



Effect of prior ipsilateral lower extremity surgery on 2-year outcomes following hip arthroscopy for femoroacetabular impingement syndrome

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ABSTRACT

The purpose of this study was to determine the influence of prior lower extremity surgery on patient reported outcomes following hip arthroscopy for femoroacetabular impingement syndrome (FAIS). Consecutive patients who underwent hip arthroscopy for FAIS and a prior history of ipsilateral lower extremity surgery were identified and matched 2:1 by age, gender, and body mass index (BMI) to controls without a history of lower extremity surgery. The minimal clinically important difference (MCID) and patient acceptable symptomatic state (PASS) were calculated for HOS-ADL, HOS-SS, and mHHS. Preoperative and 2-year postoperative patient reported outcomes of both groups were compared, and logistic regression was performed to determine whether lower extremity surgery influenced achieving MCID and PASS. A total of 102 patients (24.94%) with prior history of ipsilateral lower extremity surgery were identified. Ipsilateral orthopaedic knee surgery accounted for more than half (53.92%) of all prior surgeries. Patients with a history of ipsilateral lower extremity surgery had significant lower 2-year PROs, satisfaction, and greater pain when compared to patients without lower extremity surgery ($P < 0.001$ all). A history of ipsilateral lower extremity surgery was a negative predictor of achieving MCID for HOS-ADL and HOS-SS, as well as PASS for HOS-ADL, HOS-SS, and mHHS ($P < 0.001$ all).

In conclusion, patients with prior lower extremity surgery were found to have inferior outcome scores and a lower likelihood of achieving clinically significant outcome improvement compared to patients without a history of lower extremity surgery at two years postoperatively.

INTRODUCTION

Hip arthroscopy for femoroacetabular impingement syndrome (FAIS) improves pain and restores function in patients with clinical and radiographical findings of impingement secondary to osseous abnormalities of the hip joint [1–6]. These patients may also present with a history of previous surgeries prior to hip arthroscopy, which may potentially contribute to observed functional impairment and the development of hip impingement [7]. Despite consistent reports of post-operative improvements in patients with FAIS, only few studies have investigated the

effect of prior lower extremity surgeries on outcomes after hip arthroscopy.

Ayers and colleagues [8] evaluated the effect of ipsilateral joint involvement on post-operative outcomes in patients undergoing total knee replacement. The authors found that moderate to severe preoperative pain in the ipsilateral hip was a risk factor for inferior outcomes 6 months after total knee replacement. Furthermore, Perets and colleagues [9] demonstrated that patients who underwent ipsilateral hip arthroscopy prior to total hip arthroplasty (THA) had inferior outcomes than controls without prior hip surgery.

Although these studies highlight the impact of previous joint surgery and morbidity on post-operative outcomes, the impact that lower ipsilateral lower extremity surgeries have on outcomes after hip arthroscopy for FAIS is not well-understood. The purpose of this study was to determine the influence of prior ipsilateral lower extremity surgery on patient reported outcomes following hip arthroscopy. We hypothesized that a history of ipsilateral lower extremity surgery would negatively influence post-operative outcomes in this patient population.

MATERIALS AND METHODS

Patient selection

Following institutional board approval, data were collected from all patients undergoing hip arthroscopy for FAIS by a single, fellowship-trained surgeon between January 2012 and January 2015 ($n = 409$). Inclusion criteria included all patients during this time period with a history, physical examination and radiographic findings indicative of FAIS who underwent arthroscopic intervention with a minimum of 2-year follow-up. Exclusion criteria included length of follow-up less than 2 years, patients not agreeing to participate in the study, patients undergoing hip arthroscopy for avascular necrosis or gluteus medius repair, and patients with prior history of pediatric deformities [developmental dysplasia of the hip (LCEA $<20^\circ$), slipped capital femoral epiphysis, and Perthes disease], and/or osteoarthritis or joint space narrowing (Tönnis grade >1). Subsequently, patients with a history of prior ipsilateral lower extremity surgery at a minimum of 1 year prior to hip arthroscopy ($n = 102$) were matched 2:1 by age, body mass index (BMI) and gender to patients without a history of orthopaedic surgery prior to hip arthroscopy ($n = 204$). Of the initial matching pool for the control group ($n = 307$), a total of 58 (18.9%) were lost to follow-up.

