Nonoperative Management of Femoroacetabular Impingement

A Prospective Study

Andrew T. Pennock,*†‡§ MD, James D. Bomar,† MPH, Kristina P. Johnson,†‡ ATC, OPA-C, Kelly Randich,†‡ DPT, and Vidyadhar V. Upasani,†§ MD
Investigation performed at Rady Children's Hospital, San Diego, California, USA

Background: The literature has given little attention to the nonoperative management of femoroacetabular impingement (FAI) syndrome despite a rapidly expanding body of research on the topic.

Purpose: To perform a prospective study utilizing a nonoperative protocol on a consecutive series of patients presenting to our clinic with FAI syndrome.

Study Design: Cohort study; Level of evidence, 2.

Methods: Between 2013 and 2016, patients meeting the following criteria were prospectively recruited in a nonoperative FAI study: no prior hip surgery, groin-based pain, a positive impingement test, and radiographic FAI syndrome. The protocol consisted of an initial trial of rest, physical therapy, and activity modification. Patients who remained symptomatic were then offered an image-guided intra-articular steroid injection. Patients with recurrent symptoms were then offered arthroscopic treatment. Outcome scores were collected at 12 and 24 months. Statistical analysis was performed to identify risk factors for the need for operative treatment and to determine patient outcomes based on FAI type and treatment.

Results: Ninety-three hips (n = 76 patients: mean age, 15.3 years; range, 10.4-21.4 years) were included in this study and followed for a mean ± SD 26.8 ± 8.3 months. Sixty-five hips (70%) were managed with physical therapy, rest, and activity modification alone. Eleven hips (12%) required a steroid injection but did not progress to surgery. Seventeen hips (18%) required arthroscopic management. All 3 groups saw similar improvements in modified Harris Hip Score (P = .961) and nonarthritic hip score (P = .975) with mean improvements of 20.3 ± 16.8 and 13.2 ± 15.5, respectively. Hips with cam impingement and combined cam-pincer impingement were 4.0 times more likely to meet the minimal clinically important difference in modified Harris Hip Score (P = .004) and 4.4 times more likely to receive surgical intervention (P = .05) than patients with pincer deformities alone. Participants in team sports were 3.0 times more likely than individual sport athletes to return to competitive activities (P = .045).

Conclusion: A majority (82%) of adolescent patients presenting with FAI syndrome can be managed nonoperatively, with significant improvements in outcome scores at a mean follow-up of 2 years.

Clinical Relevance: A nonoperative approach should be the first-line treatment for young active patients with symptomatic FAI syndrome.

Keywords: femoroacetabular impingement (FAI) syndrome; hip pain; labral tear; nonoperative treatment

Femoroacetabular impingement (FAI) syndrome is a common cause of hip pain among adolescents and young adults. Since originally described by Ganz et al,[18] the number of hip arthroscopies performed in the United States has increased dramatically for this diagnosis.[17] Similarly, there has been a near exponential increase in publications on this topic in the literature. To date, a disproportionate number of these publications focused on surgical techniques and surgical outcomes, with very little attention focused on nonoperative management. This surgical bias is seen not only in the literature but also clinically, with many surgeons favoring surgical intervention over nonoperative treatment.[21] Anecdotally, at our institution, we have observed that many patients with FAI syndrome respond well to a nonoperative approach. In 2012, in conjunction with our physical therapy (PT) department, we developed and instituted a standardized nonoperative pathway for patients with symptomatic FAI syndrome.

The purpose of this prospective study was to evaluate the success rate of our nonoperative protocol, which utilizes a mandated period of rest, PT, activity modifications, and injections. Furthermore, we wanted to identify factors

The American Journal of Sports Medicine
2018;46(14):3415–3422
DOI: 10.1177/0363546518804805

that predict the need for subsequent surgical intervention. We hypothesized that a large percentage of patients could be successfully treated nonoperatively but that a subset of patients, especially those with large cam lesions or abnormalities of the head-neck junction, would more likely progress to surgery.

METHODS

From April 2013 to August 2016, all patients presenting to our clinic for evaluation of groin-based hip pain, radiographic evidence of FAI, and a positive anterior impingement test were offered participation into this prospective internal review board–approved study. Patients were excluded if they had a history of hip surgery or radiographic abnormalities consistent with non-FAI hip conditions, such as femoral neck stress fractures, slipped capital femoral epiphysis, tumor, or rheumatologic conditions. Patient demographic and injury data were documented, including age, sex, primary sport, duration of symptoms, and previous treatment. Patients' primary sports were categorized into the following categories: cutting, flexibility, contact, impingement, asymmetric overhead, and endurance (based on the Shibata et al[22] modified sports categories for high-level athletes). Athletes were further classified as team or individual sport participants based on their primary sports.

