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Predictors of Persistent Postoperative Pain at Minimum 2 Years After Arthroscopic Treatment of Femoroacetabular Impingement

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Background: Hip arthroscopy for femoroacetabular impingement syndrome (FAIS) is a rapidly expanding field, and preoperative factors predictive of persistent postoperative pain are currently unknown.

Purpose: To identify predictors for persistent postoperative pain at the site of surgery after hip arthroscopy for FAIS.

Study Design: Case-control study; Level of evidence, 3.

Methods: Patients who underwent hip arthroscopy for FAIS and had a minimum 2-year follow-up with patient-reported outcomes (PROs) were included in this study. Patients with previous open hip surgery and diagnoses other than FAIS were excluded. Patients were grouped by visual analog scale scores for pain as limited (<30) and persistent (≥30). Patient factors and outcomes were analyzed with univariate and correlation analyses to build a logistic regression model to identify predictors of persistent postoperative pain.

Results: The limited pain (n = 514) and persistent pain (n = 174) groups totaled 688 patients (449 females). There was a statistically significant difference in age between groups, with the persistent pain group being older than the low pain group (35.9 ± 12.2 vs 32.4 ± 12.6, respectively; $P = .002$). Patients with persistent postoperative pain demonstrated significantly lower preoperative PRO scores in the Hip Outcome Score–Activities of Daily Living (57.6 ± 21.2 vs 67.7 ± 16.8), Hip Outcome Score–Sport Specific (35.9 ± 23.9 vs 44.1 ± 22.7), modified Harris Hip Score (51.6 ± 16.2 vs 59.6 ± 12.9), and International Hip Outcome Tool (32.0 ± 16.8 vs 40.0 ± 17.82) but no significant differences in preoperative visual analog scale scores for pain (7.3 ± 1.8 vs 7.2 ± 1.7). Mean postoperative PRO differences between pain groups were all statistically significant. Bivariate logistic regression analysis demonstrated that history of anxiety or depression (odds ratio, 1.8; 95% CI, 1.02-3.32; $P = .042$), revision hip arthroscopy (odds ratio, 8.6; 95% CI, 1.79-40.88; $P = .007$), and a low preoperative modified Harris Hip Score (odds ratio, 0.97; 95% CI, 0.95-0.99; $P = .30$) were predictors of persistent postoperative pain.

Conclusion: Independent predictors for persistent postoperative pain include revision hip arthroscopy and mental health history positive for anxiety and depression. Our analysis demonstrated significant improvements in pain and functional PROs in the limited pain and persistent pain groups; however, those with persistent pain demonstrated significantly lower PRO scores.

Keywords: persistent pain; hip arthroscopy; femoroacetabular impingement syndrome; patient-reported outcomes

Femoroacetabular impingement syndrome (FAIS) was recently defined as a movement-related clinical hip disorder that represents the symptomatic contact between the proximal femur and acetabulum during hip motion.[14] FAIS presents with hip or groin pain and activity-related symptoms and is most commonly diagnosed among young individuals and active adults.[14] The use of hip arthroscopy to treat FAIS has grown exponentially in recent years.[5,26] The primary goal of hip arthroscopy is to reduce pain and improve overall function. Short- to midterm outcome studies indicated that patients demonstrate very good to excellent patient-reported outcomes (PROs) scores for function and quality of life after hip arthroscopic surgery for FAIS.[12,13,24-26,29] Despite the considerable evidence of improvement in PROs, certain patients report persistent pain hip pain after hip arthroscopy.[18]

Persistent pain after hip arthroscopy for FAIS is frustrating for patients, therapists, and surgeons. Structural factors, such as underlying acetabular dysplasia or residual femoroacetabular impingement, have been posited as risk factors for persistent hip pain and failure of primary hip arthroscopy.[4,27,33] Very little evidence exists on other preoperative factors (eg, patient characteristics)

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that may contribute to persistent pain after hip arthroscopy.[9,13] Westermann and colleagues[39] recently investigated patient characteristics and intraoperative findings that predicted preoperative patient-reported pain and function among patients undergoing hip arthroscopy; however, the outcome measures of pain and function were limited to those before surgery. The authors found that mental health status, preoperative activity level, sex, and smoking status were most predictive of baseline preoperative PROs before hip arthroscopic surgery. It was interesting that intraoperative articular findings during hip arthroscopy were not correlated with hip pain and function before surgery. This study's findings highlight the need to investigate the effect of preoperative patient pain and function that may predict postoperative PROs after hip arthroscopy.

An understanding of the patient characteristics that contribute to persistent pain and impaired function after hip arthroscopic surgery is important to improving patient selection for this procedure. Ultimately, improved patient selection for hip arthroscopy will reduce the number of inferior outcomes after surgery.[11,12,14,16,23,33] The purpose of this study was to identify patient characteristics that predict postoperative pain and function among people undergoing hip arthroscopy for FAIS. We hypothesize that patient factors such as preoperative pain history >2 years, preoperative narcotic use, preoperative history of smoking, and a preoperative history of mental illness diagnosis will be predictors of low reported outcomes and persistent hip pain after hip arthroscopic surgery at 2-year minimum follow-up.

