Rate of Surgery and Baseline Characteristics Associated With Surgery Progression in Young Athletes With Prearthritic Hip Disorders

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Background: Prearthritic hip disorders (PAHD), such as femoroacetabular impingement (FAI), acetabular dysplasia, and acetabular labral tears, are a common cause of pain and dysfunction in adolescent and young adult athletes, and optimal patient-specific treatment has not been defined. Operative management is often recommended, but conservative management may be a reasonable approach for some athletes.

Purpose: To identify (1) the relative rate of progression to surgery in self-reported competitive athletes versus nonathletes with PAHD and (2) baseline demographic, pain, and functional differences between athletes who proceeded versus those who did not proceed to surgery within 1 year of evaluation.

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

Methods: An electronic medical record review was performed of middle school, high school, and college patients who were evaluated for PAHD at a single tertiary-care academic medical center between June 22, 2015, and May 1, 2018. Extracted variables included patients' self-reported athlete status, decision to choose surgery within 1 year of evaluation, and baseline self-reported pain and functional scores on Patient-Reported Outcomes Measurement Information System (PROMIS) domains, the Hip disability and Osteoarthritis Outcome Score (HOOS), and the modified Harris Hip Score.

Results: Of 260 eligible patients (289 hips), 203 patients (78%; 227 hips) were athletes. Athletes were no more likely to choose surgery than nonathletes (130/227 hips [57%] vs 36/62 hips [58%]; relative risk [RR], 0.99 [95% CI, 0.78-1.25]). Among athletes, those who proceeded to surgery over conservative care were more likely to be female (81% vs 69%; RR, 1.34 [95% CI, 0.98-1.83]) and had more known imaging abnormalities (FAI: 82% vs 69%, RR, 1.47 [95% CI, 1.09-1.99]; dysplasia: 48% vs 27%, RR, 1.44 [95% CI, 1.16-1.79]; mixed deformity: 30% vs 10%, RR, 2.91 [95% CI, 1.53-5.54]; known labral tear: 84% vs 40%, RR, 2.79 [95% CI, 2.06-3.76]). Athletes who chose surgery also reported worse baseline hip-specific symptoms on all HOOS subscales (mean difference, 10.8-17.7; $P < .01$ for all).

Conclusion: Similar to nonathletes, just over half of athletes with PAHD chose surgical management within 1 year of evaluation. Many competitive athletes with PAHD continued with conservative management and deferred surgery, but more structural hip pathology and worse hip-related baseline physical impairment were associated with the choice to pursue surgery.

Keywords: femoroacetabular impingement; acetabular dysplasia; acetabular labral tear; athletes; hip arthroscopy; conservative management

Prearthritic hip disorders (PAHD) are variations in hip anatomy that can contribute to chronic pain, disability, and early hip osteoarthritis (OA) in otherwise healthy adolescents and young adults.[10,33] Conditions such as femoroacetabular impingement (FAI), acetabular dysplasia, and acetabular labral tears are all examples of PAHD, and these conditions preferentially affect athletes.[11,14] A recent meta-analysis demonstrated that athletes who participate in sports such as ice hockey, basketball, and other jumping sports during adolescence have a 1.9- to 8-fold increased risk of developing a cam deformity during skeletal maturation.[31] Labral tears are also particularly common in athletes who participate in sports that involve cutting and rotation-related movements,[30] with incidence rates of asymptomatic labral tears as high as 89% in adolescent skiers and hockey players.[5] Furthermore, a high rate of acetabular dysplasia has been found in ballet dancers.[18] The high prevalence of PAHD in athletes may contribute to the higher prevalence of hip OA in former athletes compared with nonathletes.[50]

Athletes diagnosed with symptomatic PAHD currently face a dilemma when choosing a treatment path. They must

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consider both the overall efficacy of the treatment plan and its impact on returning to sport. Surgical management is often recommended and can result in relatively good return-to-sport rates when performed by experienced surgeons. After surgery for FAI, 87% of athletes return to sport,[7] and after periacetabular osteotomy for dysplasia, 80% return to sport and only 7% to 11% report activity limitations from persistent hip pain.[4,20,37] However, the mean time to return to sport after FAI surgery is 9.4 months,[32] and the median return time after periacetabular osteotomy is 9 months.[20] These prolonged recovery times are undesirable for many athletes. Because sports participation is associated with increased subjective well-being[13] and because injuries in athletes are known to contribute to emotional distress,[25,27,41,45] minimizing time away from sport should be a consideration in the management of PAHD.

Conservative management typically offers a quicker return to play than surgical management,[35,39] and it has proven to be effective in some athletes.[22] However, athletes who do not improve sufficiently with an extensive trial of conservative care and proceed to surgery anyway have an even more protracted return to play than if they had pursued surgery earlier in their course.[22] To our knowledge, the proportion of competitive athletes who pursue surgery over continued conservative management is unknown. Furthermore, identification of athlete-specific variables that are associated with progression to surgery rather than continued conservative management may assist providers in counseling patients and directing them to appropriate treatment options that will expedite their recovery and return to play.

The purpose of this study was 2-fold: (1) to identify the relative rate of progression to surgery in self-reported competitive athletes versus nonathletes with PAHD and identify unique baseline characteristics associated with being an athlete, and (2) to identify demographic, pain, and functional differences between athletes who proceed versus do not proceed to surgery within 1 year of evaluation. We hypothesized that the high physical demand in athletes would result in a higher rate of surgery compared with nonathletes and that athletes who chose surgery would report worse baseline pain and function compared with those who continued with conservative care.

METHODS

This retrospective cohort study was conducted at a single tertiary-care academic medical center. Institutional review board approval was granted by the institution.

