Treatment of Hip Subluxation in Skeletally Mature Patients With Cerebral Palsy

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abstract

Hip subluxation is common in children with spastic cerebral palsy. Most physicians favor intervention to treat hip subluxation in skeletally immature patients with cerebral palsy. However, treatment in skeletally mature patients with cerebral palsy is controversial. The goal of this study was to evaluate radiographic and clinical outcomes after hip reconstruction in skeletally mature patients with cerebral palsy. The authors performed a retrospective review of all skeletally mature patients (n=20) with cerebral palsy who underwent hip surgery for subluxation at the authors’ institution between 2005 and 2011. Charts were reviewed for demographic characteristics, procedure, follow-up, and complications. Acetabular index, migration index, and neck-shaft angle were measured on preoperative and most recent radiographs. Average follow-up was 2.2 years. Average migration index for the entire group improved from 57% to 20% (P<.0001). Of patients who had all radiographic abnormalities addressed at surgery (varus derotational femoral osteotomy for neck-shaft angle >135°, open reduction for migration index >50%, and acetabular osteotomy for acetabular index >25°), 91% had a final migration index of less than 25%. In patients who did not have all radiographic abnormalities addressed, 33% had a migration index of less than 25% at final follow-up. No intraoperative complications occurred; however, 13 patients had at least 1 postoperative complication. Hip subluxation in skeletally mature patients with cerebral palsy is difficult to treat and is associated with a high incidence of complications. The likelihood of a successful outcome appears to be related to the appropriateness of the surgical procedure. When all radiographic abnormalities were addressed during surgery, a successful radiographic outcome at final follow-up was much more likely than when intervention was less comprehensive. [Orthopedics. 2015; 38(4):e248-e252.]
Hip subluxation and dislocation are common in children with spastic cerebral palsy. Prevalent work showed that their incidence is directly proportional to the severity of neuromuscular involvement, as assessed by the Gross Motor Function Classification System score. Because of concerns about current and future function, ease of care, and pain associated with hip subluxation in this population, surveillance and treatment protocols are used in skeletally immature patients. Treatment of chronic hip subluxation and dislocation in skeletally mature patients with cerebral palsy is less defined, and there is little information in the literature to guide decision making and surgical planning.

Various procedures have been evaluated for the treatment of chronic hip subluxation in skeletally mature patients with cerebral palsy. Inan et al. evaluated 33 hips in skeletally mature patients treated with incomplete transiliac osteotomy and proximal femoral varus osteotomy. They reported good results, with 26 of 33 hips painless at follow-up. Alternatively, techniques such as hip arthrodesis, proximal femoral valgus osteotomy, and proximal femoral resection with interpositional arthroplasty have been reported as treatment options, with variable clinical success and complication rates. The best treatment option is unknown.

The goal of the current study was to evaluate radiographic results and complications of hip reconstruction in skeletally mature patients with cerebral palsy and hip subluxation or dislocation.

**Materials and Methods**

The authors performed a retrospective review of all skeletally mature patients with spastic cerebral palsy who underwent surgical treatment for a subluxated or dislocated hip at their institution between April 2005 and December 2010. Patients with incomplete radiographs or clinical records, open triradiate cartilage, or follow-up of less than 1 year were excluded. Institutional review board approval was obtained.

Medical records were reviewed to determine patient demographic and treatment information. Demographic information included sex, pattern of neurologic involvement, ambulatory status, previous procedures, and presence of a baclofen pump. Treatment data included procedure type, implant, blood loss, and intraoperative complications. Postoperative clinical outcomes were recorded and included complications and use of pain medication.

Radiographic evaluation was performed with the digital measurement tools on the authors’ institution’s radiology picture archiving and communication system (Synapse; Fujifilm, Stamford, Connecticut). Preoperative, first postoperative, and latest follow-up radiographs of the pelvis were used for evaluation. Measurements included neck-shaft angle, Reimer’s migration index, and acetabular inclination (Tönnis angle), as described by Clohisy et al. A migration index of 33% to 99% indicated a subluxated hip, and a migration index of 100% indicated a dislocated hip.

Statistical analysis was performed with Student’s t test for continuous data and Fisher’s exact test for categorical data. Significance was defined as $P<.05$.

**Results**

A total of 20 patients (20 hips) were included in the review, with 8 female and 12 male patients. Mean patient age at the time of surgery was 15.1 years (range, 8.7-21.3 years). All patients had a Gross Motor Function Classification System score of 4 or 5. Fifteen patients had 25 previous procedures: 12 patients had procedures to the ipsilateral hip, 5 patients had procedures to the contralateral hip, 4 patients had placement of intrathecal baclofen pumps, 3 patients had posterior spinal fusion, and 1 patient had a dorsal rhizotomy. Average follow-up was 2.2 years (range, 1.1-5.7 years).

