A Comparison of Clinical Outcomes After Unilateral or Bilateral Hip Arthroscopic Surgery

Age- and Sex-Matched Cohort Study

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Background: A significant number of patients undergoing hip arthroscopic surgery for femoroacetabular impingement (FAI) have bilateral deformities and may require surgery for both hips.

Purpose: To compare outcomes between patients who underwent bilateral hip arthroscopic surgery to a matched cohort of patients who underwent unilateral hip arthroscopic surgery.

Study Design: Cohort study; Level of evidence, 3.

Methods: A consecutive series of patients who underwent primary hip arthroscopic surgery for FAI by a single fellowship-trained surgeon from January 2012 to January 2014 and had a minimum follow-up of 2 years were evaluated. Patients who underwent staged bilateral hip arthroscopic surgery were identified and matched 1:2 to patients who underwent unilateral hip arthroscopic surgery based on age, sex, and body mass index (BMI). Demographic, preoperative, and postoperative variables were compared between the groups.

Results: Forty-three patients in the bilateral group were matched with 86 patients in the unilateral group based on sex (24 female [56%] vs 48 female [56%], respectively; $P > .99$), age (28.6 $\pm$ 10.8 years vs 28.9 $\pm$ 10.8 years, respectively; $P = .88$), and BMI (24.8 $\pm$ 5.8 kg/m^2 vs 24.8 $\pm$ 4.0 kg/m^2, respectively; $P = .98$). There were no significant preoperative demographic or radiographic differences between the groups. Both groups demonstrated significant preoperative to postoperative improvements in the Hip Outcome Score–Activities of Daily Living (HOS-ADL), Hip Outcome Score–Sports Subscale (HOS-SS), and modified Harris Hip Score (mHHS) ($P < .0001$ for all). When compared with patients in the unilateral group, patients who underwent bilateral hip arthroscopic surgery had less improvement in mHHS and pain scores. Sixty-five (76%) patients in the unilateral group achieved the minimum clinically important difference (MCID) for the mHHS compared with 21 (49%) in the bilateral group ($P = .03$), while 64 (74%) patients achieved the patient acceptable symptomatic state (PASS) for the mHHS compared with 22 (51%) in the bilateral group ($P = .02$). Patients in the bilateral group with greater than 10 months between surgical procedures had lower postoperative HOS-ADL scores ($P = .04$) and lower improvement in pain and HOS-SS scores ($P < .0001$ and $P = .05$, respectively).

Conclusion: Patients who underwent unilateral and bilateral hip arthroscopic surgery for FAI had improved functional outcomes after 2 years. However, patients who underwent bilateral hip arthroscopic surgery had less improvement in their mHHS and pain scores compared with those who underwent unilateral hip arthroscopic surgery but no differences in HOS-ADL, HOS-SS, or satisfaction scores. Patients in the bilateral group with longer than 10 months between surgical procedures had lower outcome scores than patients who underwent their second surgical procedure within 10 months of their primary surgery.

Keywords: hip arthroscopic surgery; FAI; bilateral; patient acceptable symptomatic state (PASS)

Femoroacetabular impingement (FAI), first described by Ganz et al[14] in 2003, is a common cause of hip pain and disability. The osseous abnormalities in FAI, including cam and pincer impingement, can cause labral tears and premature cartilage injuries.[4,14,33] Left untreated, FAI and its sequelae may lead to abnormal hip joint kinematics

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and contact forces, predisposing the hip to premature secondary osteoarthritis.[3,33,34] Several treatment strategies address FAI including open procedures, hip arthroscopic surgery, or a combination of both. Over the past several years, hip arthroscopic surgery has evolved to become the primary treatment strategy for FAI, with improvements in pain and function with a low complication rate.[8,13,18]

Patients with symptomatic FAI frequently inquire about the treatment prognosis as well as the risk for similar injuries on the contralateral side. Allen et al[1] found evidence of contralateral radiographic disease in 78% of patients presenting with symptomatic FAI; however, only 26% of the contralateral hips were symptomatic. More recent studies have found that up to 20% of patients with FAI require a second procedure for contralateral disease.[21] Several reports of simultaneous bilateral arthroscopic surgery for FAI have shown comparable outcomes to patients undergoing a staged bilateral approach.[10,29] The advantages of simultaneous surgery include the use of a single anesthetic, a shorter recovery with faster return to activity and sport, and minimizing repeated postoperative and rehabilitation costs.[10] The disadvantages can include a longer time under anesthesia, prolonged traction time, and more challenging initial rehabilitation requiring 4-point gait.[22] While there is evidence to suggest that patients who undergo simultaneous or staged bilateral hip arthroscopic surgery have similar improvements in clinical outcomes with low complication rates, there remains a paucity in the literature regarding the timing of the second surgical procedure and comparative outcomes with matched unilateral control groups.