Patients

Participants included adolescent and young adult patients aged 13 to 25 years who were initially evaluated by a board-certified nonoperative sports medicine specialist or orthopaedic surgeon with sports medicine and/or hip preservation expertise. Patients were included regardless of whether they had previously been evaluated by other providers at different institutions or with different medical training for the same issue (such as a primary care physician, physical therapist, and/or athletic trainer). Patients had to report a chief complaint of hip pain, and the physician documentation had to state that an intra-articular, nonarthritic hip disorder was the suspected cause of their symptoms. Eligible structural diagnoses included cam FAI (ie, reduced femoral head-neck offset), pincer FAI (ie, acetabular overcoverage), combined FAI (ie, coexisting cam and pincer morphology), acetabular dysplasia (ie, acetabular undercoverage), mixed deformity (ie, coexisting cam FAI and acetabular dysplasia), and acetabular labral tear. Both FAI and dysplasia morphology were included in this study because the patient populations, clinical evaluations, and initial treatment recommendations often overlap, and the conditions can commonly coexist.[52] Consistent with previous effectiveness-focused research in this population,[16,38] no specific quantitative radiographic measurement cutoffs were required for inclusion.

Because the distinction of "competitive athlete" can become ambiguous in adult populations who participate in activities ranging from intramural city leagues to regional or national club leagues to professional sports, the eligible cohort for this study was restricted to students in middle school, high school, and college at the time of initial evaluation. In this population, competitive athletics can be defined in a more straightforward fashion, for example by participation in organized youth or young adult activities such as school-sponsored sports or by participation in

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Ethical approval for this study was obtained from Washington University in St. Louis (ID No. 20184172).

higher-level competition such as semiprofessional or professional sports.

All initial clinical encounters occurred between June 22, 2015, and May 1, 2018. The start date was chosen to correspond with implementation of Patient-Reported Outcomes Measurement Information System (PROMIS) measure collection as standard of care for all patients evaluated at our orthopaedic department. Some of the PROMIS measures are specifically designed for patients of certain age groups, so for this study we defined adolescents as being 13 to 17 years old and young adults as patients 18 years and older. Exclusion criteria included other hip conditions that tend to initially present in a different patient demographic (eg, slipped capital femoral epiphysis, Legg-Calvé-Perthes disease, and avascular necrosis), moderate or severe hip OA (Tönnis grade 2 or 3), prior same-side hip surgery or fracture, prior same-side hip infection or tumor, inflammatory arthropathy, and pregnancy. Patients whose competitive athletic status was unknown were also excluded.

Given the observational nature of this study, there was no predetermined, strict treatment protocol for these patients. However, all the young adult hip providers at the study institution follow a relatively standard treatment protocol that includes an initial trial of conservative management consisting of physical therapy, activity modification, anti-inflammatory medications, and/or intra-articular hip injections. Patients who do not sufficiently improve with these conservative measures are offered surgical management if they are deemed appropriate candidates.

Potentially eligible patients were identified via a query of hip-related billing codes (listed in the Appendix) in patients aged between 13 and 40 years. This query was performed to create a comprehensive repository of prearthritic hip patients evaluated at our institution. Final eligibility for this study was confirmed with manual chart review by 1 of 3 researchers (R.W.C., A.B.M., or C.N.). Before data extraction, all 3 researchers underwent standardized training and assessment of appropriate, consistent data interpretation. Questions regarding participant eligibility were resolved by consultation with the senior author (A.L.C.).

Outcome Measures

The primary outcome measure was the relative rate of progression to surgery at the study institution within 1 year in self-reported athletes versus nonathletes. (Because the study was performed at a tertiary referral center with regional and national recognition for expertise in hip disorders in young adults, it was assumed that the vast majority of patients who proceeded with surgery did so within the study institution.) Secondary measures included comparison of patient characteristics and baseline self-reported physical and behavioral health between athletes and nonathletes and, within the athlete cohort, between those who chose surgery versus those who did not proceed to surgery within 1 year of evaluation.

The following self-reported descriptive variables were recorded: patient demographics (age, sex, race, and grade level); body mass index; baseline activity level as measured by the University of California Los Angeles (UCLA) Activity Score (scored from 1 [wholly inactive] to 10 [regularly active in impact sports]); history of depression and/or low back pain; hip pain duration; participation in competitive sports; number of and which sports were played; and the physician-documented PAHD diagnosis. Patients who endorsed involvement in competitive sports were considered athletes, while those who did not were considered nonathletes. For the majority of patients, competitive athlete status was determined by their answers on a standard-of-care form that systematically inquires about their athletic participation in organized sports. Because "being an athlete" is accompanied by unique psychological identity traits compared with being a person who is "physically active,"[21] we felt that patients' self-reported athlete status was the best method to capture this construct. For the patients who were evaluated by physicians who did not routinely collect this form, athlete status was determined by review of the clinical notes. With the exception of the UCLA score, all descriptive variables were recorded as part of standard clinical care for all included patients. The UCLA score was only routinely collected in select circumstances, as described below.

When available, baseline patient-reported outcome measures (PROMs) were also recorded (Table 1). These included the modified Harris Hip Score (mHHS), the Hip disability and Osteoarthritis Outcome Score (HOOS), and physical and behavioral health domains from PROMIS. Both the mHHS and the HOOS are hip-specific measures that are scored from 0 to 100, with higher scores being favorable.[19,34] PROMIS consists of multiple health domains, each of which is normalized to a mean score of 50 and standard deviation of 10 in the general population. Higher scores represent more of the specific domain being tested.[6] PROMIS computer-adaptive test measures were collected as part of standard clinical care. The PROMIS Physical Function domain encompasses both upper and lower body function, while the Mobility domain focuses exclusively on lower body function. The Depression and Anxiety measurements were not assessed in pediatric patients due to concern for potential psychological distress associated with answering the questions. The Peer Relationships domain was chosen as a proxy for pediatric psychosocial health.

