Simultaneous Bilateral Hip Arthroscopy in Adolescent Athletes With Symptomatic Femoroacetabular Impingement

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Background: Femoroacetabular impingement represents a common cause of hip pain in adolescents. The purpose of the present study was to evaluate the safety and efficacy of simultaneous bilateral hip arthroscopy for bilateral symptomatic femoroacetabular impingement in adolescent athletes.

Methods: Clinical data were collected in a prospective database on patients who underwent unilateral or simultaneous bilateral hip arthroscopy and included complications, reoperation rate, and return to play time. Differences in International Hip Outcome Tool (iHOT)-12 scores according to hip side and postoperative follow-up time (preoperative, 1.5, 3, 6, 12, and 24 mo) were evaluated using a 2×6 repeated-measures analysis of variance with post hoc repeated-measures 1-way analysis of variance and Bonferroni-corrected paired t tests.

Results: In total, 24 patients (36 hips) were studied, of whom 12 underwent simultaneous bilateral hip arthroscopy (24 hips) and a case-matched control group of 12 patients underwent unilateral hip arthroscopy. There were 5 males in each group (41.7%). Average age was 15.7 and 16.5 years in the bilateral and unilateral groups, respectively. No patients were lost to follow-up. In the bilateral group, a significant increase in mean iHOT-12 score was observed between 1.5- and 3-month follow-up (61.8 vs. 82.8, respectively; $P = 0.003$), and 6-, 12-, and 24-month follow-up (91.4, 95.1, and 96.6, respectively, $P = 0.004$). At all follow-up times, there were no significant differences in mean iHOT-12 scores or other outcome measures between bilateral and unilateral cohorts. Time to return to preinjury level of activity was similar between the bilateral and unilateral groups (4.7 vs. 4.9 mo, respectively; $P = 0.40$). One transient lateral femoral cutaneous nerve palsy occurred in each group, though no other complications were documented. No patients required revision surgery by latest follow-up.

Conclusions: Bilateral simultaneous hip arthroscopy is safe and reproducible in adolescent athletes, achieving equivalent outcomes, and similar rehabilitation time when compared with unilateral surgery.

Level of Evidence: Level II—therapeutic study.

Key Words: femoroacetabular impingement, hip arthroscopy, adolescent, groin pain

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Femoroacetabular impingement (FAI) represents one of the most common causes of chronic hip pain in adolescent athletes.[1,2] Recent studies have highlighted the propensity for FAI to occur bilaterally.[3–5] Arthroscopic treatment of FAI has historically resulted in high rates of patient satisfaction and return to preinjury level of activity,[6–9] and recent literature has supported arthroscopic treatment of FAI in the adolescent population.[10–13] However, the advantages of bilateral, simultaneous hip arthroscopy under the same anesthetic, which have been demonstrated in adult patients, have not been examined in adolescent patients.[14] Bilateral, simultaneous hip arthroscopy offers advantages such as reduced cost and anesthesia time, perhaps leading to a lower intraoperative complication rate.

The purpose of the present study was to evaluate the safety and efficacy of simultaneous bilateral hip arthroscopy for bilateral symptomatic FAI in adolescent athletes, and to compare these results to adolescent athletes undergoing unilateral hip arthroscopy as a reference standard.

METHODS

Population

In 2012, the senior author implemented an Institutional Review Board-approved prospective registry dedicated to the tracking of patients who presented to a hip preservation center between December 2012 and February

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2015. Inclusion criteria for operated patients selected for this study were as follows: (1) age of 18 years or less, (2) persistent unilateral or bilateral hip pain refractory to nonoperative management, (3) reproducible clinical examination findings suggestive of impingement, and (4) joint-space width > 3 mm on all views of plain radiography and 3-dimensional computed tomography.[15] In addition, all included patients were involved in competitive athletics requiring at least 15 hours of commitment per week. Patients undergoing surgical treatment for diagnoses of acetabular dysplasia, slipped capital femoral epiphysis, Legg-Calve-Perthe disease, osteochondromatosis, or post-dislocation syndrome were excluded.