The purpose of this study was to compare patient demographics as well as outcomes and complications between patients who underwent staged bilateral hip arthroscopic surgery with patients who underwent unilateral hip arthroscopic surgery. We hypothesized that at a minimum 2-year follow-up, patients who underwent bilateral hip arthroscopic surgery would have similar functional outcomes and complication rates to patients who underwent unilateral hip arthroscopic surgery.

METHODS

Patient Selection

An institutional review board (IRB)–approved (#120221080) clinical repository of continuous patients undergoing hip arthroscopic surgery from January 1, 2012 to January 1, 2014 at the senior author's (S.J.N.) institution was accessed to identify patients undergoing bilateral surgery. Inclusion criteria required a clinical diagnosis of bilateral FAI with surgical correction of cam and/or pincer deformities. Both patients presenting with bilateral hip pain as well as patients presenting with unilateral hip pain who developed contralateral-sided pain were included in the study. Patients in the unilateral group did not develop bilateral symptoms in the course of the study. The initial hip arthroscopic procedure must have been performed between January 1, 2012 and January 1, 2014, with the second surgical procedure occurring no later than April 1, 2014. A minimum of 2-year follow-up after the second bilateral surgical procedure was required for inclusion into the study. Exclusion criteria included hip arthroscopic surgery for conditions other than FAI, any history of rheumatological disease, any prior hip surgery or revision hip arthroscopic surgery, and less than a 2-year follow-up. A 2:1 age (±3 years)–, sex-, and, where possible, body mass index (BMI; ±5)–matched group of patients undergoing hip arthroscopic surgery for unilateral FAI was generated from the repository as a control group.[25] Inclusion into the control group required a unilateral presentation as well as unilateral arthroscopic correction for FAI. Patients were excluded from the control group if they met any of the same exclusion criteria as the bilateral group.

Demographic and Clinical Data

Demographic (age, sex, BMI, sport participation) and clinical (presentation side, acuity of presentation, physical examination findings, surgical information, postoperative course) data were obtained from a chart review. Sport participation was assessed based on the history endorsed in the first clinic note. For the purposes of this study, we included all patients who participated in recreational or high-level amateur sports (varsity high school, intercollegiate) as participating in athletics. Radiographic data (preoperative joint space width [JSW], preoperative and postoperative alpha angle, preoperative and postoperative lateral center edge angle [LCEA]) were evaluated using preoperative and postoperative standing anteroposterior (AP) pelvis and Dunn lateral radiographs. The JSW was measured according to the method of Lequesne et al[23] on preoperative AP pelvis radiographs. The diagnosis of FAI was based on both clinical and radiographic evidence.

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The senior author's surgical technique has been published previously.[12,15,35] All patients in the bilateral and unilateral groups underwent femoral osteochondroplasty for cam lesions, acetabular rim trimming for pincer lesions, and capsular closure. Additional procedures including labral repair, microfracture, and trochanteric bursectomy were recorded. All bilateral surgical procedures were performed in a staged manner at a mean 6.1 ± 4.3 months. Patients underwent a 4-phase return-to-activity rehabilitation protocol that was not different between the bilateral and unilateral groups. Patients in the bilateral group had data for their first and second surgical procedures coded separately to allow for a comparison between contralateral procedures.

Functional Outcome Scores

All patients were assigned validated patient-reported outcome (PRO) surveys preoperatively and at 2 years postoperatively. The PRO surveys were administered electronically on a tablet or verbally through a telephone call administered by IRB-approved personnel. Postoperative outcome scores were assessed at a minimum of 2 years after the second surgical procedure in the bilateral group. The primary outcome measure for this study was the Hip Outcome Score–Activities of Daily Living (HOS-ADL), with secondary measures including the Hip Outcome Score–Sports Subscale (HOS-SS) and the modified Harris Hip Score (mHHS).[2,25] Preoperative and postoperative pain levels and satisfaction with surgery were assessed on a visual analog scale (VAS) from 1 to 100. Clinically meaningful improvements were assessed using the minimum clinically important difference (MCID) and patient acceptable symptomatic state (PASS). MCID cutoff values of 9, 6, and 8 were used for the HOS-ADL, HOS-SS, and mHHS, respectively, while PASS cutoff values were 87, 75, and 74, respectively, for the HOS-ADL, HOS-SS, and mHHS.[6,9,26,27]