All 20 patients had surgical intervention for unilateral hip subluxation or dislocation. There were 4 dislocated hips (migration index ≥100%) and 16 subluxated hips (average migration index, 46.5%). Average estimated blood loss was 300±170 mL, and there were no intraoperative or immediate postoperative (in-hospital) complications. The procedures performed are listed in Table 1 and were chosen at the discretion of the surgeon. The types of acetabular osteotomy performed included 4 shelf osteotomies, 8 Dega-type osteotomies, and 1 Chiari osteotomy. Although all patients had closed triradiate cartilage, Dega-type osteotomy was performed with the osteotomy hinging through the osteopenic bone at the medial cortex of the iliac wing.

The preoperative migration index was significantly improved postoperatively, with little change at final measurement.
For the 18 patients who underwent proximal femoral varus derotational osteotomy, neck-shaft angle showed significant improvement after surgery, with no change at final measurement (Figure 2). Acetabular index improved in the 13 patients who were treated with acetabular osteotomy, with no change at final follow-up (Figure 3). Patients with subluxated hips showed better migration index at final follow-up compared with those with dislocated hips (10% vs 57%, \( P = .0004 \)) (Figure 4).

Comparison of migration index among the different procedures is shown in Figure 5. No statistically significant difference in preoperative migration index or final migration index was seen between procedures, although patients treated with varus derotational femoral osteotomy plus acetabular osteotomy and varus derotational femoral osteotomy plus acetabular osteotomy plus anterior open reduction had a lower average migration index at final follow-up compared with those treated with varus derotational femoral osteotomy or acetabular osteotomy alone or varus derotational femoral osteotomy plus anterior open reduction.

The authors further analyzed the data to determine the factors that affected final migration index. They defined 3 parameters on preoperative radiographs that indicated abnormal anatomy that should be addressed surgically. Based on previous literature, they proposed that varus derotational femoral osteotomy was indicated for femoral neck-shaft angle greater than 135°, acetabular osteotomy was indicated for acetabular inclination greater than 25°, and open reduction was indicated for migration index greater than 50°. The authors defined a successful radiographic outcome at final follow-up as migration index of less than 25%. This is a more stringent definition than most recommended surgical indications for a subluxated hip. Preoperative radiographs were evaluated for each of the 3 parameters to determine whether all preoperative abnormalities were addressed. If all radiographic abnormalities were addressed, 91% of patients had a successful radiographic outcome at final follow-up (migration index <25%); however, if all abnormalities were not addressed, 67% of patients had an unsuccessful radiographic outcome at final follow-up (migration index >25%) (Table 2).

The authors found no immediate in-hospital complications in these patients. There were 13 complications noted at follow-up: 6 patients with persistent hip pain requiring use of pain medication, 5 patients with a skin ulcer as a result of immobilization after surgery (all treated nonoperatively with local wound care), 1 patient with significant heterotopic ossification postoperatively that limited hip motion, and 1 patient with ipsilateral distal femur fracture 5 months after surgery that was treated without incident in a long leg cast.

**Discussion**

Patients with spastic cerebral palsy presenting with hip subluxation or dislocation after skeletal maturity are difficult to treat. Currently, there is debate regarding the clinical and functional outcomes of untreated hips as these children age. Some argue that these hips become pain-
ful, whereas others have suggested that the incidence of hip pain is low in this population.3,14 In addition, hip subluxation and dislocation may limit range of motion, lead to limb length discrepancy, make appropriate perineal care difficult, and increase caregiver anxiety.2 To avoid these issues, there is uniform agreement that progressive hip subluxation in skeletally immature children with cerebral palsy should be addressed and attempts should be made to maintain a concentrically reduced hip.2,15-21 If complications can be avoided and hip reduction can be maintained, treatment of hip subluxation in skeletally mature patients should be the same. However, there is little information on the results of this approach. The study findings showed that the short-term radiographic outcome of treating skeletally mature patients was successful. The authors reported improvement in all radiographic parameters measured, with the result maintained throughout the follow-up period. The final migration index was significantly better in hips treated for subluxation vs dislocation (Figure 4), indicating that intervention before complete hip dislocation is most efficacious. The radiographic results came at the cost of a high postoperative complication rate (13 complications in 20 patients); however, most complications were relatively benign and there were no cases of medical morbidity or mortality.

