Preoperative Predictors of Achieving Clinically Significant Athletic Functional Status After Hip Arthroscopy for Femoroacetabular Impingement at Minimum 2-Year Follow-Up

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Purpose: To identify predictors of achieving clinically significant sport function in athletic patients undergoing hip arthroscopy for femoroacetabular impingement syndrome (FAIS). **Methods:** Data were analyzed for all patients who treated for FAIS between 2012 to 2016 and reported being athletes, including recreational and competitive athletes. All patients had a minimum of 2-year follow-up with patient-reported athletic function in the form of the Hip Outcome Score−Sport Specific (HOS-SS), visual analog score−pain, and patient satisfaction. Achieving clinically significant sports function was defined as either reaching the minimally clinical important difference (MCID) or the patient acceptable symptomatic state (PASS) for HOS-SS at 2-year follow-up. An exploratory factor analysis was used to determine specific domains for the predictor variables and to reduce the redundancy in these variables. A ogistic regression analysis was used to identify significant predictors of achieving clinically significant sports function. **Results:** Of 780 qualifying patients, 626 completed the 2-year minimum follow-up (80%), with a mean age and body mass index of 31.6 ± 11.9 years and 24.6 ± 8.6, respectively. A total of 500 patients (86.5%) achieved high functional status, with 77.9% achieving MCID HOS-SS and 68.7% achieving PASS HOS-SS. Logistic regression analysis identified increased the α angle (odds ratio [OR] 0.976; $P = .027$), preoperative pain duration (OR 0.729; $P = .011$), and body mass index (BMI) (OR 0.919; $P = .018$), as well as the presence of femoral chondral defects (OR 0.769; $P = .013$), as negative predictors for achieving MCID. Negative predictors for achieving PASS HOS-SS included the presence of a preoperative limp (OR 0.384; $P = .013$), anxiety or depression (OR 0.561; $P = .041$), and increased BMI (OR 0.945; $P = .018$) and preoperative pain duration (OR 0.987; $P < .001$). **Conclusions:** Several predictors of achieving clinically significant sport function performance exist, including a history of anxiety or depression, BMI, preoperative α angle, limp, femoral chondral damage, *and preoperative symptom duration. Our results suggest there are both modifiable and nonmodifiable preoperative factors that have the potential to predict achieving high athletic function after hip arthroscopy for FAIS. **Level of Evidence:** IV, Case Series.

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Introduction

Hip arthroscopy is widely used to treat femoroacetabular impingement syndrome (FAIS).[1,2] These procedures aim to reduce pain and improve function in younger, active patients and are highly successful.[3,4] FAIS with labral repair and osteochondroplasty leads to a high patient satisfaction rate and return to sports.[5-9] The success has been attributed to less soft tissue damage and a more rapid recovery.[10] A recent systematic review revealed a 92% return to sport

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rate in all athletes and a return to previous level of competition in 88% of these athletes.[7] The rates of return to sport after hip arthroscopy range from 73% to 95% in recreational through professional athlete.[9,11-13] These studies evaluated a broad range of sporting activities for both professional and recreational athletes. Additional factors influencing return to sport include the sport type, level of competition, and severity of the intra-articular hip damage.[14] This information demonstrates that a multitude of factors contribute to patient outcomes and return to sport, which also highlights the complexity in predicting these outcomes. Therefore, a detailed understanding of the predictors of both superior and inferior outcomes of athletic function after arthroscopic surgery for FAIS is imperative for treating surgeons. This information will help guide surgeons and patients in choosing the optimal treatment algorithm.[15-20]