Statistical Analysis

Statistical analysis was performed using JMP statistical software (SAS Institute). Age, BMI, outcome scores, and similar variables were treated as continuous data, while group status (bilateral/unilateral), sex, PASS/MCID rates, and similar variables were treated as categorical data. One-way analysis of variance was used to compare categorical data with continuous data, the Fisher 2-tailed exact test was used to compare categorical data with categorical data, and bivariate regression was used to compare continuous data with continuous data. The matched-pair t test was used when comparing preoperative and postoperative data. Means and SDs were reported for continuous data, while percentages were reported for categorical data. A standard least squares multivariate model was constructed to evaluate the effect of age, sex, BMI, smoking status, surgical group (unilateral vs bilateral), and preoperative mHHS score on postoperative improvement of the mHHS score. A receiver operating characteristic (ROC) curve comparing the MCID and PASS rates for the HOS-ADL to the time between surgical procedures was constructed to identify a cutoff point based on maximizing the specificity and sensitivity of achieving clinical significance. An a priori power analysis revealed that 364 patients in the bilateral group and 728 patients in the unilateral group would be required to detect a difference between improvements in the HOS-ADL, with a power ($1 - \beta$) of 80% and α error of 0.05. An alpha value ≤0.05 was used to determine statistical significance.

RESULTS

Patient Selection and Group Generation

Of the 474 patients who underwent primary hip arthroscopic surgery between January 1, 2012 and January 1, 2014, 71 (15%) patients underwent bilateral surgery. Of these, there was a minimum 2-year follow-up on 66 patients (93%). Twenty-three patients were excluded because their first surgery occurred before January 1, 2012 or their second surgery occurred after April 1, 2014, resulting in a final bilateral group of 43 patients (86 hips) with a mean follow-up of 2.3 ± 0.37 years. From the 403 patients in the repository who underwent unilateral hip arthroscopic surgery, 51 (13%) developed contralateral symptoms and were excluded from the study. Of the remaining 352 patients, a 2:1 age (±3 years)–, sex-, and BMI (±5)–matched control group was constructed (86 patients) with a mean follow-up of 2.64 ± 0.56 years. One patient in the bilateral group was unable to have the BMI matched to 2 controls because of a preoperative BMI of 45 kg/m^2.

Patient Demographics and Clinical Data

The bilateral group was composed of 43 patients with 24 female patients (56%), a mean age of 28.6 ± 10.8 years (range, 14-54 years), and a mean BMI of 24.8 ± 5.8 kg/m^2 (range, 18-45 kg/m^2) (Table 1). The unilateral group contained 86 patients with 48 female patients (56%), a mean age of 28.9 ± 10.8 years (range, 15-57 years), and a mean BMI of 24.8 ± 4.0 kg/m^2 (range, 19-42 kg/m^2). There were no differences in sport participation between the unilateral and bilateral groups (66 [77%] vs 34 [79%], respectively; P = .83). Clinically, 28 patients in the bilateral group had bilateral hip pain, while the remaining 15 developed contralateral hip pain after primary arthroscopic surgery. No patients in the unilateral group endorsed bilateral symptoms. There were no differences in preoperative or postoperative flexion, external rotation, or internal rotation between the groups (Table 1). Preoperative to postoperative flexion and internal rotation increased significantly for both groups, but the bilateral group did not demonstrate an increase in postoperative external rotation (44.6° ± 10.2° to 44.5° ± 4.7°; P = .79), while the unilateral group had increased external rotation postoperatively (42.2° ± 10.9° to 46.0° ± 9.8°; P = .006).

The mean alpha angle for the bilateral group was 63.4° ± 10.9° preoperatively, which decreased to 39.3° ± 4.3° after surgery (P < .0001). The mean alpha angle for the unilateral group was 61.7° ± 10.8° preoperatively and decreased to 39.3° ± 4.1° postoperatively (P < .0001) (Table 1). There

TABLE 1
Demographic, Clinical, and Radiographic Characteristics of Unilateral and Bilateral Groups[a]

