Original Article

Male Gender and Competitive Athlete Status Are Associated With Better Outcomes Following Hip Arthroscopy In Patients With Global Acetabular Retroversion

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Purpose: To evaluate outcomes of hip arthroscopy in patients with global acetabular retroversion and to identify correlations between sex, radiographic measurements, athlete status, and return to play with patient-reported outcomes (PROs). **Methods:** Retrospective study of patients with global acetabular retroversion who underwent arthroscopic femoroacetabular impingement (FAI) surgery was performed. Global acetabular retroversion was defined by 3 criteria: the crossover sign, ischial spine sign, and posterior wall sign on an anteroposterior (AP) pelvic radiograph. Radiographs were used to measure lateral center edge angle, alpha angle, and anterior and posterior wall indices. Femoral version was measured with 3-dimensional computed tomography. Demographics included age, gender, athlete status, return to play, and reoperation. PROs included modified Harris Hip Score, Hip Outcome Score (HOS), Hip Disability and Osteoarthritis Outcome Score, visual analog scale (VAS), and Veterans RAND-12. Spearman correlation determined correlation with perioperative PROs. Generalized estimating equation determined independent predictors. Significance was set at $P = .05$. **Results:** From 2013 to 2019, 149 patients (65.0% female) with 160 hips with FAI and global acetabular retroversion underwent hip arthroscopy. Follow-up averaged 29.6 months. All PROs demonstrated significant improvement with the exception of the Veterans RAND-12 Mental. Female patients scored significantly lower on most postoperative PROs and had greater VAS scores ($P = .0002$-0.0402). A greater proportion of male subjects met the minimum clinically important difference for the modified Harris Hip Score (88.00% vs 78.79%) Low femoral version correlated with greater HOS ADL, HOS Sport, and Hip Disability and Osteoarthritis Outcome Score Sport scores ($P = .0077$-0.0177). Athletes reported lower preoperative VAS scores, and higher perioperative scores in multiple PROs ($P = .0004$-0.0486). Nine hips (5.63%) underwent reoperation. **Conclusions:** Patients with global acetabular retroversion and FAI undergoing hip arthroscopy report good outcomes at short-term follow-up. Male subjects and athletes had superior outcomes compared to female subjects and nonathletes. Radiographic measurements did not correlate with outcomes with exception of low femoral version. Athletes reported lower preoperative pain scores and greater postoperative PROs than nonathletes. **Level of Evidence:** Level IV, therapeutic case series.

The normal anatomic position of the acetabulum has been defined as the anterior tilt of the acetabular roof, measured at approximately 17 ± 6° in the literature.[1] Global acetabular retroversion refers to acetabular anatomical variation that can result in normal-to-increased coverage of the femoral head

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anterolaterally and low coverage posteriorly.[2-5] This anatomic variant is defined by 3 radiographic signs present on the anteroposterior view: the crossover sign, ischial spine sign, and posterior wall sign.[3,4,6,7] The presence of all 3 signs signifies a greater degree of retroversion resulting in a combination of posterior instability and anterior impingement.[7] The incidence of acetabular retroversion is thought to be approximately 5% in the normal population, 20% of patients undergoing total hip arthroplasty, and 16% to 30% of patients with hip dysplasia.[8,9] Global acetabular retroversion often is associated with femoroacetabular impingement (FAI), intra-articular soft-tissue pathology, posterior instability, and osteoarthritis.[2,5,10,11] In patients with these radiographic findings, anteverting, or "reverse" periacetabular osteotomy (PAO) is an established treatment with good outcomes, but many recent studies have explored arthroscopic techniques for addressing the associated pathologies.[10,12,13] Vahedi et al.[14] recently described lower postoperative outcome scores in patients with acetabular retroversion undergoing femoroacetabular osteoplasty with a mini-open approach compared with those without retroversion, raising concern for using a minimalistic approach in this patient population.

The role for isolated hip arthroscopy in the setting of global acetabular retroversion is not fully understood. Concern exists regarding performing acetabular rim trimming in patients with posterior undercoverage with a potential risk for iatrogenic instability. There are few studies investigating arthroscopic treatment for FAI in the setting of global acetabular retroversion, which are difficult to interpret, with conflicting results given a lack of consistency between studies.[15,16] More recent studies have suggested low complication rates and good outcomes after hip arthroscopy in globally retroverted patients.[17,18] Our study adds further data regarding athlete status and return to play in the population with global acetabular retroversion.

The purposes of this study were to evaluate outcomes of hip arthroscopy in patients with global acetabular retroversion and to identify correlations between sex, radiographic measurements, athlete status, and return to play with patient-reported outcomes. We hypothesized patients with acetabular retroversion and FAI would improve with hip arthroscopy with low revision and complication rates.