Routine radiographs were obtained, including an anteroposterior pelvis radiograph and either a frog-leg lateral view or a Dunn lateral view of the affected hip. Radiographic measurements and assessment included the lateral center edge angle (LCEA), alpha angle, the presence of a crossover or ischial spine sign, and the status of the proximal femoral physis.[19,25] Magnetic resonance imaging (MRI) of the hip was not routinely obtained at patient enrollment, as recently suggested by Cunningham et al,[8] in an attempt to minimize cost and gadolinium exposure. Magnetic resonance arthrograms of the hip were performed when patients continued to experience pain despite the initiation of the nonoperative protocol. When MRI was obtained, the presence of a torn labrum was documented per the radiology report. Additionally, the alpha angle was measured on the radial oblique image that depicted the largest prominence of the femoral head-neck junction. FAI was grouped per impingement type and radiographically defined as follows:

Cam impingement: an alpha angle $\geq 50°$ on the frog-leg lateral view, the Dunn lateral view, or MRI radial oblique imaging.

Pincer impingement: the presence of a crossover sign or an LCEA $\geq 40°$.

Combined impingement: patients meeting the radiographic criteria for both cam impingement and pincer impingement.[19]

The nonoperative protocol that was utilized for this study was developed in conjunction with our PT department. Regardless of previous treatment at an outside institution (rest, PT, and injections), patients started at the beginning of the protocol. All sporting activities were discontinued for 6 weeks. Formal PT was also ordered at this time and typically took 2 to 6 weeks to get authorized and initiated. Our detailed PT protocol is outlined in Appendix 1 (available in the online version of this article). In general, the primary focus of PT was core stability exercises. Flexibility exercises focusing on deep hip flexion and internal rotation were actively discouraged. As patients became less symptomatic, sports participation was slowly reintroduced. As patients returned to sport, they were informed to modify their activity as much as possible to avoid deep flexion. For example, for soccer players, videos were reviewed demonstrating shots and hard kicks with low follow-through as compared with players with high kick follow-through. Ballet dancers were encouraged to transition to dance forms potentially requiring less hip flexion, such as jazz or lyrical. If patients remained significantly symptomatic such that they could not return to sport, they were then offered an image-guided intra-articular steroid injection (Kenalog, 40 mg). Patients who continued to be symptomatic were offered arthroscopic surgery. Of note, 6 patients elected to forgo the injection and proceed directly to surgery after not responding to their trials of rest and PT. Figure 1 presents the flow of patients through our study.

Surgery was performed under general anesthesia with muscle relaxation in the supine position with a hip distractor. An anterolateral peritrochanteric portal and a midanterior portal were used for all arthroscopies. The hip was distracted approximately 10 mm, and both portals were established with a spinal needle. After diagnostic arthroscopy was completed in the central compartment, the labrum, if torn or unstable, was secured with suture anchors. The sutures were passed either around the labrum or through the labrum, depending on the thickness and size of the labral tissue. A rim resection was performed when the patient had a positive crossover sign with an LCEA $>35°$ or if the LCEA was $>40°$. Osteochondroplasty was performed in all patients with an alpha angle $>50°$ or

*Address correspondence to Andrew T. Pennock, MD, Rady Children's Hospital, San Diego, 3030 Children's Way, Suite 410, San Diego, CA 92123, USA (email: apennock@rchsd.org).

†Rady Children's Hospital, San Diego, California, USA.

‡360 Sports Medicine, San Diego, California, USA.

§University of California, San Diego, California, USA.

Presented at the annual meeting of the AOSSM, San Diego, California, July 2018.

One or more of the authors has declared the following potential conflict of interest or source of funding: A.T.P. has received payments unrelated to this work from Smith & Nephew (speaking fees, education, and hospitality), Arthrex (education, hospitality), and Sportstek Medical (education, hospitality). V.V.U. has received payments unrelated to this work from OrthoPediatrics (hospitality, charitable contributions), Depuy Synthes Sales (hospitality), and Innovasis (hospitality). AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