	Unilateral	Bilateral	*P* Value
Demographics			
Patients/hips, n	86/86	43/86	>.99
Female sex, n (%)	48 (56)	24 (56)	>.99
Age, y	28.9 ± 10.8	28.6 ± 10.8	.88
BMI, kg/m^2	24.8 ± 4.0	24.8 ± 5.8	.98
Sport participation, n (%)	66 (77)	34 (79)	.83
Clinical findings			
Bilateral presentation, n (%)	0 (0)	28 (65)	—
Acute presentation, n (%)	25 (29)	11 (26)	.57
Flexion, deg			
Preoperative	112.0 ± 13.6	112.0 ± 14.8	.91
Postoperative	119.9 ± 13.1	117.0 ± 9.7	.17
P value	**<.0001**	**.0019**	
External rotation, deg			
Preoperative	42.2 ± 10.9	44.6 ± 10.2	.13
Postoperative	46.0 ± 9.8	44.5 ± 4.7	.32
P value	**.006**	.79	
Internal rotation, deg			
Preoperative	15.1 ± 10.7	14.8 ± 10.1	.85
Postoperative	21.4 ± 8.4	19.9 ± 6.6	.21
P value	**<.0001**	**<.0001**	
Radiographic measurements			
Alpha angle, deg			
Preoperative	61.7 ± 10.8	63.4 ± 10.9	.32
Postoperative	39.3 ± 4.1	39.3 ± 4.3	.97
P value	**<.0001**	**<.0001**	
LCEA, deg			
Preoperative	32.8 ± 6.2	32.3 ± 4.6	.54
Postoperative	30.0 ± 4.9	28.8 ± 4.2	.09
P value	**<.0001**	**<.0001**	
JSW, mm			
Lateral	4.7 ± 0.8	4.4 ± 1.0	.10
Apical	4.2 ± 0.7	4.2 ± 0.9	.74
Medial	4.2 ± 0.8	4.3 ± 0.9	.60
Average	4.3 ± 0.6	4.3 ± 0.7	.70
Tönnis grade 1, n (%)	5 (6)	9 (21)	.41

[a]Data are presented as mean ± SD unless otherwise specified. Bolded values indicate significance when preoperative and postoperative data were compared. BMI, body mass index; JSW, joint space width; LCEA, lateral center edge angle.

were no significant differences between the preoperative and postoperative alpha angles between the groups (*P* = .32 and *P* = .97, respectively). The mean LCEA decreased for both the bilateral (32.3° ± 4.6° to 28.8° ± 4.2°; *P* < .0001) and unilateral groups (32.8° ± 6.2° to 30.0° ± 4.9°; *P* < .0001). There were no differences between the preoperative and postoperative LCEAs between the groups (*P* = .54 and *P* = .09, respectively). There was no difference in the mean preoperative JSW between the bilateral and unilateral groups (4.3 ± 0.7 mm vs 4.3 ± 0.6 mm, respectively; *P* = .70).

Operative Data and Postoperative Course

Intraoperatively, cam deformities were identified in 84 (98%) bilateral hips compared with 78 (91%) hips in the unilateral group (*P* = .09) (Table 2). Bilateral hips had a greater number of pincer deformities compared with hips in the unilateral group (80 [93%] vs 69 [80%], respectively; *P* = .02). There was no difference in the labral tear rate between the bilateral and unilateral groups (85 [99%] vs 83 [97%], respectively; *P* = .62). Cartilage delamination was seen in 30 (35%) hips in the unilateral group compared with 36 (42%) hips in the bilateral group (*P* = .83).

TABLE 2
Intraoperative Data for Unilateral and Bilateral Groups[a]

	Unilateral	Bilateral	*P* Value
Diagnoses			
Cam FAI	78 (91)	84 (98)	.09
Pincer FAI	69 (80)	80 (93)	**.02**
Mixed FAI	67 (78)	78 (91)	**.03**
Labral tear	83 (97)	85 (99)	.62
Procedures			
Labral repair	80 (93)	84 (98)	.28
Cartilage delamination	30 (35)	36 (42)	.83
Femoral osteochondroplasty	85 (99)	86 (100)	>.99
Acetabular rim trimming	71 (83)	80 (93)	.06
Trochanteric bursectomy	3 (3.5)	2 (2.3)	>.99
Microfracture	1 (1.2)	0 (0)	>.99
Postoperative endpoints			
Reoperation	0 (0)	2 (2.3)	.23
Total hip arthroplasty	0 (0)	0 (0)	>.99

[a]Data are presented as n (%). Bolded values represent significant findings. FAI, femoroacetabular impingement.

There were no differences in the rates of labral repair, femoral osteochondroplasty, trochanteric bursectomy, or microfracture between the groups. At last follow-up, there were 2 total reoperations in the bilateral group compared with 0 reoperations in the unilateral group (*P* = .23). Both of these procedures occurred in the same patient, who required excision of heterotopic ossification from both hips. There were no conversions to total hip arthroplasty.