Of note, at this institution during the study period, the UCLA score, mHHS, and HOOS measures were only completed as standard of care by patients who had scheduled surgery with any hip surgeon or if they were evaluated by the senior hip preservation surgeon (J.C.C.), regardless of whether they pursued surgery or not. Furthermore, the PROMIS Anxiety domain was not routinely collected until 10 months after the study start date, and the adult PROMIS Mobility domain was only collected from patients who were evaluated by surgeons. Therefore, some PROM data were preferentially missing from patients who continued conservative management because of the administrative limitations of this retrospective study.

Statistical Analysis

Descriptive variables are reported as means and standard deviations for continuous data and frequency and

TABLE 1
Baseline Patient-Reported Outcome Measures Recorded[a]

Adult PROMIS CAT[b]	
Depression V 1.0	
Anxiety V 1.0[c]	
Pain Interference V 1.1	
Physical Function V 1.2 or V 2.0	
Mobility V 1.2[d]	
Pediatric PROMIS CAT[b]	
Peer Relationships V 2.0	
Pain Interference V 2.0	
Mobility V 2.0	
mHHS[e]	
HOOS[e]	
Symptoms	
Pain	
ADL	
Sports	
QoL	

[a]ADL, Activities of Daily Living; CAT, computer adaptive test; HOOS, Hip disability and Osteoarthritis Outcome Score; mHHS, modified Harris Hip Score; PROM, patient-reported outcome measure; PROMIS, Patient-Reported Outcomes Measurement Information System; QoL, Quality of Life.

[b]Adult PROMIS CAT measures were collected from patients 18 years of age and older. Pediatric PROMIS measures were collected from patients younger than 18 years.

[c]PROMIS Anxiety was not routinely collected until 10 months after the study start date.

[d]Adult PROMIS Mobility was only collected from patients who were evaluated by surgeons.

[e]The mHHS and HOOS PROMs were only completed as standard of care by patients who scheduled surgery with any hip surgeon or if they were evaluated by the senior hip preservation surgeon.

percentages for categorical data. The primary outcome was calculated as a relative risk (RR) with a 95% CI. In patients who were evaluated for bilateral hip pain (either at a single encounter or over 2 separate encounters), each hip was considered individually because progression to surgery is specific to each hip. Additionally, a multilevel multiple logistic regression was performed to assess the association between athlete status and progression to surgery when controlling for age, sex, hip morphology (ie, presence of FAI or acetabular dysplasia), and the instances of bilateral hip pain. Regarding the secondary measures, differences in continuous variables (between athletes versus nonathletes and between surgical versus nonsurgical patients among the athlete cohort) were assessed using unpaired *t* tests, and mean differences (MDs) with 95% CIs are reported. Differences in categorical variables were evaluated using chi-square tests or Fisher exact tests, as indicated, and the RR with a 95% CI is reported. Because 1 primary outcome was prespecified and the rest of the comparisons were exploratory secondary outcomes, no multiple-comparison adjustment was performed. Missing data are listed in the tables shown in the Results section. $P \leq .05$ was prespecified to represent statistical significance. All statistical analyses were performed using SAS software, Version 9.4.

RESULTS

Of the 1476 potential participants identified from the initial billing query, 260 middle school, high school, and college students (289 hips) with confirmed PAHD were eligible for this study (Figure 1). Of these, 203 patients (78%; 227 hips) were athletes. Running-related sports were the most commonly reported activity, followed closely by dance, soccer, and baseball/softball (Table 2).

Athletes Versus Nonathletes

Athletes were no more likely than nonathletes to choose surgery within 1 year of evaluation (130/227 hips [57%] vs 36/62 hips [58%], respectively; RR, 0.99 [95% CI 0.78-1.25]; $P = .91$) (Table 3). Even after controlling for age, sex, presence of FAI and dysplasia, and bilateral symptoms, 2-level multiple logistic regression did not demonstrate a statistically significantly increased surgical rate in athletes (OR, 1.20 [0.57-2.55]; $P = .62$). However, there were other demographic differences between the 2 cohorts. Compared with nonathletes, the athlete cohort was younger (17.1 vs 19.2 years; $P < .001$) and more likely to be in middle school or high school instead of college (80% vs 33%; $P < .001$). The athlete cohort also had relatively fewer female patients (75% vs 91%; $P = .01$), and on average, athletes were evaluated after a shorter symptom duration (56% vs 32% within 1 year; $P < .001$). Regarding hip morphology, athletes were more likely to have a diagnosis of FAI (77% vs 56%; $P = .002$) and were less likely to have acetabular dysplasia (39% vs 63%; $P = .001$). The prevalence of known labral tears was similar between groups (57% vs 58%; $P = .74$).

Regarding self-reported physical health, athletes reported less overall pain interference compared with nonathletes (Adult PROMIS Pain Interference, MD = 2.9 points; $P = .017$; and Pediatric PROMIS Pain Interference, MD = 4.1 points, $P = .034$), but there was no statistically significant difference in hip-specific symptoms or function as measured by the mHHS or HOOS subscales (Table 4). Adult athletes also reported better overall physical function (Adult PROMIS Physical Function, MD = –3.0 points; $P = .018$), but lower body mobility was not different in adolescent or adult athletes versus nonathletes. Regarding behavioral health, athletes had a much lower prevalence of self-reported history of depression (4% vs 28%; $P < .001$), but the between-group differences in Adult PROMIS Depression and Anxiety scores at initial evaluation did not reach statistical significance. Of note, because the majority of eligible participants were younger than 18 years, the sample size for Adult PROMIS measures was limited.

