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CLINICAL RESEARCH

Results of Treatment of Femoroacetabular Impingement in Adolescents with a Surgical Hip Dislocation Approach

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Abstract

Background The literature contains few studies of open treatment with an open surgical hip dislocation approach for treatment of femoroacetabular impingement (FAI) in adolescents. The average age and associated disorders in adolescents with FAI reveal a critical need to study younger patients whose hip disorder has not had time to progress.

Questions We assessed (1) how validated measures of patient-oriented assessment of hip function and quality of life change after surgical hip dislocation; (2) whether any patient-related or technique variables correlated with changes in the outcome scores; and (3) what the complications of treatment are and how many reoperations we performed on these patients.

Methods We retrospectively reviewed a consecutive series of 71 hips in adolescents younger than 21 years who underwent surgical hip dislocation for FAI. The final cohort consisted of 44 patients (52 hips) with a mean age of 16 years. We analyzed changes in outcome variables after surgical hip dislocation and recorded reoperations during the study period.

Results The minimum followup was 12 months (average, 27 months; range, 12–60 months). Modified Harris hip scores increased from a mean of 57.7 preoperatively to a mean of 85.8 postoperatively. Mean SF-12 scores increased from 42.3 to 50.6. Mean preoperative hip flexion increased from 97.5° to 106.2°. Mean internal rotation of the affected hip at 90° flexion increased from 18.19° to 34°.

Conclusions Early results revealed improvements in hip function, patient quality of life, and ROM after surgical hip dislocation for the majority of this group of adolescents with FAI. However, 10% of the patients did not improve, and an additional 15% improved but still did not consider their hips good or excellent. This points toward the need for further studies in this population of patients.

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
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Introduction

Femoroacetabular impingement (FAI) of the hip is a pathologic condition for which the pathomechanics were elucidated a decade ago [15]. An osseous abnormality of the proximal femur and/or the acetabulum combined with the process of motion leads to a conflict of the proximal femur on the acetabular rim complex. This may lead to hip pain, labral tears, cartilage delamination, and potentially to osteoarthritis later in life [5, 15, 20, 29]. Patients report predominantly anterior groin pain with activities involving hip flexion. The hip examination commonly reveals a limitation in hip flexion and hip internal rotation at 90° flexion [34]. Common radiographic abnormalities are deficient offset between the femoral head and neck, a nonspherical femoral head, and/or acetabular overcoverage [15, 33].

The effects of femoral head deformity in athletic adolescents were described by Murray and Duncan [22]. They asserted that athletically active adolescents may be at risk for degenerative joint disease later in life secondary to an acquired femoral deformity. Throughout the last decade, heightened awareness of hip impingement has led to increasing recognition of FAI in children and adolescents [30] who often present with hip pain during athletic training, competition, or activities involving extreme hip ROM.

Management of FAI begins with conservative methods such as activity modification and physical therapy. For patients who do not improve using these interventions, surgical approaches to address FAI range from open surgical dislocation through a transtrochanteric approach [15] to arthroscopic approaches [8] to a combination of anterior open surgery with or without arthroscopy [6, 10]. All of these approaches are used to access the hip to perform the necessary interarticular procedures required to create impingement-free motion and labral repair if needed. Although all of these surgical strategies commonly are used, the open surgical dislocation approach has been used as a benchmark when comparing alternative surgical options since its description in 2001 [14]. The surgical dislocation approach allows full observation of the acetabulum and proximal femur. Visual inspection of the pathomechanics is possible as the hip is taken through its full ROM. The approach allows access for an osteoplasty of the femoral head-neck junction, acetabular rim resection, and labral refixation, if indicated, thereby improving clearance for hip motion and alleviating femoral abutment against the acetabular rim [3, 17, 19, 21, 23].

Multiple studies have had good to excellent short- and midterm results of open surgical hip dislocation, open femoral neck osteoplasty, and acetabuloplasty in the adult population [3, 9, 12, 21, 23]. The average age and associated disorders in these cohorts reveal a critical need to study younger patients whose hip disorders have not had time to progress and in whom we expect to discover a lesser degree of chondrolabral damage and joint space narrowing. Studies have described the use of surgical hip dislocation to treat children and adolescents, although patients with other deformities such as slipped capital femoral epiphysis (SCFE), Legg-Calvé-Perthes disease, osteonecrosis, and exostosis were included in the cohort [28, 32].