The appropriateness of the procedure significantly affects the final radiographic result. The authors reported a successful radiographic outcome in 91% of cases when all radiographic abnormalities were surgically addressed. However, when surgical treatment did not address all radiographic abnormalities, the failure rate at final follow-up was 67%. Unlike in younger patients, further growth is not an issue, and the authors believe that addressing all of the radiographic abnormalities known to predispose patients to hip subluxation results in a low likelihood of subluxation postoperatively. The minimum amount of correction needed for each anatomic parameter addressed is impossible to determine with the authors’ limited population. The authors set the surgical thresholds at levels generally recognized as abnormal: migration index of greater than 50%, neck-shaft angle of greater than 135°, and acetabular inclination of greater than 25°.2,12,17,22 The authors do not advocate surgical intervention if these measurements are simply found on radiographic evaluation of a skeletally mature patient. However, if the hip is subluxated or dislocated, the authors believe that these radiographic measurements are good guides for surgical planning of hip reduction.

Minimal data are available on the treatment of hip subluxation and dislocation in skeletally mature patients with cerebral palsy. In general, previous studies had the same issues as the current study, namely, a small number of patients, lack of objective outcome measurements, and limited follow-up. Previously suggested treatment methods included hip fusion for chronic hip dislocation, as suggested by de Moraes Barros Fucs et al.3 They reported improved pain in 14 patients treated with this approach; however, they had a significant complication rate, with 3 nonunions and 2 patients having a femur fracture distal to the fused hip. Hogan et al6 reported the use of valgus subtrochanteric femoral osteotomy for this condition. They reported a variable outcome in terms of clinical and functional improvement, with a 63% complication rate. A survey of the caregivers of these patients found a high satisfaction rate with this procedure. Knaus and Terjesen7 reported the use of proximal femoral resection and interpositional arthroplasty in a group of 20 patients with chronic hip subluxation and cerebral palsy. They reported improved pain control and good patient and caregiver satisfaction with this approach, but their patients required hospitalization for 2 to 5 weeks for traction postoperatively. Finally, Inan et al4 reported 27 skeletally mature patients with spastic cerebral palsy and hip subluxation treated with proximal femoral varus osteotomy and incomplete iliopsoas release. They found improvement in the radiographic outcome of all hips and improvement in pain in 79% of patients. The current findings are similar to these published outcomes.

Given the limitations of the existing data and the apparent similarities in patient outcomes and reported complications, it is difficult to recommend a particular treatment method over another. Instead, the authors analyzed their data to provide guidance in surgical planning. The authors found that when all of the radiographic abnormalities were surgically addressed (hip subluxation, acetabular dysplasia, and proximal femoral valgus) patients had a high rate of radiographic success (91% with final migration index <25%). With no current guidelines for intervention in this patient population, the authors based their outcomes on guidelines for intervention in skeletally immature patients. These guidelines support surgical intervention for hips with migration index of greater than 30% to 40%.2,12 Thus the authors’ definition of success is even more stringent than the current indication for surgical intervention. The recommendation to address all radiographic abnormalities is not new and led to good results in skeletally immature patients previously.16,18,19 However, this is the first study to show the utility of this surgical approach in a group of skeletally mature patients with spastic hip subluxation.

Limitations

The current study had significant limitations. It included a small number of patients with a heterogeneous presentation in terms of disease severity (amount of hip subluxation and degree of spasticity). However, because few skeletally mature patients with cerebral palsy are treated for this condition, these limitations are consistent throughout the literature. Additionally, the authors used subjective reporting...
of pain improvement based on the clinical follow-up notes of the treating physicians that showed persistent use of pain medication. However, this method was burdened by reporting bias. The authors’ focus was on the radiographic success of their approach rather than subjectively reported patient outcomes. This study also had limited follow-up. Given the lack of growth in these patients, there was less chance of subsequent change in hip position over time. There was also significant heterogeneity of the acetabular procedures performed for acetabular dysplasia, limiting the ability to define the best specific surgical technique.

The average age of the study patients was 15.1 years, and the oldest patient was 21 years. This study did not include enough patients to allow stratification of results based on age, and the authors did not evaluate femoral head sphericity. Femoral head deformity develops and is probably more severe in hips with long-standing dislocation. Although skeletally immature patients have the potential for remodeling on reduction, older patients may not. Those with significant femoral head deformity as a result of long-standing dislocation may not benefit from hip reconstruction. Applicability of the results to adult patients is not clear.

**CONCLUSION**

The current study showed that surgical hip reconstruction can achieve radiographic hip reduction in skeletally mature patients with spastic cerebral palsy and hip subluxation or dislocation. This approach leads to good subjectively reported pain control, with few significant postoperative complications. The best radiographic results are achieved when intervention is performed before hips are completely dislocated and when all preoperative radiographic abnormalities are addressed.

**REFERENCES**