METHODS

This study received approval from the institutional review board of our local hospital and university (12022108-IRB0). A retrospective analysis was performed of a single surgeon's (S.J.N.) database, which was collected from January 2012 to December 2015. All patients who were treated with primary hip arthroscopy for FAIS and had a minimum 2-year follow-up on PROs were eligible for inclusion in the study. Patients were diagnosed with FAIS via previously described hip symptoms, clinical signs, and imaging findings.[17] Indication for surgery was any patient with a FAIS diagnosis who failed nonoperative treatment (rest from aggravating activity, physical therapy, nonsteroidal anti-inflammatory drugs). The inclusion criteria for FAIS diagnosis were hip pain for >6 weeks, positive impingement testing (anterolateral hip pain during flexion, adduction, and internal rotation of the symptomatic hip), and imaging findings consistent with cam, pincer, or mixed FAIS deformity on standard radiographs. All patients received a series of preoperative radiographs consisting of a standing anteroposterior pelvis radiograph, a false-profile hip radiograph, and a Dunn lateral hip radiograph.[20] Cam- and pincer-type FAIS deformity was quantified with the alpha angle and lateral center-edge angle (LCEA), respectively. Cam-type FAIS was defined as an alpha angle >50° on the Dunn lateral view. Pincer-type FAIS was defined as an LCEA >40° on anteroposterior pelvis radiograph. Mixed-type deformity was diagnosed if patients demonstrated a combination of an alpha angle >50° and an LCEA >40°.[22,31] The anteroposterior pelvis radiograph was also used to measure joint space width at 3 locations, as well as to define the Tönnis grade. Inclusion criteria of patients for arthroscopic hip surgery for FAIS included skeletal maturity at time of surgery, ≥6 weeks of failed nonoperative management, and hip pain for >6 weeks. Exclusion criteria for arthroscopic hip surgery were joint space width ≤2 mm at any location or advanced osteoarthritis (Tönnis grade >1), evidence of acetabular dysplasia (LCEA <20° on anteroposterior radiograph), and evidence of excessive femoral torsion or angulation. General exclusion criteria for the current study also included history of open hip surgery, history of substantial ipsilateral hip or knee injury, inflammatory arthropathy, bilateral FAIS diagnosis, bilateral hip arthroscopy, and revision hip arthroscopy.

Hip Arthroscopy Surgical Technique

Patients underwent hip arthroscopy for the treatment of symptomatic FAIS in the supine position as previously described.[11,16,35] Diagnostic arthroscopy was performed, and labral tears were repaired when there was gross detachment from the acetabular rim. Labral debridement was selectively performed for patients with sufficient labral tissue and minimal or no detachment. The peripheral compartment was then addressed with an osteochondroplasty for cam lesions. A transverse interportal capsulotomy and a T-capsulotomy were utilized for visualization in all cases. As part of routine closure, the interportal and T-capsulotomy incisions were closed or plicated. All patients followed a standard rehabilitation protocol.[22]

Persistent Postoperative Pain and PROs

The visual analog scale (VAS) for pain was used to define persistent postoperative pain. The VAS is a continuous

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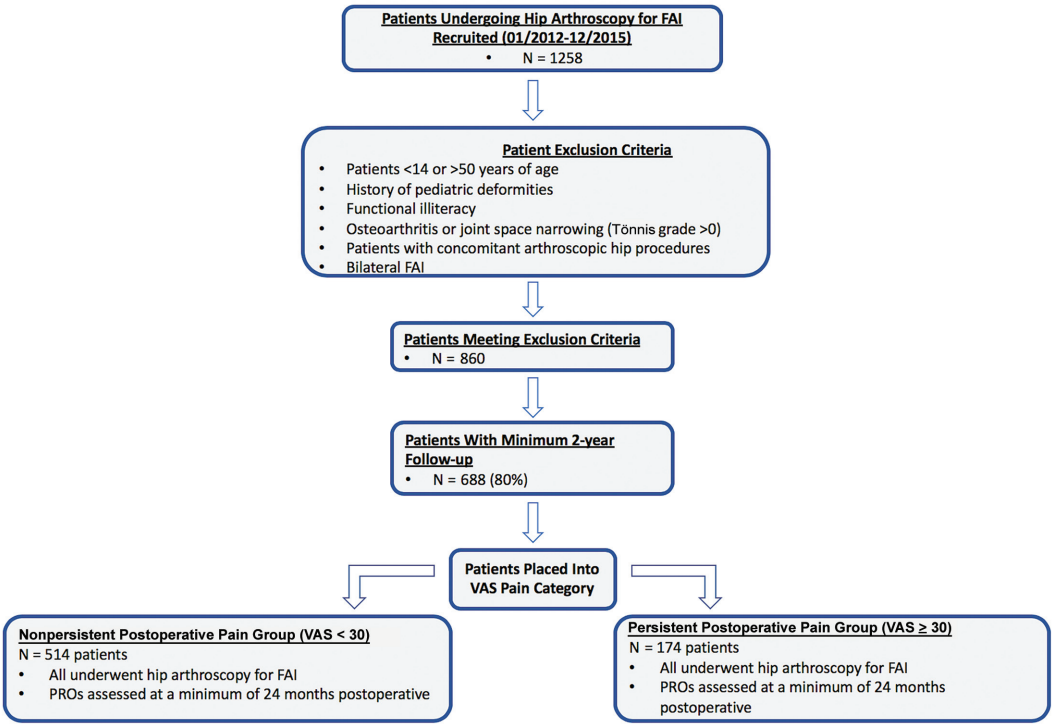