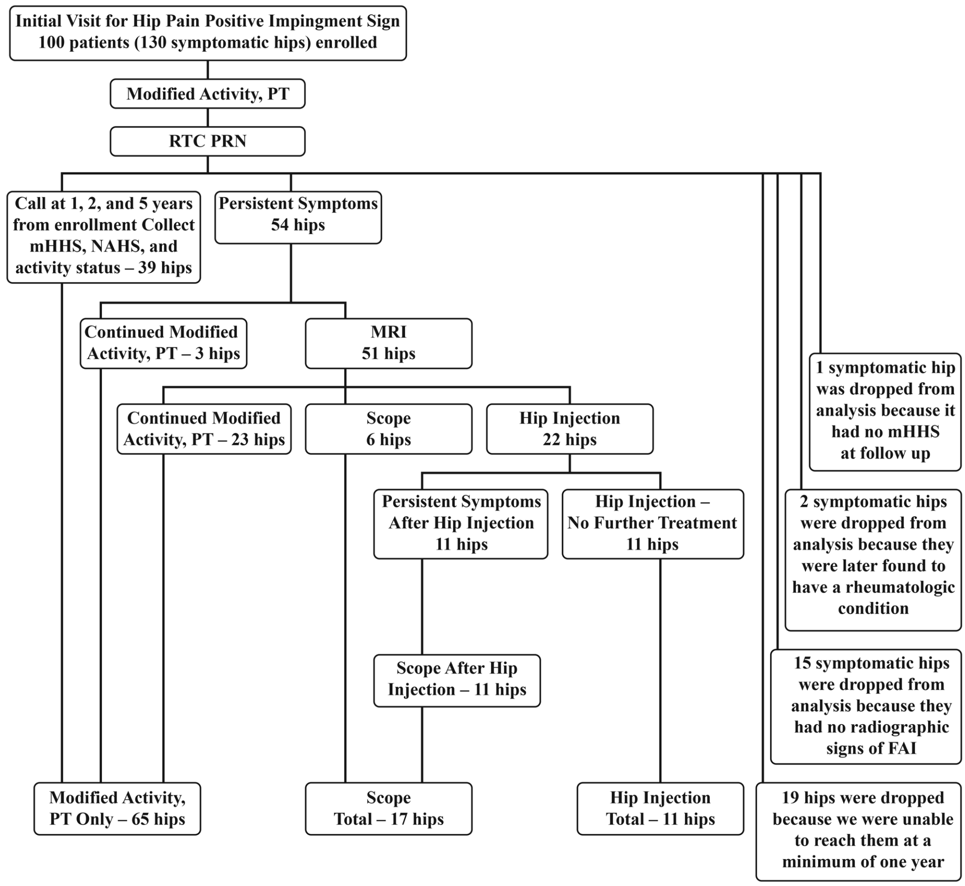

Figure 1. Flow of symptomatic hips through the nonoperative protocol for managing femoroacetabular impingement (FAI). mHHS, modified Harris Hip Score; MRI, magnetic resonance imaging; NAHS, nonarthritic hip score; PRN, pro re nata; PT, physical therapy; RTC, return to clinic.

if dynamic impingement was observed intraoperatively with flexion and internal rotation of the hip. In female patients and in male patients with an LCEA <25°, the capsule was routinely closed. Postoperatively, patients were kept to toe-touch weightbearing for 3 weeks; they were prescribed heterotopic ossification prophylaxis; and formal PT was initiated 1 week after surgery. Patients progressed to a running progression program around 8 to 12 weeks postoperatively, and full clearance to sport was allowed between 4 and 6 months.

Patient outcomes were recorded at baseline as well as 12 and 24 months after enrollment. Outcomes of interest included return to the same level of sports participation, the modified Harris Hip Score (mHHS), and the nonarthritic hip score (NAHS).[3,6,13] Patients were identified who met the minimal clinically important difference (MCID) in the mHHS (improvement ≥8 points).[9] Those who did not have an mHHS at the most recent follow-up were excluded from the data analysis. Patients were also excluded if they had <1 year of clinical follow-up. Note that 1 patient was included with <1 year of follow-up, because the follow-up came a few days before the 1-year anniversary (11.7 months).

Patients were classified into 3 treatment groups. Those who were treated with arthroscopic surgery were classified as the "scope" group. Nonoperative patients were classified into an injection group (for those who underwent a hip injection but did not progress to surgery) and an activity modification group (for those who underwent rest, decreased activity, or formal PT).

The hip was used as the unit of analysis, except for return-to-activity analysis. When return to activity was evaluated, the patient was used as the unit of analysis, and those who were not involved in sports at their initial visits were excluded. In bilateral cases, in which 1 hip underwent a scope or injection and the other did not, the patient was classified into the scope or injection group. No patients underwent a scope on 1 hip and an injection on the other hip. Basic descriptive statistics are presented. The Shapiro-Wilk test of normality and the Levene test of homogeneity of variance were performed on all continuous data. Normally distributed data were evaluated with analysis of variance, and nonnormally distributed data were evaluated with the Kruskal-Wallis and Mann-Whitney tests. Friedman analysis of variance was used to evaluate changes in mHHS and NAHS between the first clinic visit and the last contact. Chi-square and Fisher exact tests were used to evaluate differences in proportions among categorical data. All analysis was performed with SPSS