We report the outcomes of an adolescent cohort who underwent surgical dislocation of the hip for FAI not associated with pediatric deformities such as Perthes, SCFE, or osteonecrosis. In this study, we posed the following questions: (1) How do validated measures of patient-oriented assessment of hip function and quality of life (modified Harris hip score [HHS], SF-12 score) and hip ROM change after surgery? (2) Are any variables (gender, age at surgery, length of followup, labral repair, lateral center-edge angle [CEA], and alpha angle), correlated with changes in the outcome scores? (3) What are the complications of treatment and how many patients undergo reoperation?

Patients and Methods

This retrospective study comparing the change in outcome variables after open treatment of FAI by a surgical hip dislocation approach was approved by our institutional review board with waiver of informed consent for patients lost to followup. The cohort of 71 hips is a consecutive series of all adolescent hips in patients younger than 21 years with FAI who underwent surgical hip dislocation performed by the senior author (ELS) from January 2006 to November 2009. This period was chosen to include a potential minimum of 2 years followup. Indications for treatment were patients with FAI who had hip symptoms that affected their activities of daily living, a positive impingement test, radiographs with criteria for FAI, and having at least 6 months of failed conservative treatment. Excluded were patients who underwent a surgical hip dislocation performed for the diagnosis of Legg-Calvé-Perthes disease, SCFE, hip dysplasia, trauma, and osteonecrosis. Forty-four patients (52 hips) consented to participate in the study and all had postoperative examination and postoperative validated patient-oriented hip outcome scores (modified HHS and SF-12).

Indications for surgery were based on symptoms of FAI affecting activities of daily living that were refractory to a minimum of 6 months of nonoperative treatment, which included activity modification and physical therapy. All patients presented with pain; anterior groin pain was present in 51 hips, whereas one hip was symptomatic for posterior peritrochanteric pain preoperatively. A positive impingement test (pain provoked similar to their symptoms with hip flexion, slight adduction, and internal rotation) was elicited in all patients on physical examination before surgery. On physical examination, ROM, specifically hip flexion and internal rotation at 90°, was recorded as measured clinically by the senior surgeon (ELS). Positive clinical examination findings included decreased internal rotation of the hip when flexed to 90° and a positive impingement sign [13] in all patients. Criteria of FAI on AP and lateral radiographs and/or MRI included evidence of acetabular overcoverage, retroversion, coxa profunda, or a decreased femoral head-neck offset (alpha angle > 50°) on the lateral radiograph of the hip or radial sequence MRI.

All surgery was performed by the senior author (ELS). Surgical hip dislocation was performed through a lateral incision using a Gibson modification and trochanteric flip osteotomy as described by Ganz et al. in 2001 [14]. Inspection of the hip during surgery revealed a gross labral tear in 42 hips (81%). Cartilage injury as classified by Beck et al. [3], which describes the pattern of cartilage delamination, was observed in all but two hips. Anatomic femoral head-neck offset (osteoplasty) was restored in all patients. A partial rim resection and labral reattachment were performed in 31 hips. The remaining hips had no labral repair or rim resection. After the osteochondroplasty and labral repair were adequately addressed, the hip was reduced and brought through a physiologic ROM, evaluating for any remaining impingement. The trochanteric osteotomy was repaired using two to three 3.5-mm fully threaded cortical screws in all hips.

Postoperatively, all patients adhered to the same protocol with 30% weightbearing for 4 to 6 weeks and continuous passive motion for 2 weeks postoperatively. Patients began rehabilitation 6 weeks postoperatively and were cleared to return to athletics or activities as tolerated after 4 to 6 months depending on progress with physical therapy and any residual symptoms.