Imaging Protocol and Measurements

After a comprehensive history and physical examination were performed, patients underwent a standardized series of preoperative plain radiographs [including supine anteroposterior (AP), cross-table lateral, and AP pelvic views], magnetic resonance imaging, and computed tomography scans with 3-dimensional surface-rendered reconstruction of the entire pelvis, proximal femurs, and knees.

In addition to suggestive physical examination findings, the clinical diagnosis of FAI was determined according to accepted pathomorphologic measurements on radiographic and magnetic resonance imaging.[2,15] Confirmative findings of pincer-FAI included features corresponding to focal acetabular overcoverage (cross-over sign or ischial spine sign), a lateral center edge angle exceeding 40 degrees, and/or acetabular inclination < 0 degree. Cam-FAI was diagnosed based on an α angle exceeding 50 degrees on radial sequences of the head-neck junction and a femoral head-neck offset ratio < 0.18. Mixed-FAI diagnosis was diagnosed by the coexistence of pincer-type and cam-type morphologies.

Surgical Technique

The senior author's preferred surgical technique has been described previously.[16–18] The authors do not use deep venous thrombosis prophylaxis unless a patient has known risk factors such as a previous deep venous thrombosis or known coagulopathy. Antibiotic prophylaxis includes 1 to 2 g Ancef (based on patient weight) preoperatively and once additionally at 4 hours intraoperatively. The patient is positioned supine on a traction table with the foot well-padded in a traction boot. The patient is placed in 8 to 13 degrees of Trendelenburg tilt and traction is applied after venting the joint, until 10 to 15 mm of distraction is achieved across the hip joint. No perineal post is used. The operative limb is placed in 0 to 5 degrees abduction with 15 to 20 degrees of internal rotation at the hip, whereas the nonoperative limb is placed in 40 degrees of abduction to allow the fluoroscopy unit access to the hip joint for AP and true cross-table lateral views.

With the aid of fluoroscopy, the hip is cannulated using the standard anterolateral and midanterior portals. An intraportal capsulotomy is performed. The joint is assessed and the central compartment pathology is addressed. Traction is then released, the table is brought back to a horizontal position, and the peripheral compartment intervention is undertaken after which the anterior portion of the intraportal capsulotomy is closed with interrupted absorbable sutures (Vicryl no. 2). The wounds are closed in a standard manner.[19] The patient and equipment is repositioned to allow access to the contralateral limb (shavers, burrs, wands, and all sterile instruments are protected and reused), the second side is redraped and the surgical intervention is undertaken in a similar manner as the first hip.

Patients are usually discharged home within 2 to 3 hours after the procedure. Less than 5% of patients stay overnight due to anesthesia side effects such as nausea or vomiting. Patients are placed on nonsteroidal anti-inflammatory drugs (naproxen orally 2 times per day) for 30 days as prophylaxis against heterotopic ossification if large cam or pincer lesions were addressed. Patients start riding a stationary bicycle with no resistance on the day of surgery or the first postoperative morning. Formal physical therapy is begun ~7 to 10 days postoperatively following a designated protocol. Patients are permitted full weight-bearing with crutches used for 2 weeks as needed or until walking without a limp. If a large cam lesion was removed, the patient will be asked to use crutches, full weight-bearing, for 5 to 6 weeks to avoid a potential femoral neck stress fracture.

Patients in this study underwent at least one of the following procedures: labral repair, pincer resection, cam resection, and ligamentum teres thermal debridement. In addition, synovectomy was performed and all patients underwent capsule repair at the end of the procedure. Procedures were comparable between hips in patients undergoing bilateral hip arthroscopy as well as between unilateral and bilateral cohorts.

Outcome Measures

All patients filled out demographic data sheets and preoperative hip outcome scores (iHOT-12).[20] Demographic data collected included age, sex, height, weight, body mass index (BMI), duration of symptoms, level of activity, and presence of adductor, abductor, or abdominal symptoms. The iHOT-12 is a short, 12-question version of the iHOT-33. The iHOT-12 is a validated questionnaire and has shown excellent agreement with results of the iHOT-33.[20] Questions are graded on a visual analog scale and are related to 4 domains of the iHOT: symptoms and functional limitations; sport and recreational activities; job-related concerns; and social, emotional, and lifestyle concerns.