TABLE 1
Patient Information

	Hips, n (%) or Mean ± SD (Range)			
	Activity Modification (n = 65)	Injection (n = 11)	Arthroscopic Surgery (n = 17)	Total (N = 93)
Femoroacetabular impingement				
Cam	15 (23)	6 (55)	6 (35)	27 (29)
Pincer	27 (42)	1 (9)	2 (12)	30 (32)
Combined	23 (35)	4 (36)	9 (53)	36 (39)
Sex				
Male	23 (35)	4 (36)	6 (35)	33 (35)
Female	42 (65)	7 (64)	11 (65)	60 (65)
Age, y (*P* = .086)	15.1 ± 2.0 (10.4-21.4)	16.6 ± 2.0 (13.6-21.4)	15.4 ± 0.9 (13.4-17.2)	15.3 ± 1.9 (10.4-21.4)
Symptom duration before enrollment, mo (*P* = .076)	10.8 ± 17.2 (0.25-84)	17.9 ± 17.9 (1-60)	5.1 ± 4.5 (0.5-12)	10.7 ± 16.0 (0.25-84)
Follow-up, mo (*P* = .023)	25.7 ± 6.7 (12.2-45.5)	25.4 ± 8.8 (11.7-40)	31.8 ± 11.6 (12.3-49.7)	26.8 ± 8.3 (11.7-49.7)
Physis status (*P* = .731)				
Open	11 (17)	1 (9)	2 (12)	14 (15)
Closed	54 (83)	10 (91)	15 (88)	79 (85)
Labrum status (*P* = .127)				
Labral tear	16 (70)	11 (100)	13 (76)	40 (78)
No labral tear	7 (30)	0 (0)	4 (24)	11 (22)

TABLE 2
Initial and Most Recent Patient-Derived Outcome Measures[a]

	Modified Harris Hip Score			Nonarthritic Hip Score		
	Initial	Most Recent	*P* Value	Initial	Most Recent	*P* Value
Treatment						
Activity modification	69.9 ± 13.9	90.0 ± 11.8	<.001	74.1 ± 16.3	87.1 ± 14.3	<.001
Injection	68.3 ± 12.2	90.0 ± 10.2	.003	72.8 ± 13.7	86.3 ± 10.4	.011
Arthroscopic surgery	68.4 ± 9.4	89.0 ± 9.9	.013	72.8 ± 10.8	86.7 ± 13.1	.052
P value	.888	.582		.81	.463	
FAI						
Cam	68.8 ± 11.2	90.3 ± 10.5	<.001	71.5 ± 17.4	86.9 ± 13.5	<.001
Pincer	73.1 ± 11.0	86.1 ± 13.3	.002	76.8 ± 13.2	84.6 ± 15.0	.008
Combined	66.8 ± 15.6	92.8 ± 9.1	<.001	72.8 ± 14.8	89.1 ± 12.2	.003
P value	.158	.276		.434	.568	

[a]Values are presented as mean ± SD. FAI, femoroacetabular impingement.

(v 24; IBM). No a priori power analysis was performed, as the purpose of this study was to prospectively determine the effectiveness of a nonoperative treatment protocol. Statistical significance was defined as $P < .05$.

RESULTS

One hundred patients were enrolled in the study (n = 130 symptomatic hips). Nineteen symptomatic hips were excluded because they had <1 year of follow-up, but none of these patients underwent arthroscopic intervention. Fifteen hips were excluded because they did not meet the radiographic criteria for FAI syndrome. Two hips were excluded because they were later found to have rheumatologic causes of symptoms. One hip was excluded because the mHHS at most recent follow-up was not recorded. Seventy-six patients representing 93 hips were included in this study, with a mean ± SD follow-up of 26.8 ± 8.3 months. Table 1 presents the baseline demographic and radiographic data.

In total, 69.9% of the cohort was treated with rest, PT, and activity modifications alone and did not require further intervention (activity modification group); 11.8% of the total cohort required a single steroid injection but did not progress to surgical intervention (injection group).

TABLE 3
Distribution of Hips That Met the MCID for mHHS[a]

	n	%
Treatment (*P* = .364)		
Activity modification (n = 64)	43	67
Injection (n = 10)	8	80
Arthroscopic surgery (n = 13)	11	85
FAI (*P* = .015)		
Cam (n = 26)	22	85
Pincer (n = 29)	15	52
Combined (n = 32)	25	78

[a]FAI, femoroacetabular impingement; MCID, minimal clinically important difference; mHHS, modified Harris Hip Score.

Meanwhile, 18.3% of the cohort (n = 17 hips) continued to experience pain and progressed to hip arthroscopy. There was no significant difference in mHHS or NAHS at initial visit or most recent follow-up among our 3 groups ($P > .4$). Furthermore, there were no differences in clinical outcomes based on impingement type ($P > .2$) (Table 2).