Figure 1. Flowchart of patient recruitment and follow-up. FAI, femoroacetabular impingement; PRO, patient-reported outcome; VAS, visual analog scale.

scale composed of a 100-mm horizontal line anchored by 2 descriptors, 1 for each symptom extreme (0, no pain; 100, extreme pain). Persistent postoperative pain was defined as a postoperative VAS score >75th percentile of all sampled patients at a minimum 2-year follow-up. In the current study, the 75th percentile for pain was ≥30. This threshold was based on reported analysis of the VAS pain score for moderate or greater pain and those patterns cited in the hip and chronic musculoskeletal pain literature.[4,10,36] As such, patients were defined to have persistent postoperative pain if they had a VAS score ≥30, whereas patients who had a postoperative VAS score <30 were defined as having limited postoperative pain.

The outcome variables of interest in the current study were PRO scores at ≥2 years after hip arthroscopy for the Hip Outcome Score–Activities of Daily Living (HOS-ADL), Hip Outcome Score–Sport Specific (HOS-SS), International Hip Outcome Tool (iHOT-12), and modified Harris Hip Score (mHHS). Additionally, VAS pain and patient satisfaction scores at ≥2 years after hip arthroscopic surgery were outcome variables of interest.

Statistical Analysis

All data were inspected before analysis to determine if the variables met all statistical assumptions for parametric testing. In cases where parametric statistical analysis assumptions were violated, the appropriate analogous nonparametric statistical tests were performed. Independent-samples *t* tests were performed to determine group differences between patients with persistent and nonpersistent postoperative pain for demographics and pre- and postoperative patient-reported clinical function.

A total of 67 variables were analyzed with Pearson *r* coefficients to determine what factors correlated with persistent postoperative pain. The categories for these variables included demographics, medical and surgical history, preoperative physical findings, intraoperative findings, postoperative findings, and postoperative patient-reported clinical outcomes. All variables are summarized in Appendix Table A1 (available in the online version of this article). Those variables that had a statistically significant correlation were then entered into a binary multivariable logistic regression model to identify what were independent predictors of persistent postoperative pain. Statistical significance was set at $P \leq .05$ for all analyses. All statistical analyses were performed with SPSS (v 23.0; IBM Corp).

RESULTS

A total of 860 patients met the inclusion criteria, and 688 patients (449 females) were available for 2-year follow-up (Figure 1). The persistent postoperative pain group included 174 patients (25%), whereas the limited postoperative pain group consisted of 514 patients (75%). The persistent postoperative pain group was significantly older than the limited postoperative pain group (Table 1).

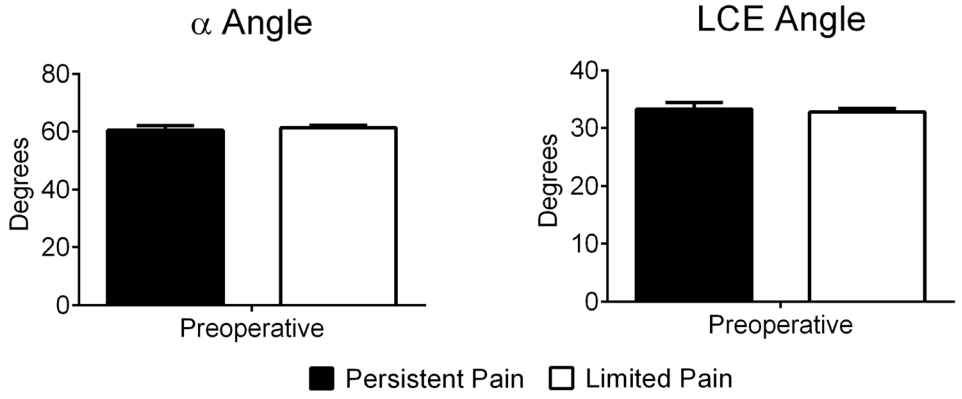

Figure 2. Preoperative radiographic measurements for patients with and without persistent postoperative pain. Nonpersistent pain was delineated with a visual analog scale score <30. Values are presented as mean ± SD. LCE Angle, lateral center-edge angle.