Patient-Reported Outcomes

Both groups demonstrated significant preoperative to postoperative improvements for all PRO and pain scores (*P* < .0001) (Table 3). For the bilateral and unilateral groups, there were no differences in preoperative HOS-ADL (68.1 ± 19.4 vs 68.1 ± 16.4, respectively; *P* = .99), HOS-SS (44.9 ± 23.1 vs 45.6 ± 24.1, respectively; *P* = .87), mHHS (60.6 ± 15.2 vs 59.2 ± 13.0, respectively; *P* = .61), or pain scores (72.0 ± 2.3 vs 75.1 ± 16.1, respectively; *P* = .48). There were no postoperative differences in HOS-ADL (84.0 ± 17.8 vs 87.3 ± 14.8, respectively; *P* = .27), HOS-SS (71.6 ± 28.1 vs 73.4 ± 26.0, respectively; *P* = .72), or satisfaction scores (76.6 ± 27.3 vs 77.9 ± 28.0, respectively; *P* = .80) between the bilateral and unilateral groups. Postoperatively, the unilateral group had higher mean mHHS (79.2 ± 13.8 vs 71.6 ± 19.4, respectively; *P* = .01) and lower mean pain scores (14.4 ± 16.8 vs 23.3 ± 24.4, respectively; *P* = .02).

There were no differences in score improvements between the bilateral and unilateral groups for the VAS

TABLE 3
Patient-Reported Outcome Scores for Unilateral and Bilateral Groups[a]

	Unilateral	Bilateral	*P* Value
HOS-ADL			
Preoperative	68.1 ± 16.4	68.1 ± 19.4	.99
Postoperative	87.3 ± 14.8	84.0 ± 17.8	.27
P value	<.0001	<.0001	
HOS-SS			
Preoperative	45.6 ± 24.1	44.9 ± 23.1	.87
Postoperative	73.4 ± 26.0	71.6 ± 28.1	.72
P value	<.0001	<.0001	
mHHS			
Preoperative	59.2 ± 13.0	60.6 ± 15.2	.61
Postoperative	79.2 ± 13.8	71.6 ± 19.4	**.01**
P value	<.0001	<.0001	
Pain			
Preoperative	75.1 ± 16.1	72.0 ± 2.3	.48
Postoperative	14.4 ± 16.8	23.3 ± 24.4	**.02**
P value	<.0001	<.0001	
Satisfaction	77.9 ± 28.0	76.6 ± 27.3	.80

[a]Data are presented as mean ± SD. Bolded values represent significant findings. HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sports Subscale; mHHS, modified Harris Hip Score.

(46.1 ± 36.6 vs 59.7 ± 27.8, respectively; *P* = .07), HOS-ADL (17.6 ± 15.2 vs 23.3 ± 20.2, respectively; *P* = .11), and HOS-SS (23.2 ± 30.4 vs 31.7 ± 26.6, respectively; *P* = .12) (Figure 1). However, patients in the unilateral group demonstrated greater postoperative improvement in the mean mHHS score (27.0 ± 22.8 vs 13.2 ± 16.3, respectively; *P* = .002) compared with patients in the bilateral group. To control for potentially confounding effects, a multivariate model was constructed comparing surgical group, age, sex, BMI, sport participation, smoking history, and preoperative survey scores to postoperative improvement on the mHHS. Of these factors, the only significant variables were surgical group (*P* = .0004) and preoperative mHHS score (*P* = .007) (see Appendix Table A1, available in the online version of this article).

There were no differences between the unilateral and bilateral groups for PASS and MCID rates for the HOS-ADL or HOS-SS (Table 4). Sixty-five (76%) patients in the unilateral group achieved the MCID for the mHHS compared with 21 (49%) in the bilateral group (*P* = .03), while 64 (74%) patients achieved the PASS for the mHHS compared with 22 (51%) in the bilateral group (*P* = .02).

Comparison Between First and Second Procedures

Bilateral surgery was staged for the 28 patients who presented bilaterally, while it was scheduled after symptom onset and failure of nonsurgical treatment for the remaining 15 patients. There were no differences in preoperative demographic or radiographic characteristics between the first and second surgical procedures (Table 5). For the patients who presented unilaterally, contralateral symptom onset occurred at a mean 4.9 ± 3.2 months (range,

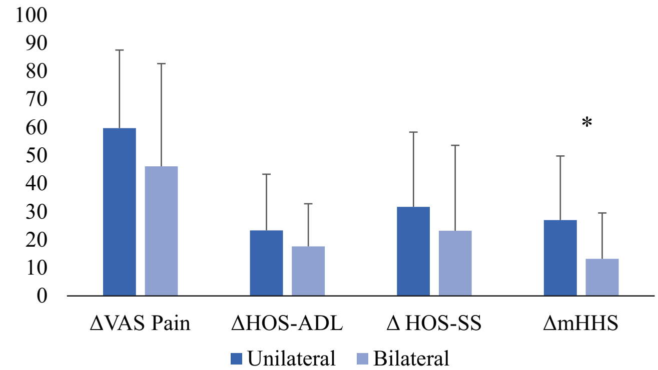

Figure 1. Improvements in patient-reported outcome scores. Δ indicates the difference between preoperative and postoperative scores. Asterisk indicates a significant difference in the mHHS scores (P = .002).