Preoperative predictors of clinically significant sport function level at 2 years after hip arthroscopy are unclear. Westermann and colleagues[21] identified that mental health, activity level, sex, and smoking predict greater baseline pain and decreased baseline function before hip arthroscopy; however, the authors did not evaluate the efficacy of the intervention or predictors of postoperative pain and function. Furthermore, as with other previous studies, the authors did not identify preoperative variables predictive of achieving high sports-specific functional status after undergoing hip arthroscopy for FAIS in athletic patients. As such, the purpose of this study was to identify predictors of achieving clinically significant sport function in athletic patients undergoing hip arthroscopy for FAIS. An advanced understanding of factors that may influence postoperative outcomes and functional status would provide vital information for clinical decision-making for the treatment of athletic patients with FAIS across a large spectrum of athletic involvement. We hypothesized that both modifiable (i.e., age, body mass index [BMI], mental status, etc.) and nonmodifiable (α angle, Tonnis grade, pain duration, chondral damage, etc.) preoperative factors will predict achieving high functioning status in patients who undergo hip arthroscopy at a minimum of 2-year follow-up regardless of their athletic level.

Methods

Study Design

After approval from our institutional review board, patients who were scheduled to undergo hip arthroscopy were enrolled in a database repository. A retrospective analysis was performed on a single surgeon's database, which was collected from January 2012 through June 2016. Inclusion criteria were undergoing hip arthroscopy for FAIS, self-reporting as an athlete (recreational, high school, college, or professional), and a minimum of 2-year follow up. Exclusion criteria included not being an athlete, a medical history of ipsilateral or contralateral hip surgery, advanced osteoarthritis, reduced joint space (Tonnis grade >1), or evidence of congenital hip disorders [e.g., slipped capital femoral epiphysis, developmental dysplasia of the hip (lateral center-edge angle <20°),[22] and Perthes disease]. All eligible patients had been diagnosed with FAIS based on history, physical examination, and radiographic findings[23] and had failure of conservative, nonoperative treatment including the use of nonsteroid anti-inflammatory treatment, corticosteroid injections, and physical therapy.

Every surgical candidate who volunteered to be entered into the database received a preoperative clinical assessment that was made with the use of the Hip Outcome Score—Sport Specific (HOS-SS) and an assessment of preoperative pain by use of a visual analog scale (VAS-pain) via electronic tablet and was stored in an encrypted data collection system (Oberd, Columbia, MO). Patient demographics, including age, BMI, sex, and physical activity level, as well as pertinent medical history (e.g., pain duration, history of back pain, and history of mental disorders), were gathered electronically at the time of surgical clearance. Medical history was confirmed from the electronic medical record if the patient was seen previously at our institution. After the surgery, patient-reported outcomes (PROs) were evaluated by using the same surveys, in addition to satisfaction, which was assessed by using VAS-satisfaction, and were all administered electronically at a minimum of 24 months.

High Versus Low Function After Hip Arthroscopy

To assess the outcome of patients involved in sports, clinically significant sport function was determined by reaching the minimally clinical important difference (MCID), patient acceptable symptomatic state (PASS) for the Hip Outcome Score—Sports Subscale (HOS-SS) at 2-year follow-up. Although previous studies have described the MCID and PASS scores for patients undergoing hip arthroscopy for FAIS, every study population is unique and therefore both scores should be calculated to concisely represent the group being analyzed. In same manner as described previously in the literature, MCID for HOS-SS was determined by calculating the half—standard deviation (SD) of the HOS-SS average in the study patients.[24-26] The MCID was calculated to be 14.1. Any patient with an average improvement in 2-year HOS-SS score from baseline of <14.1 was considered to not be achieving a minimal threshold of meaningful athletic functional status. However, patients with an average improvement of ≥14.1 were considered to be achieving a minimal threshold of achieving meaningful athletic functional status.

