Early Impact of Hip Arthroscopy on the Resolution of Symptom Burden in Athletes With Femoroacetabular Impingement

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Background: Coexisting symptoms can confound outcomes after arthroscopic correction of femoroacetabular impingement (FAI). Symptom burden (SB) represents the cumulative load of patient-reported symptoms.

Purpose: To quantify the prevalence of symptoms in athletes before and after arthroscopic correction of FAI and evaluate the impact of independent and cumulative SB resolution on outcomes.

Study Design: Case series; Level of evidence, 4.

Methods: Included were 509 hips of 386 athletes (89% men; age, 26.4 ± 6.1 years) who underwent primary hip arthroscopy for FAI between 2011 and 2020. Symptom prevalence was assessed preoperatively and 1 year postoperatively using a 15-item SB survey, with the total number of symptoms reported as the SB score. Minimal clinically important difference (MCID-SB) and substantial clinical benefit (SCB-SB) thresholds according to the proportional pre- to postoperative resolution of SB were calculated, and 1- and 2-year postoperative patient-reported outcome measures (PROMs)—including the modified Harris Hip Score and 36-Item Short Form Survey—were compared relative to MCID-SB and SCB-SB achievement. Multivariable stepwise regression was used to evaluate the ability of individual symptom resolution for MCID and SCB achievements on PROMs.

Results: The SB score was 6 ± 2.9 preoperatively, improving to 2.8 ± 2.7 at 1 year postoperatively ($P < .001$). A proportional reduction in symptoms by 48.5% and 70.3% defined the MCID-SB and SCB-SB, respectively; this was achieved by 63.6% and 43.8% of the hips, respectively. Postoperatively, PROMs were superior where clinically meaningful SB resolution thresholds were achieved ($P < .001$). A significantly higher proportion of these cases returned to their main sport (79.4% vs 63.1% achieved MCID-SB; 83.8% vs 65.2% achieved SCB-SB) ($P < .001$). Odds ratios for symptoms associated with achieving the MCID on PROMs included resolution of groin pain (2.6-5.5), side hip pain (3.4), pain during (3.1) and after (2.6-3.5) activity, hamstring tightness (2.6), and limping after activity (2.6). Symptom resolution associated with achieving SCB included groin pain (3.0-3.1), pain during (3.3) and after (2.7-4.2) activity, and limping after activity (3-6.8).

Conclusion: Achieving thresholds of clinically important SB resolution was associated with superior postoperative PROM scores and higher rates of return to sports for this athletic cohort. Resolution of groin pain, pain during/after activity, hamstring tightness, and limping after activity increased the odds of achieving clinically important improvement on PROMs.

Keywords: arthroscopy; femoroacetabular impingement; hip; symptom burden

Femoroacetabular impingement (FAI) is a complex mechanical hip pathology,[14] more recently defined as a triad of patient symptoms, clinical signs, and radiological findings.[18] The repetitive and premature contacts between the opposing bony morphologies located to the femoral head-neck junction (cam) and/or acetabular rim (pincer) induce shear forces that result in damage to the labrum in the first instance and are linked to the development of early-onset osteoarthritis over time.[2,27]

Over the past 2 decades, there has been an exponential increase in the volume of research output related to the arthroscopic management of FAI-related pathology, which is considered the treatment of choice, through short-, mid-, and long-term outcome-based studies demonstrating reproducible and positive benefits for patients. Various contraindicators to a successful outcome have been identified, primarily related to patient characteristics (eg, age, body

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mass index, and symptom duration), radiographic parameters (eg, loss of joint space, dysplasia), and intraoperative findings (eg, chondral defects, poor quality labrum, and cystic changes).[29,36] Recognition of variables potentially confounding positive outcomes from hip arthroscopy (HA) is important for both appropriate patient selection and guiding realistic expectations in the first instance as well as being a useful guide for rehabilitation postoperatively.

Symptom burden (SB) is defined as the "subjective, quantifiable prevalence, frequency, and severity of symptoms that places physiologic burden on patients resulting in multiple negative physical and emotional patient responses."[15] In patients with FAI, primary symptoms include anterior groin pain, exacerbated by activity, in addition to the subjective feeling of stiffness, which is often objectively evident by a reduced range of flexion, internal rotation, and adduction of the affected hip. Concomitant symptoms are often reported at various anatomic locations, including pain in the lower back, thigh, referred pain to the symphysis pubis or extending toward the knee,[13,32] in addition to functional symptoms (eg, stiffness, catching, and pinching) exacerbated by bouts of physical activity[12] or prolonged sitting.

In addition to the classic clinical signs and radiographic markers in keeping with FAI, symptoms are distinctly reported by the patient experiencing the physical disturbance. The basis of reporting symptoms can stem from distinct, multimodal, primary pathologies or secondary pathologies to an underlying primary hip condition or even as a consequence of delayed or complicated treatment intervention.

The impact of coexisting symptoms and pathologies confounding postoperative outcomes after the arthroscopic correction of FAI has gained increased awareness.[§] Much of this available literature involves comparative analysis whereby independent groups are defined by the presence or absence of a distinct coexisting or compensatory pathology. By contrast, SB represents the cumulative load of subjective symptoms reported by the patient.

This study aimed to (1) quantify the prevalence of location- and function-based symptoms in a cohort of athletes, scheduled for arthroscopic management of FAI; (2) determine the rate of resolution of each preoperatively reported symptom independently at 3 months and 1 year after HA; and (3) identify the impact of SB resolution on postoperative patient-reported outcome measure (PROM) scores and ability to achieve metrics of clinically important improvement. We hypothesized that there would be a significant reduction in the prevalence of all symptoms at 1 year after surgery and that early SB resolution would be associated with superior clinical outcomes at 1 and 2 years postoperatively.

[§]References 1, 3, 4, 7, 11, 20, 22, 25, 28, 31, 33, 42, 44, 47.