The mean age of the patients at the time of surgery was 16.2 years (range, 13–19 years). There were 43 hips in 37 female patients and nine hips in seven male patients. Thirty-two right hips and 20 left hips were treated. Four of the 52 hips had prior hip surgery (arthroscopy) without relief of symptoms. Preoperative crossover sign was present in 43 of 51 hips (84.3%). Mean lateral CEA preoperatively was 32.8° (range, 21°–45°). The mean preoperative alpha angle was 53° (range, 33°–85°). The minimum followup was 12 months (average, 27 months;

Table 1. Patient-oriented assessment of hip function and ROM

Measurement tool	Preoperative mean (range)	Postoperative mean (range)	Improvement, mean percent of hips (range)	Outcomes
Modified HHS	57.7 (14.3–95.7)	85.8 (40.7–100)	84.4 34.4 (16.5–59.4)	Modified HHS > 90 Excellent: 30 hips (58%) Modified HHS 80–89 Good: 8 hips (15%) Modified HHS 70–79 Fair: 3 hips (6%) Modified HHS < 70 Poor: 11 hips (21%)
SF-12 physical	42.4 (18.8–53.4)	50.5 (28.8–58.8)	86.8 10.6 (0.86–27.14)	
SF-12 mental	51.9 (33.3–62.9)	53.9 (27.6–65.5)	68.4 7.03 (0.05–25.4)	
Hip flexion	97.6° (80°–125°)	106.3° (90°–125°)	75 13.1° (5°–35°)	
Internal rotation at 90°	18.3° (−5°–45°)	34.5° (15°–50°)	86.9% 19.4° (5°–40°)	

HHS = Harris hip score.

range, 12–60 months). In this cohort there were 30 patients (36 hips) with a minimum 24-month followup (range, 24–60 months). There were 14 patients (16 hips) with only 12 months followup and one patient (one hip) with 18 months followup who did not return for their 2-year followup despite attempts at contacting the families.

Changes in the following outcome variables as a result of surgical hip dislocation from the preoperative to the final postoperative followup were analyzed: hip flexion, hip internal rotation, modified HHS, and SF-12 score. Variables that are associated with the outcomes were analyzed including gender, lateral CEA, and alpha angle. Complications of the procedure and subsequent procedures such as implant removal or hip arthroscopy were noted.

Statistical analyses were performed using SAS 9.2 software (SAS Institute Inc, Cary, NC, USA). An exact method was used to calculate 95% CIs for proportions. Paired t-tests were used to analyze changes between preoperative and postoperative outcome measures. Using a dichotomized variable to define clinically significant improvement, binary logistic regression then was performed to explore factors predicting improvement in subgroup analyses. Candidate predictors included gender, age at surgery, length of followup, labral repair, lateral CEA, and alpha angle. The Pearson correlation coefficient was used to assess the extent of correlation between the different outcome measures. The level of significance was set at a probability of 0.05 or less for all analyses. Improvement of the modified HHS was set at greater than 10 points.

Results

The modified HHS increased from a mean of 57.7 points (range, 14.3–95.7 points) preoperatively to a mean of 85.8 points (range, 40.7–100 points) postoperatively ($p < 0.001$). Preoperatively one hip was rated as excellent, one was good, seven were fair, and 36 were poor. At the time of final followup, 30 hips were rated as excellent (modified HHS > 90) and eight were good (modified HHS, 80–89). Therefore, 38 hips (73%) were considered good or excellent (modified HHS > 80). Three hips were fair (modified HHS 70–79), and 11 hips (21%) were poor (modified HHS < 70). Of the 36 patients with poor preoperative modified HHS, 26 were considered to have a good or excellent score postoperatively. Of the 5 patients (5 hips) with poor scores postoperatively, five () had substantial improvement in modified HHS ranging from 17.6 to 53.9 points (Table 1). Of the 45 hips with preoperative and postoperative modified HHSs, 38 (84.4%) (95% CI, 74%–95%) had substantial improvement (> 10 points) in modified HHS with a mean improvement of 34.4 points (range, 16.5–59.4 points). SF-12 scores increased from a preoperative mean of 42.3 (range, 18.8–53.4) to a postoperative mean of 50.6 (range, 28.8–58.5) in 39 patients ($p < 0.0001$). All but five patients improved in their SF-12 physical component; three of five who did not improve also had a corresponding decrease in their modified HHS. Of the 39 patients with preoperative and postoperative SF-12 mental scores, 26 had higher scores and 13 had lower scores postoperatively. Hip ROM (either hip flexion or internal rotation) improved after surgery as follows: the preoperative hip flexion increased ($p < 0.001$) from a mean of 97.5° (range, 80°–125°) to a mean of 106.2° (range, 90°–125°) with improvement in 37 of 49 hips. The mean preoperative internal rotation of the affected hips at 90° flexion was 18.19° (range, −5° to 45°) and improved to 34° (range, 15°–50°) ($p < 0.001$) with increased internal rotation in 40 of 47 hips (85.1%).