PASS was calculated by using an anchor-based method. At 2-year follow-up, patients were asked the following anchor question: "Taking into account all the activities you have during your daily life, your level of pain, and also your functional impairment, do you consider that your current state is satisfactory?" The 2-year PASS value was then identified by using an receiver operating characteristic (ROC) curve analysis as previously done in prior studies (analysis provided in Appendix 1).[3,23,24,27-29] A sensitivity and specificity of 0.80 was used as the cut-off for determining an acceptable HOS-SS PASS score. Patients were classified as achieving PASS if PASS was achieved on any of the included outcome measures. The score necessary for achieving PASS HOS-SS was calculated to be 72.1. Any patient with a 2-year HOS-SS score of <72.1 was considered to not be achieving a high threshold of meaningful athletic functional status, whereas patients with a score of ≥72.1 were considered to be achieving a high threshold of meaningful athletic functional status.

Surgical Technique

Patients underwent hip arthroscopy for the treatment of FAIS in the supine position as previously described.[30-32] All operations were performed with the patient in the supine position on a standard traction table under general anesthesia. Anterolateral (AL), mid-anterior, and distal anterolateral accessory (DALA) portals were created to address the central compartment pathology, and a T-capsulotomy was performed for visualization of the peripheral compartment. Labral refixation was performed in all cases amenable to repair. Hip traction was released immediately after work was concluded in the central compartment, and the peripheral compartment was addressed after a dynamic examination to identify the zones of the impingement.

Once the arthroscopic procedure was complete, a complete capsular closure was performed to restore biomechanical properties of the IFL. The vertical limb of the T-capsulotomy was closed with 2 to 4 side-to-side sutures, and the interportal capsulotomy limb was closed with 2 or 3 sutures. Capsular closure began with the distal portion of the vertical limb at the base of the iliofemoral ligament (IFL). A crescent tissue penetrating device (Slingshot; Stryker Sports Medicine) was loaded with high-strength No. 2 suture (Zipline; Stryker Sports Medicine) and placed through the AL portal to sharply pierce the lateral leaflet of the IFL approximately 6 mm from the edge. The No. 2 suture was then shuttled into the intra-articular side of the capsule. Through the DALA portal, the penetrating device was then used to pierce the medial leaflet approximately 3 mm from the edge to retrieve the free suture. Next, the looped suture retriever was used to pull the suture from the AL portal to the DALA portal so the suture can be tied. The authors prefer to tie each suture individually after it is passed, but all of the sutures can be passed first and then tied. Because successive suture placement and knot tying inherently tighten the capsule, successive visualization requires more precision. Each subsequent suture is similarly passed, about 1 cm proximal to the previous stitch. Most patients were closed via plication, with the lateral leaflet bite titrated 0 to 3 mm depending on the capsular laxity.

After closure of the vertical limb of the T-capsulotomy, the authors prefer to close the interportal capsulotomy with the InJector II Capsule Restoration System (Stryker Sports Medicine), a device that allows for closure through a single cannula lateral to medial. This device was passed through the AL cannula to bring the suture end through the proximal IFL attached to the acetabulum. The device was removed from the cannula, and the other suture end is placed in the device and passed through the distal IFL. The stitch was then tensioned and tied. Likewise, closure of the medial IFL involved passing the InJector through the DALA cannula and bringing the first suture end through the proximal IFL attached to the acetabulum. The Injector was then removed from the cannula, and the other suture end was placed in the device and passed through the distal IFL. The stitch was then tensioned and tied with the hip in neutral extension. Depending on the length of the incision and integrity of the capsule, 2 or 3 stitches are used to close the interportal capsulotomy. Complete capsular closure was confirmed by the inability to visualize the underlying femoral head/neck and by probing the anterior capsule to ensure proper tension.

Postoperative Rehabilitation Process

All patients followed the standard rehabilitation protocol previously as described.[33] After surgery, all patients went through the same 4-phase rehabilitation protocol that lasted 24 to 32 weeks. Patients ambulated with the aid of bilateral crutches for a minimum of 3 weeks with a 20-lb, foot flat weightbearing restriction. Hip orthosis was used to prevent active abduction, hip flexion beyond 90°, extension beyond neutral, and external rotation. Daily passive motion and soft tissue mobilization with supervised physical therapy started on postoperative day 1. At 3 weeks, closed chain exercises were initiated, and patients progressed to weightbearing as tolerated without crutches or a brace. At 12 weeks, patients progressed to straight line rotational control, agility, and plyometric exercises.