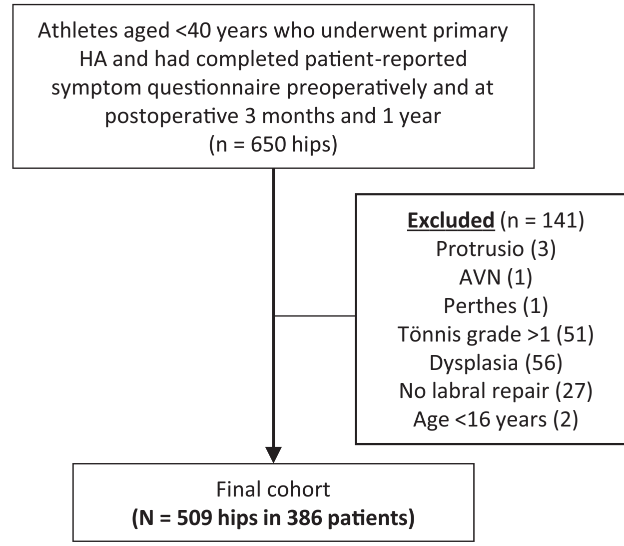

Figure 1. A flowchart of patient selection for this study. AVN, avascular necrosis; HA, hip arthroscopy.

METHODS

Patient Selection

Our prospective, institutional board-approved, HA registry was retrospectively reviewed and queried for all competitive and recreational athletes undergoing arthroscopic correction of FAI between May 2011 and October 2020. Diagnosis of FAI was made by a single experienced high-volume arthroscopic hip surgeon (P.C.) using well-recognized clinical and radiological criteria, as previously described.[10] Arthroscopic surgery was performed when classic FAI-related symptoms were unresolved after a minimum of 3 months of nonoperative management, including physical therapy, rest, and activity modification.

The inclusion criteria consisted of primary HA for FAI, involvement in competitive/recreational athletic activities, age <40 years at the time of surgery, and completion of patient SB survey preoperatively and at 3 months and 1 year postoperatively. The exclusion criteria consisted of recognized contraindicators to an optimal

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outcome—including Tönnis grade >1, dysplasia (lateral center-edge angle <25°), protrusio, Perthes disease, avascular necrosis, and hips in which labral repair was not undertaken. A total of 509 hips in 386 athletes met the inclusion and exclusion criteria (Figure 1).

Surgical Technique and Rehabilitation Protocol

All surgical procedures were performed by the senior author (P.C.). The surgical technique has previously been described in detail.[6,9] In brief, patients underwent general anesthesia and were positioned supine on a distraction table. Standard anterolateral and modified midanterior portals were utilized and safe access was gained to the hip joint using an interportal capsulotomy. In all cases, the labrum was surgically reflected from the acetabular margin protecting the intact chondrolabral junction where possible. The pincer deformity was corrected using a 4-mm mechanical bur under radiographic guidance. The labrum was repaired in all cases. No formal treatment was undertaken for damaged articular cartilage. Where a cam deformity was present, femoroplasty was undertaken using a 5.5-mm mechanical bur under radiographic guidance. The capsule was routinely repaired in all cases starting in October 2013.

After surgery, patients were asked to follow a standardized, self-administered home rehabilitation program covering a 12-week timeframe. Patients were mobilized 4 hours after surgery and permitted to fully bear weight comfortably with the aid of crutches for 5 days. Early movement was encouraged with the use of a stationary bicycle from postoperative day 1, and hydrotherapy was recommended once incisions had healed, usually at postoperative day 10, at which time patients were permitted to return to work. The breaststroke and full hip rotation were introduced at 4 weeks. Return to running was permitted from 6 weeks, sprinting from 8 to 10 weeks, and full return to sports training by 12 weeks postoperatively. Patients were permitted to supplement the standardized rehabilitation program provided with the aid of their own club/team physical therapist if desired.

Outcomes Assessment

Symptom Burden Score. An SB survey was developed (Figure 2) to assess the level of burden from location- and function-based FAI-related symptoms. The survey consisted of 15 items representative of the main symptoms reported by patients evaluated at the clinic after a review of their initial consultation notes; it was guided by preexisting literature describing location-based sources of primary and referred symptoms[13,46] in addition to the description of activity-based symptoms and dysfunctions widely reported to be present among FAI patients.[18] There were 7 location-based symptoms of pain at rest (groin, front hip, side hip, buttock, lower back, thigh, and knee) and 8 function-based hip symptoms (pain during/after activity, stiffness during/after activity, hamstring tightness, hip clicking, and limping [constant/after activity]). Patients were provided with a list of all symptoms at each of the time points and asked the

Do you suffer from any of the following symptoms now? Tick all that apply.

(For bilateral symptoms, please tick and indicate for right and left specifically, where applicable.)

Symptom	**Right**	**Left**
Groin pain *at rest*		
Front hip pain *at rest*		
Side hip pain *at rest*		
Buttock pain *at rest*		
Lower back pain *at rest*		
Thigh pain *at rest*		
Knee pain *at rest*		
Pain *during* activity		
Pain *following* activity		
Hamstring tightness		
Stiffness *at rest*		
Stiffness *following* activity		
Hip clicking		
Constant limping		
Limping *following* activity		

Figure 2. Symptom burden survey.

question, "*Do you suffer from any of the following symptoms now? Tick all that apply.*" The survey was completed for each hip for patients with bilateral symptoms.

This institutional survey was the primary outcome of interest, and patients completed it at 3 time points—preoperatively, 3 months postoperatively, and 1 year postoperatively. Optional symptoms were given equal weight, and the cumulative number of symptoms reported at each time point was used to generate the SB score (range, 0-15). The comparative frequency of the reporting of symptoms at 1 year relative to baseline was used to generate the extent of SB change. The status for each symptom was categorized into 4 groups: *resolved* (present at baseline but not at 1 year); *persisting* (present at baseline and 1 year); *new* (not present at baseline but present at 1 year); or *never* (not present at either baseline or 1 year).