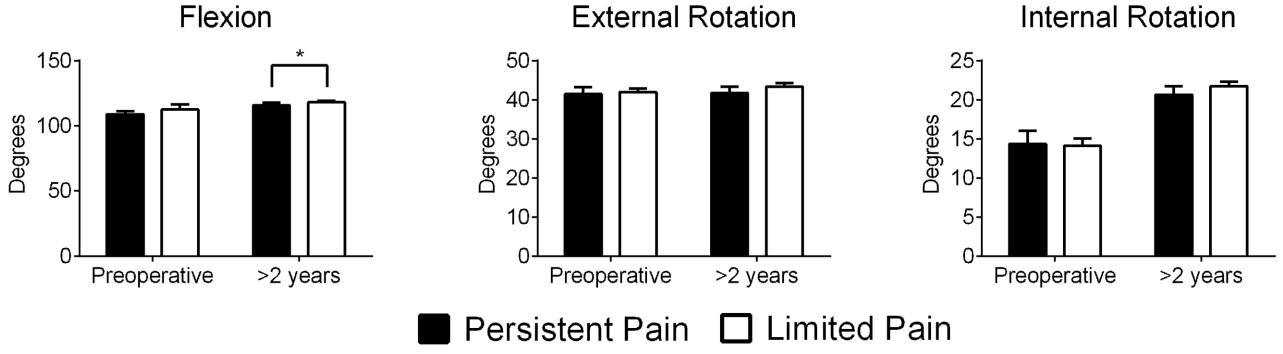

Figure 3. Pre- and postoperative passive range of motion for patients with and without persistent postoperative pain. Values are presented as mean ± SD. *$P \leq .05$.

TABLE 1
Patient Demographics for People With Persistent Pain and Nonpersistent Pain After Hip Arthroscopy

	Postoperative Pain, n (%) or Mean ± SD		
	Nonpersistent	Persistent	*P* Value
Patients	514	174	
Females	334 (65)	115 (66)	.744
Age, y	32.4 ± 12.6	35.9 ± 12.2	.002[a]
Body mass index	25.2 ± 9.60	25.9 ± 5.40	.316

[a]$P \leq .05$.

Comparison of Radiographic Imaging and Range of Motion

Preoperative radiograph images and range of motion were compared to determine whether there were any significant differences between the pain groups. There was no statistically significant difference between groups in terms of alpha angle ($P = .340$) and LCEA ($P = .412$) (Figure 2). Although there were no statistically significant differences between the groups at the preoperative time point, a significant difference for passive hip flexion was observed at 2 years postoperatively ($P = .036$) (Figure 3).

Patient-Reported Outcomes

Patients with persistent postoperative pain demonstrated significantly lower preoperative scores for the HOS-ADL (57.6 ± 21.2 vs 67.7 ± 16.8), HOS-SS (35.9 ± 23.9 vs 44.1 ± 22.7), mHHS (51.6 ± 16.2 vs 59.6 ± 12.9), and iHOT-12 (32.0 ± 16.8 vs 40.0 ± 17.82) but no significant differences in preoperative VAS pain scores (7.3 ± 1.8 vs 7.2 ± 1.7). Analysis of the postoperative PROs demonstrated that patients in the persistent pain group had statistically significant lower PRO scores as compared with the limited pain group (Table 2).

Correlation Analysis

A number of preoperative factors were found to have a weak and statistically significant correlation with persistent postoperative pain (Table 3). Briefly, age, workers' compensation claim, hypertension, history of psychiatric conditions, preoperative use of narcotics, history of spine surgery, number of prior surgeries, and Tönnis grade were all positively and weakly correlated with persistent

TABLE 2
Analysis of Pre- and Postoperative Patient-Reported Outcomes in the Persistent vs Limited Pain Groups[a]

	Group, Mean ± SD		
Outcome	Limited Pain	Persistent Pain	*P* Value
Preoperative			
iHOT-12	40.0 ± 17.82	32.0 ± 16.8	.001
HOS-ADL	67.7 ± 16.8	57.6 ± 21.2	<.001
HOS-SS	44.1 ± 22.7	35.9 ± 23.9	<.001
mHHS	59.6 ± 12.9	51.6 ± 16.2	<.001
VAS: pain	7.2 ± 1.7	7.3 ± 1.8	.554
Postoperative			
iHOT-12	80.3 ± 19.3	34.8 ± 20.7	<.001
HOS-ADL	91.6 ± 10.5	65.5 ± 19.7	<.001
HOS-SS	81.4 ± 21.1	40.3 ± 25.6	<.001
mHHS	85.6 ± 11.6	57.3 ± 16.9	<.001
VAS: pain	8.6 ± 9.1	56.7 ± 17.7	<.001
VAS: satisfaction	88.6 ± 17.2	50.4 ± 32.3	<.001

[a]HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sport Specific; iHOT-12, International Hip Outcome Tool; mHHS, modified Harris Hip Score; VAS, visual analog scale.