Therapy specific to a return to sport protocol included certain precautions for the first 6 weeks, including avoidance of the extremes of range of motion in all planes to protect the capsular plication and repaired labrum, as well as to prevent secondary injury to tight or weak muscular tissue structures. Patients were subsequently introduced to cycling exercises progressed using an upright stationary elliptical machine. Patients

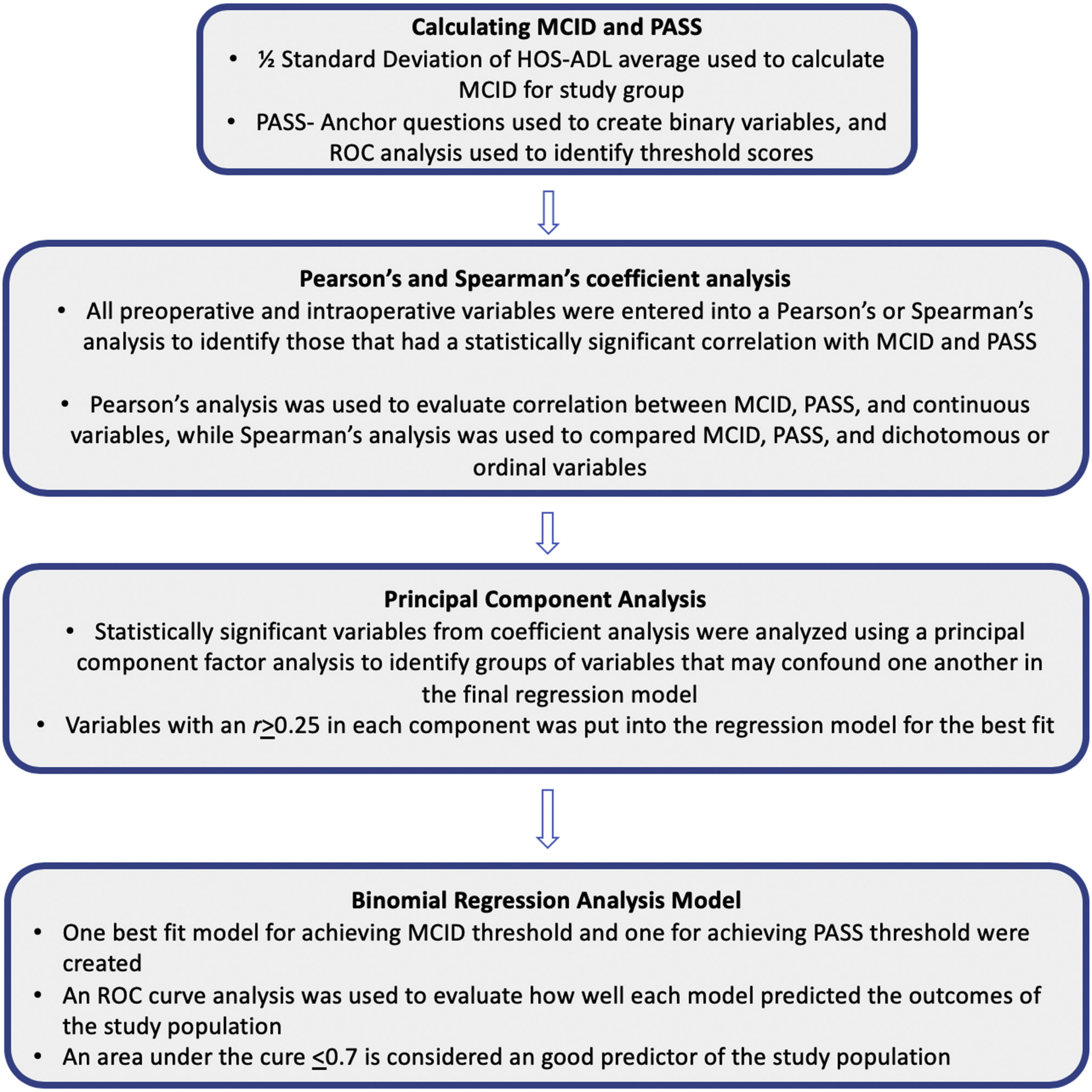

Fig 1. Binary logistic regression models for achieving minimally clinical important difference (MCID) or the patient acceptable symptomatic state (PASS).

progressed with single leg stance balance activities, eccentric and concentric core and lower extremity strength training, advanced core activation and proximal control, and femoroacetabular and acetabulofemoral rotational control and strength. The clinician assessed the patient's ability to progress with minimal pain, good proximal control with exercises and functional activities, and absent compensatory gait pattern, with a goal of clearing patients for return to sport by 24 weeks.

Statistical Analysis

All data were screened to determine if they met all parametric statistical assumptions before analysis. Two binary logistic regression models were created: one for achieving MCID and another for achieving PASS. The process of creating the models is summarized in Figure 1. Pearson and Spearman covariate analyses were carried out to identify correlations between MCID and PASS HOS-SS, versus preoperative, intraoperative, and postoperative variables, to identify variables to fit in the exploratory analysis for the final logistic models. An exploratory factor analysis was performed on the variables with statistically significant correlations to the primary outcomes (achieving MCID or PASS HOS-SS) by using a principal component (PC) extraction with a varimax rotation to reduce the redundancy in the

Table 1. Patient Demographics

	Total/Mean
Female, n	437 (69.8%)
Age, yr	31.6 ± 11.9
Body mass index	24.6 ± 8.6