PROMs and Return to Sports. Patients completed PROMs preoperatively and then at 1 and 2 years postoperatively. The primary PROMs included the modified Harris Hip Score (mHHS)—the most widely used outcome measure within the HA literature,[21,26,34] with most scoring weight from this measure assessing hip pain, which is the primary symptom reported by patients with pathologic FAI; and the 36-Item Short Form Survey (SF-36)—a well-developed, validated generic measure of health and well-being recommended for this population,[24,40] which is used as a reference to validate newer PROMs in the assessment of an FAI population.[35,46] Additional secondary PROMs included the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) (0-100 scale; higher scores indicating worse outcome) for the assessment of pain, stiffness, and physical functioning, and the University of California–Los Angeles

(UCLA) activity scale (0-10 scale; lower scores indicating more reduced activity) in addition to an institutional sports-specific survey for the assessment of physical capabilities and player's activity engagement over time.

Return to the main preoperative sport was also evaluated at the 1-year follow-up. When failure to return was reported, the reasons were recorded.

Statistical Analysis

The normality of data was assessed using the Shapiro-Wilk test. Summary statistics for patient characteristics and PROMs were reported as means with standard deviations or medians with interquartile ranges, depending on normality. The proportion of symptoms at the different time points was compared using the McNemar test. The independent-samples Mann-Whitney *U* test was used to evaluate differences in PROM scores between groups, while the related-samples Wilcoxon signed-rank test was used to evaluate differences in PROM scores within groups at different time points.

The proportional change in SB was calculated as a percentage of possible improvement (POPI-SB): $\textit{POPI-SB} = \frac{\textit{No. of preoperative symptoms} - \textit{No. of 1-year postoperative symptoms}}{\textit{No. of preoperative symptoms}} \times 100\%$. An "expectations" anchor question ("*How well did the surgery on your joint meet your expectations?*") was then used to estimate a cutoff of POPI-SB equitable to metrics of clinically important improvement (considering only those hips with an observable reduction in symptoms [n = 404; 79%]). A mean change for a response of *fair* on a 5-point scale (*excellent*, *very good*, *good*, *fair*, and *poor*) was used to define the minimal clinically important difference (MCID-SB) (lower threshold), while a response of *very good* was used to define the substantial clinical benefit (SCB-SB) (upper threshold). Baseline, 1-year, and 2-year postoperative PROM scores were then compared relative to achieving these thresholds.

Clinical metrics of improvement were also evaluated for both of the primary PROMs (mHHS and SF-36). The MCID-PROM and SCB-PROM were calculated utilizing a similar anchor-based and POPI calculation technique as above and as previously described.[8]

Binary logistic regression analysis (comparing symptom status between the resolved vs persisting groups) was performed for each of the symptoms independently to determine their effect on achieving the MCID-PROM and SCB-PROM for the mHHS and the SF-36. Age and sex were controlled for as potential confounders. A multivariable forward stepwise regression model was built using all symptoms found to be significant on univariate analysis to evaluate the independent association of each on achieving MCID-PROM and SCB-PROM. All statistical analysis was performed using SPSS software Version 29 (IBM). Statistical significance was set at $P < .05$.

RESULTS

The baseline characteristics, radiographic parameters, and activity levels of the 509 included hips are displayed in Table 1. The mean age of the athletes was 26.4 ± 6.1 years (range, 16.1-39.9 years), and 89.6% were men. Field-based team sports comprised >90% of activity type. The mean follow-up durations were 3.2 ± 0.7 and 13 ± 1.9 months.

TABLE 1
Preoperative Patient Characteristics, Radiographic Characteristics, and Activity Level (N = 509 Hips in 386 Athletes)[a]

Characteristic	Value
Age, y	26.4 ± 6.1 (16.1-39.9)
Sex, male/female	456 (89.6)/53 (10.4)
Symptom duration, %	
<6 mo	21.20
6-12 mo	22.90
>1-2 y	21.40
>2-5 y	24.10
>5 y	10.30
Radiographic data	
LCEA, deg (n = 493)	34.9 ± 6.2 (25-68)
AA (Dunn), deg (n = 452)	59.5 ± 13.9 (30-129)
AA (AP), deg (n = 490)	65.3 ± 18.5 (34.0-123)
NSA, deg (n = 458)	131 ± 8.6 (117-150)
Tönnis grade (n = 495)	
0	396 (80)
1	99 (20)
Sports level	
Competitive	429 (84.3)
Recreational	80 (15.7)
Main competitive sport	
Hurling	184 (42.7)
Gaelic football	132 (30.6)
Soccer	50 (11.6)
Rugby	26 (6)
Running/athletics	9 (2.1)
Other	30 (7)
Training frequency	
1-2 d/wk	77 (15.1)
3-5 d/wk	283 (55.6)
>5 d/wk	67 (13.2)
Missing	82 (16.1)
Competition frequency	
1-2 times/mo	82 (16.1)
3-5 times/mo	238 (46.8)
>5 times/mo	102 (20)
Missing	87 (17.1)

[a]Data are presented as mean ± SD (range) or No. of hips (% of total) unless otherwise indicated. AA, alpha angle; AP, anteroposterior; LCEA, lateral center-edge angle; NSA, neck-shaft angle.