Surgical technique

All hip arthroscopic procedures were performed with the patient under general anaesthesia in the supine position on a standard traction table as previously described in [10–13]. A standard anterolateral portal was established under fluoroscopic guidance and anterior portal was established under direct visualization. The modified mid anterior portal was established via spinal needle localization under direct arthroscopic visualization. A 2–4 cm capsulotomy connecting the anterior to anterolateral port was performed. Central compartment pathology was then addressed in a standard fashion, including labral repair and acetabular rim trimming if pincer morphology was present. If required, a 5.5-mm burr was used to perform acetabular

rim trimming as was deemed adequate based on preoperative imaging and intraoperative appearance. Hip traction was then released to allow for T-capsulotomy and access to the peripheral compartment such that femoral osteochondroplasty of the cam lesion could be performed. The vertical limb of the T-capsulotomy was made perpendicular to the interportal cut, and was approximately 2–4 cm without violating the zona orbicularis. Dynamic examination and fluoroscopic imaging were used to confirm that there was no further impingement and that head–neck offset was restored. Once the arthroscopic procedure was complete, a complete capsular closure was performed. Following plication of the vertical limb of the T-capsulotomy, the interportal capsulotomy was then repaired in a side-by-side fashion using a capsular closure device (Injector, Stryker Sports Medicine, Greenwood Village, CO).

Functional outcome analysis

All patients completed hip-specific outcome instruments preoperatively and at a minimum of 2-years post-operatively that included the hip outcome score (HOS)-activities of daily living (ADL), HOS-sports-specific subscale (SS), modified Harris hip score (mHHS), visual analog scale (VAS) for pain and satisfaction [14–17]. Following completion of hip-specific outcome instruments, differences in pre and post-operative scores were calculated and clinically significant outcome improvement was determined using the minimal clinically important differences (MCIDs) and patient acceptable symptom state (PASS) as established in the literature [18]. MCID standards were set to 8 for the mHHS, 9 for the HOS-ADL and 6 for the HOS-SS [15]. PASS threshold scores were set to 74 for the mHHS, 87 for the HOS-ADL and 75 for the HOS-SS [19].

Statistical analysis

Continuous variables were described as means with standard deviations and categorical variables were described as frequencies and percentages. Paired *t*-tests were used to determine whether patients experienced statistically significant functional and clinical improvements at a minimum of 2-year follow-up relative to preoperative baseline levels. Independent *t*-tests were performed to compare pre and post-operative PROMs between the prior ipsilateral lower extremity surgery cohort and the cohort without a history of lower extremity surgery. Binary logistic regression models were constructed to determine whether a history of prior ipsilateral lower extremity surgery predicted (i) clinically significant outcome improvement, (ii) likelihood of conversion to THA and (iii) subsequent need for revision surgery. A *post hoc* power analysis for computed achieved power given the experimental and control group sample

sizes indicated that the analyses were powered at 98.4% to observe a medium effect size ($d = 0.5$). All statistical tests were performed using Stata version 15.1 (StataCorp, College Station, TX). Two-tailed P -values of less than 0.05 were considered to indicate statistical significance.

RESULTS

Demographics

A total of 306 patients were included in the final analysis with a mean (\pm standard deviation) age of 34.7 ± 11.6 years, BMI 26.4 ± 5.1 kg/m² and follow-up of 2.6 ± 0.6 (range: 2.0–6.1) years. Of these patients, 177 (58.42%) were female. All patients demonstrated statistically significant improvements in all outcome measures at latest follow-up relative to preoperative baseline levels ($P < 0.001$). A total of 102 (24.94%) patients had a history of prior lower extremity surgery ipsilateral to the operative

hip. There were no differences in preoperative baseline characteristics between the study group and matched controls (Table I). Prior surgical procedures in the prior ipsilateral lower extremity surgery cohort are described in Table II.

Patient reported outcomes

Independent t -test analyses demonstrated that patients with a history of ipsilateral lower extremity surgery prior to hip arthroscopy had statistically similar preoperative PROM scores when compared with those without a history of surgery with the exception of the HOS-SS. However, these patients demonstrated significantly lower PROM scores when compared with patients without prior ipsilateral lower extremity surgery for the HOS-ADL (92.4 ± 8.6 versus 76.8 ± 18.2 , $P < 0.001$), HOS-SS (83.0 ± 18.6 versus 64.6 ± 26.1 , $P < 0.001$), mHHS (82.1 ± 10.9