TABLE 3
Patient Factors Significantly Correlated With Persistent Postoperative Pain[a]

Factor	Correlation Coefficient	*P* Value
Age	0.118	.002
Primary hip arthroscopy	–0.141	<.001
Workers' compensation	0.089	.02
Hypertension	0.128	.001
History of psychiatric conditions	0.101	.008
Preoperative narcotic use	0.147	<.001
Regular physical exercise	–0.101	.009
Running as primary exercise	–0.189	<.001
HOS-ADL	–0.234	<.001
HOS-SS	–0.151	<.001
mHHS	–0.246	<.001
Prior spine surgery	0.078	.001
No. of prior surgical procedures (not hip)	0.167	<.001
Tönnis grade	0.122	.002

[a]HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sport Specific; mHHS, modified Harris Hip Score.

postoperative pain. Regular exercise, running, and preoperative clinical baseline (ie, HOS-ADL, HOS-SS, and mHHS) were all negatively and weakly correlated with persistent postoperative pain.

Binary Logistic Regression

After univariate analysis and significant correlations, binary logistic regression identified several specific predictors for persistent postoperative pain after hip arthroscopy. Among all the variables, patients undergoing revision hip surgery had the highest odds of having persistent postoperative pain (odds ratio [OR], 8.6; 95% CI, 1.79-40.88; $P = .007$). In addition, patients with a psychiatric history of anxiety and/or depression were more likely to have persistent pain (OR, 1.8; 95% CI, 1.02-3.32; $P = .042$). The only patient-reported clinical baseline measure that had a statistically significant OR was mHHS; however, the ratio was very close to 1 (OR, 0.97; 95% CI, 0.95-0.99; $P = .30$). No other variables were significant predictors of persistent postoperative pain after hip arthroscopy (Table 4).

TABLE 4
Multivariable Logistic Regression Predictor Analysis[a]

Predictor Variable	Odds Ratio	95% CI	*P* Value
Age	1.018	0.99-1.04	.104
Workers' compensation claim	1.870	0.69-5.08	.219
Hypertension	1.509	0.67-3.40	.321
History of psychiatric conditions	1.844	1.02-3.32	.042[b]
Preoperative narcotic use	0.844	0.44-1.62	.612
Currently physically active	1.743	0.95-3.19	.072
Currently run for exercise	0.736	0.44-1.23	.245
HOS-ADL	0.981	0.96-1.00	.108
HOS-SS	0.996	0.99-1.03	.136
mHHS	0.971	0.95-0.99	.030[b]
History of spine surgery	1.588	0.55-4.59	.393
History of prior surgery	0.979	0.59-1.61	.935
Revision hip surgery	8.563	1.79-40.88	.007[b]
Tönnis grade	0.000	0-0	≥.999

[a]HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sport Specific; mHHS, modified Harris Hip Score.
[b]$P \leq .05$.

DISCUSSION

The purpose of this study was to identify patient characteristics that predict persistent versus limited postoperative pain among those undergoing hip arthroscopy for FAIS. We found that 75% of patients in our sample had limited pain after surgery (ie, VAS <30), whereas 25% had persistent postoperative pain (ie, VAS ≥30). Our study identified that revision hip arthroscopy, history of psychiatric diagnosis, and preoperative function as measured by the mHHS were significant predictors of postoperative pain status. Patients who cited undergoing a revision hip arthroscopy were 8 times more likely to experience persistent postoperative pain after hip arthroscopy for FAIS. Similarly, patients who had a history of psychiatric diagnosis were 84% more likely to report persistent postoperative pain after hip arthroscopy. Conversely, patients who indicated high-level preoperative function, as measured by the mHHS, were 3% less likely to report persistent postoperative pain. The main findings from this study are that patients who had a previous hip arthroscopy and a history of psychiatric conditions were more likely to report high persistent pain postoperatively after hip arthroscopy for

FAIS. Although patients who reported higher levels of preoperative function on the mHHS were less likely to experience high persistent postoperative pain, this finding may be due to this PRO measure exhibiting a ceiling effect for the measurement of function among these patients. This study highlights that preoperative patient characteristics can influence negative aspects of patient outcome, such as persistent pain after arthroscopic surgery. As such, these factors should be considered in the clinical decision-making algorithm of surgeons performing hip arthroscopy.

Correlation analysis demonstrated a weak association between athletic participation and improved VAS pain scores <30, defined as limited pain. The findings show that running and a higher level of athletic performance were significantly negatively correlated with postoperative pain such that running for exercise and higher athletic performance were associated with lower reported pain. These results seem to indicate that higher activity levels and running are protective for developing persistent postoperative pain. Runners were demonstrated to have high rates of patient satisfaction and return to running after hip arthroscopy.[21] Athletes are highly motivated and also have a high rate of return to sport.[2,6,7,23,28,38] These findings should be encouraging to patients and surgeons that an active lifestyle and strong motivation may lead to decreased risk for continued postoperative pain.

