The Role of Proximal Femoral Valgus Osteotomy in Legg-Calvé-Perthes Disease

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Abstract

Proximal femoral valgus osteotomy for Legg-Calvé-Perthes disease was evaluated at an average 5 years postoperatively in 31 consecutive patients. The indications for osteotomy were hinge abduction and pain. The Iowa hip scores at follow-up for 21 patients averaged 93 points. Combined clinical and radiographic review for these patients yielded 6 (29%) excellent, 7 (33%) good, 5 (24%) fair, and 3 (14%) poor results. The 10 remaining patients had good pain relief and were satisfied but were unable to return for hip scale evaluation.

Containment and preservation of range of motion are the mainstays of treatment for early cases of Legg-Calvé-Perthes disease. In the later stages of Legg-Calvé-Perthes disease, the deformity of the femoral head is well established and concentric reduction often is not possible. The goals of treatment are thus directed toward pain relief, improvement of hip mechanics, and improvement in the congruency of the hip joint, thereby minimizing or delaying degenerative changes.

Valgus osteotomy of the proximal femur has been recommended for late cases of Legg-Calvé-Perthes disease with established femoral head deformity, but validation of its role in the treatment of these patients is not well documented in the literature. We used the valgus osteotomy in the treatment of patients with hip pain and radiographic evidence of hinge abduction.

Hinge abduction is the phenomenon that occurs when one attempts to abducted the deformed hip. Instead of gliding concentrically within the acetabular cup, the femoral head moves eccentrically, abutting against and then hinging on the superior lip of the acetabulum. The inferomedial portion of the femoral head is levered laterally away from the teardrop in the floor of the acetabulum. The radiographic effect of this occurrence is widening of the inferomedial joint space, documented by an increase in the medial dye pool seen on arthrography (Figure 1).

In our experience, the valgus osteotomy reduces hinge abduction by removing the laterally extruded portion of the femoral head from contact with the acetabulum, relieves pain, and improves range of motion and the radiographic congruity of the joint. We reviewed our experience with the valgus osteotomy to define its effectiveness in patients with symptomatic deformity following Legg-Calvé-Perthes disease.

MATERIALS AND METHODS

Two hundred fifty-nine patients with Legg-Calvé-Perthes disease were treated at Shriners Hospital for Children, Tampa, Florida, during the study period. Proximal femoral valgus osteotomies were performed in a subgroup of 31 (12%) patients (25 males and 6 females). All patients who underwent a valgus proximal femoral osteotomy for Legg-Calvé-Perthes disease during the study period were reviewed. The specific indications for proximal femoral valgus osteotomy included complaints of hip pain and hinge abduction either documented by arthrogram demonstrating medial dye pool formation (27 hips) or plain radiographs demonstrating a significant deformity of the lateral femoral head with lateral extrusion and impingement on the lateral acetabulum with abduction (4 hips).

All patients had Catterall group III or IV (Salter-Thompson group B) dis-
ease. Average patient age at diagnosis was 6.7 years (range: 3.3-13 years). Average patient age at surgery was 10.2 years (range: 5.1-15.5 years). Average follow-up was 5.2 years postoperatively (range: 4.5-6.2 years). At surgery, these patients averaged the 43rd percentile for height (range: 5th to >100th percentile) and the 64th percentile for weight (range: 5th to >100th percentile). The procedure was performed on 18 right hips and 13 left hips.

Prior nonsurgical treatment included balanced suspension traction in 16 patients (average: 2.9 weeks), spica casting in 15 patients (average: 8.2 weeks), and an abduction orthosis in 29 patients (average: 11.2 months). Prior surgical treatment included a proximal femoral varus rotational osteotomy in 3 patients and proximal femoral rotational osteotomy in 1 patient. Additionally, 6 patients had previously undergone an adductor release. No patient had undergone a pelvic osteotomy.

Bilateral Legg-Calvé-Perthes disease was present in 7 of 31 patients. No patient required bilateral proximal femoral valgus osteotomies. Two patients underwent a proximal femoral varus rotational osteotomy and 1 patient underwent a greater trochanteric epiaphyseodesis on the contralateral hip.