Prevalence of Symptoms Reported Pre- and Postoperatively

The preoperative SB score was 6 ± 2.9. Location-based symptoms included pain in the groin (40.5%), lower back (36.3%), front of the hip (34.2%), side of the hip (31.4%), buttock (21.6%), knee (10.8%), and thigh (8.1%). Function-based symptoms included pain after activity

TABLE 2
Prevalence of Symptoms Reported Pre- and Postoperatively[a]

		Postop		*P*	
Symptom	Preop	3 Months	1 Year	Preop vs 3 Months	Preop vs 1 Year
Location-based					
Groin	206 (40.5)	97 (19.1)	82 (16.)	**<.001**	**<.001**
Front hip	174 (34.2)	87 (17.1)	75 (14.7)	**<.001**	**<.001**
Side hip	160 (31.4)	64 (12.6)	74 (14.5)	**<.001**	**<.001**
Buttock	110 (21.6)	65 (12.8)	68 (13.4)	**<.001**	**<.001**
Lower back	185 (36.3)	89 (17.5)	73 (14.3)	**<.001**	**<.001**
Thigh	41 (8.1)	29 (5.7)	17 (3.3)	.111	**<.001**
Knee	55 (10.8)	26 (5.1)	18 (3.5)	**<.001**	**<.001**
Function-based					
Hamstring tightness	194 (38.1)	153 (30.1)	126 (24.8)	**.002**	**<.001**
Pain during activity	354 (69.5)	141 (27.7)	134 (26.3)	**<.001**	**<.001**
Pain after activity	402 (79)	172 (33.8)	168 (33)	**<.001**	**<.001**
Stiffness at rest	226 (44.4)	111 (21.8)	123 (24.2)	**<.001**	**<.001**
Stiffness after activity	383 (75.2)	226 (44.4)	218 (42.8)	**<.001**	**<.001**
Hip clicking	292 (57.4)	186 (36.5)	179 (35.2)	**<.001**	**<.001**
Limp (constant)	32 (6.3)	13 (2.6)	7 (1.4)	**.004**	**<.001**
Limp (after activity)	226 (44.4)	65 (12.8)	62 (12.2)	**<.001**	**<.001**

[a]Data are presented as No. of hips (% of total). Bold *P* values indicate a statistically significant difference compared with the preoperative value ($P < .05$, McNamer test). Postop, postoperative; Preop, preoperative.

TABLE 3
Overall Allocation of Hips According to Symptom Status From Preop to 1 Year Postop (N = 509)[a]

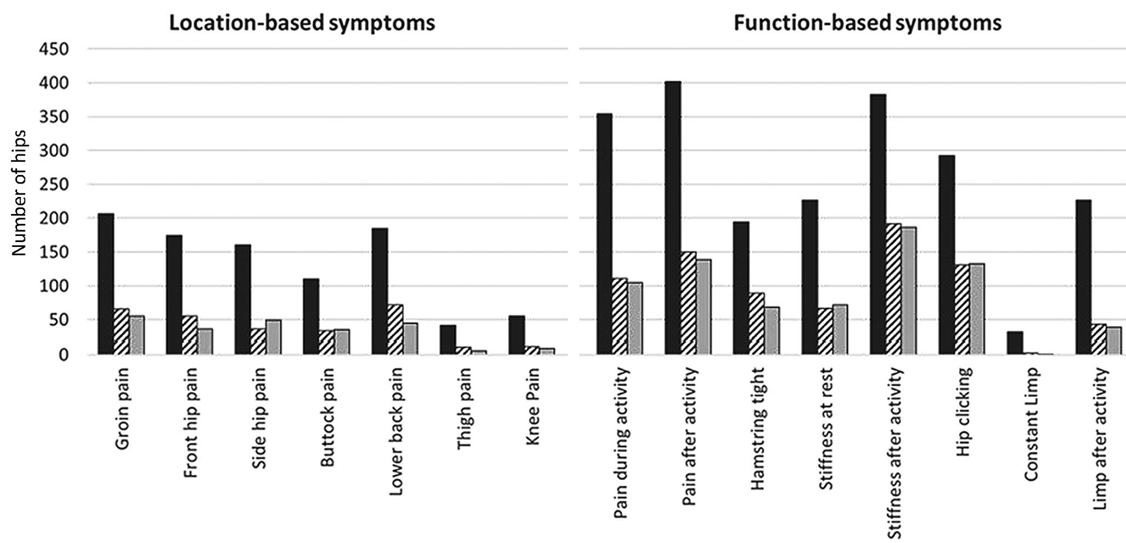
Symptom	Resolved[b]	Persisting[b,c]	New[c]	Never
Groin	151 (29.7)	55 (10.8)	27 (5.3)	276 (54.2)
Front Hip	138 (27.1)	36 (7.1)	39 (7.7)	296 (58.2)
Side Hip	111 (21.8)	49 (9.6)	25 (4.9)	324 (63.7)
Buttock	75 (14.7)	35 (6.9)	33 (6.5)	366 (71.9)
Lower back	140 (27.5)	45 (8.8)	28 (5.5)	296 (58.2)
Thigh	33 (6.5)	6 (1.2)	11 (2.2)	459 (90.1)
Knee	46 (9)	9 (1.8%)	9 (1.8)	445 (87.4)
Pain during activity	249 (48.9)	105 (20.6)	29 (5.7)	126 (24.8)
Pain after activity	263 (51.7)	139 (27.3)	29 (5.7)	78 (15.3)
Hamstring tightness	126 (24.8)	68 (13.4)	58 (11.4)	257 (50.5)
Stiffness at rest	154 (30.3)	72 (14.1)	51 (10)	232 (45.6)
Stiffness after activity	197 (38.7)	186 (36.5)	32 (6.3)	94 (18.5)
Hip clicking	159 (31.2)	133 (26.1)	46 (9)	171 (33.6)
Limp (constant)	31 (6.1)	1 (0.2)	6 (1.2)	471 (92.5)
Limp (after activity)	187 (36.7)	39 (7.7)	23 (4.5)	260 (51.1)

[a]Data are presented as No. of hips (% of total). Resolved, present at baseline but not at 1 year postoperatively; persisting, present at baseline and 1 year postoperatively; new, not present at baseline but present at 1 year postoperatively; never, not present at either baseline or 1 year postoperatively. Postop, postoperative; Preop, preoperative.
[b]Preop symptoms.
[c]Postop symptoms.