Revision Hip Arthroscopy

It is not surprising that a history of revision hip arthroscopy for FAIS is a predictor of high postoperative pain. As demonstrated in previous studies, 51% to 81% of revision arthroscopic hip surgery cases are secondary to incomplete resection of femoroacetabular impingement deformity, which can lead to labral retear and continued postoperative clinical symptoms.[25] It is possible that this is due to early arthroscopic hip surgical techniques' primary focus on repairing soft tissue injury, such as labral tears, while placing less emphasis on resection of the FAIS deformity.[10,15,19,29,34] Advancements in the understanding of the direct association between FAIS deformity and soft tissue injury has led to a greater emphasis on complete resection of cam and pincer lesions, as well as management of the joint capsule via closure, plication, or reconstruction.[19] Based on the results of the current study, it may be beneficial to discuss the potential limitations in pain relief among patients undergoing revision hip arthroscopy.

Revision hip arthroscopy previously demonstrated successful improvements in PROs.[19,25] The degree of improvement offered by revision hip arthroscopy is likely underestimated, since several studies cited the mHHS as a primary PRO, which demonstrates a ceiling effect that limits its sensitivity for detecting meaningful functional improvement among patients undergoing hip arthroscopy.[37] Larson and colleagues[19] studied a cohort of patients with revision hip arthroscopy for correction of residual femoroacetabular impingement and demonstrated significant postoperative improvements in the mHHS and VAS in both groups.

A recent study by Westermann and colleagues[39] identified preoperative predictors of significant hip pain at the time of arthroscopic treatment of FAIS but not for postoperative pain. Their analysis identified that female sex, lower education levels, smoking, lower mental health scores, and lower activity levels predicated Hip disability and Osteoarthritis Outcome Score pain and function preoperatively.[39] Our study identified several overlapping correlations with persistent postoperative pain, including a diagnosis of anxiety and depression, a higher Tönnis grade, and regular physical activity; however, only previous hip arthroscopy and history of depression and anxiety were significant predictors of persistent postoperative pain 2 years after hip arthroscopy. Both Nepple et al[24] and Westermann et al[39] found that female sex was a predictor of baseline preoperative pain, but our results indicate that sex was not a predictor of persistent pain after surgery. Frank et al[12] conducted an age-and-sex analysis of 150 patients undergoing hip arthroscopy for FAIS and identified increasing age and female sex as risk factors for inferior PROs at >2 years, which included pain components. Persistent pain is associated with decreased outcome and is reflected in the pain component of the PROs; our results remain congruent with those documented by Frank et al,[12] since the inferior outcomes among female patients were associated with age >45 years and our mean age was 32 and 36 years in the limited and persistent pain groups, respectively.

In the present study, we identified significant associations with mental health diagnoses on postoperative pain and functional PROs. Similar trends with inferior outcomes were previously indicated after treatment for other orthopaedic pathology.[1,5,26,40] Patient distress risk was reported to negatively affect baseline hip pain and function scores at the time of hip arthroscopy.[31] Poor mental health scores were subsequently identified as independent risk factors for increased baseline preoperative pain.[39] Patients with greater psychological distress at the time of surgery have greater perioperative demands for increased pain control.[30] Those patients with at-risk or distressed scores from the Distress Risk Assessment Method utilize more intraoperative opioids and postoperative fascia iliac nerve blocks than do patients with normal scores.[30] Our study did not examine short-term postoperative pain, but future investigation may identify poor perioperative pain control as a risk factor for persistent postoperative pain. The growing evidence regarding psychological distress and poor mental health would support that patients with mental health disease may not achieve the same postoperative pain and functional gains as those without concurrent disease.[36]

The results in our study also did not identify the presence of low back pain as a predictor or risk factor for increased postoperative pain in contradistinction to a history of spine surgery. The hip-spine relationship is well established, and patients may have overlapping symptoms and altered hip range of motion.[3,8,20,32] Our study did not identify a significant correlation between low back pain and hip range of motion, unlike the results from a systematic review by Redmond et al[32]; however, our studies have

congruent conclusions that low preoperative back pain is not associated with poor PROs, persistent postoperative pain, or patient satisfaction. Our results and the literature support that low back pain should not deter a patient or surgeon from consideration for hip arthroscopy, but those who have undergone previous spinal surgery may be at an increased risk of persistent postoperative pain.

A minimum time point of 2 years was considered adequate to assess persistent postoperative pain. A systematic review of pain, activities of daily living, and return to sport found that the first clinically relevant improvement in hip pain was observed at 3 to 6 months after hip arthroscopy.[18] Improvements in pain continued to postoperative 1 year, but continued improvement was not evident during 1- to 5-year follow-up.[18] These findings suggest that those with persistent pain at final follow-up (at least 2 years) will likely not experience additional improvement in their symptoms.

Limitations

Our study carries common limitations of a case-control study. We analyzed all consecutive patients treated by the senior author (S.J.N.) during a defined period, which may not be generalizable to a wider patient cohort. The practice is a large tertiary referral center and treats a high volume of FAIS. Furthermore, all patients were treated with the same capsulotomy and closure, which reduces variability associated with surgical technique. Last, while all patients in the study underwent hip arthroscopy for FAIS treatment, 1% to 2% of them had concomitant procedures, including psoas release, excision of heterotopic ossifications, and trochanteric bursectomy, which may have confounded the results. However, we believe that the large study group (N = 688) blunted any effect modification from the other concomitant procedure variables.