Table I. Baseline patient characteristics

	No prior orthopaedic surgery		Prior orthopaedic surgery		All patients		P
	No./mean	% (SD)	No./mean	% (SD)	No./mean	% (SD)	
Overall	204		102		306		
Demographics							
Age (years)	34.7 \pm 11.6		34.9 \pm 11.6		34.7 \pm 11.6		0.862
BMI (kg/m ²)	26.3 \pm 5.1		26.4 \pm 5.1		26.4 \pm 5.1		0.866
Female gender	121 (59.3%)		56 (54.9%)		177 (58.4%)		0.458
Surgical limb							0.764
Left	90 (44.1%)		52 (51.0%)		142 (46.4%)		
Right	114 (55.9%)		50 (49.0%)		164 (53.6%)		
Procedures							
Labral repair	191 (93.6%)		97 (95.1%)		288 (94.1%)		0.606
Acetabular rim trimming	172 (84.3%)		91 (89.2%)		263 (86.0%)		0.245
Femoroplasty	204 (100.0%)		102 (100.0%)		306 (100.0%)		1.000
Synovectomy	204 (100.0%)		102 (100.0%)		306 (100.0%)		1.000
Capsular plication	204 (100.0%)		102 (100.0%)		306 (100.0%)		1.000
Adverse outcomes							
Revisions	3 (1.5%)		1 (0.98%)		4 (1.3%)		0.739
Conversion to THA	1 (0.5%)		1 (0.98%)		2 (0.7%)		0.603

Age calculated as date of birth subtracted from date of surgery. Independent t -test used to compare baseline patient characteristics.

No., number; %, relative frequency for categorical variables; SD, standard deviation of the mean for continuous variables; BMI, body mass index as calculated by weight in kilograms divided by height in metres squared.

Table II. Documented ipsilateral surgeries prior to hip arthroscopy

<i>Orthopaedic procedure</i>	<i>No.</i>
Foot	
Metatarsal pinning	1
ORIF	3
Unspecified tendon transfer	1
Accessory navicular removal	1
Morton's neuroma removal	2
Posterior tibial tunnel release	2
Lisfranc fracture repair	3
Ankle	
Achilles tendon repair	2
Unspecified ankle surgery	1
Arthroscopic removal of bone fragments	1
Bimalleolar ankle fracture repair	1
Anterior talofibular ligament reconstruction	1
Leg	
Fibula ORIF	2
Femur ORIF	1
Tibia ORIF	1
Knee	
Bilateral ACLR	1
Unilateral ACLR	11
Knee arthroscopy	6
TKA	5
Meniscectomy	4
Proximal tibial osteotomy	5
Posterolateral corner reconstruction	2
PCLR	1
Arthroscopic lateral release	3
MCLR	4
Meniscal repair or debridement	13

(continued)

Table II. Continued

<i>Orthopaedic procedure</i>	<i>No.</i>
Hip	
Bilateral hip arthroscopy for FAI	2
Unilateral hip arthroscopy for FAI	15
ORIF	3
Pinning	1
Periacetabular osteotomy	1
Posterior wall ORIF	1
Total	102

ORIF, open reduction internal fixation; ACLR, anterior cruciate ligament reconstruction; PCLR, posterior cruciate ligament reconstruction; MCLR, medial collateral ligament reconstruction; TKA, total knee arthroplasty.

versus 72.7 ± 17.2 , $P < 0.001$) and VAS satisfaction (86.2 ± 19.4 versus 67.9 ± 31.5 , $P < 0.001$) at a minimum of 2-years post-operatively. Furthermore, these patients had significantly greater VAS pain scores compared with patients without a history of ipsilateral lower extremity surgery at 2-years post-operatively (Table III).

Binary logistic regression models using the MCID and PASS as dependent variables demonstrated that a history of ipsilateral lower extremity surgery was a negative predictor of achieving the MCID for the HOS-ADL [odds ratio (OR): 0.182, $P < 0.0001$] and HOS-SS (OR: 0.43, $P = 0.005$), as well as a negative predictor of achieving PASS for the HOS-ADL (OR: 0.223, $P < 0.0001$), HOS-SS (OR: 0.337, $P = 0.0004$) and mHHS (OR: 0.311, $P = 0.0006$) (Table IV).

Clinical failure rates

There were three revisions (1.47%) and one conversion to THA (0.49%) in the control group, and one (0.98%) revision and one conversion to THA (0.98%) in the study group. A history of ipsilateral lower extremity surgery did not influence the likelihood for conversion to THA (OR: 2.03, $P = 0.618$) or likelihood of subsequent revision hip arthroscopy (OR: 0.67, $P = 0.730$).