TABLE 4
Rates of Achieving MCID or PASS for Unilateral and Bilateral Groups[a]

	Unilateral	Bilateral	*P* Value
PASS for HOS-ADL	59 (69)	24 (56)	.32
PASS for HOS-SS	45 (52)	22 (51)	.85
PASS for mHHS	64 (74)	21 (49)	**.02**
MCID for HOS-ADL	62 (72)	24 (56)	.14
MCID for HOS-SS	65 (76)	26 (60)	.09
MCID for mHHS	65 (76)	20 (46)	**.03**

[a]Data are presented as n (%). Bolded values represent significant findings. HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sports Subscale; MCID, minimum clinically important difference; mHHS, modified Harris Hip Score; PASS, patient acceptable symptomatic state.

1.07-10.20 months) after the first procedure. The mean time interval between surgical procedures for the bilaterally presenting patients was 5.2 ± 4.5 months and 7.8 ± 2.9 months for unilaterally presenting patients (*P* = .05). Intraoperatively, there were no differences between the first and second surgical procedures in cam or pincer frequency as well as the labral repair rate. However, patients had a higher rate of cartilage delamination found in their first surgery versus their second surgery (23/43 [54%] vs 13/43 [30%], respectively; *P* = .01). There were no differences in any outcome measure between patients with unilateral or bilateral presentations. The mean time between bilateral surgical procedures was 6.1 ± 4.3 months. A longer time interval between surgical procedures was associated with lower 2-year HOS-ADL (*r* = 0.33; *P* = .03), lower mHHS (*r* = 0.32; *P* = .04), and lower improvement in pain (*r* = 0.60; *P* = .001) scores but not HOS-SS (*r* = 0.25; *P* = .14) or satisfaction scores (*r* = 0.20; *P* = .22).

A ROC curve analysis identified 10.4 months (area under the curve [AUC], 0.63) to be the optimally defined cutoff for patients who were unable to meet the PASS and 10.6 months (AUC, 0.48) for the MCID. On the basis

TABLE 5
Comparison Between First and Second Surgical Procedures of Bilateral Group[a]

	First Surgery	Second Surgery	*P* Value
No. of patients	43	43	
Age, y	28.2 ± 10.8	28.9 ± 10.9	.83
BMI, kg/m^2	24.7 ± 5.8	24.8 ± 5.8	.94
Alpha angle, deg			
Preoperative	64.2 ± 9.8	62.6 ± 12.0	.51
Postoperative	39.5 ± 4.3	39.1 ± 4.3	.95
LCEA, deg			
Preoperative	31.8 ± 4.7	32.8 ± 4.6	.31
Postoperative	28.0 ± 4.1	29.7 ± 4.2	.07
JSW (average), mm	4.2 ± 0.67	4.4 ± 0.78	.31
Tönnis grade 1, n (%)	4 (9)	5 (12)	.99
Labral tear, n (%)	43 (100)	42 (98)	.99
Cam FAI, n (%)	41 (95)	43 (100)	.49
Pincer FAI, n (%)	39 (91)	41 (95)	.68
Cartilage delamination, n (%)	23 (54)	13 (30)	**.01**
Revision, n (%)	1.0 (2.3)	1.0 (2.3)	.99

[a]Data are presented as mean ± SD unless otherwise specified. Bolded values represent significant findings. BMI, body mass index; FAI, femoroacetabular impingement; JSW, joint space width; LCEA, lateral center edge angle.

of these results, the bilateral group was split into cohorts of patients who had their second surgery before or after 10 months (Table 6). There were no differences in demographic variables or preoperative outcome scores; however, patients who had their second surgery after 10 months had significantly lower postoperative HOS-ADL scores (P = .04) as well as lower improvement in pain (P < .0001) and HOS-SS scores (P = .05). Additionally, patients with greater than 10 months between surgical procedures also had lower rates of achieving the PASS for the HOS-ADL and mHHS (Table 7).