History of back pain, n	74 (11.8%)
History of anxiety or depression, n	79 (12.6%)
Psychiatric history	80 (12.8%)
Chronic pain preoperatively (>2 yr)	187 (29.9%)
Average length of preoperative pain, mo	23.2 ± 33.1
Running for regular exercise (yes)	481 (76.8%)
Limp when walking	37 (5.9%)
History of hip injections	363 (57.9%)
Level of athletic performance	
Recreational	464 (74.1%)
High school	60 (9.6%)
College	47 (7.5%)
Professional	10 (1.6%)

NOTE. Values given as n (%) except where otherwise indicated.

predictor variables. A Kaiser-Meyer-Olkin test value of 0.7 was found, which demonstrates the data were appropriate for factor analysis as this value exceeded a recommended value of 0.6 for exploratory factor analysis.[34] A scree plot was examined to determine the number of PCs to retain for analysis. Each extracted PC was used to calculate the percent variance explained (% VAF) by dividing the eigenvalue of each PC by the sum of all eigenvalues. The contribution of each variable to the PC was determined by using the factor loadings of each variable. Variables that demonstrated a factor loading of >±0.25 for a PC was retained as a predictor variable for the follow-up binary logistic regression analysis used to predict a high-versus low-functioning 2-year postoperative PRO outcome scores. An ROC curve analysis was then used to identify the model with the best fit and, therefore, the variables with the best fit for the model. The final regression models for MCID and PASS were chosen based on the highest area under the curve (AUC) in the ROC curve analysis.

Descriptive statistics for all continuous variables are reported as mean and SD values, and frequency statistics were reported for all noncontinuous variables. Paired-sample *t* tests were used to compare preoperative and 2-year postoperative PROs in patients with FAIS. One-way analysis of variance was used to compare 2-year postoperative PROs stratified by athlete type (recreational, high school, college, professional). Statistical significance for all analysis was set at an á ≤ .05.