While no significant differences were noted in the proportion of patients meeting the MCID in the mHHS among the 3 treatment groups (*P* = .364), a significant difference was observed per impingement type (*P* = .015). The cam impingement and combined impingement groups were 4.0 times more likely than the pincer group to meet the MCID for mHHS (8 points; *P* = .004) (Table 3). Similarly, the cam impingement and combined impingement groups were 4.4 times more likely than the pincer group to progress to arthroscopy (*P* = .05).

Five patients were not involved in sports at their initial visits and were excluded from return to sport analysis. At most recent follow-up, 83% of patients (59 of 71) provided detailed information about their ability to return to sport. Overall, 41% of patients had returned to the same sport or activity, and 13% had elected to pursue a different sport or activity. In total, 17% of patients had quit their sports because of pain. No significant differences were observed in the proportion of patients who returned to sport based on treatment or impingement type (*P* = .459 and .269, respectively) (Table 4). Sports categorization was associated with an athlete's ability to return to the same sport, with those participating in endurance, flexibility, or impingement sports having a lower probability of returning to full activities (*P* = .037) (Table 5). Team sport athletes were 3.0 times more likely to return to competitive sports regardless of treatment as compared with individual sport athletes (*P* = .045).

DISCUSSION

Despite the orthopaedic literature suggesting little role for the nonoperative management of FAI syndrome, the results of the current study show that the majority of young active patients could be successfully treated without surgery.[24] The standardized nonoperative protocol utilized in this study led to significant increases in patient outcome scores that were maintained for a minimum of 1 year and a mean of 2 years. Additionally, while we found that patients with larger cam deformities were more likely to be treated operatively, the majority (76%) did not progress to surgery, and their nonoperative outcomes were potentially better than those of the pincer impingement group.

To date, the literature has given little attention to the nonoperative management of FAI syndrome. While many articles mention that a trial of nonoperative treatment was attempted or should be attempted, these nonoperative protocols are rarely defined in detail and have not been standardized. Until recently, there were no prospective or randomized controlled studies on the topic. Earlier this year, however, 2 randomized controlled trials were published with conflicting outcomes. Griffin et al[12] completed a multicenter randomized trial examining hip arthroscopy as compared with best nonoperative therapy. Their results showed significant improvements in both treatment arms but greater improvements in the surgical arm of the study. Key differences between the current study and the study by Griffin et al were that the patients in the randomized controlled trial were older (mean age, 35 years), they did not undergo an injection as part of their best nonoperative treatment protocol, and no return-to-sport data were presented.

The second study, by Mansell et al,[16] was a randomized controlled trial examining hip arthroscopy versus PT in a population of military personal with symptomatic FAI syndrome. The results of their study, which was limited by high patient crossover between treatment groups, showed no differences in outcomes between patients undergoing hip arthroscopy and those performing PT. Additionally, a relatively high percentage of patients (33%) were unable to return to active military duty regardless of treatment. Once again, key differences between the current study and the Mansell et al study were that the patients in the randomized controlled trial were older (mean age, 30 years), they were all active duty military, and their nonoperative protocol did not utilize injections.

Other than these 2 recent studies, only 3 other studies (that we are aware of) examined nonoperative outcomes, and all had weaknesses in study design, follow-up, and surgical bias. Emara et al[11] studied a subset of 37 patients with "mild" FAI (alpha angle <60°). Their results were similar to ours, with 89% of their patients treated without surgery at a mean follow-up of 2 years. Additionally, patients treated nonoperatively experienced significant improvements in their Harris Hip Score and NAHS. Hunt et al[14] reported less promising outcomes with a nonoperative approach, with 61% of their 18 patients with FAI syndrome requiring surgery. Cianci et al[7] found that 76% of patients treated nonoperatively went on to surgery and that patients with radiographic FAI and labral tears were more likely to require operative treatment.

One potential reason that our nonoperative results are different from previous reports may be the utilization of a mandatory nonoperative protocol. A case example would be a male patient with a larger cam lesion (alpha angle >55°) who was referred to our clinic with a 3-month history of groin pain and who had already performed PT at

TABLE 4
Distribution of Return to Sport by Treatment Group[a]

		Return to Sport/Activity			Quit Sport				
Treatment	n	Same	Different	Total	Because of Pain	Not Because of Pain	No Reason Given	Total	Did Not Respond
Activity modification	46	21 (46)	5 (11)	26 (57)	8 (17)	1 (2)	3 (7)	12 (26)	8 (17)
Injection	10	4 (40)	1 (10)	5 (50)	1 (10)		3 (30)	4 (40)	1 (10)
Scope	15	4 (27)	3 (20)	7 (47)	3 (20)	1 (7)	1 (7)	5 (33)	3 (20)
Total	71	29 (41)	9 (13)	38 (54)	12 (17)	2 (3)	7 (10)	21 (30)	12 (17)

[a]Values are presented as n (%). Five patients were omitted because they did not play a sport at initial visit.