CONCLUSION

Independent predictors for persistent postoperative pain include revision hip arthroscopy and mental health history positive for anxiety and depression. Our analysis demonstrated significant improvements in pain and functional PROs in the limited pain and persistent pain groups; however, those with persistent pain demonstrated significantly lower PRO scores.

REFERENCES

1. Abtahi AM, Brodke DS, Lawrence BD, Zhang C, Spiker WR. Association between patient-reported measures of psychological distress and patient satisfaction scores after spine surgery. *J Bone Joint Surg Am*. 2015;97(10):824-828.
2. Alradwan H, Philippon MJ, Farrokhyar F, et al. Return to preinjury activity levels after surgical management of femoroacetabular impingement in athletes. *Arthroscopy*. 2012;28(10):1567-1576.
3. Ben-Galim P, Ben-Galim T, Rand N, et al. Hip-spine syndrome: the effect of total hip replacement surgery on low back pain in severe osteoarthritis of the hip. *Spine (Phila Pa 1976)*. 2007;32(19):2099-2102.
4. Bogunovic L, Gottlieb M, Pashos G, Baca G, Clohisy JC. Why do hip arthroscopy procedures fail? *Clin Orthop Relat Res*. 2013;471(8):2523-2529.
5. Brander VA, Stulberg SD, Adams AD, et al. Predicting total knee replacement pain: a prospective, observational study. *Clin Orthop Relat Res*. 2003;416:27-36.
6. Byrd JW, Jones KS. Arthroscopic management of femoroacetabular impingement in athletes. *Am J Sports Med*. 2011;39:7S-13S.
7. Byrd JW, Jones KS, Gwathmey FW. Femoroacetabular impingement in adolescent athletes: outcomes of arthroscopic management. *Am J Sports Med*. 2016;44(8):2106-2111.
8. Clohisy JC, Knaus ER, Hunt DM, Lesher JM, Harris-Hayes M, Prather H. Clinical presentation of patients with symptomatic anterior hip impingement. *Clin Orthop Relat Res*. 2009;467(3):638-644.
9. Collins JA, Beutel BG, Garofolo G, Youm T. Correlation of obesity with patient-reported outcomes and complications after hip arthroscopy. *Arthroscopy*. 2015;31(1):57-62.
10. Cvetanovich GL, Harris JD, Erickson BJ, Bach BR Jr, Bush-Joseph CA, Nho SJ. Revision hip arthroscopy: a systematic review of diagnoses, operative findings, and outcomes. *Arthroscopy*. 2015;31(7):1382-1390.
11. Frank RM, Lee S, Bush-Joseph CA, Kelly BT, Salata MJ, Nho SJ. Improved outcomes after hip arthroscopic surgery in patients undergoing T-capsulotomy with complete repair versus partial repair for femoroacetabular impingement: a comparative matched-pair analysis. *Am J Sports Med*. 2014;42(11):2634-2642.
12. Frank RM, Lee S, Bush-Joseph CA, Salata MJ, Mather RC 3rd, Nho SJ. Outcomes for hip arthroscopy according to sex and age: a comparative matched-group analysis. *J Bone Joint Surg Am*. 2016;98(10):797-804.
13. Giordano BD, Suarez-Ahedo C, Gui C, Darwish N, Lodhia P, Domb BG. Clinical outcomes of patients with symptomatic acetabular rim fractures after arthroscopic FAI treatment. *J Hip Preserv Surg*. 2018;5(1):66-72.
14. Griffin DR, Dickenson EJ, O'Donnell J, et al. The Warwick Agreement on femoroacetabular impingement syndrome (FAI syndrome): an international consensus statement. *Br J Sports Med*. 2016;50(19):1169-1176.
15. Gupta A, Redmond JM, Stake CE, Dunne KF, Hammarstedt JE, Domb BG. Outcomes of revision hip arthroscopy: 2-year clinical follow-up. *Arthroscopy*. 2016;32(5):788-797.
16. Harris JD, Slikker W 3rd, Gupta AK, McCormick FM, Nho SJ. Routine complete capsular closure during hip arthroscopy. *Arthrosc Tech*. 2013;2(2):e89-e94.
17. Kemp JL, Beasley I. 2016 international consensus on femoroacetabular impingement syndrome: the Warwick Agreement—why does it matter? *Br J Sports Med*. 2016;50(19):1162-1163.
18. Kierkegaard S, Langeskov-Christensen M, Lund B, et al. Pain, activities of daily living and sport function at different time points after hip arthroscopy in patients with femoroacetabular impingement: a systematic review with meta-analysis. *Br J Sports Med*. 2017;51(7):572-579.
19. Larson CM, Giveans MR, Samuelson KM, Stone RM, Bedi A. Arthroscopic hip revision surgery for residual femoroacetabular impingement (FAI). *Am J Sports Med*. 2014;42(8):1785-1790.
20. Lesher JM, Dreyfuss P, Hager N, Kaplan M, Furman M. Hip joint pain referral patterns: a descriptive study. *Pain Med*. 2008;9(1):22-25.
21. Levy DM, Kuhns BD, Frank RM, et al. High rate of return to running for athletes after hip arthroscopy for the treatment of femoroacetabular impingement and capsular plication. *Am J Sports Med*. 2017;45(1):127-134.
22. Malloy P, Gray K, Wolff AB. Rehabilitation after hip arthroscopy: a movement control-based perspective. *Clin Sports Med*. 2016;35(3):503-521.
23. McDonald JE, Herzog MM, Philippon MJ. Return to play after hip arthroscopy with microfracture in elite athletes. *Arthroscopy*. 2013;29(2):330-335.