Progression to Surgery in Athletes

Among the athlete cohort, the surgical group was more female predominant (81% vs 69%; $P = .045$), had suffered from hip pain for a somewhat longer duration (73% vs 58% with pain longer than 6 months; $P < .001$), and had a higher prevalence of radiographic FAI (82% vs 69%; $P = .020$) and acetabular dysplasia (48% vs 27%; $P = .001$), especially in

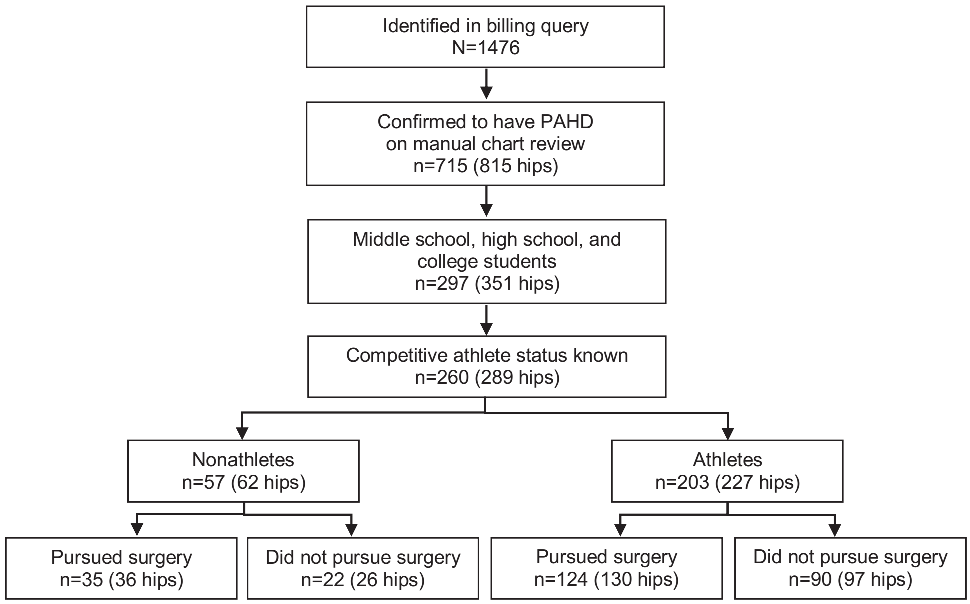

Figure 1. Participant inclusion flowchart. PAHD, prearthritic hip disorder.

TABLE 2
Competitive Sports Participation Among Middle School, High School, and College Students Evaluated Between 2015 and 2018[a]

	n (%)
Number of Sports (n = 260)	
0	57 (22)
1	123 (47)
2	52 (20)
3	24 (9)
≥4	4 (2)
Sport played (n = 203)	
Running (track/cross-country)	53 (26)
Dance	44 (22)
Soccer	32 (16)
Baseball/softball	32 (16)
Basketball	27 (13)
Volleyball	21 (10)
Cheer	20 (10)
Football	15 (7)
Swimming	14 (7)
Lacrosse	10 (5)
Field hockey	5 (2)
Tennis	5 (2)
Gymnastics	5 (2)

[a]Because some athletes played multiple sports, the sum of percentages of athletes involved in each sport exceeds 100%. Competitive sports that were reported in <5 participants are not listed.

the presence of a diagnosed acetabular labral tear (84% vs 40%; $P < .001$). Coexisting (mixed) FAI and dysplasia deformity was also more common in the surgical group (30% vs 10%; $P = .001$). Other participant demographics were similar between those who did and did not proceed with surgery (Table 5).

Compared with athletes who did not pursue surgery within one year, athletes who progressed to surgery reported worse hip dysfunction on all 5 HOOS subscales (MD = 10.8-17.7; all $P < .01$) but not on the mHHS (Table 6). Furthermore, among adolescent athletes (age <18 years), the surgical group reported worse pain interference and lower body mobility on PROMIS measures, as well (Pediatric PROMIS Pain Interference, MD = –4.7 points; $P < .001$; and Pediatric PROMIS Mobility, MD = 4.9 points; $P < .001$). Regarding behavioral health, there was no between-group difference in self-reported history of depression at initial evaluation. There were also no statistically significant between-group differences on any of the Adult PROMIS measures, but again, the sample size for this older group of athletes was limited.

DISCUSSION

Contrary to our hypothesis, in this study of students evaluated with hip pain due to PAHD, athletes were no more likely than nonathletes to choose surgical intervention within one year of evaluation. This finding remained true even after controlling for age, sex, presence of FAI and/or acetabular dysplasia, and presence of bilateral hip symptoms. In fact, only 58% of athletes opted for surgery. Athletes reported similar hip-specific symptom severity to nonathletes, but athletes experienced less overall pain interference and had a lower prevalence of preexisting depression. Within the athlete cohort, longer symptom duration, more evidence of structural abnormalities, and worse self-reported hip symptoms and overall physical function were associated with their choice to pursue surgery. There was no definitive difference in behavioral health between the surgical and nonsurgical groups.

TABLE 3
Clinical Characteristics and Choice to Pursue Surgery in Athletes Versus Nonathletes[a]