DISCUSSION

This study found that patients undergoing staged bilateral FAI correction had significant improvements in pain and functional outcome scores with low complication rates. Our hypothesis was confirmed that patients who underwent staged bilateral FAI surgery performed as well as patients who underwent unilateral FAI surgery for our primary outcome measure (HOS-ADL) and also one of the secondary outcome measures (HOS-SS). However, it rejected the hypothesis that patients who underwent staged bilateral hip arthroscopic surgery performed as well as patients who underwent unilateral surgery for the mHHS. Further, we found that patients with bilateral FAI who underwent a second procedure had inferior outcomes when the procedure was delayed by more than 10 months.

Many patients diagnosed with FAI in one hip have radiographic findings consistent with FAI in the contralateral hip, and a substantial group of patients endorse bilateral hip pain at their initial presentation.[1,24,30,31] Several recent

TABLE 6
Comparison Between Patients With Their Second Surgery Before or After 10 Months[a]

	<10 mo	>10 mo	*P* Value
No. of patients	34	9	
Age, y	27.5 ± 10.2	31.0 ± 13.0	.40
Female sex, n (%)	18 (53)	6 (67)	.46
BMI, kg/m^2	25.1 ± 6.1	23.2 ± 3.8	.37
Preoperative HOS-ADL	67.9 ± 20.0	64.0 ± 20.2	.62
Preoperative HOS-SS	47.0 ± 20.0	50.2 ± 24.7	.70
Preoperative mHHS	59.2 ± 14.5	58.0 ± 18.7	.85
Postoperative HOS-ADL	86.4 ± 16.6	73.2 ± 18.8	**.04**
Postoperative HOS-SS	73.0 ± 26.1	57.5 ± 29.6	.17
Postoperative mHHS	73.9 ± 18.1	61.1 ± 20.0	.07
ΔPain	5.7 ± 2.1	1.4 ± 1.7	**<.0001**
ΔHOS-ADL	18.4 ± 17.6	13.2 ± 18.4	.46
ΔHOS-SS	22.8 ± 09.3	–0.9 ± 30.3	**.05**
ΔmHHS	13.8 ± 16.5	5.6 ± 17.9	.25

[a]Data are presented as mean ± SD unless otherwise specified. Bolded values represent significant findings. BMI, body mass index; HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sports Subscale; mHHS, modified Harris Hip Score. Δ represents improvement in outcome score.

TABLE 7
Rates of Achieving MCID or PASS Between Patients With Their Second Surgery Before or After 10 Months[a]

	<10 mo	>10 mo	*P* Value
PASS for HOS-ADL	22 (65)	2 (22)	**.02**
PASS for HOS-SS	19 (56)	2 (22)	.16
PASS for mHHS	20 (59)	1 (11)	**.01**
MCID for HOS-ADL	20 (59)	4 (44)	.58
MCID for HOS-SS	23 (68)	3 (33)	.07
MCID for mHHS	17 (50)	3 (33)	.34

[a]Data are presented as n (%). Bolded values represent significant findings. HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sports Subscale; MCID, minimum clinically important difference; mHHS, modified Harris Hip Score; PASS, patient acceptable symptomatic state.

studies have investigated the epidemiology, presentation, and clinical findings associated with bilateral hip pain and FAI. In a prospective study of 292 patients with mechanical hip pain, Nogier et al[31] identified a 22% rate of bilateral involvement. In a study evaluating 646 consecutive patients undergoing arthroscopic correction of FAI, Klingenstein et al[21] identified 132 (20.4%) who required bilateral surgery, which is similar to the 21.7% (135/622) rate of bilateral surgery reported by Nawabi and colleagues.[30]

In the present study, 71 of 474 patients who underwent primary arthroscopic surgery for FAI required bilateral surgery, with 35% presenting with unilateral symptoms. This is similar to the approximately 20% of patients with symptomatic bilateral FAI identified in the literature.[1,21,30,31] Because of the relatively short 2-year follow-up, the 15% rate of patients requiring bilateral surgery may underestimate the percentage of those ultimately developing bilateral symptoms or requiring bilateral surgery. In a study of patients requiring bilateral surgery for FAI, Haviv and O'Donnell[16] reported that 37 of 82 (45%) had a unilateral presentation at the initial examination, with the development of contralateral symptoms occurring at a mean 9.9 months (range, 3.1-30 months) after the initial surgical procedure. Further, patients with unilateral FAI are at risk for developing bilateral symptoms, given that up to 78% of patients with a symptomatic cam deformity have radiographic evidence of FAI on the contralateral hip and asymptomatic patients with cam deformities are 4.3 times more likely to develop hip pain.[1,19] The cause underlying the development of symptoms in patients with radiographic evidence of FAI is poorly understood, and the association between recovery from primary surgery and contralateral symptom onset remains unknown. However, in a recent study of hips with bilateral cam deformities but only unilateral symptoms, McGuffin et al[28] reported significant cartilage abnormalities on T1ρ magnetic resonance imaging for both symptomatic and asymptomatic hips. Thus, given the association between cartilage damage and poor functional outcomes after arthroscopic surgery, hip surgeons are recommended to educate patients on the possibility of developing contralateral symptoms as well as perform frequent follow-up evaluations.[7,16,17,20]