Results

Patient Demographics

Of the 780 qualifying patients, 626 completed the 2-year minimum follow-up (80%); mean (±SD) age and body mass index (BMI) were 31.5 (11.9) years and 24.6 (8.6), respectively (Table 1). The majority of patients were female (n = 437, 69.8%) and nonsmokers (n = 570, 91.1%), and 187 patients (29.9%) experienced preoperative symptoms for longer than 2 years. The majority of patients in the study group were recreational athletes (74.1%), followed by high school (9.6%), college (7.5%), and professional (1.6%) athletes.

PROs

There was a statistically significant improvement in the HOS-SS score average after surgery (43.9 ± 22.0 to 77.9 ± 23.5; $P < .001$). In addition, VAS-pain was significantly decreased from 66.1 ± 20.29 to 4.5 ± 9.1 ($P < .001$) with a high satisfaction score average of 84.4 ± 20.5 at 2-year minimum follow-up (Table 2). Subanalysis by athletic type (recreational, high school, college, professional) demonstrated a statistically significant difference when comparing 2-year HOS-SS score average values (Table 3). However, there was no difference in overall change (Δ) in HOS-SS and VAS-pain between athletic performance. A total of 500 patients (86.9%) achieved high functional status (achieved either PASS, MCID, or both), with 77.9% achieving MCID HOS-SS and 68.7% achieving PASS HOS-SS (Table 4).

MCID and PASS Logistic Regression Models

The factor analysis for achieving high functional status consisted of 9 PCs that explained 62.3% of the variance of the predictor variables. The variables retained for analysis were based on the PC loadings, and those that were statistically significant in the MCID and PASS regression models are reported in Tables 5 and 6, respectively. Preoperative predictors of achieving a minimal threshold of meaningful clinical outcome based on MCID include smaller α angle (odds ratio [OR] 0.976, 95% confidence interval [CI] 0.956-0.997; $P = .027$), absence of femoral chondral defects (OR 0.769, CI 0.625-0.946; $P = .013$), shorter preoperative pain duration (OR 0.729, CI 0.571-0.931; $P = .011$), and lower BMI (OR 0.919, CI 0.865-0.977; $P = .018$). The regression model had an appropriate fit based on the ROC curve analysis (AUC 0.691) (Appendix 2). Preoperative predictors of achieving a higher threshold of meaningful clinical outcome based

Table 2. Patient-Reported Outcomes

Scale	Preoperative (Mean ± SD)	Postoperative (Mean ± SD)	*P*
HOS-SS	43.9 ± 22.0	77.9 ± 23.5	<.001*
VAS-pain	66.1 ± 20.29	18.1 ± 21.8	<.001*
VAS-satisfaction	NA	84.4 ± 20.5	NA

NOTE. Values given as mean ± standard deviation.

HOS-SS, Hip Outcome Score—Sport Subscale; NA, not applicable; SD, standard deviation; VAS, visual analog scale.

*$P < .05$.

Table 3. Patient-Reported Outcomes by Athletic Performance

	Recreational	High School	College	Professional	*P*
Preoperative					
HOS-SS	43.1 ± 22.0	46.8 ± 22.9	46.2 ± 18.1	52.4 ± 22.4	.652
VAS-pain	65.7 ± 20.6	71.1 ± 17.3	64.4 ± 20.0	60.0 ± 20.1	.527
Postoperative					
HOS-SS	76.2 ± 24.3	85.6 ± 18.0	83.8 ± 18.6	88.1 ± 21.6	.008*
VAS-pain	18.7 ± 22.6	11.4 ± 15.5	15.2 ± 16.4	17.9 ± 25.5	.194
VAS-satisfaction	84.4 ± 20.6	88.9 ± 15.9	83.9 ± 20.3	72.8 ± 24.5	.275
Δ					
HOS-SS	32.7 ± 28.8	39.8 ± 27.3	40.8 ± 19.1	27.9 ± 16.1	0.163
VAS-pain	62.1 ± 23.3	72.1 ± 18.8	61.4 ± 23.9	57.2 ± 22.8	0.331

NOTE. Values given as mean ± standard deviation.