	Athletes (n = 203)	Nonathletes (n = 57)	RR (95% CI)	MD (95% CI)	*P* Value
Age, y	17.1 ± 2.2	19.2 ± 2.9	—	2.2 (1.3 to 3.0)	**<.001**
Female sex	153 (75)	52 (91)	0.82 (0.73 to 0.92)	—	**.010**
Race					.505
White	192 (95)	53 (93)	1.02 (0.94 to 1.10)	—	
Black	6 (3)	3 (5)	0.56 (0.14 to 2.18)	—	
Asian	3 (1)	0 (0)	2.00 (0.10 to 37.98)	—	
Hispanic/Latino	2 (1)	1 (2)	0.56 (0.05 to 6.08)	—	
Grade level					**<.001**
Middle school	19 (9)	3 (5)	1.78 (0.55 to 5.80)	—	
High school	145 (71)	16 (28)	2.54 (1.66 to 3.89)	—	
College	39 (19)	38 (67)	0.29 (0.21 to 0.40)	—	
UCLA Activity Score[b]	7.9 ± 2.6	5.7 ± 2.7	—	–2.2 (–3.1 to –1.3)	**<.001**
BMI[c]	23.0 ± 3.7	23.6 ± 4.5	—	0.7 (–0.5 to 1.8)	.271
Depression[d]	8 (4)	15 (28)	0.14 (0.06 to 0.31)	—	**<.001**
Low back pain[e]	28 (15)	9 (17)	0.90 (0.45 to 1.80)	—	.773
	Athlete Hips (n = 227)	Nonathlete Hips (n = 62)			
Hip pain duration					**<.001**
<6 mo	76 (33)	8 (13)	2.59 (1.32 to 5.08)	—	
6 to 12 mo	52 (23)	12 (19)	1.18 (0.68 to 2.07)	—	
1 to 3 y	66 (29)	18 (29)	1.00 (0.65 to 1.55)	—	
3 to 5 y	21 (9)	14 (23)	0.41 (0.22 to 0.76)	—	
>5 y	12 (5)	10 (16)	0.33 (0.15 to 0.72)	—	
Hip pathology				—	
FAI	174 (77)	35 (56)	1.36 (1.08 to 1.71)	—	**.002**
Cam	128 (56)	25 (40)	1.40 (1.01 to 1.93)	—	
Pincer	13 (6)	2 (3)	1.78 (0.41 to 7.66)	—	
Combined	6 (3)	1 (2)	1.64 (0.20 to 13.36)	—	
Unknown subtype	27 (12)	7 (11)	1.05 (0.48 to 2.30)	—	
FAI + labral tear[f]	117 (52)	24 (39)	1.33 (0.95 to 1.87)	—	.097
Acetabular dysplasia	88 (39)	39 (63)	0.62 (0.48 to 0.79)	—	**.001**
Dysplasia + labral tear[f]	56 (25)	23 (37)	0.67 (0.45 to 0.99)	—	**.043**
Mixed (FAI + dysplasia)	49 (22)	17 (27)	0.79 (0.49 to 1.27)	—	.323
(Known) labral tear	148 (65)	39 (63)	1.04 (0.84 to 1.28)	—	.738
Chose surgery	130 (57)	36 (58)	0.99 (0.78 to 1.25)	—	.911

[a]Continuous variables are reported as mean ± SD, and categorical variables are reported as n (%). Comparisons between athletes and nonathletes are reported as relative risk (RR) for categorical variables and mean difference (MD) for continuous variables. Boldface *P* values indicate a statistically significant difference between groups. Dashes indicate not applicable. BMI, body mass index; FAI, femoroacetabular impingement; UCLA, University of California, Los Angeles.
[b]Athletes, n = 107; nonathletes, n = 40.
[c]Athletes, n = 202; nonathletes, n = 57.
[d]Athletes, n = 201; nonathletes, n = 54.
[e]Athletes, n = 186; nonathletes, n = 54.
[f]Patients with FAI, dysplasia, and a known labral tear are represented in both the "FAI + labral tear" and "Dysplasia + labral tear" counts.

Our results build on the findings by Hunt et al,[22] in which patients with PAHD completed a standardized conservative management protocol and then were given the option of surgical management if their symptoms were not controlled. Similar to our results, the cohort was predominantly female, and only 56% of those patients chose to have surgery. However, in that prospective study, patients who were more active were more likely to choose surgery, whereas in our cohort, competitive athletes were no more likely to proceed to surgery than nonathletes, and the athletes who proceeded to surgery reported similar activity levels to the athletes who continued with conservative care. One potential reason for the discrepancy between the two studies is that our cohort was younger than the Hunt et al cohort (mean age, 17 vs 35 years), and younger active people are likely more involved in organized, competitive sports during their school-aged years, whereas older active adults may more often engage in independent fitness activities.[1,49] Our findings yield new insights because participation in competitive sports involves external psychosocial pressures[21] often linked to injury,[3,40] which makes competitive athletes a unique population distinct from generally active people. Athletes involved in competitive sports have been found to have better pain coping strategies and less pain catastrophization than

TABLE 4
Self-Reported Baseline Health in Athletes Versus Nonathletes[a]

	Athletes (n = 203)	Nonathletes (n = 57)	MD (95% CI)	*P* Value	Athletes/Nonathletes, n
Adult PROMIS[b]					
Depression	44.9 ± 8.4 (42.6 to 47.1)	48.2 ± 10.5 (44.7 to 51.7)	3.3 (–0.6 to 7.2)	.098	56/37
Anxiety	48.2 ± 9.7 (45.0 to 51.4)	52.6 ± 10.8 (48.2 to 57.0)	4.4 (–0.8 to 9.6)	.097	38/25
Pain Interference	59.2 ± 5.2 (57.8 to 60.5)	62.0 ± 6.1 (60.0 to 64.1)	2.9 (0.5 to 5.2)	**.017**	56/37
Physical Function	43.8 ± 5.5 (42.3 to 45.2)	40.7 ± 6.5 (38.6 to 42.9)	–3.0 (–5.5 to –0.5)	**.018**	56/37
Mobility	44.4 ± 6.6 (41.3 to 47.4)	41.7 ± 8.3 (36.9 to 46.4)	–2.7 (–7.9 to 2.5)	.298	20/14
Pediatric PROMIS[b]					
Peer Relationships	54.4 ± 9.6 (52.7 to 56.1)	55.1 ± 9.4 (50.3 to 60.0)	0.8 (–4.1 to 5.7)	.758	122/17
Pain Interference	55.9 ± 7.5 (54.6 to 57.2)	60.0 ± 6.4 (56.7 to 63.3)	4.1 (0.3 to 7.8)	**.034**	125/17
Mobility	38.1 ± 7.1 (36.8 to 39.3)	36.1 ± 6.8 (32.6 to 39.6)	–2.0 (–5.6 to 1.6)	.275	125/17
mHHS[c]	62.8 ± 14.2 (60.1 to 65.5)	58.0 ± 14.0 (53.5 to 62.5)	–4.8 (–10.0 to 0.4)	.070	107/40
HOOS[c]					
Symptoms	53.9 ± 17.8 (50.5 to 57.4)	50.9 ± 23.1 (43.5 to 58.3)	–3.1 (–11.1 to 5.0)	.451	107/40
Pain	57.6 ± 18.6 (54.0 to 61.1)	52.8 ± 21.4 (45.9 to 59.6)	–4.8 (–11.9 to 2.3)	.185	107/40
ADL	70.8 ± 19.0 (67.1 to 74.4)	65.3 ± 22.8 (58.0 to 72.6)	–5.4 (–12.8 to 1.9)	.146	107/40
Sports	44.2 ± 22.9 (39.8 to 48.6)	38.7 ± 27.2 (30.0 to 47.4)	–5.5 (–14.4 to 3.3)	.220	106/40
QoL	36.4 ± 19.6 (32.6 to 40.1)	32.5 ± 20.8 (25.9 to 39.1)	–3.9 (–11.2 to 3.5)	.299	107/40