On subgroup analysis, no demographic or surgical variables (including sex, age at surgery, length of followup, labral repair, lateral CEA, and alpha angle) were predictive of any of the measured outcome scores. This was likely the result of the small number of patients without clinical improvement in this cohort (six hips), which may have limited our statistical ability to identify a relationship if one were to have been present. There was a correlation between SF-12 physical score and modified HHS ($r = 0.75$, $p < 0.001$), but there was no correlation between SF-12 mental scores and modified HHS ($r = 0.21$, $p = 0.19$).

Fifteen patients had subsequent surgery after the index procedure. Nine hips had trochanteric screw removal alone. Other reoperations were necessary in six hips: arthroscopy ($n = 5$) and periacetabular osteotomy ($n = 1$). All patients who underwent arthroscopy to débride capsular scar tissue had higher final modified HHS scores compared with preoperative scores. The only reported complication was a Grade I complication [31], asymptomatic heterotopic ossification (Brooker Grade 1) [4]. There were no instances of trochanteric nonunion, postoperative infection, fracture, pulmonary emboli, or other major complications. The subset of patients (six of 44) whose scores did not improve was a diverse group; we were able to arrive at no conclusions regarding the reason for lack of improvement. One patient had a preoperative modified HHS of 95.7 (of 100) and there was no change postoperatively. However, internal rotation in this patient increased by 40° (range, −5° to 35°). One female patient had a history of being treated for a complex regional pain syndrome and had a severe SCFE on the contralateral side. One patient also had borderline hip dysplasia (lateral CEA of 22°); however, impingement was the primary presenting symptom. After the impingement symptoms improved in this patient, complaints attributed to hip instability were present and a periacetabular osteotomy was performed. Another female patient has an undiagnosed soft tissue autoimmune disorder yet had enough symptom relief that she opted for surgery on the contralateral side. Three of the six patients whose modified HHSs were not improved had a major decrease in SF-12 mental scores.

Discussion

FAI occurs when osseous abnormalities of the proximal femur and acetabulum result in hip pain, acetabular labral, and cartilage injury [15]. The pathomechanics of FAI eventually may lead to osteoarthritis. The goals of surgical treatment are to provide impingement-free physiologic hip motion either by recreating the offset between the femoral head-neck junction or by acetabular rim resection and labral refixation. An understanding of the potential benefits and risks of surgery for FAI in the pediatric and adolescent populations is important because these populations will likely have less cartilage injury, and therefore might benefit most from the procedure. Outcome studies have shown arthroscopic and open approaches have improved pain and function in the short- to midterm [1, 3, 12, 23, 24, 28]. The majority of these studies, however, focused on patients older than adolescents. Other studies are of adolescent cohorts who were treated by an arthroscopic approach or include results of residual pediatric deformity such as Legg-Calvé-Perthes disease or SCFE [13, 27, 32]. In the current study, we analyzed a consecutive adolescent cohort who underwent surgical hip dislocation for FAI not caused by common childhood structural abnormalities such as Legg-Calvé-Perthes disease or SCFE.

We acknowledge limitations to this study. As with previous studies, the long-term benefits of impingement surgery and its capacity to alter the natural history of osteoarthritis remain unknown. Additionally, although treatment was not randomized and there was no control group for comparison, this cohort study was comprised of a consecutive series of surgical hip dislocations for FAI in which all patients had conservative treatment that failed. We chose a consecutive series to avoid selection bias. Loss to followup may limit our ability to draw conclusions from the results of this series. Of 61 patients (71 hips) who had a surgical dislocation during the study period, 44 patients (52 hips) consented to participate in the study and 14 of the remaining 44 patients chose not to return after 1-year followup, leaving 51% of the original cohort available for analysis at a minimum followup of 2 years, so patients with 12 months of followup were included in the analysis. The outcome measures used in this study are not specifically validated in pediatric and adolescent patients; however, they have been validated for hip disorders and are the best available outcome metrics for this patient cohort. Finally, this cohort was treated between 2006 and 2009. There have been advances in some of the diagnostic tests and improved understanding of FAI since that time. For example, the use of CT and looking closer at acetabular and femoral version and diagnostic intraarticular injections may alter indications for surgery and the procedure chosen in a minority of patients; based on these advances, it is difficult to say how differently the cohort currently would be treated.