Δ, Change in reported outcomes over average 2-year time period; HOS-SS, Hip Outcome Score−Sport Subscale; SD, standard deviation; VAS, visual analog scale.

$^*P < .05$.

on PASS include absence of limp (OR 0.384, CI 0.18-0.818; $P = .013$), absence of anxiety or depression (OR 0.561, CI 0.322-0.975; $P = .041$), lower BMI (OR 0.945, CI 0.903-0.99; $P = .018$), and shorter preoperative pain duration (OR 0.987, CI 0.981-0.994; $P < .001$). The regression model had an appropriate fit based on the ROC curve analysis (AUC 0.700) (Appendix 3).

Discussion

The primary finding in this study was that the absence of mental health disease, lower BMI, and shorter preoperative pain duration were positive predictors of achieving MCID after hip arthroscopy for FAIS in patients who participate in sports. Furthermore, physical findings such as limp while ambulating and intraoperative findings including femoral chondral defects were negative predictors of achieving PASS in the same study population. Last, there was a statistically significant improvement in sports function score averages, regardless of sports performance level. The current study adds to the literature in that it derived MCID and PASS for the patient study population as opposed to what has been previously published; it has twice the study population as current 2-year outcome studies; it defines clinical high functional status; and it provides ROC curve and factor analysis for creating predictor models.[35]

Psychological distress and mental health disease are increasingly recognized as significant influences on pain and function associated with orthopedic conditions.[21,36-40] In a previous study, preoperative predictors of increased baseline (preoperative) pain and decreased baseline function included mental health, activity level, sex, and smoking.[21] Psychological distress was reported to negatively affect both baseline hip pain and function scores at the time of hip arthroscopy.[41] Poor mental health scores were subsequently identified as independent risk factors for increased baseline pain prior to hip arthroscopy.[21] Patients with greater psychological distress at the time of surgery have greater perioperative demands for increased pain control.[38] Therefore, when the current findings are considered in the context of these previous studies, it is not surprising that the absence of mental health disease, shorter durations of preoperative symptoms, and no preoperative narcotic use all predicted patients who were high functioning after surgery. Each of these predictors likely evaluates factors associated with a patient's pain behavior before surgery; therefore, it is also not surprising that these factors all seem to represent this domain.

The multifactorial nature of clinically significant sport function outcomes can be further emphasized by looking at return to sport after hip arthroscopy. Athletes are generally highly motivated and demonstrate a high rate of return to sport after hip arthroscopy sport (reported to be 88% to 96%).[5-9,12,42] Young amateur athletes in a variety of sports demonstrated a 92% return to sport rate after hip arthroscopic labral repair.[43]

Table 4. MCID and PASS Frequencies

	Achieved, Total	Not Achieved, Total
High functional status	500 (86.9)	78 (11.8)
MCID HOS-SS	371 (77.9)	105 (22.1)
PASS HOS-SS	430 (68.7)	196 (31.3)

NOTE. Values given as n (%) except where otherwise indicated.

High functional status, achieved either PASS, MCID, or both; HOS-SS, Hip Outcome Score−Sport Subscale; MCID, minimal clinically important difference; PASS, patient acceptable symptomatic state.

Table 5. Binary Logistic Regression Model for MCID HOS-SS

		95% CI		
	Odds Ratio	Lower Bound	Upper Bound	*P*
Preoperative α angle (AP)	0.976	0.956	0.997	.027
Femoral chondral defects	0.769	0.625	0.946	.013
Preoperative pain duration (in months)	0.729	0.571	0.931	.011
BMI	0.919	0.865	0.977	.007

AP, anteroposterior; BMI, body mass index; CI, confidence interval; MCID, minimal clinically important difference; PASS, patient acceptable symptomatic state.