Methods

Patient Selection

A retrospective review of patients with global acetabular retroversion who underwent hip arthroscopy for a diagnosis of FAI and symptomatic labral tear from January 2012 to January 2019 at a single institution was performed. Preoperative diagnosis was based on the presence of hip pain and radiographic evidence of FAI (cam FAI, pincer FAI, or mixed FAI). The preoperative anteroposterior (AP) pelvis radiographs of all patients indicated for a primary hip arthroscopy procedure were reviewed by 2 authors (C.L., M.D.) for global acetabular retroversion. Global acetabular retroversion was defined by the presence of 3 radiographic criteria: the crossover sign, ischial spine sign, and posterior wall sign on a well-positioned AP pelvic radiograph.[4,6,7,17,19-21] Patients exhibiting all 3 radiographic signs were included in the analysis. Patients without all 3 signs were excluded from the collection, as well as patients who elected not to undergo surgical treatment, patients with a history of previous surgical procedure to the hip, and those that did not agree to participate in the study. This study received approval from the institutional review board.

Patient Characteristics, Radiographic Measures, and PROs

Anteroposterior radiographs were used to measure lateral center edge angle, Tönnis grade, anterior wall index and posterior wall index, and alpha angle.[22] Alpha angle also was measured on Dunn lateral radiographs.[22] All femoral version measures were performed by one dedicated musculoskeletal radiologist (H.F.) using 3-dimensional computed tomography. Patient demographics were collected, including age, gender, height, weight, body mass index, and hip laterality. Specific inquiry regarding athlete status, return to play at the same or higher level, and need for revision or reoperation also was completed. The term "athlete" was used to define patients who participated in competitive athletics (high school, collegiate, or professional athletics) routinely; recreational athletes were not considered. Return to play was defined as returning to at least the same level of competitive athletics before surgical intervention. Patient-reported outcome (PROs) included modified Harris Hip Score (mHHS), Hip Outcome Score (HOS), Hip Disability and Osteoarthritis Outcome Score (HOOS), visual analog scale (VAS), and quality of life with Veterans RAND-12 (VR-12). PROs were collected at the preoperative visit, as well as the intervals at which patients routinely returned to clinic: 3 months, 6 months, and 1 year. Any patients who returned to clinic after their 1-year postoperative visit also completed PROs at subsequent visits.

Statistical Analysis

Characteristic data are presented as means and standard deviations or percentages where appropriate. Spearman correlation coefficients were used to determine correlation of demographics, radiographic measures, athlete status and return to play with pre- and postoperative PROs. Generalized estimating equation was used to determine independent predictors for

Table 1. Patient Demographics and Intraoperative Findings

Demographics		***P* Value**
Hips included in study, n (%)		
Total	160 (100%)	
Female	104 (65.00%)	
Male	56 (35.00%)	
Left	83 (51.88%)	
Right	77 (48.12%)	
Bilateral	12 (7.5%)	
Gender		
Female	97 (65.54%)	
Male	51 (34.46%)	
Age, y, mean ± SD		.0768
Female	26.93 ± 10.81	
Male	22.97 ± 8.01	
BMI, mean ± SD		**<.0001**
Female	22.96 ± 3.87	
Male	25.48 ± 4.07	
Follow up, mo, mean ± SD		.7975
Female	29.30 ± 20.67	
Male	29.97 ± 22.16	
Range	5.98-88.89	
Sports*		
Hockey	16 (18.2%)	
Dance	13 (14.8%)	
Football	12 (13.6%)	
Baseball	10 (11.4%)	
Basketball	10 (11.4%)	
Track and field	7 (8.0%)	
Soccer	5 (5.7%)	
Volleyball	5 (5.7%)	
Marathon running	4 (4.5%)	
Triathlon	4 (4.5%)	
Wrestling	3 (3.4%)	
Swimming	3 (3.4%)	
Cross country	3 (3.4%)	
Gymnastics	3 (3.4%)	
Cheerleading	2 (2.3%)	
Lacrosse	2 (2.3%)	
Olympic weightlifting	1 (1.1%)	
Tennis	1 (1.1%)	
Softball	1 (1.1%)	
Color guard	1 (1.1%)	
Nordic skiing	1 (1.1%)	
Cycling	1 (1.1%)	
Horseback riding	1 (1.1%)	
Handball	1 (1.1%)	

NOTE. Bold values indicate statistically significant ($P < .05$).
BMI, body mass index; SD, standard deviation.
*Includes multisport athletes.

outcome scores. Statistical significance was set at $P = .05$.