Clinical evaluation included chart review of the clinical course in all 31 patients. Twenty-one patients returned for a follow-up clinic visit and evaluation according to the Iowa hip scale. The remaining 10 patients had been evaluated by physical and radiographic examination, but were unable to return for the evaluation according to the Iowa hip scale.

Preoperative, immediate postoperative and follow-up radiographs were obtained for all patients. Standard radiographs included an anteroposterior view of the pelvis, and a frog lateral view. Femoral head involvement was classified by the method of Catterall. The following measurements were determined: femoral neck-shaft angle, the center-edge angle of Wiberg, Sharp angle, articulotrochanteric distance, and percent lateral extrusion (the percentage of the femoral head which is not covered by the osseous acetabulum). Pre- and postoperative lateral radiographs were insufficiently standardized for measurement of changes in flexion and extension. The Stulberg classification was assigned by a single attending orthopedic surgeon on review of final radiographs.

Surgical Technique
A laterally-based closing wedge osteotomy was performed at or just distal to the lesser trochanter. The surgical plan was based on the preoperative arthrogram in which the femur was adducted to simulate the position that would most optimally relieve hinging and increase congruency. Flexion/extension and internal/external rotation were also assessed to document the "best fit" of the femoral head within the acetabulum in all planes. Templates were used preoperatively to determine the placement of the osteotomy and the fixation device. Fixation was secured with a blade plate (26 patients), a bifurcated blade plate (2 patients), or a contoured dynamic compression plate (3 patients). Following stabilization of the osteotomy, the hip was ranged from the neutral position into abduction. This maneuver confirmed a decrease in the preoperative hinging (Figure 2).

Postoperatively, patients were placed in a single-leg hip spica cast for an average of 6 weeks. Four patients required a postoperative transfusion.

RESULTS

Pain/Satisfaction
All 31 patients complained of severe activity-limiting pain preoperatively. At follow-up, 20 (65%) patients reported no pain, ability to perform unlimited activities including recreational sports, and usage of anti-inflammatory medications less than once per month. Nine (29%) patients reported occasional pain and anti-inflammatory medication usage less than twice per week. These patients reported unlimited walking capacity.

The 29 patients whose preoperative pain was relieved by surgery were satisfied with their range of motion and ability to function in activities of daily living, recreational sports, or both. Two patients were unsatisfied. One patient continued to have severe activity-limiting pain with walking limited to less than three blocks and daily anti-inflammatory medication usage but had no further operative intervention. This patient is in the 98th percentile of weight for height. The other patient who was not satisfied with the procedure due to unrelieved pain underwent a hip arthrodesis.

Range of Motion
Flexion, abduction, and internal rotation were modestly increased postoperatively (Table 1). There were no postoperative flexion contractures.

Radiographic Results
The femoral neck shaft angle aver-
aged 140\(^\circ\) preoperatively (range: 120\(^\circ\)-161\(^\circ\)) and 153\(^\circ\) postoperatively (range: 130\(^\circ\)-170\(^\circ\)). This statistically significant increase in valgus of 13\(^\circ\) was maintained to most recent follow-up. The center-edge angle of Wiberg, Sharp angle, percent lateral subluxation and articular trochanteric distance measurements were not statistically altered on the preoperative versus postoperative radiographs (Table 2). Statistical comparisons were made using the Chi-square test.

**Limb-Length Discrepancy**

At latest follow-up, scanograms were performed in 24 of 31 patients to assess limb-length discrepancy (minimum 1 cm). The operative side was longer than the nonoperative side in 2 patients by 2.3 cm and 1.7 cm, respectively. In 11 patients, the contralateral limb was longer by an average of 2.1 cm (range: 1.1-3.7 cm). Preoperative limblength discrepancy was not routinely well documented, but the involved side was shorter in the majority of patients.

**Classifications**

There were 15 Catterall III and 17 Catterall IV hips. All patients were Salter-Thompson B. At follow-up there, were 3 Stulberg I hips, 6 Stulberg II hips, 13 Stulberg III hips, 6 Stulberg IV hips, 2 Stulberg V hips, and 1 patient underwent hip arthrodesis.

