, and in 1 patient it fully resolved.

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<tr>
<td><strong>Stems Used</strong></td>
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<tr>
<td><strong>Stem</strong></td>
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<tr>
<td>Wagner*</td>
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<td>Lord†</td>
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<td>S-ROM‖</td>
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construct.10,19 The problems connected there is good bone stock available for re-
ing the cup in the true acetabulum where
restore normal joint mechanics by plac-
ing present technical diffi culties in THA
eties.2,3,21
many and different anatomical abnormali-
tions connected to THA in nondislocated hips due to the
THA is problematic, and complications
complications can be reduced by taking care when using the retractors, which may
damage the connections that the femoral
ergve contracts with the anterior muscles
of the thigh.

Cup positioning and soft tissue han-
dling present technical difficulties in THA
in high congenital dislocation of the hip
joint. It is preferable, where possible, to
restore normal joint mechanics by plac-
ing the cup in the true acetabulum where
there is good bone stock available for re-
construction.10,19 The problems connected
to hypoplasia of the true acetabulum can be
addressed by:
1. Using small components deeply seated
and possibly using Hess’s protrusio sock-
et technique;
2. Performing a biological roof graft us-
ing an appropriately contoured resected
femoral head;
3. Combining the previous techniques (the
use of press-fit cups in some cases where
the acetabulum is extremely deficient but
the thickness of the iliac wing allows,
and additional screws are advisable);
4. Using a stemmed cup when coverage of
the component is extremely reduced.
The need to use small cups can limit
the choice of coupling material and impel
the use of a metal-polyethylene coupling,
which we normally prefer to avoid in
young patients due to polyethylene wear
debris. Initially stability is essential and
this stability should not be compromised
by attempts to insert components large
enough to use ceramic/ceramic cup links;
the case of acetabular loosening that we
observed was connected to the excessive
size of the prosthetic component, which
was implanted to use the ceramic-ceramic
coupling.
The problems in the femur are deter-
mined by altered metadiaphyseal mor-
phology, due to: (1) rotation anomalies;
and (2) the narrowness and straightness
of the femoral canal. Therefore, straight,
small stems; modular components that al-
low restoration of an appropriate soft tis-
sue tension; good offset; and correct ori-
entation of the components are required to
reduce the risk of dislocation and improve
joint function.
Several surgical options exist with re-
gard to the type and level of the osteoto-
my.10,13,19,22 We used metaphyseal osteot-
omy to avoid additional internal fixation.
In the first cases of our series we used a
Z osteotomy because the type of stem did
not allow rotational stability when cor-
recting the axis of the femur. Subsequent-
ly, we used a circular stem with distal
flutes. This gave us distal rotational sta-
ibility. The correct version of the stem could
be inserted into the diaphysis. A sleeve
could be inserted into the metaphysis to
give maximum canal fill. The sleeve could
be connected to the stem in any rotational
position. This design contributes to the ro-
tational stability of the stumps, which is
further increased by the femoral stem that,
at this level, acts as an intramedullary nail.
In addition, it allows the correct femoral
axis to be recovered on the coronal plane
by rotating the osteotomy surfaces.
No significant differences were ob-
served between the union times of the
oblique and the Z osteotomy. In our se-
ries, only 2 complications (6%) were con-
ected to the osteotomy: 1 nonunion in an
oblique osteotomy and 1 fracture of the
arms of the osteotomy (which did not in-
fluence the final stability of the implant) in
a Z osteotomy.
The rate of neurological complications
in the femoral nerve was 11.5%; these
complications can be reduced by taking
care when using the retractors, which may
damage the connections that the femoral
ergve contracts with the anterior muscles
of the thigh.
In consideration of the technical diffi-
culties and the greater risk of complica-
tions connected to the surgical procedure
in comparison with a standard THA, the
indications for THA and shortening oste-
tomy in a single stage should be limited
to grade IV congenital hip dislocation ac-
cording to Crowe’s classification in young
patients, epiphyseal proximal migration
≥35 mm, and marked clinical symptoms.
Identifying the true acetabulum, the
accurate correction of the rotational axes,
and the correct retention of the soft tissues
are certainly the most demanding aspects
of this technique. Currently we prefer to
use small cups, sometimes fixed with ad-
ditional screws, or cups with iliac fixation.
For the stem, a modular prosthesis with
metaphyseal sleeve allows the oblique oste-
tomy to be used, thus enabling mechanici-
ical stability; therefore, we have abandoned
the more complex Z osteotomies.
Overall, this procedure offers a high
rate of positive results (87.9%), with a high
rate of pain relief, improvement in limb-length discrepancy, and reduced limping, leading to a smaller or no insole.

REFERENCES