Results

Overall Demographics and PROs

Between 2013 and 2019, 148 patients (160 hips) with global acetabular retroversion underwent arthroscopic FAI correction and were included in the study. Overall, 65.5% of patients (97/148) and 65.0% (104/160) of hips were female. Male patients had a greater body mass index than female patients (25.48 ± 4.07 vs 22.96 ± 3.87, $P < .0001$). No other patient demographic measure was found to be statistically significant between genders (Table 1). Intraoperatively, 98% of patients had labral tears, and 93% had a cam impingement lesion (Table 2). Complete patient demographics and intraoperative findings are listed in Table 1.

Table 2. Patient Intraoperative Findings

Intraoperative Findings	N	%
Labral tear	157	98.13%
Cam impingement	148	92.5%
Pincer impingement	89	55.63%
Subspine impingement	84	52.50%
Chondral lesion	32	20%
Ligamentum teres pathology	13	1.3%

Patient-Reported Outcomes

At average 30-month follow-up (range 6-89 months), there was significant improvement ($P < .0001$) in all PROs postoperatively, with the exception of VR-12 Mental score (Table 3). Overall, female subjects scored significantly lower than men on almost all postoperative PROs (Table 4). Male patients were found to have greater improvement in mHHS scores postoperatively (25.61 ± 16.66 vs 19.02 ± 20.21, $P = .0419$), as well as a significantly greater preoperative and postoperative mHHS scores ($P = .0287$, $P = .003$ respectively). In total, 51.92% of female and 76.79% of male subjects scored ≥80 on the mHHS, indicating a successful outcome. Of those who reported pre- and postoperative mHHS scores, 76.98% met the minimum clinically important difference (MCID), with 70.79% of female subjects and 88.00% of male subjects demonstrating an improvement of ≥8 points.[23] Regarding the patient acceptable symptom state, 66.88% of those reporting postoperative mHHS scores met the patient acceptable symptom state threshold, with 59.62% of female subjects and 80.36% of male subjects scoring at least a 74.[24] Female subjects were found to have greater pre- and postoperative VAS scores; however, improvement was found to be similar between genders, although not statistically significant (3.32 [female] vs 3.38 [male], $P = .4757$)

Radiographic Measures

Female subjects were found to have a lower preoperative alpha angle than men on both AP and lateral views ($P < .0001$). Female subjects were also found to have significantly greater femoral version than men (16.90° vs 13.73°, $P = .0106$). Those with femoral version <5° were found to have significantly greater postoperative HOS ADL, HOS Sport, and HOOS Sport scores than those with greater femoral version; however, the sample size of patients with low femoral version ($n = 9$, Table 5) was considerably smaller than

Table 3. Pre- and Postoperative Patient-Reported Outcomes

Patient-Reported Outcome Measure	Preoperative	Hips, n	Postoperative	Hips, n	*P* Value
mHHS	59.20 ± 14.98	139	80.83 ± 18.70	160	**< .0001**
HOS ADL	66.01 ± 19.86	135	85.08 ± 17.57	153	**< .0001**
HOS Sport	41.99 ± 24.81	128	69.69 ± 28.52	152	**< .0001**
HOOS Daily Living	71.68 ± 21.32	142	88.61 ± 15.92	152	**< .0001**
HOOS Sports	44.82 ± 23.76	141	71.93 ± 26.04	150	**< .0001**
VR-12 Physical	35.63 ± 10.62	146	45.79 ± 11.29	158	**< .0001**
VR-12 Mental	54.57 ± 12.19	148	55.52 ± 10.45	158	0.8539
VAS	6.24 ± 1.77	125	3.05 ± 2.71	157	**< .0001**

NOTE. Bold values indicate statistically significant ($P < .05$).

ADL, Activities of Daily Living; HOS, Hip Outcome Scale; HOOS, Hip Disability and Osteoarthritis Outcome Score; modified Harris Hip Score; VAS, visual analog scale; VR-12, Veterans RAND-12.

those with femoral version >5°. Femoral version did not correlate with any preoperative or postoperative radiographic measure. No radiographic measure studied correlated with significant improvement in PROs, athlete status, or return to play in an athlete population (all $P > .05$).

Athlete Status and Return to Play

Competitive athletes made up 55.0% (88/160) of hips included in the study, and 81.8% (72/88) of hips returned to play after arthroscopy in the setting of global acetabular retroversion. Of the 16 hips that did not return to play, 62.5% cited a hip-related reason.