**Iowa Hip Scale**

Iowa hip scale results were obtained for 21 of 31 patients who were able to return for specific assessment. This scale assesses 100 possible points: 35 for freedom from pain, 35 for function, 10 for gait, 10 for freedom from deformity, and 10 for motion. The average total was 93 points (range: 62-100 points). Preoperative Iowa hip scale ratings were not available for comparison.

**Combined Clinical Outcome**

The radiographic and clinical findings in 21 patients were combined to further assess outcomes. The combined outcome was assigned based on the least favorable outcome between the two rating systems. Excellent results were assigned to patients with a Stulberg I or II classification and an Iowa hip score >95; good results for Stulberg III and Iowa score >90; fair results for Stulberg IV and Iowa score >85; poor for Stulberg V, Iowa score <85, or subsequent reconstructive surgery. Assessment based on these parameters revealed 6 (29%) patients with excellent outcomes, 7 (33%) good, 5 (24%) fair, and 3 (14%) patients with poor outcomes (Table 3).

The remaining 10 patients who were not available for participation in the Iowa hip scale evaluation reported relief of pain, unlimited activity, and satisfaction with surgical outcome at most recent follow-up.

**Additional Surgeries**

A second procedure for removal of hardware was routinely performed between 9 and 18 months postoperatively early in the study. This is no longer routinely recommended. One patient fell 6 weeks postoperatively and sustained a femur fracture at the osteotomy site with a broken plate; reinsertion was required. Three patients underwent further reconstructive procedures: one patient had abductor weakness for which a greater trochanteric advancement was performed; one patient underwent a shelf procedure for subluxation of the femoral head; and one patient underwent a hip arthrodesis for continued pain.

**DISCUSSION**

Catterall established hinge abduction as a significantly negative influence on the biomechanics of the hip joint and a major source of pain in late cases of Legg-Calvé-Perthes disease.\(^9,10,17\) Stretching of the sensitive inferior hip capsule and synovium that occurs during the abduction phase of gait may be responsible for pain in the patient with hinge abduction who has no evidence of arthritis or loose bodies.\(^14\) Repetitive superolateral impact also may cause synovitis.

Pauwels\(^18\) theorized that early degeneration is the result of high pressure loading of a localized area of the articular surface of the femoral head. Bombelli\(^19\) recommended a valgus osteotomy of the proximal femur in adults to restore the altered biomechanics of hips with degenerative changes. Several authors recommend applying these same principles to children to restore motion and increase the congru-
Table 2

<table>
<thead>
<tr>
<th></th>
<th>Neck Shaft Angle (°)</th>
<th>Center Edge Angle (°)</th>
<th>Sharp Angle (°)</th>
<th>Lateral Subluxation (%)</th>
<th>Articulotrochanteric Distance (mm)</th>
</tr>
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<tbody>
<tr>
<td>Preoperative</td>
<td>140 (120-161)</td>
<td>16.5 (~8 to 47)</td>
<td>44 (32-60)</td>
<td>29.7 (0-72.5)</td>
<td>13 (~10 to 37)</td>
</tr>
<tr>
<td>Follow-up</td>
<td>153 (130-170)</td>
<td>18 (~6 to 44)</td>
<td>45 (32-60)</td>
<td>30.9 (8.3-75)</td>
<td>14 (0-35)</td>
</tr>
</tbody>
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Table 3

**Combined Clinical and Radiographic Outcomes**

<table>
<thead>
<tr>
<th>Combined Outcome</th>
<th>Stulberg Classification</th>
<th>Iowa Hip Score</th>
<th>No. Patients (%)</th>
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<tbody>
<tr>
<td>Excellent</td>
<td>I or II</td>
<td>≥95</td>
<td>6 (29)</td>
</tr>
<tr>
<td>Good</td>
<td>&lt;III</td>
<td>≥90</td>
<td>7 (33)</td>
</tr>
<tr>
<td>Fair</td>
<td>IV</td>
<td>≥85</td>
<td>5 (24)</td>
</tr>
<tr>
<td>Poor</td>
<td>V</td>
<td>&lt;85†</td>
<td>3 (14)</td>
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*Based on the least favorable outcome between the two systems.
†Or subsequent surgery.

ence of the weight-bearing area of the femoral head. The reduction of the compressive forces on the lateral acetabulum by the femoral head following the valgus osteotomy might also allow the resumption of some lateral growth of the acetabulum and eventually better coverage of the femoral head. Such a response is age-related.