Prospective clinical data collected on each patient included complications associated with the surgical procedure, need for surgical revision, length of hospital stay, and return to play time. The primary outcome measure used in this study was the iHOT-12 score, which was collected preoperatively and at 1.5, 3, 6, 12, and 24 months postoperatively. Only those patients with iHOT scores at a minimum of 1 year were included in this study.

In addition, patients were asked to record the daily amount of time they cycled on the stationary bike for the first 2 weeks. The recommended starting time was 5 minutes twice daily with 0 resistance, building up gradually as patients felt comfortable.

Statistical Analysis

A priori power analysis indicated that a total sample size of 24 hips would be required given a 2×6 repeated-measures analysis of variance with an effect size of the primary outcome measure of 0.30 (medium), an α of 0.05, and a required power (1-β) of 0.80.[21] Descriptive statistics were summarized as means and SDs for quantitative variables and as counts and frequencies for categorical variables. Baseline demographic characteristics were compared between the unilateral and bilateral surgery cohorts using the Fisher exact tests, χ^2 tests, and independent samples t tests. iHOT-12 outcomes were modeled longitudinally using a generalized estimation equation with an unstructured working correlation, identity link function, and robust SEs.[22] The generalized linear model included intervention (bilateral or unilateral surgery), time (preoperative, 1.5, 3, 6, 12, and 24 mo postoperatively), and the interaction term of intervention $\times$ time terms. A parsimonious model was determined using a backwards, stepwise hierarchical approach. Statistical significance for all comparisons was set at $P < 0.05$ (2-tailed).

RESULTS

Participants and Descriptive Data

In total, 24 patients (36 hips) were studied, of which 12 patients underwent simultaneous bilateral (same anesthetic, consecutive FAI cohort) hip arthroscopy and 12 patients underwent unilateral hip arthroscopy. All patients who underwent unilateral hip arthroscopy had unilateral symptomatology. The cohorts were matched based on age, sex, BMI, pathology, activity level, and follow-up time. There were 5 males in each group (41.7%). Average age was 15.7 ± 1.4 and 16.5 ± 1.9 years in the bilateral and unilateral cohorts, respectively. No patients were lost to follow-up. Ten patients in each group completed 2-year follow-up, whereas 2 patients per group were between 1- and 2-year follow-up during outcomes analysis. Sports in which patients were involved included high-level competitive/performance dance, soccer, football, skateboarding, lacrosse, and basketball. Overall, the average duration between symptom onset and surgery was 6 months (range, 5 to 13 mo).

Patient demographics are outlined in Table 1. Clinical indications for surgery included mixed-type FAI in 16 (66.7%) patients, isolated cam-type FAI in 5 (20.8%) patients, and isolated pincer-type FAI in 3 (12.5%) patients. There were no significant differences in age, height, weight, BMI, sex, or incidence of FAI subtypes between the bilateral and unilateral hip arthroscopy groups (Table 1).

TABLE 1. Patient Demographics and Baseline Characteristics

	Bilateral (Experimental) Cohort	Unilateral (Control) Cohort	P*
Total no. patients (no. hips) (N)	12 (24)	12 (12)	—
Male sex [n (%)]	5 (41.7)	5 (41.7)	NS
Age [mean (SD)] (y)	15.7 (1.4)	16.5 (1.9)	NS
Height [mean (SD)] (cm)	167.0 (12.2)	170.7 (12.4)	NS
Weight [mean (SD)] (kg)	56.8 (15.3)	63.8 (17.6)	NS
BMI [mean (SD)] (kg/m^2)	20.3 (3.1)	21.5 (2.9)	NS
Clinical diagnosis, no. hips (%)			
Mixed-type FAI	16 (66.7)	6 (50)	NS
Cam-type FAI	5 (20.8)	4 (33.3)	NS
Pincer-type FAI	3 (12.5)	2 (16.6)	NS

*Comparison of variable of interest between bilateral and unilateral surgery cohorts using the Fisher exact, χ^2, or independent samples t tests ($P > 0.05$).

BMI indicates body mass index; FAI, femoroacetabular impingement; NS, nonsignificant.