TABLE 5
Distribution of Return to Sport by Category[a]

		Return to Sport/Activity			Quit Sport				
Sport	n	Same	Different	Total	Because of Pain	Not Because of Pain	No Reason Given	Total	Did Not Respond
Asymmetric overhead	10	6 (60)	2 (20)	8 (80)	1 (10)			1 (10)	1 (10)
Contact	8	3 (38)	1 (13)	4 (50)			1 (13)	1 (13)	3 (38)
Cutting	21	11 (52)	2 (10)	13 (62)	1 (5)	1 (5)	1 (5)	3 (14)	5 (24)
Endurance	7	1 (14)	2 (29)	3 (43)	2 (29)	1 (14)	1 (14)	4 (57)	
Flexibility	20	7 (35)	2 (10)	9 (45)	6 (30)		3 (15)	9 (45)	2 (10)
Impingement	5	1 (20)		1 (20)	2 (40)		1 (20)	3 (60)	1 (20)
Total	71	29 (41)	9 (13)	38 (54)	12 (17)	2 (3)	7 (10)	21 (30)	12 (17)

[a]Values are presented as n (%). Five patients were omitted because they did not play a sport at initial visit.

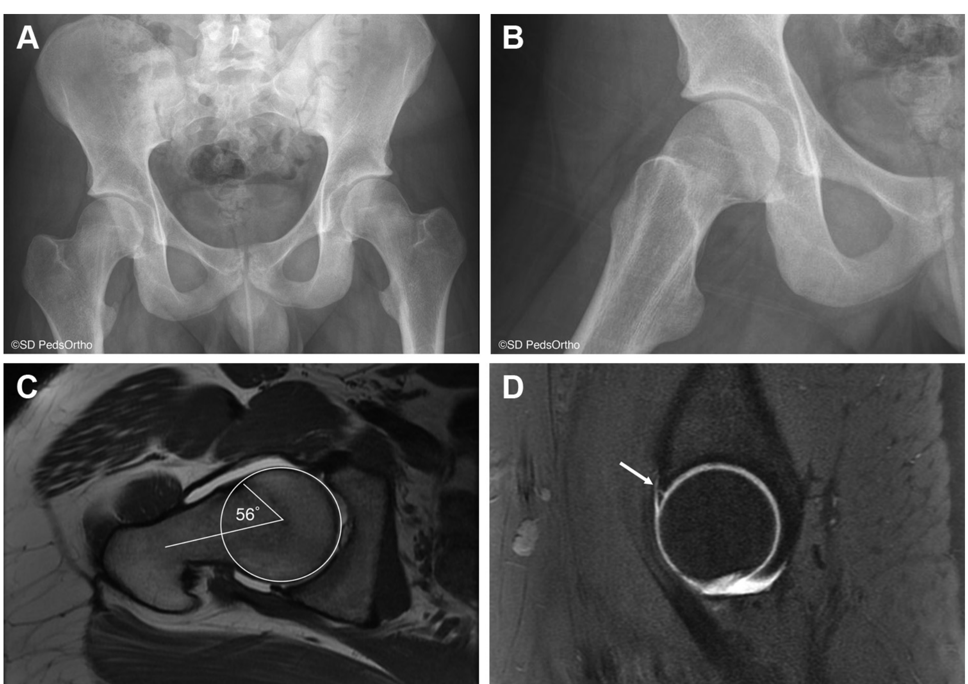

Figure 2. (A) Seventeen-year-old male basketball player with closed proximal femoral growth plates and right hip pain with femoroacetabular impingement. (B) Dunn lateral view showing decreased offset of the head-neck junction consistent with cam impingement. (C) Axial oblique T1 image demonstrating the cam lesion with an alpha angle of 56°. (D) Sagittal T1 fat-saturated image demonstrating the anterosuperior labral tear (arrow).

an outside institution (Figure 2). Before our nonoperative protocol was standardized, this patient would have been immediately offered arthroscopic surgery. With our protocol in place, patients like this undergo a more comprehensive and prolonged nonoperative course that is successful for the majority of them. With that said, patients with cam impingement were still 4 times more likely to progress to surgery than patients with pincer impingement. There are 2 possible explanations for this finding. First, there may exist a cohort of cam patients who do not respond as well to nonoperative means. Second, a surgical bias may exist where patients with larger cams are still being preferentially offered surgery because they have a radiographic "structural" abnormality that can be improved with surgery. A future randomized study might be necessary to clarify this finding.