(79%), stiffness after activity (75.2%), pain during activity (69.5%), hip clicking (57.4%), stiffness at rest (44.4%), limp after activity (44.4%), hamstring tightness (38.1%), and constant limping (6.3%) (Table 2).

The SB scores at 3 months and 1 year postoperatively were 3 ± 2.6 and 2.8 ± 2.7, respectively. Apart from the reporting of thigh pain ($P = .111$), a significantly lower overall prevalence of each symptom was reported at 3 months postoperatively ($P \leq .004$ for all). A significantly lower overall prevalence of all symptoms was reported at 1 year postoperatively ($P < .001$ for all) (Table 2).

Symptom status based on comparative preoperative and 1-year postoperative reporting (resolved/persisting/new/never) are shown for each symptom in Table 3.



	Groin pain	Front hip pain	Side hip pain	Buttock pain	Lower back pain	Thigh pain	Knee Pain	Pain during activity	Pain after activity	Hamstring tight	Stiffness at rest	Stiffness after activity	Hip clicking	Constant Limp	Limp after activity
Preoperative, n	206	174	160	110	185	41	55	354	402	194	226	383	292	32	226
% reduction: 3 mo	-68.0%	-68.4%	-77.5%	-69.1%	-61.1%	-73.2%	-78.2%	-68.6%	-62.7%	-54.1%	-70.4%	-49.9%	-55.1%	-93.8%	-81.0%
% reduction: 1 y	-73.3%	-79.3%	-69.4%	-68.2%	-75.7%	-85.4%	-83.6%	-70.3%	-65.4%	-64.9%	-68.1%	-51.4%	-54.5%	-96.9%	-82.7%
P (3 mo vs 1 y)	.215	**.013**	.098	>.999	**.001**	.180	.607	.661	.460	**.020**	.668	.691	.920	>.999	.659

Figure 3. Resolution of preoperatively reported location-based and function-based symptoms over time. The graphs show the number of hips with symptoms preoperatively (black bars) versus those with symptoms persisting at 3 months postoperatively (striped bars) and at 1 year postoperatively (gray bars). The corresponding table indicates the rate of resolution of the preoperatively reported symptoms by 3 months and 1 year postoperatively. Bold *P* values indicate statistically significant changes in symptom resolution between 3 months and 1 year postoperatively ($P < .05$, McNamer test).

Effect of Arthroscopic FAI Correction on Independent Symptoms Reported Preoperatively

There was a significant resolution of each preoperatively reported symptom at 1-year follow-up ($P < .001$ for all). The rate of resolution and persistence for each preoperatively reported symptom at 3 months and 1 year postoperatively is displayed in Figure 3. In particular, there was significant resolution in front hip pain (from 68.4% to 79.1%; P = .013), lower back pain (from 61.1% to 75.7%, P = .001), and hamstring tightness (from 54.1% to 64.9%; P = .020) from 3 months to 1 year postoperatively.

Effect of SB on Patient-Reported Clinical Outcomes

The MCID-SB threshold was calculated as a 48.5% reduction of preoperative SB score by 1 year postoperatively, while the SCB-SB threshold was calculated as a 70.3% reduction in the SB score. Overall, 63.6% of hips (n = 318) achieved MCID-SB, and 43.8% of hips (n = 219) achieved SCB-SB.

PROMs were available for 100% of hips at 1 year postoperatively. At 2 years postoperatively, 19 hips (3.7%) underwent repeat arthroscopy and 2 (0.4%) underwent conversions to total hip arthroplasty; some patients (n = 9 hips; 1.8%) did not wish to remain in long-term follow-up, leaving 479 hips eligible for PROMs assessment at this time point. PROMs were available for 92% (mHHS, UCLA), 70% (SF-36), and 65% (WOMAC) of hips.

Preoperatively, PROM scores were similar between groups stratified relative to MCID-SB or SCB-SB achievement. In addition, significant improvements in all PROMs from baseline to 1 and 2 years postoperatively were observed for both the MCID-SB and SCB-SB groups ($P <$ .001 for all) (Table 4). Postoperatively, all PROM scores were superior for hips that achieved thresholds of clinically meaningful SB resolution (Table 4).

Clinically Meaningful Changes in PROM Scores

The MCID-PROM thresholds calculated for the mHHS and SF-36 were 62.7% and 38.9%, respectively. Overall, the MCID was achieved by 71.9% (mHHS) and 69% (SF-36) of hips at 1 year postoperatively and by 70.7% (mHHS) and 69.5% (SF-36) of hips at 2 years postoperatively. The SCB-PROM thresholds for the mHHS and SF-36 were calculated as 88.4% and 65.4%, respectively. These thresholds were achieved by 51.4% (mHHS) and 45.5% (SF-36) of hips at 1 year postoperatively and 46.4% (mHHS) and 43.5% (SF-36) at 2 years postoperatively.

Multivariate Regression Analysis Results

Independent symptom resolution associated with increased odds of achieving clinically meaningful change in PROMs compared with where each symptom was at 1 year postoperatively were as follows (Table 5):

TABLE 4
PROM Scores Compared Between Time Points and Based on MCID-SB and SCB-SB Achievement[a]