24. Nepple JJ, Riggs CN, Ross JR, Clohisy JC. Clinical presentation and disease characteristics of femoroacetabular impingement are sex-dependent. *J Bone Joint Surg Am*. 2014;96(20):1683-1689.
25. Newman JT, Briggs KK, McNamara SC, Philippon MJ. Revision hip arthroscopy: a matched-cohort study comparing revision to primary arthroscopy patients. *Am J Sports Med*. 2016;44(10):2499-2504.
26. Nwachukwu BU, Chang B, Voleti PB, et al. Preoperative Short Form Health Survey Score is predictive of return to play and minimal clinically important difference at a minimum 2-year follow-up after anterior cruciate ligament reconstruction. *Am J Sports Med*. 2017;45(12):2784-2790.
27. Parvizi J, Bican O, Bender B, et al. Arthroscopy for labral tears in patients with developmental dysplasia of the hip: a cautionary note. *J Arthroplasty*. 2009;24(6)(suppl):110-113.
28. Philippon M, Schenker M, Briggs K, Kuppersmith D. Femoroacetabular impingement in 45 professional athletes: associated pathologies and return to sport following arthroscopic decompression. *Knee Surg Sports Traumatol Arthrosc*. 2007;15(7):908-914.
29. Philippon MJ, Schenker ML, Briggs KK, Kuppersmith DA, Maxwell RB, Stubbs AJ. Revision hip arthroscopy. *Am J Sports Med*. 2007;35(11):1918-1921.
30. Potter MQ, Sun GS, Fraser JA, et al. Psychological distress in hip arthroscopy patients affects postoperative pain control. *Arthroscopy*. 2014;30(2):195-201.
31. Potter MQ, Wylie JD, Sun GS, Beckmann JT, Aoki SK. Psychologic distress reduces preoperative self-assessment scores in femoroacetabular impingement patients. *Clin Orthop Relat Res*. 2014;472(6):1886-1892.
32. Redmond JM, Gupta A, Hammarstedt JE, Stake CE, Domb BG. The hip-spine syndrome: how does back pain impact the indications and outcomes of hip arthroscopy? *Arthroscopy*. 2014;30(7):872-881.
33. Ross JR, Clohisy JC, Baca G, Sink E; ANCHOR Investigators. Patient and disease characteristics associated with hip arthroscopy failure in acetabular dysplasia. *J Arthroplasty*. 2014;29(9)(suppl):160-163.
34. Sardana V, Philippon MJ, de Sa D, et al. Revision hip arthroscopy indications and outcomes: a systematic review. *Arthroscopy*. 2015;31(10):2047-2055.
35. Slikker W 3rd, Van Thiel GS, Chahal J, Nho SJ. The use of double-loaded suture anchors for labral repair and capsular repair during hip arthroscopy. *Arthrosc Tech*. 2012;1(2):e213-e217.
36. Sochacki KR, Brown L, Cenkus K, Di Stasi S, Harris JD, Ellis TJ. Preoperative depression is negatively associated with function and predicts poorer outcomes after hip arthroscopy for femoroacetabular impingement. *Arthroscopy*. 2018;34(8):2368-2374.
37. Stone AV, Jacobs CA, Luo TD, et al. High degree of variability in reporting of clinical and patient-reported outcomes after hip arthroscopy. *Am J Sports Med*. 2018;46(12):3040-3046.
38. Weber AE, Kuhns BD, Cvetanovich GL, Grzybowski JS, Salata MJ, Nho SJ. Amateur and recreational athletes return to sport at a high rate following hip arthroscopy for femoroacetabular impingement. *Arthroscopy*. 2017;33(4):748-755.
39. Westermann RW, Lynch TS, Jones MH, et al. Predictors of hip pain and function in femoroacetabular impingement: a prospective cohort analysis. *Orthop J Sports Med*. 2017;5(9):2325967117726521.
40. Wylie JD, Suter T, Potter MQ, Granger EK, Tashjian RZ. Mental health has a stronger association with patient-reported shoulder pain and function than tear size in patients with full-thickness rotator cuff tears. *J Bone Joint Surg Am*. 2016;98(4):251-256.