Prolonged nonoperative treatment has several benefits: it allows the patients to improve on their own, and it enables some patients to age out of their sports. Many patients were in the midst of intense high school sports when they initially presented to our clinic. At most recent follow-up, many of them had matriculated into college and university and were no longer pursuing their previous sports, as evidenced by our data showing that only 41% were still playing their original sports. Although many patients were no longer participating in the same sport, only 17% quit because of continued pain. Almost all patients had significant improvements in their outcome scores, demonstrating that many of these patients will get better if they can just get through their sporting years. Ability to return to sports, however, may be dependent on the nature and category of the sport, with individual athletes and those participating in flexibility, impingement, and endurance sports having lower rates of successful return. Other potential keys to success were our avoidance of hip flexion activities and flexibility exercises during PT and as the patient returned to sport. Additionally, for each patient, we worked to develop an individualized treatment plan that would modify and/or limit his or her deep hip flexion in sport. Occasionally, this would require the removal of plyometric training and box jumps. Other times, this customized approach would require altering a cheerleader's routine to avoid high kicks.

While nonoperative outcome scores are lacking in the literature, several recently published reports demonstrated good arthroscopic outcomes for adolescents with FAI syndrome. Reported improvements in the mHHS ranged from 17 to 37 points, with final scores ranging from 86 to 94.[4,5,10,20,23] We observed similar improvements in the mHHS in our scope group, indicating that a delay in surgical treatment (8.8 months in the current study) does not adversely affect the eventual outcomes of surgery. More important, our nonoperative group saw similar improvements in the mHHS, suggesting that nonoperative treatment may be as effective as surgical intervention for many patients.

Intra-articular injections are frequently performed in the workup and treatment of patients with FAI syndrome. The exact role of these injections is still unclear, and there are limited data to guide clinicians. Injections are generally utilized for 1 of 4 reasons: diagnostic, prognostic, therapeutic, and to buy time while the natural history of hip pain runs its course. While there is some evidence in the literature supporting each of these approaches, our data suggest that approximately 50% of patients requiring an injection will not progress to surgery.[1,15] This subset of patients experienced significant improvements in their outcome scores at 1 to 2 years after injection. For this reason, our institution has continued to routinely use a single steroid injection on nearly all patients with FAI before proceeding to surgical intervention.

There are several limitations to this study. First, it is unclear how durable the results of this nonoperative protocol will be long term. While there is concern that an untreated cam lesion may lead to early degenerative changes at the chondrolabral junction,[2] it has not been conclusively shown in the literature that early surgical management will prevent future arthritis or slow the progression of cartilage degradation. Currently, we have institutional review board approval to contact these patients 5 years after enrollment, which will help determine the longer-term durability of this approach. A second limitation is that our study may be underpowered to perform risk stratification for all patient variables. A larger cohort may be able to better determine if there are certain patients who are less likely to respond to a nonoperative protocol and what components of the nonoperative protocol are most responsible for improved outcomes. Third, it is unclear how these data apply to older patients with FAI syndrome, since the age of our cohort at initial visit was 10 to 21 years. Fourth, approximately 25% of the cohort was lost to follow-up despite repeated attempts to reach out to these families. Unfortunately, this is not uncommon when dealing with mobile adolescent patients and an urban hospital based in a border town with a large military population. Finally, the current study is biased by the lead clinicians' nonoperative treatment preference for young patients with symptomatic FAI syndrome. This bias is contrary to most of the orthopaedic literature on this topic, where there tends to be a surgical bias, and it potentially creates a lack of equipoise in treatment approach.

In conclusion, 82% of adolescent hips presenting to our orthopaedic department with a diagnosis of FAI syndrome were managed with a nonoperative protocol and did not require surgical intervention. Patient outcome scores improved significantly with the nonoperative protocol and were maintained for 2 years after enrollment. These positive outcomes were observed across all patients, including those with labral tears (per magnetic resonance arthrogram) as well as larger cam lesions. Not all patients were able to return to their same sporting activity; this was particularly true of individual sport athletes and those participating in flexibility, impingement, and endurance sports. As a result of this study, our institution has become more conservative about treating patients with all types of FAI, resulting in lower rates of hip arthroscopy at our institution over the past 5 years.

REFERENCES

1. Ayeni O, Farrokhyar F, Crouch S, Chan K, Sprague S, Bhandari M. Pre-operative intra-articular hip injection as a predictor of short-

term outcome following arthroscopic management of femoroacetabular impingement. *Knee Surg Sports Traumatol Arthrosc*. 2014;22(4): 801-805.