Table 6. Binary Logistic Regression Model for PASS HOS-SS

		95% CI		
	Odds Ratio	Lower Bound	Upperbound	*P*
Limp	0.384	0.18	0.818	.013
Anxiety or depression	0.561	0.322	0.975	.041
BMI	0.945	0.903	0.99	.018
Preoperative pain duration, mo	0.987	0.981	0.994	<.001

AP, anteroposterior; BMI, body mass index; CI, confidence interval; HOS-SS, Hip Outcome Score—Sport Subscale; PASS, patient acceptable symptomatic state.

These athletes were between 13 and 23 years old, and the patient age, sex, and BMI were not significantly associated with any collected PROs.[43] However, in a cohort of recreational and competitive runners, BMI was associated with the rate of return to running and postoperative HOS-SS scores, which is consistent with the observations of the current study that BMI is predictive of achieving MCID and PASS in patients who participate in all sports.

Limitations

Our study carries common limitations associated with retrospective cohort analysis. First, we analyzed all consecutive patients treated by the senior author during a defined period, which may not be generalizable to a wider patient cohort. Second, the predictive models for inferior clinical outcomes and clinical failures demonstrated an appropriate fit based on the ROC curve analysis; however, it is possible that better models exist. A number of different models were analyzed by using the variables in the factor analysis, but it is possible that confounders and other nonlinear associations exist between the primary outcomes and other variables not tested. Third, we did not stratify the MCID/PASS analysis by sports performance type, because the number of professional athletes was low and likely would have been underpowered. Additionally, return to sports information was not specifically recorded, so it is possible that patients reported a high athletic functional score regardless of return to competition. Finally, all patients in the current study were operated on by a single, fellowship-trained surgeon at a single institution, which limits the external validity of the study.

Conclusions

Several predictors of achieving clinically significant sport function performance exist, including a history of anxiety or depression, BMI, preoperative α angle, limp, femoral chondral damage, and preoperative symptom duration. Our results suggest that there are both modifiable and nonmodifiable preoperative factors that have the potential to predict achievement of high athletic function after hip arthroscopy for FAIS.

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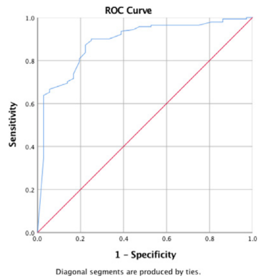
Appendix 1. ROC Curve Analysis for Determining HOS-SS Score for PASS

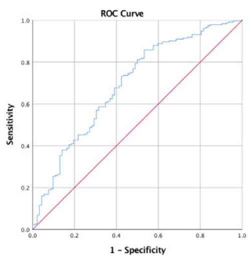


Area Under the Curve

Area	Standard error	*P*	95% Confidence interval	
			Lower bound	Upper bound
0.886	0.031	<.001	0.826	0.946

HOS-SS, Hip Outcome Score–Sport Subscale; PASS, patient acceptable symptomatic state; ROC, receiver operating characteristic.

Appendix 2. ROC Curve Analysis for MCID HOS-SS Logistic Regression Model

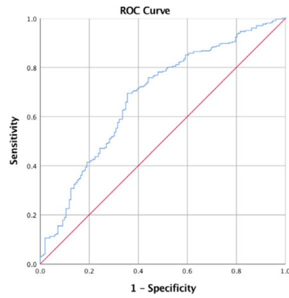


Area Under the Curve

Area	Standard error	*P*	95% Confidence interval	
			Lower bound	Upper bound
0.691	0.33	<0.001	0.625	0.756

HOS-SS, Hip Outcome Score–Sport Subscale; MCID, minimal clinically important difference; ROC, receiver operating characteristic.

Appendix 3. ROC Curve Analysis for PASS HOS-SS Logistic Regression Model



Area Under the Curve

Area	Standard error	*P*	95% Confidence interval	
			Lower bound	Upper bound
0.7	0.027	<.001	0.627	0.733

HOS-SS, Hip Outcome Score–Sport Subscale; PASS, patient acceptable symptomatic state; ROC, receiver operating characteristic.