Sub-analysis: influence of lower extremity surgery excluding revision hip arthroscopy patients

To better understand the influence of previous lower extremity surgery without confounding by previous hip arthroscopy, a sub-analysis was performed excluding

Table III. Patient reported outcome measures

Outcome	No prior orthopaedic surgery Mean (SD)	Prior orthopaedic surgery Mean (SD)	P-value
Preoperative			
HOS-ADL	70.4 (14.3)	68.1 (17.9)	0.22
HOS-SS	45.4 (23.8)	42.3 (23.0)	0.028
mHHS	58.6 (13.8)	58.2 (13.5)	0.81
VAS pain	7.6 (1.4)	7.6 (1.9)	1.00
Post-operative			
HOS-ADL	92.4 (8.6)	76.8 (18.2)	<0.0001*
HOS-SS	83.0 (18.6)	64.6 (26.1)	<0.0001*
mHHS	82.1 (10.9)	72.7 (17.2)	<0.0001*
VAS pain	1.4 (1.9)	2.5 (2.5)	<0.0001*
VAS satisfaction	86.2 (19.4)	67.9 (31.5)	<0.0001*

*Indicates statistical significance at the $P < 0.0001$ level.

SD, standard deviation of the mean for continuous variables; HOS-ADL and HOS-SS, hip outcome score-activities of daily living and sports-specific subscale; mHHS, modified Harris hip score.

Table IV. Clinically significant outcome improvement measures

Outcome	No prior orthopaedic surgery		Prior orthopaedic surgery		Multivariate logistic regression ^a	
	No.	%	No.	%	OR	P-value
MCID HOS-ADL	143	70.0	38	37.3	0.182	<0.0001*
MCID HOS-SS	147	72.1	61	59.8	0.43	0.005**
MCID mHHS	133	65.2	57	55.9	0.563	0.06
PASS HOS-ADL	159	77.9	45	44.1	0.223	<0.0001*
PASS HOS-SS	135	66.2	44	43.1	0.337	0.0004*
PASS mHHS	165	80.9	57	55.9	0.311	0.0006*

Prior orthopaedic surgery cohort set as control variable and OR are relative to this cohort.

^aMultivariate logistic regression model controlling for age, BMI, and gender.

*Indicates statistical significance at the $P < 0.0001$ level.

**Indicates statistical significance at $P < 0.01$ level.

MCID, minimal clinically important difference; PASS, patient acceptable symptomatic state; HOS-ADL and HOS-SS, hip outcome score-activities of daily living and sports-specific subscale; mHHS, modified Harris hip score.

the 17 patients who underwent previous femoroacetabular impingement (FAI) surgery. This analysis revealed that patients with a history of lower extremity surgery still experienced inferior outcomes at 2-years post-operatively for the HOS-ADL (92.5 ± 8.4 versus 76.5 ± 19.6 ,

$P < 0.001$), HOS-SS (83.3 ± 18.1 versus 64.2 ± 27.6 , $P < 0.001$), mHHS (82.2 ± 10.7 versus 72.7 ± 17.2 , $P < 0.001$), VAS Pain (1.4 ± 1.8 versus 2.5 ± 2.4 , $P = 0.001$), and VAS satisfaction (86.7 ± 18.4 versus 64.3 ± 33.6 , $P < 0.001$). Furthermore, these patients still had a lower

likelihood of achieving clinically significant outcome improvement: MCID HOS-ADL (OR: 0.17, $P < 0.001$); MCID HOS-SS (OR: 0.40, $P = 0.007$); PASS ADL (OR: 0.21, $P < 0.001$); PASS HOS-SS (OR: 0.37, $P < 0.001$) and PASS mHHS (OR: 0.27, $P < 0.001$). Although a history of lower extremity surgery conferred lower odds of achieving the MCID for the mHHS, this association remained insignificant (OR: 0.75, $P = 0.42$).

DISCUSSION

The most important finding of this study was that patients with prior ipsilateral lower extremity surgery had statistically significant lower patient reported outcome measures when compared with patients without a prior surgical history. Furthermore, the prevalence of ipsilateral lower extremity surgeries was high in patients undergoing hip arthroscopy for FAIS in this particular cohort, with knee surgeries accounting for over half of these procedures. Lastly, prior ipsilateral lower extremity surgery was a negative predictor of achieving meaningful clinically significant outcome improvement after undergoing hip arthroscopy for FAIS.