[a]Variables are reported as mean ± SD (95% CI). Bolded *P* values indicate a statistically significant difference between groups. ADL, Activities of Daily Living; HOOS, Hip disability and Osteoarthritis Outcome Score; MD, mean difference; mHHS, modified Harris Hip Score; PROM, patient-reported outcome measure; PROMIS, Patient-Reported Outcomes Measurement Information System; QoL, Quality of Life.

[b]In total, 97 patients (59 athletes, 38 nonathletes) were ≥18 years of age and met criteria to complete the Adult PROMIS measures, and 163 patients (144 athletes, 19 nonathletes) were <18 years of age and met criteria to complete the Pediatric PROMIS measures.

[c]The mHHS and HOOS PROMs were only completed as standard of care by patients who scheduled surgery with any hip surgeon or if they were evaluated by the senior hip preservation surgeon.

nonathletes,[12,47] which may explain why the athletes reported in our study reported similar levels of hip pain severity to the nonathletes but less interference in their daily lives from their symptoms. Furthermore, the opportunity to participate in school-sponsored competitive athletics is only possible during a limited timeframe (even in the absence of injury), so these young competitive athletes may be more likely than otherwise active adults to defer surgery in order to finish a sports season or career. In contrast, active adults may have completed their competitive careers and have had pain for a longer duration, which may sway them to pursue surgery if their symptoms have not adequately been controlled with conservative measures.

Our statistically significant mean score differences approximated or exceeded previously published minimal clinically important differences (MCIDs) for all reported PROMs, which are summarized in Table 7. This suggests that the significant PROM differences in this study are consistent with clinically meaningful findings. Of course, comparison of our findings with previously determined MCIDs should still be interpreted with caution because some of the MCIDs were calculated in patients with other medical conditions,[2,8,26,28,36,48] and although the published mHHS and HOOS MCIDs were calculated in patients with hip pain, those patients had all undergone hip arthroscopy, whereas many patients in our cohort did not.[24]

Self-reported baseline behavioral health reported by the athletes and nonathletes in our study is also notable. Although our athlete cohort consisted of significantly fewer individuals with a self-reported history of depression than the nonathlete cohort, a previous meta-analysis found depressive symptoms to be similar in high-performance athletes and nonathletes,[15] and other evidence has demonstrated a high frequency of depression in athletes after injury.[25,27,41,45] However, other literature suggests that athletes may be more likely to ignore depressive symptoms[17,42,44,51] and may be more adept at dealing with them.[23] It is possible that the interplay between these two phenomena contributed to the trend of lower rates of self-reported behavioral health impairment reported in the athlete subgroup of our study. Nevertheless, baseline depression and anxiety are associated with worse pre- and postoperative hip function (specifically after hip arthroscopy),[9,46] so we still advocate for screening for current or prior psychological impairment. When appropriate, guiding affected patients to resources for behavioral health management can be incorporated as part of a conservative management plan or for preoperative optimization.[43]

Strengths

Unlike most of the existing PAHD literature, this study included patients who were evaluated by both operative and nonoperative sports medicine specialists, and the study population included patients who both chose and did not choose to proceed to surgery. The operative and nonoperative specialists at this institution follow a relatively standard treatment protocol, as described in the Methods section. However, patients who choose to be evaluated by operative versus nonoperative specialists may have

TABLE 5
Clinical Characteristics in Athletes Based on Decision to Pursue Hip Surgery[a]