In one of the studies looking at this age group, Spencer et al. [32] reported a retrospective case series of 19 patients who underwent surgical hip dislocation and osteoplasty with and without intertrochanteric osteotomy. All patients in their series had femoral-sided cam lesions that were either idiopathic ($n = 7$) or related to healed SCFE deformity ($n = 12$). At an average 1-year followup, 12 of 19 patients noted improvement in WOMAC scores; however, subgroup analysis of the seven patients who underwent femoral head-neck osteoplasty for idiopathic cam deformity indicated poorer outcomes. Of that group, five of the seven patients had minimal relief or symptoms that worsened postoperatively. The results of our series correspond only to treatment for FAI (excluding other pediatric deformity), so comparison is not possible. The poorer results in their idiopathic cam group were not seen in our series; however, both series indicate improved ROM and a minimal complication rate.

Three series have evaluated arthroscopic management of FAI in pediatric and adolescent populations [13, 26, 27]. Philippon et al. [27] reported clinical improvements in modified HHS and hip outcome score instruments in 16 hips after arthroscopy for treatment of FAI in a cohort of active adolescents at an average followup of 1.36 years. Fabricant et al. [13] reported a retrospective series of 27 hip arthroscopies for cam, pincer, and combined disorders. Improvements in modified HHS similar to those reported for the adult population [7, 16, 18, 25, 27] were noted in all patients at an average followup of 1.5 years. Additional procedures included arthroscopic psoas fractional lengthening in 25% of patients. Finally, Philippon et al. [26] described outcomes in 60 patients with a mean age of 15 years at a mean followup of 3 years. In their series [26], the modified HHS increased from 57 to 91 on average; clinical improvement also was substantially higher postoperatively. Thirteen percent of their patients underwent surgery to release capsulolabral adhesions [26], which occurred in 10% of our open treatment group.

There are several strengths of our study when compared with previous studies. This is the only consecutive series of pediatric and adolescent patients who underwent open surgical treatment for purely idiopathic FAI (excluding Perthes, SCFE, and osteonecrosis). Furthermore, our patients had an average of 27 months of followup (range, 12–60 months). We also quantify improvements in hip ROM and validated quality-of-life measures (SF-12 scores) in addition to validated hip-specific outcome scores (modified HHS) in the adolescent population. Finally, although data were analyzed retrospectively, all measures, outcomes, and examination findings were collected prospectively, thus reducing the likelihood of recall bias.

Thirteen patients (15 hips) of the 44 patients (52 hips) for whom followup was available (29%) underwent reoperation. Five of these patients underwent arthroscopy to release capsular scar tissue for lesions, described by Beck [2], after surgical hip dislocation in which the capsule became adherent to the femoral neck leading to secondary impingement. In a followup study, Dudda et al. reported 18 of 21 patients had relief of symptoms after capsular scar release [11]. We found similar results in our series when arthroscopy was used to further resolve the symptoms. All of these patients had improved modified HHS after lysis of these adhesions. Because a trochanteric osteotomy is part of the surgical dislocation approach, outpatient implant removal of symptomatic implants is cause for potential reoperation in these patients.

We observed improvements in validated measures of hip function, patient quality of life, and ROM (particularly hip flexion and internal rotation) after open treatment in a cohort of pediatric and adolescent patients with FAI. Improvements experienced in this cohort were similar to those reported in the literature with few complications. Although the majority of patients improved in the short term, there was a group of patients who did not get a high level of function or pain relief from the procedure, and nearly 30% of the patients underwent reoperations (although most were for removal of hardware). These issues highlight the challenges when treating this group of adolescents with significant hip pain. We await long-term studies to determine whether benefits from open surgical treatment of FAI persist with time and whether they prevent or delay the onset of hip osteoarthritis.

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