Surgical management strategies for bilateral FAI include simultaneous bilateral surgery, staged bilateral surgery, or unilateral surgery for the more severe hip with conservative management of the contralateral hip.[10,16,21,29] For patients with symptomatic bilateral FAI, the more severe hip is usually corrected first, followed by a rehabilitation interval before the second surgical procedure.[20] The timing before second surgery is surgeon and patient dependent but is generally not shorter than 6 weeks.[16,20] Comparing the first and second surgical procedures, we found no differences in preoperative clinical or radiographic characteristics as well as no differences in the frequency of cam or pincer deformities and labral tears. However, we found that there was an increased rate of cartilage delamination found intraoperatively at the first surgical procedure. This is likely because of the increased severity of hip dysfunction in cases of bilaterally presenting hips or a relatively short period of contralateral symptom duration for unilaterally presenting hips, which may explain the lower mHHS scores found in the bilateral group.

Arthroscopic correction of FAI has consistently demonstrated improved functional outcomes with increases in pain-free range of motion and high rates of return to activity and sport.[5,13,32] Patients who underwent bilateral hip arthroscopic surgery in the present study had significant improvements in all outcome scores. The 16-point improvement in the HOS-ADL was comparable with the 17-point improvement in the staged bilateral cohort reported by Degen et al.[10] However, our study found lower improvements in the HOS-SS and mHHS scores (27 and 11, respectively) compared with the 31- and 26-point improvements, respectively, found in their study.[10] This discrepancy may be a result of the interval between surgical procedures, as the mean interval was 6.1 months in the present study compared with 1.5 months reported by Degen et al.[10] Further, the PRO scores were worse in the bilateral group compared with the unilateral group, with the mHHS scores reaching significance for 2-year scores, score improvement, and MCID and PASS rates. Additionally, the bilateral group had significantly higher pain scores at 2 years postoperatively compared with the unilateral group. The difference in lower mHHS scores and higher pain scores found in the bilateral group compared with the unilateral group may be attributed to many factors. First, the bilateral group had a high degree of cartilage delamination found at the primary surgical procedure. The presence of cartilage wear at primary surgery may be associated with these worse clinical outcomes and requires further investigation. Additionally, patients in the bilateral group underwent 2 surgical procedures and 2 full rehabilitation periods, which means that patients may be in rehabilitation for several years. Understandably, their pain may be higher and their satisfaction may be lower than their unilateral counterparts who underwent only 1 surgery and 1 rehabilitation period. Given the negative correlation between the time interval between surgical procedures and patient outcomes, we recommend that patients diagnosed with FAI who present bilaterally should undergo a staged procedure within 10 months of the index surgery and that patients presenting unilaterally be counseled on the possibility for contralateral hip involvement. For operative patients presenting with bilateral FAI, we recommend staged procedures between 4 and 12 weeks apart.

Limitations

This study has multiple limitations. Given the 2-year follow-up period, it is likely that more patients from the registry, which we were unable to include in the present study, will require bilateral surgery. Additionally, outcome differences that did not reach significance may be representative of type II errors, given the relatively small sample size. From our power analysis, we determined that 364 bilateral patients and 728 unilateral patients would be required for the difference in HOS-ADL scores identified in this study to reach significance. Further, we did not assess femoral or acetabular version or the severity of chondral damage, which have been recently shown to affect outcomes after arthroscopic surgery for FAI.[11,17] All procedures were performed by a single high-volume hip arthroscopic surgeon who performed the same general procedure, limiting the generalizability of the results. Despite these limitations, we believe that this study contributes valuable information to the orthopaedic community, given the paucity of data on outcomes after bilateral surgery for FAI.

CONCLUSION

Patients who underwent unilateral and bilateral hip arthroscopic surgery for FAI had improved functional outcomes after 2 years. However, patients who underwent bilateral hip arthroscopic surgery had less improvement in their mHHS and pain scores compared with unilateral patents. Patients with bilateral FAI who had an increased time between their arthroscopic procedures were found to have less improvement in their pain, HOS-ADL, and HOS-SS scores.

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