The specific operative goals of the valgus osteotomy in this group of children were to reduce hinge abduction by removing the laterally extruded portion of the femoral head from contact with the acetabulum, relieve pain, improve range of motion (especially abduction), and improve the lever arm of the abductor musculature. All of these factors would ultimately improve the biomechanics of the deformed hip joint and theoretically delay onset of degenerative changes.

There are no scales that have been validated to specifically evaluate the adolescent hip. The Iowa scale was chosen as the scale, which most accurately reflected the outcome in these patients. This scale has been used previously to assess outcomes in adolescents.

Although the valgus osteotomy creates more lateral uncoverage of the femoral head radiographically, the authors agree with Klisic that the anterolaterally deformed or extruded portion of the head consists of osteocartilaginous material that is not functional in weight-bearing. The valgus osteotomy places more normal articular cartilage beneath the weight-bearing surface of the acetabulum.

Many surgical procedures previously recommended for patients with late deformity are considered salvage procedures. Extensive muscle release, including the adductors, psoas, and abductors, has been found to reduce the compressive forces acting across the joint and provide at least short-term relief of pain. Cheilectomy has been recommended to remove the extruded portion of the femoral head, but this intracapsular procedure has been associated with increased hip stiffness. Although the radiographic appearance improves following cheilectomy, there is little enhancement of joint function. Additionally, the residual shortness and abductor weakness are not addressed. Transfer of the greater trochanter laterally and distally redirects the pull of the hip abductors and thereby theoretically alters the forces across the joint to decrease the potential for degenerative changes. Givon et al.

Nineteen patients with severe Legg-Calvé-Perthes disease were treated by shelf arthroplasty at the DuPont Institute. Long-term follow-up showed that the laterally displaced, flattened, and enlarged femoral head could be successfully covered and protected by an acetabular shelf procedure. This procedure remains an alternative, however, a valgus osteotomy would seem more physiologic in the presence of hinge abduction.

The Chiari osteotomy may provide increased lateral coverage for an enlarged femoral head, but does not necessarily improve the lateral impingement on abduction and may exacerbate any abductor weakness. A combination of pelvic osteotomy (either innominatae or Chiari) with a proximal femoral osteotomy (either varus or valgus) has been reported to provide improved coverage in the older patient with severe deformity. This approach would allow modification of both sides of the hip joint, which may be beneficial for certain patients. None of our patients underwent concomitant pelvic osteotomies.

Quain and Catterall reported the short-term results (6 months) of an abduction-extension osteotomy in 26 hips with pre-existing hinge abduction, 22 secondary to Legg-Calvé-Perthes.
disease. They reported a significant reduction of hip pain in all but 3 patients. Our results, presenting longer clinical follow-up, support their findings and suggest patients and families remain satisfied with the outcome in the majority of cases.

**CONCLUSION**

Our findings, at an average of 5.2 years postoperatively, must still be considered short-term relative to the life span of these children. Longer outcomes would be necessary to demonstrate lessening of future problems and degenerative changes. Our patients did have a significant improvement in symptoms and function, although significant measurable signs of radiographic improvement were not evident. However, the radiographic signs of degenerative changes, which might be expected in this group of patients, have not occurred.

We believe the valgus osteotomy of the proximal femur is a useful procedure in this subgroup of patients with late changes of Legg-Calvé-Perthes disease, and hinge abduction. The valgus osteotomy allows the surgeon an alternative method of achieving the treatment goals, realizing that no procedure will allow for complete normalization of the affected hip joint.

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**REFERENCES**

8. Bizouky DT, Glancy GL. Valgus producing proximal femoral osteotomy revisited. Presented at the annual meeting of the Pediatric Orthopaedic Society of North America; May 15, 1991; Dallas, TX.