	Surgical Hips (n = 130)	Nonsurgical Hips (n = 97)	RR (95% CI)	MD (95% CI)	*P* Value
Age, y	17.1 ± 2.1	16.8 ± 2.4	—	–0.3 (–0.9 to 3.0)	.355
Female sex	105 (81)	67 (69)	1.34 (0.98 to 1.83)	—	**.045**
Race					.700
White	124 (95)	90 (93)	1.03 (0.96 to 1.10)	—	
Black	3 (2)	5 (5)	0.45 (0.11 to 1.83)	—	
Asian	2 (2)	1 (1)	1.49 (0.14 to 16.22)	—	
Hispanic/Latino	1 (1)	1 (1)	0.75 (0.05 to 11.78)	—	
Grade level					.503
Middle school	11 (8)	12 (12)	0.68 (0.32 to 1.48)	—	
High school	92 (71)	69 (71)	0.99 (0.84 to 1.18)	—	
College	27 (21)	16 (16)	1.26 (0.72 to 2.20)	—	
UCLA Activity Score[b]	7.6 ± 2.7	8.4 ± 2.2	—	0.8 (–0.3 to 1.9)	.138
BMI[c]	23.2 ± 3.6	22.7 ± 3.7	—	–0.5 (–1.5 to 0.5)	.308
Depression[d]	7 (5)	4 (4)	1.28 (0.38 to 4.23)	—	.762
Low back pain[e]	21 (17)	10 (12)	1.42 (0.70 to 2.83)	—	.334
Hip pain duration					**<.001**
<6 mo	35 (27)	41 (42)	0.64 (0.44 to 0.92)	—	
6 to 12 mo	34 (26)	18 (19)	1.41 (0.85 to 2.34)	—	
1 to 3 y	42 (32)	24 (25)	1.31 (0.85 to 2.00)	—	
3 to 5 y	12 (9)	9 (9)	0.99 (0.44 to 2.27)	—	
>5 y	7 (5)	5 (5)	1.04 (0.34 to 3.19)	—	
Hip pathology				—	
FAI	107 (82)	67 (69)	1.47 (1.09 to 1.99)	—	**.020**
Cam	78 (60)	50 (52)	1.16 (0.92 to 1.48)	—	
Pincer	2 (2)	4 (4)	0.37 (0.07 to 2.00)	—	
Combined	12 (9)	1 (1)	8.95 (1.18 to 67.70)	—	
Unknown subtype	15 (12)	12 (12)	0.93 (0.46 to 1.90)	—	
FAI + labral tear[f]	95 (73)	22 (23)	3.22 (2.20 to 4.72)	—	**<.001**
Acetabular dysplasia	62 (48)	26 (27)	1.44 (1.16 to 1.79)	—	**.001**
Dysplasia + labral tear[f]	43 (33)	13 (13)	2.47 (1.41 to 4.33)	—	**.002**
Mixed (FAI + dysplasia)	39 (30)	10 (10)	2.91 (1.53 to 5.54)	—	**.001**
(Known) labral tear	109 (84)	39 (40)	2.79 (2.06 to 3.76)	—	**<.001**

[a]Continuous variables are reported as mean ± SD, and categorical variables are reported as n (%). Comparisons between the surgical and nonsurgical groups are reported as relative risk (RR) for categorical variables and mean difference (MD) for continuous variables. Boldface *P* values indicate a statistically significant difference between groups. Dashes indicate not applicable. BMI, body mass index; FAI, femoroacetabular impingement; UCLA, University of California, Los Angeles.

[b]Surgery, n = 83; no surgery, n = 32.

[c]Surgery, n = 129; no surgery, n = 94.

[d]Surgery, n = 129; no surgery, n = 96.

[e]Surgery, n = 124; no surgery, n = 83.

[f]Patients with FAI, dysplasia, and a known labral tear are represented in both the "FAI + labral tear" and "Dysplasia + labral tear" counts.

inherently different treatment preferences, and the specialty training backgrounds of specialists may influence the evaluation and management of patients in ways that have not yet been thoroughly studied. Therefore, our patient population likely provides a closer representation of the full spectrum of patients with PAHD than previous observational studies that have reported only on patients who have undergone surgery with nationally and internationally recognized hip preservation surgeons.

Limitations

Because this study was performed at a single tertiary-care institution, there is likely still some bias in the population of patients with PAHD who were evaluated. While some patients came for their first evaluation of hip pain, others chose to come or were referred for a second or third opinion regarding PAHD management. Therefore, our PAHD surgical rate may still be an overestimate compared with all adolescents and young adults who come to a physician for a first evaluation of hip pain related to a PAHD. A second limitation is that, because of the departmental workflow, some PROMs were disproportionately completed by patients who were initially evaluated by surgeons rather than nonoperative specialists. This was a known limitation from the outset of the study, but because PROM data in nonsurgical patients with PAHD are scant in the existing literature, we felt the analyses were worth pursuing and could still provide valuable insight as exploratory findings. Still, our study may have been underpowered to detect between-group differences in some of the secondary outcomes. Third, competitive athlete status was unknown in a small proportion of

TABLE 6
Self-Reported Baseline Health in Athletes Based on Decision to Pursue Surgery[a]

	Surgical Hips (n = 130)	Nonsurgical Hips (n = 97)	MD (95% CI)	*P* Value	Surgery/No Surgery, n
Adult PROMIS					
Depression	44.2 ± 7.6 (41.6 to 46.8)	45.3 ± 9.3 (41.7 to 48.9)	1.1 (–3.1 to 5.3)	.608	28/36
Anxiety	48.4 ± 10.1 (44.0 to 52.9)	47.8 ± 9.3 (43.4 to 52.1)	–0.7 (–6.7 to 5.4)	.827	20/22
Pain Interference	60.3 ± 5.1 (58.6 to 62.0)	58.0 ± 5.0 (56.0 to 59.9)	–2.3 (–4.9 to 0.2)	.073	36/28
Physical Function	42.9 ± 6.0 (41.0 to 44.8)	44.4 ± 5.5 (42.3 to 46.5)	1.5 (–1.3 to 4.3)	.298	36/28
Mobility	44.9 ± 7.4 (40.6 to 49.2)	43.0 ± 4.4 (38.5 to 47.6)	–1.9 (–8.7 to 5.0)	.572	14/6
Pediatric PROMIS					
Peer Relationships	52.8 ± 9.7 (50.6 to 55.0)	56.0 ± 9.1 (53.6 to 58.3)	3.2 (–0.1 to 6.4)	.055	77/59
Pain Interference	58.3 ± 5.5 (57.1 to 59.6)	52.9 ± 8.4 (50.7 to 55.1)	–5.5 (–7.9 to –3.0)	**<.001**	80/59
Mobility	35.8 ± 4.9 (34.7 to 36.9)	40.6 ± 8.5 (38.4 to 42.8)	4.8 (2.3 to 7.2)	**<.001**	80/59
mHHS	61.9 ± 14.1 (58.8 to 65.0)	66.4 ± 14.2 (61.2 to 71.6)	4.5 (–1.4 to 10.4)	.135	82/31
HOOS					
Symptoms	51.4 ± 16.4 (47.8 to 55.0)	62.3 ± 18.8 (55.4 to 69.2)	10.8 (3.7 to 18.0)	**.003**	82/31
Pain	54.8 ± 16.7 (51.2 to 58.5)	67.3 ± 21.2 (59.5 to 75.1)	12.5 (4.9 to 20.0)	**.001**	82/31
ADL	68.5 ± 17.9 (64.6 to 72.4)	79.3 ± 19.7 (72.1 to 86.5)	10.8 (3.1 to 18.5)	**.006**	82/31
Sports	40.5 ± 21.1 (35.8 to 45.1)	58.1 ± 24.0 (49.2 to 67.1)	17.7 (8.4 to 26.9)	**<.001**	82/30
QoL	33.7 ± 18.6 (29.6 to 37.8)	45.8 ± 21.6 (37.8 to 53.7)	12.1 (3.9 to 20.2)	**.004**	82/31