Few studies have investigated the effect of prior surgical intervention on outcomes after hip surgery. Perets et al. [9] performed a match-controlled study of 35 patients with a history of ipsilateral hip arthroscopy prior to undergoing THA with 35 controls without such history. The authors reported that patients with prior ipsilateral hip arthroscopy had lower Harris hip and Forgotten joint-12 scores at a minimum of 2-years post-operatively when compared with the control group. Beutel et al. [20] evaluated nine patients undergoing hip arthroscopy with a history of contralateral THA or ipsilateral and contralateral total knee arthroplasty (TKA) and compared them to nine control patients without a prior history of surgery. The authors found that all patients demonstrated statistically significant improvements in the mHHS and non-arthritic hip score following surgery ($P = 0.03$). However, there were no differences in post-operative outcomes between the two groups at latest follow-up.

The results of this study are in accordance with the study conducted by Perets et al. in that patients with a history of ipsilateral lower extremity surgery experience worse post-operative outcomes than those without a surgical history. Interestingly, while the study conducted by Beutel et al. examined hip arthroscopy in particular, the authors did not identify a difference in post-operative outcomes. Given the small sample size of their study, it is possible that their study groups were significantly underpowered to detect a difference in outcomes. This study builds on the current literature by increasing the number of patients in

both study groups and demonstrating that patients with prior ipsilateral lower extremity surgery have inferior patient reported outcomes when compared with those who do not have a history of lower extremity surgery. These findings identify a potential difference in post-operative outcomes that can be discussed with patients preoperatively. Given that many studies have demonstrated that abnormal biomechanics secondary to orthopaedic conditions are risk factors for future injury and serve as prognostic variables [7, 21–25], it appears that there is a strong relationship between initial injury and the development of subsequent pathology and functional impairment within joints of the lower extremities, which may portend to worse outcomes after surgical intervention.

Recently, there has been a shift in the orthopaedic literature towards reporting post-operative clinically meaningful improvement rather than statistical improvement [4, 18, 26–30]. In this study, the rates of achieving MCID and PASS for the cohort with a history of prior ipsilateral lower extremity surgery were significantly lower when compared with the patients without a history of prior ipsilateral lower extremity surgery. Prior literature has demonstrated that the MCID differs among similar patients with different disease states, and may suggest unaddressed joint or movement imbalances [26]. It is plausible that the differences in clinically significant outcome improvement is reflective of this reasoning as previous lower extremity surgery has the potential to alter biomechanics. Of note, while there was not a significant difference between the rates of achieving the MCID mHHS between the two study groups, this may be due to the high ceiling effect of the mHHS score previously described in the literature [19, 31].

Although the aforementioned studies lack quantitative outcome measures, they highlight the finding that a prior history of orthopaedic pathologies within the lower kinetic chain has the potential to predispose patients to the development of subsequent functional limitations due to alterations within the lower kinetic chain. The authors of this study conjecture that this is a potential contributor to the inferior outcomes observed in the cohort with a history of ipsilateral lower extremity surgery prior to hip arthroscopy; however, this study is not able to assert causation to this end. Future studies are warranted to better understand how a history of lower extremity surgery may lead to inferior outcomes following hip arthroscopy.

Limitations

This study has a number of limitations. This study was retrospective, which involves inherent limitations to this type of study. Although all patients in the prior surgery cohort had ipsilateral lower extremity surgery at a minimum

of 1 year prior to hip arthroscopy, it is difficult to ascertain whether 1 year was a sufficient period of time for recovery of function. As such, it remains unknown whether the inferior outcomes in this group were due to lack of rehabilitation from the prior surgery, or if the prior surgery actually predisposed patients to worse outcomes due to a currently poorly defined mechanism. Future studies are warranted to better isolate this effect. Finally, all procedures were performed by a single, fellowship-trained hip arthroscopic surgeon who performed the same general procedure. This fact limits the generalizability of the results to external populations of patients. Despite these limitations, we believe that this study contributes valuable information to the orthopaedic community given that there is a paucity of literature reporting on outcomes after arthroscopic surgery for FAIS for patients with previous ipsilateral lower extremity surgeries.

CONCLUSIONS

The prevalence of prior lower extremity surgery at the time of hip arthroscopy was 24.94%, with knee surgeries accounting for over half of these procedures, and patients with prior lower extremity surgery were found to have inferior hip-specific outcome scores and a lower likelihood of achieving clinically significant outcome improvement compared with patients without a history of lower extremity surgery at 2 years post-operatively. These findings may serve as valuable prognostic information and help guide patient expectations prior to hip arthroscopy.

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