2. Beck M, Kalhor M, Leunig M, Ganz R. Hip morphology influences the pattern of damage to the acetabular cartilage: femoroacetabular impingement as a cause of early osteoarthritis of the hip. *J Bone Joint Surg Br*. 2005;87(7):1012-1018.
3. Byrd JW, Jones KS. Prospective analysis of hip arthroscopy with 2-year follow-up. *Arthroscopy*. 2000;16(6):578-587.
4. Byrd JW, Jones KS, Gwathmey FW. Arthroscopic management of femoroacetabular impingement in adolescents. *Arthroscopy*. 2016;32(9):1800-1806.
5. Byrd JW, Jones KS, Gwathmey FW. Femoroacetabular impingement in adolescent athletes: outcomes of arthroscopic management. *Am J Sports Med*. 2016;44(8):2106-2111.
6. Christensen C, Althausen P, Mittleman M, Lee J, McCarthy J. The nonarthritic hip score: reliable and validated. *Clin Orthop Relat Res*. 2003;406:75-83.
7. Cianci A, Sugimoto D, Stracciolini A, Yen Y, Kocher M, D'Hemecourt P. Nonoperative management of labral tears of the hip in adolescent athletes: description of sports participation, interventions, comorbidity, and outcomes [published online August 16, 2017]. *Clin J Sport Med*. doi:10.1097/JSM.0000000000000503
8. Cunningham DJ, Paranjape CS, Harris JD, Nho S, Olson SA, Mather R 3rd. Advanced imaging adds little value in the diagnosis of femoroacetabular impingement syndrome. *J Bone Joint Surg Am*. 2017;99(24):e133.
9. Cvetanovich G, Weber A, Kuhns B, et al. Clinically meaningful improvements after hip arthroscopy for femoroacetabular impingement in adolescent and young adult patients regardless of gender [published online October 2016]. *J Pediatr Orthop*. doi:10.1097/BPO.0000000000000852
10. Degen R, Mayer S, Fields K, Coleman S, Kelly B, Nawabi D. Functional outcomes and cam recurrence after arthroscopic treatment of femoroacetabular impingement in adolescents. *Arthroscopy*. 2017;33(7):1361-1369.
11. Emara K, Samir W, Motasem el H, Ghafar K. Conservative treatment for mild femoroacetabular impingement. *J Orthop Surg (Hong Kong)*. 2011;19(1):41-45.
12. Griffin DR, Dickenson EJ, Wall PDH, et al. Hip arthroscopy versus best conservative care for the treatment of femoroacetabular impingement syndrome (UK FASHIoN): a multicentre randomised controlled trial. *Lancet*. 2018;391(10136):2225-2235.
13. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am*. 1969;51(4):737-755.
14. Hunt D, Prather H, Harris Hayes M, Clohisy JC. Clinical outcomes analysis of conservative and surgical treatment of patients with clinical indications of prearthritic, intra-articular hip disorders. *PM R*. 2012;4(7):479-487.
15. Khan W, Khan M, Alradwan H, Williams R, Simunovic N, Ayeni O. Utility of intra-articular hip injections for femoroacetabular impingement: a systematic review. *Orthop J Sports Med*. 2015;3(9): 2325967115601030.
16. Mansell NS, Rhon DI, Meyer J, Slevin JM, Marchant BG. Arthroscopic surgery or physical therapy for patients with femoroacetabular impingement syndrome: a randomized controlled trial with 2-year follow-up. *Am J Sports Med*. 2018;46(6):1306-1314.
17. Maradit Kremers H, Schilz S, Van Houten H, et al. Trends in utilization and outcomes of hip arthroscopy in the United States between 2005 and 2013. *J Arthroplasty*. 2017;32(3):750-755.
18. Myers S, Eijer H, Ganz R. Anterior femoroacetabular impingement after periacetabular osteotomy. *Clin Orthop Relat Res*. 1999;363: 93-99.
19. Nötzli H, Wyss T, Stoecklin C, Schmid M, Treiber K, Hodler J. The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg Br*. 2002;84(4):556-560.
20. Philippon MJ, Ejnisman L, Ellis H, Briggs K. Outcomes 2 to 5 years following hip arthroscopy for femoroacetabular impingement in the patient aged 11 to 16 years. *Arthroscopy*. 2012;28(9):1255-1261.
21. Ross J, Bedi A, Clohisy JC, Gagnier JJ, Group AS, Larson CM. Surgeon willingness to participate in randomized controlled trials for the treatment of femoroacetabular impingement. *Arthroscopy*. 2016;32(1):20-24.
22. Shibata KR, Matsuda S, Safran MR. Arthroscopic hip surgery in the elite athlete: comparison of female and male competitive athletes. *Am J Sports Med*. 2017;45(8):1730-1739.
23. Tran P, Pritchard M, O'Donnell J. Outcome of arthroscopic treatment for cam type femoroacetabular impingement in adolescents. *ANZ J Surg*. 2013;83(5):382-386.
24. Wall P, Fernandez M, Griffin D, Foster N. Nonoperative treatment for femoroacetabular impingement: a systematic review of the literature. *PM R*. 2013;5(5):418-426.
25. Wiberg G. Studies on dysplastic acetabula and congenital subluxation of the hip joint: with special reference to the complication of osteoarthritis. *Acta Chir Scand Suppl*. 1939;58:7-38.