	MCID-SB[b]			SCB-SB[c]		
	Achieved	Not Achieved	*P*	Achieved	Not Achieved	*P*
mHHS						
Preop	76 (71-93)	81 (73-93)	.660	78 (71-93)	80 (72-93)	.821
1 y postop	100 (96-100)	95 (83-99)	**<.001**	100 (98-100)	96 (86-100)	**<.001**
2 y postop	100 (96-100)	96 (84-100)	**<.001**	100 (96-100)	96 (92-100)	**<.001**
P (preop vs 1 y)	**<.001**	**<.001**		**<.001**	**<.001**	
P (preop vs 2 y)	**<.001**	**<.001**		**<.001**	**<.001**	
SF-36						
Preop	74 (61-84)	71 (59-83)	.278	74 (61-84)	72 (61-83)	.476
1 y postop	93 (89-97)	84 (71-90)	**<.001**	94 (90-97)	88 (76-92)	**<.001**
2 y postop	92 (85-95)	88 (77-93)	**<.001**	92 (86-95)	89 (78-93)	**<.001**
P (preop vs 1 y)	**<.001**	**<.001**		**<.001**	**<.001**	
P (preop vs 2 y)	**<.001**	**<.001**		**<.001**	**<.001**	
UCLA						
Preop	7 (5-9)	7 (5-10)	.567	7 (5-10)	7 (5-9)	.874
1 y postop	10 (9-10)	9 (6-10)	**<.001**	10 (9-10)	9 (7-10)	**<.001**
2 y postop	10 (9-10)	9 (7-10)	**<.001**	10 (9-10)	9 (7-10)	.092
P (preop vs 1 y)	**<.001**	**<.001**		**<.001**	**<.001**	
P (preop vs 2 y)	**<.001**	**<.001**		**<.001**	**<.001**	
WOMAC						
Preop	18 (7-31)	15 (9-26)	.873	17 (6-31)	17 (9-28)	.297
1 y postop	1 (0-4)	7 (2-14)	**<.001**	0 (0-2)	6 (2-11)	**<.001**
2 y postop	2 (0-7)	4 (1-10)	**.001**	1 (0-6)	4 (0-10)	**<.001**
P (preop vs 1 y)	**<.001**	**<.001**		**<.001**	**<.001**	
P (preop vs 2 y)	**<.001**	**<.001**		**<.001**	**<.001**	

[a]Data are presented as median (interquartile range). Bold *P* values indicate statistically significant differences, either within groups at different time points (preop vs postop; related-samples Wilcoxon signed-rank test) or between groups (achieving vs not achieving metrics of clinically important improvement; independent-samples Mann-Whitney *U* test) ($P < .05$). MCID, minimal clinically important difference; mHHs, Modified Harris Hip Score; postop, postoperative; preop, preoperative; SB, symptom burden; SF-36, Short Form-36; UCLA, University of California–Los Angeles; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.
[b]MCID was defined as a reduction in preop SB score by 48.5%.
[c]SCB-SB was defined as a reduction in preop SB score by 70.3%.

- *MCID for mHHS*: Resolution of groin pain (odds ratio [OR], 5.5; $P < .001$), side hip pain (OR, 3.4; $P = .005$), pain during activity (OR, 3.1; $P < .001$), and pain after activity (OR, 2.6; $P = .002$).
- *SCB for mHHS*: Resolution of groin pain (OR, 3; $P = .009$), pain during activity (OR, 3.3; $P < .001$), pain after activity (OR, 2.7; P = .002), and limping after activity (OR, 6.8; $P = .007$).
- *MCID for SF-36*: Resolution of groin pain (OR, 2.6; $P = .010$), pain after activity (OR, 3.5, $P < .001$), hamstring tightness (OR, 2.6; $P = .009$), and limping after activity (OR, 2.6; $P = .023$).
- *SCB for SF-36*: Resolution of groin pain (OR, 3.1; $P = .004$), pain after activity (OR, 4.2; $P < .001$), and limping after activity (OR, 3; $P = .022$).

Return to Sports

Responses to the focused sports question at 1 year postoperatively were received for 492 (96.7%) hips. Some athletes (n = 59 hips) indicated that they were able to return to their main sport but decided not to for reasons not linked to their hips. For athletes of the remaining 433 hips, 343 (79.2%) returned to sports and 90 (20.8%) did not. Reasons for nonreturn included having the same symptoms as before surgery (n = 40; 9.2%), other hip-related symptoms (n = 34; 7.9%), and other nonhip-related symptoms (n = 10; 2.3%). Six (1.4%) patients provided no reason. A significantly higher proportion of hips that achieved MCID-SB and SCB-SB returned to sports compared with those in which thresholds of improvement were not achieved (MCID-SB achieved vs not achieved: 79.4% vs 63.1%, $\chi^2 = 15.273$; $P < .001$; SCB-SB achieved vs not achieved: 83.8% vs 65.2%, $\chi^2 = 21.318$; $P < .001$).

DISCUSSION

The results of this study indicated that a spectrum of both location- and function-based symptoms are present in athletes diagnosed with FAI. At 1 year after arthroscopic correction of FAI, there was a significant resolution of each baseline-reported symptom, independently. By contrast,

TABLE 5
Influence on achieving the MCID and SCB for the mHHS and SF-36 (Resolved vs Persisting Groups)[a]

Variable	OR (95% CI)	*P*
Achieving MCID for mHHS		
Groin pain	5.499 (2.411-12.544)	**<.001**
Side hip pain	3.381 (1.453-7.869)	**.005**
Pain during activity	3.148 (1.660-5.967)	**<.001**
Pain after activity	2.603 (1.426-4.749)	**.002**
Achieving MCID for SF-36		
Groin pain	2.61 (1.261-5.403)	**.01**
Pain after activity	3.541 (2.074-6.047)	**<.001**
Hamstring tightness	2.647 (1.275-5.497)	**.009**
Limp after activity	2.587 (1.142-5.860)	**.023**
Achieving SCB for mHHS		
Groin pain	3.032 (1.314-6.999)	**.009**
Pain during activity	3.28 (1.695-6.347)	**<.001**
Pain after activity	2.67 (1.435-4.969)	**.002**
Limp after activity	6.816 (1.709-27.183)	**.007**
Achieving SCB for SF-36		
Groin pain	3.113 (1.431-6.775)	**.004**
Pain after activity	4.188 (2.489-7.046)	**<.001**
Limp after activity	2.986 (1.169-7.627)	**.022**

[a]An OR >1 indicates an increased odds of achieving metrics of improvement on the associated PROM with the resolution of each preoperative reported symptom (ie, resolved symptom status) compared with persisting symptom status. Bold *P* values indicate statistical significance ($P < .05$). MCID, minimal clinically important difference; mHHS, modified Harris Hip Score; OR, odds ratio; PROM, patient-reported outcome measure; SCB, substantial clinical benefit; SF-36, 36-Item Short Form Survey.