Evaluation of Postoperative Outcome Using the iHOT-12 Score

Generalized estimating equation analysis showed no significant differences in mean iHOT-12 score between bilateral and unilateral surgical cohorts at any follow-up period. In both cohorts, mean iHOT-12 score increased significantly between preoperative and 1.5 months postoperative (pooled difference, 18.0 points; $P < 0.001$) and between 1.5 and 3 months postoperative (pooled difference, 20.2 points; $P < 0.001$; Fig. 1). Mean iHOT-12 scores remained statistically unchanged in both cohorts from 3 to 24 months postoperatively (Fig. 1).

There was no difference between bilateral and unilateral cohorts in the length of time patients were able to cycle on a stationary bike at 2 weeks postoperatively (29.2 vs. 33.7 min daily, respectively; $P = 0.41$) or in total time required for return to preinjury level of activity (4.7 vs. 4.9 mo, respectively; $P = 0.40$).

No postoperative complications were seen in either group with the exception of 1 patient in each group who sustained a temporary paresthesia along the distribution of the lateral femoral cutaneous nerve, which resolved in both cases by 2 weeks postoperatively. Neither group demonstrated a requirement for operative revision at 2-year follow-up.

DISCUSSION

The purpose of this study was to investigate the safety and efficacy of bilateral hip arthroscopy under a single anesthetic in an adolescent population. The authors also sought to compare outcome scores and time to return to sport between these patients and those who underwent unilateral surgery. Our results indicate that adolescent patients undergoing simultaneous bilateral hip arthroscopy attain similar outcome scores and time to return to sports as patients undergoing unilateral surgery. These

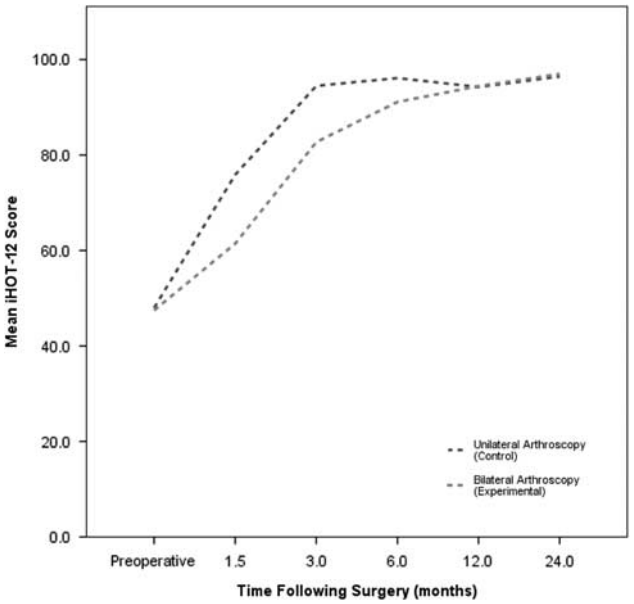

FIGURE 1. Mean iHOT-12 scores in patients undergoing bilateral simultaneous hip arthroscopy (gray) or unilateral hip arthroscopy (black). There were no significant differences in mean iHOT-12 scores between both cohorts at any postoperative follow-up time. Within both groups, a significant increase in mean iHOT-12 score was observed from preoperative to 1.5 months postoperative, and from 1.5 to 3 months postoperative ($P<0.001$ for all comparisons). Mean iHOT-12 scores remained statistically unchanged between 3 to 24 months postoperative. iHOT indicates International Hip Outcome Tool.

results were obtained without an increase in complications, use of pain medications, or reoperation rate. The results of the current study support the performance of simultaneous bilateral hip arthroscopy in appropriately selected adolescents with bilateral symptomatic FAI.

FAI is a common cause of groin pain in the young athletic population,[11,12] and radiographic findings of FAI are common in elite athletes.[23,24] Both open and arthroscopic treatments of FAI in adolescents have been shown to be effective with significant improvements in outcome scores. Sink et al[25] reported the results of open surgical dislocation for the treatment of FAI in 44 adolescents. They found a significant improvement in range of motion and functional outcomes, with the Harris Hip Score improving from 57.7 preoperatively to 85.8 postoperatively.