[a]Variables are reported as mean ± SD (95% CI). Boldfaced *P* values indicate a statistically significant difference between groups. ADL, Activities of Daily Living; HOOS, Hip disability and Osteoarthritis Outcome Score; MD, mean difference; mHHS, modified Harris Hip Score; PROMIS, Patient-Reported Outcomes Measurement Information System; QoL, Quality of Life.

TABLE 7
Mean Differences in PROMs Between Patient Subgroups in This Study Compared With Published MCIDs[a]

	Athletes vs Nonathletes	Athletes: Surgery vs No Surgery	MCID	MCID Reference Population
Adult PROMIS				
Depression	3.3 (–0.6 to 7.2)	1.1 (–3.1 to 5.3)	2 to 3.1	Chronic MSK pain,[26] knee OA[28]
Anxiety	4.4 (–0.8 to 9.6)	–0.7 (–6.7 to 5.4)	2.3 to 3.4	Knee OA[28]
Pain Interference	**2.9** (0.5 to 5.2)	–2.3 (–4.9 to 0.2)	2 to 5	Depression,[2] back pain,[8] knee OA[28]
Physical Function	**–3.0** (–5.5 to –0.5)	1.5 (–1.3 to 4.3)	1.9 to 2.2	Knee OA[28]
Mobility	–2.7 (–7.9 to 2.5)	–1.9 (–8.7 to 5.0)	—	
Pediatric PROMIS				
Peer Relationships	0.8 (–4.1 to 5.7)	3.2 (–0.1 to 6.4)	2.0 to 3.0	Nephrotic syndrome[36,48]
Pain Interference	**4.1** (0.3 to 7.8)	**–5.5** (–7.9 to –3.0)	2.0 to 3.0	Nephrotic syndrome[36,48]
Mobility	–2.0 (–5.6 to 1.6)	**4.8** (2.3 to 7.2)	2.0 to 3.0	Nephrotic syndrome[36,48]
mHHS	–4.8 (–10.0 to 0.4)	4.5 (–1.4 to 10.4)	8	Hip arthroscopy[29]
HOOS				
Symptoms	–3.1 (–11.1 to 5.0)	**10.8** (3.7 to 18.0)	9	Hip arthroscopy[29]
Pain	–4.8 (–11.9 to 2.3)	**12.5** (4.9 to 20.0)	9	Hip arthroscopy[29]
ADL	–5.4 (–12.8 to 1.9)	**10.8** (3.1 to 18.5)	6	Hip arthroscopy[29]
Sports	–5.5 (–14.4 to 3.3)	**17.7** (8.4 to 26.9)	10	Hip arthroscopy[29]
QoL	–3.9 (–11.2 to 3.5)	**12.1** (3.9 to 20.2)	11	Hip arthroscopy[29]

[a]Variables are reported as mean difference (95% CI). Boldfaced mean differences indicate statistical significance. —, no MCID has been published for adult PROMIS mobility. ADL, Activities of Daily Living; HOOS, Hip disability and Osteoarthritis Outcome Score; MCID, minimal clinically important difference; mHHS, modified Harris Hip Score; MSK, musculoskeletal; OA, osteoarthritis; PROMIS, Patient-Reported Outcomes Measurement Information System; QoL, Quality of Life.

patients, which necessitated their exclusion from the study. Finally, this study does not elucidate why only the minority of athletes had bilateral symptoms even though PAHDs are known to preferentially affect athletes. One possible explanation is that hand dominance and asymmetric daily activities (such as driving) predispose athletes to move with asymmetric mechanics even during seemingly symmetric, reciprocal-type activities such as running. Further dedicated study is needed in order to understand this phenomenon.

CONCLUSION

In this retrospective study of adolescents and young adults who were evaluated with hip pain from PAHD, just over half of both self-reported competitive athletes and nonathletes chose surgery within one year, and athletes were no more likely than nonathletes to proceed to surgery within that timeframe. Furthermore, an athlete's progression to surgery was associated with worse baseline physical function and hip-related quality of life, but choice for surgery was not associated with worse psychological distress. These findings provide preliminary evidence that conservative management may be an acceptable option for some athletes, especially those with less structural hip pathology and less severe hip-related baseline physical impairment.

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APPENDIX

Billing codes used in electronic medical record query for potentially eligible participants.

International Classification of Diseases, Ninth Revision codes:

719.45: Pain in joint, pelvic region, and thigh
719.85: Other specified disorders of joint, pelvic region, and thigh
754.3: Congenital dislocation of hip
755.63: Other congenital deformity of hip (joint)

International Classification of Diseases, Tenth Revision codes:

M25.551: Pain in right hip
M25.552: Pain in left hip
M25.559: Pain in unspecified hip
M25.851: Other specified joint disorders, right hip
M25.852: Other specified joint disorders, left hip
M25.859: Other specified joint disorders, unspecified hip
M76.892: Other specified enthesopathies of left lower limb, excluding foot
Q65.2: Congenital dislocation of hip, unspecified
Q65.89: Other specified congenital deformities of hip
Z87.76: Personal history of (corrected) congenital malformations of integument, limbs, and musculoskeletal system