SB is defined by the total cumulative reporting of independent symptoms at any given time (culminating to an overall SB score). In this athletic cohort, SB resolution by 48.5% defined the MCID-SB, while resolution by 70.3% defined the SCB-SB, which was achieved by 63.6% and 43.8% of the study hips, respectively. SB resolution as a distinct outcome measure was associated with postoperative PROMs, whereby PROM scores at 1 and 2 years postoperatively were significantly better for hips that achieved the clinically meaningful metrics (MCID-SB and SCB-SB) of SB resolution. Thus, SB resolution as an outcome measure is an important consideration when evaluating the effect of arthroscopic correction of FAI. Based on this athletic cohort, approximate guideline thresholds of <50%, 50% to 70%, and >70% resolution can be considered as poor, fair, and good improvement, respectively. To our knowledge, the extent to which the resolution of SB affects patient outcomes after arthroscopic correction of FAI has not been previously reported.

Symptom presentation is complex and should be separated into location- and function-based symptoms. The proportional reporting of typical location-based pain in this study (40% groin, 34% front hip, and 32% side hip) was lower than that reported in previous studies[13,38]; however, these rates represent the subjective reporting of symptoms by the patient at independent locations, as opposed to pain symptoms reproduced upon specific provocation testing (eg, FADIR [flexion, adduction, internal rotation] test), which has been shown to have high sensitivity but low specificity (indicating that the test is likely to reproduce classical hip/groin pain but potentially has high false-positive rates). The classic C-sign[5] may consider these 3 independent locations (groin, front hip, side hip), of which >60% of hips in this cohort reported pain in at least 1 of these 3 locations. The comparatively higher reporting of function-based symptoms reported in this study (79% pain after activity, 75% stiffness after activity, and 70% pain during activity) is reflective of the fact that FAI is primarily a movement-related disorder.[10,18]

Considering PROM scores, the MCID was achieved in approximately 70% of cases for both mHHS and SF-36 outcome measures, while SCB was achieved in 51% of cases assessed using the mHHS and 45% when using the SF-36. The postoperative outcome score was considered high in both stratified groups (achieved/not achieved metrics of clinical significance). For this athletic cohort, the resolution of location-based groin pain is consistently important to achieve both the lower and upper thresholds of clinical improvement across different PROMs. There were 2.6- and 5.5-times increased odds of achieving the MCID and 3.1- and 3-times increased odds of achieving the SCB for the mHHS and SF-36, respectively, where groin pain was resolved compared with persisting. Resolution of lateral hip pain was the only other location-based symptom associated with achieving a meaningful improvement in PROMs, increasing the odds of achieving the MCID for the mHHS by a factor of 3.3.

In contrast, resolution of function-based symptoms was more frequently associated with achieving both the lower and upper thresholds of clinically important PROM improvement. Resolution of pain after activity and limping after activity significantly increased the odds of achieving clinically significant outcomes across both mHHS and SF-36. Resolution of pain during activity significantly increased the odds of achieving both the MCID and SCB for the mHHS and resolution of hamstring tightness significantly increased the odds of achieving the MCID for the SF-36. For an athletic cohort, restoration to uninhibited functional ability and alleviation of this component of SB was critical to achieve the most optimal outcome.

The presence of coexisting pathologies is beginning to receive more focused attention when evaluating PROMs for patients undergoing HA for FAI. For instance, hip-spine syndrome refers to concurrent hip and spine pathology with overlapping symptoms.[47] Initially recognized within the arthroplasty literature, the pathomechanics of this phenomenon, specifically the compensatory stresses on the lumbosacral spine stemming from a reduced hip range of motion as a result of structural abnormalities associated with FAI,[39] has also been evaluated in nonarthritic patients. In a matched-cohort study, Sun et al[45] demonstrated improvements in the Oswestry Disability Index score at 1 year postoperatively in patients undergoing arthroscopy for labral pathology and FAI, consistent with the trend in outcomes reported within the arthroplasty literature. The true impact of coexisting back pain on outcomes for patients undergoing arthroscopic correction for FAI is conflicting; however, with some researchers reporting a negative impact on clinical outcomes,[1,3,4,22,28,31] others have reported no differences.[11,25]

Other coexisting symptoms such as posterior/buttock pain may be less of a confounder for postoperative outcomes. Levy et al[33] reported similar outcomes and satisfaction at 2 years in patients undergoing HA for FAI with posterior/buttock pain compared with typical groin pain. The influence on clinical outcomes from lateral hip pain—including greater trochanteric pain syndrome—as a bimodal pathology coexisting with FAI is more debatable. Sun et al[44] reported that isolated arthroscopic treatment of FAI in patients with gluteus medius tear can gain satisfactory patient outcomes at 1 year although there was no comparison of outcomes made against patients with FAI only. While this, in part, theorizes that correcting a patient's FAI pathology without addressing the gluteus medius tendon tear may improve their greater trochanteric pain syndrome,[37] Sun et al[44] also stated that in the presence of a complete tear and where return to high-level sports is an end goal, then additional intervention may be necessary.