In our study, patients undergoing simultaneous bilateral hip arthroscopy achieved a mean improvement on the iHOT-12 of nearly 50 points at 1- and 2-year follow-up. These results demonstrate a return to function that paralleled and even showed an overall trend to greater improvement than the unilateral group. Female patients in this study were found to have an average preoperative iHOT-12 score almost 20 points lower than their male counterparts but achieved equivalent postoperative outcome scores as early as 3 months (38.7-88.1 mo) postoperatively.

Philippon et al[12] reported positive findings after unilateral hip arthroscopy in adolescents with FAI and an average age of 15 years. The mean improvement in Modified Harris Hip Score (mHHS) was 35 points at 1.4 years postoperatively and there was an overall high level of patient satisfaction. In 2012, Philippon et al[11] reported 2- to 5-year outcomes of hip arthroscopy in adolescents with maintained excellent outcomes evidenced by a mean improvement in the Harris Hip Score (HHS) from 57 preoperatively to 91 postoperatively. Fabricant et al[26] presented similar results after arthroscopic treatment of 21 adolescents with FAI with a mean improvement in mHHS of 21 points and significant improvements in the activities of daily living (16-point improvement) and sports outcome (32-point improvement) subsets of the Hip Outcome Score. In a recent systematic review of 435 hips, the results of both open and arthroscopic treatment of FAI in adolescents were positive with an incidence of minor complications of 3.6% and no major complications reported.[10] Similar to these previous studies, both groups in our study also had excellent improvement in outcome scores.

Bilateral radiographic findings of FAI are common. Allen et al[3] reported a 77.8% prevalence of bilateral radiographic findings in patients presenting with FAI, 26.1% of whom had bilateral symptoms. Predicting which hips with bilateral findings will eventually require surgery can be challenging but some factors known to increase the chance of requiring bilateral surgery are male sex, younger age, higher α angles, and reduced acetabular anteversion at initial presentation.[5] Bilateral hip arthroscopy under the same anesthetic has been shown to be safe in past research. Mei-Dan et al[14] demonstrated that bilateral hip arthroscopy for symptomatic FAI did not result in more pain, analgesic use, or a longer hospital stay. Most importantly, it showed that patients who received bilateral surgery had similar outcome scores at 6 and 12 months as those patients having surgery on a single symptomatic side. This allowed for a faster return to work and sports than if they had undergone staged procedures with 2 separate recovery periods. Among all patients in this study, average age was 33 years, though results were not described for a subgroup of adolescent patients.[14] In a similar study, Degen et al[4] found no difference in outcome scores or complications at 1-year follow-up after bilateral simultaneous versus staged hip arthroscopy in patients with bilateral symptoms. Patients in this study undergoing simultaneous hip arthroscopy had an average age at surgery of 21.4 years though, again, results were not described specifically for adolescents.

In this study, the authors have shown that simultaneous bilateral hip arthroscopy is safe and effective in treating bilateral symptomatic FAI in adolescents with equivalent subjective outcomes and return to sport times compared with a case-matched control group. The ability to return to a symptom-free status and return to sports quicker has important implications in this young athletic population. Another important consideration in patients who have bilateral symptoms is that they may not be able

to fully participate in rehabilitation until the second hip is surgically managed due to ongoing symptoms, which may support bilateral simultaneous surgery in appropriately selected patients. In an elite athletic population, this may mean the difference between returning to sport during the offseason and obtaining a scholarship. Of course, the benefits extend to all adolescents, not just those participating at an elite level of play, as it allows a faster return to school as well as a normal active and social life.

Careful selection of patients for bilateral surgery is important to allow a safe rehabilitation. Bilateral surgery should be avoided if prolonged protected weight-bearing is anticipated (such as after microfracture or borderline hip dysplasia), if prolonged traction time is anticipated, or if a patient is not in appropriate medical or physical condition for a longer duration of surgery.

The limitations of this study are the relatively low number of patients who underwent the procedure with a single high-volume hip preservation surgeon, inability to perform subgroup analysis comparison between sexes, and short-term follow-up.

The current study demonstrated excellent outcomes and statistically insignificant differences in outcome scores between the unilateral and bilateral cohorts at all postoperative follow-up time intervals. Furthermore, the bilateral cohort experienced no increase in complication rate, postoperative stay, or postoperative pain, thereby demonstrating that bilateral hip arthroscopy under 1 anesthetic represents a safe and effective procedure in appropriately selected patients.

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