The proximal location of the alternative coexisting symptom may be a critical factor. Inguinal disruption is the term used to consolidate the many different terminologies in the assessment of athletes with a painful groin, such as Gilmore groin, osteitis pubis, and athletic pubalgia.[43] The abnormal bony morphology associated with chronic FAI can disrupt the natural mechanics of the hip joint resulting in increased strain, leading to injury to the posterior inguinal wall and pubic symphysis, which may exacerbate symptoms more specific to inguinal disruption. In such cases of dual pathology, the approach toward dual symptom resolution has been variably reported. Larson et al[30] reported the effective management of dual pathology (FAI and athletic pubalgia) results when HA and groin-specific surgery is performed either in a staged or simultaneous approach. This conclusion was based on the higher return to sports rates where both pathologies were addressed compared with either approach in isolation. Conversely, more recent studies have demonstrated the effective alleviation of dual pathologies in the case where the FAI component alone is arthroscopically corrected. Saito et al[42] reported significant improvements in PROMs, high rates of return to sports, reduction of pubic symphysis tenderness, and resolution of MRI-evidenced osteitis pubis/bone-marrow edema after HA alone. Carton and Filan,[7] in a cohort of 104 competitive athletes with dual pathology, demonstrated that 89% of cases avoided the need for additional groin surgery where HA was the index treatment procedure and at 2 years postoperatively there was no difference in the proportion of cases continuing to play, satisfaction, or PROMs between groups undergoing 1 or 2 procedures.

Extending beyond physical symptoms, psychological/psychiatric comorbidities have also been shown to confound PROMs after HA for FAI, with the presence of depression, anxiety, or other mental health illness resulting in poorer postoperative outcomes compared with where these symptoms are not present. The overall perception of health and health-related quality of life comprises biological, psychological, and social perspectives,[48] with deficiencies in any 1 component potentially extending impact on the rest. For an athletic population, factors increasing the risk of depression include injury, career termination, or performance expectations.[17] Patients undergoing arthroscopic correction for hip-related pathology have an increased prevalence of concomitant psychiatric diagnoses compared with knee arthroscopy,[41] anterior cruciate ligament reconstruction, or shoulder stabilizing surgery.[23]

With such awareness of different variables impacting the outcomes, it is important to evaluate the impact of coexisting symptoms when interpreting patient-reported outcomes after HA for FAI. Although the validity of PROMs is established relative to the purpose of assessing a specific pathology based on the cluster of symptoms occurring most frequently within that pathology, when used in isolation they do not consider the potential influence of SB affecting a reported outcome. Given that any symptom can have an adverse impact on function and activity, evaluating outcomes should consider the impact of SB when interpreting subjectively reported patient outcomes.[12]

The survey used in this study to generate the SB score was developed based on clinical experience and classic symptoms reported both within the existing literature and by patients with FAI attending the clinic. The longitudinal follow-up and binary assessment format allowed for simplistic tracking of symptom reporting over time. The POPI technique used to evaluate clinically important improvement (MCID and SCB) has advantages over point estimates, which are predominately used within the arthroscopy literature. This calculation technique is analogous to the maximal outcome improvement originally described by Gilmer et al[16] in the shoulder literature. For the assessment of outcomes after HA for FAI, a measure of improvement based on a proportion of that available to the patient has been shown to be more accurate and inclusive, particularly for patients with higher baseline PROMs.[8,19] Applying this calculation technique to gauge the proportional resolution of SB considered meaningful for patients undergoing HA for FAI has not previously been reported to our knowledge. We found that postoperative PROM scores were significantly higher for hips that achieved clinically meaningful thresholds of SB resolution versus hips that did not achieve these thresholds. Also, a higher proportion of cases that achieved these meaningful thresholds were able to return to sports at 1 year postoperatively. Higher proportional SB resolution was also positively correlated with subjective ratings of satisfaction. This indicates that SB assessment is a valuable outcome measure when evaluating meaningful patient outcomes and understanding confounders to the most optimum success. The anchor question we used to establish a cutoff for the POPI-SB measured patient satisfaction based on expectations, and in that regard, it can establish a subjective feeling of benefit gained, which is not necessarily confounded by perceptions of changes in pain or function specifically; rather, these are evaluated through PROMs. Our use of varying metrics of clinical improvement (MCID and SCB) also allowed for more robust clinical interpretability.

We recommend an evaluation of SB as measured using the SB score to be a valuable measure to establish success for patients undergoing HA and to complement existing measures of surgical outcome, which primarily consist of reporting PROMs and their thresholds of clinically meaningful improvement. Future research directions may include a consensus statement when evaluating SB in a population with FAI and identifying and validating specific symptoms where resolution correlates well with achieving clinical metrics (MCID/SCB) of improvement.

Limitations

This study has limitations that must be acknowledged. One, the postoperative period for the assessment of symptom resolution (1 year) was short; however, to attribute any improvement in subjective symptoms to the impact of HA alone, we felt this period was appropriate—beyond this, additional symptoms prevalence may be potentially unrelated, particularly as athletes are permitted to return to full contact sports from 3 months postoperatively. Two, the binary reporting of symptoms does not consider the intensity of symptoms, which may influence outcomes; however, binary reporting does maintain the objectivity of this measure, and the complementary use of PROMs alongside an assessment of SB allows for symptom severity to be assessed separately. Three, no additional diagnostic imaging was performed for cases reporting pain in the knee or lower back. Four, the PROMs we used have an interpretability that has been substantiated previously; however, to allow for a more accurate assessment of multiple location-based symptoms (eg, knee, back), more sensitive region-specific PROMs might be valuable. Five, the SB survey did not assess for psychological comorbidities, which can also influence pre- and postoperative outcomes. Six, several factors may limit the generalizability of this study, such as the single-center, single-surgeon design, and predominantly male athletic cohort. In addition, evaluation of SB impact using just the mHHS and SF-36, where other PROMs are also routinely used in the assessment of HA for FAI.

CONCLUSION

SB and extent of resolution are important measures of outcome in patients undergoing HA to treat FAI. Achieving thresholds of clinically important SB resolution was associated with superior postoperative PROM scores and higher rates of return to main sport for this athletic cohort. Resolution of groin pain, pain during/after activity, hamstring tightness, and limping after activity increased the odds of achieving clinically important improvement on PROMs.

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