Athletes had statistically significant increase in VR-12 Mental scores compared with nonathletes (1.77 ± 12.44 vs −3.62 ± 11.21, $P = .0072$). Athletes also reported lower preoperative VAS scores (5.97 vs 6.59, $P = .043$), as well as greater pre- and postoperative mHHS, HOS Sport, HOOS Daily Living, and VR-12 Physical scores compared with nonathletes (all $P < .05$, Table 4). In total, 68.18% of athletes and 51.39% of nonathletes indicated a successful surgical outcome by scoring ≥80 on the mHHS. In patients reporting preoperative scores, however, 73.4% of athletes (58/79) and 81.67% of nonathletes (49/60) met the MCID for the mHHS.

Athletes who returned to play had significantly lower VAS scores preoperatively and postoperatively than those who did not return to play ($P = .0376$, $P = .0319$ respectively; Fig 1). The change in VAS scores, however, was not found to be statistically significant between the 2 cohorts ($P = .15$). Return to play did not further predict a significant improvement in any other PRO measure.

Complications/Revisions

Of 160 hips with true acetabular retroversion, 9 underwent subsequent surgical procedures after index arthroscopy (5.63%). Procedures included 6 revision arthroscopies, 1 reverse PAO, 1 revision arthroscopy with hardware removal, and 1 surgical hip dislocation (Table 6). Of those hips that underwent reoperation, 5 were athletes. Of the athletes who had a subsequent surgical procedure, 3 hips (of 4) did not return to play, all citing hip-related reasons for inability to resume competitive athletics. Of these, one was a dancer, one hockey player, and one hockey/soccer dual athlete. Of note, the hockey/soccer dual athlete required 2 revision procedures.

Discussion

This study demonstrated patients with global acetabular retroversion who underwent hip arthroscopy for FAI improved postoperatively in short-term follow-up with low complication and revision rates. Male gender was associated with greater improvement in mHHS scores, as well as lower pre- and postoperative VAS scores. No pre- or postoperative radiographic measure correlated with postoperative outcomes, except for femoral version. Femoral version less than 5° was associated with greater postoperative HOS ASDL, HOS Sports, and HOOS Sports scores, although the total number of patients in this subset was quite low (n = 9). This requires further study. Athletes reported higher pre- and postoperative PROs than nonathletes, including mHHS scores, HOOS Daily Living, and VR-12 Physical scores. Athletes who returned to play had lower pre- and postoperative VAS scores than those who did not return. Reoperation rate was low (5.63%).

Previous literature has shown inconsistency in definitions used to describe acetabular retroversion. A previous systematic review exposes this disparity, with only one included study requiring three radiographic parameters to characterize their retroversion population.[15,17] By the definition of global retroversion as the presence of the crossover sign, ischial spine sign, and posterior wall sign,[4,6,7,19-21] few studies have been completed to assess for postarthroscopy outcomes in these patients. Hartigan et al.[17] examined 82 hips in 78 patients, demonstrating statistically significant improvement in mHHS and VAS scores with at least 2-year follow-up, reporting 99% survivorship with only 1 patient undergoing reoperation. More recently, Maldonado et al.[18] prospectively compared 205 globally retroverted hips to a matched control group, showing significantly improved PROs in both groups at 5-year

Table 4. Differences in Patient-Reported Outcomes by Gender, Athlete Status

Patient-Reported Outcome Measure	Female	Male	*P* Value
Preoperative			
mHHS	57.45 ± 14.65	62.22 ± 15.23	**.0287**
HOS ADL	65.05 ± 18.68	67.71 ± 21.87	.2431
HOS Sport	39.68 ± 23.11	45.98 ± 27.28	.1729
HOOS Daily Living	68.91 ± 20.65	76.62 ± 21.81	**.0121**
HOOS Sports	43.14 ± 23.39	47.76 ± 24.34	.2391
VR-12 Physical	34.30 ± 9.61	37.98 ± 11.92	**.0415**
VR- Mental	53.42 ± 12.47	56.85 ± 11.49	.0968
VAS	6.63 ± 1.26	5.61 ± 2.25	**.0013**
Postoperative			
mHHS	76.85 ± 19.52	88.02 ± 14.73	**.003**
HOS ADL	81.45 ± 19.13	91.36 ± 12.28	**.0018**
HOS Sport	65.22 ± 29.01	77.35 ± 26.15	**.0057**
HOOS Daily Living	85.56 ± 17.11	94.15 ± 11.75	**.0002**
HOOS Sports	67.67 ± 27.36	79.50 ± 21.73	**.0104**
VR-12 Physical	44.23 ± 12.24	48.72 ± 8.62	**.0402**
VR-12 Mental	54.74 ± 10.82	56.96 ± 9.65	.1345
VAS	3.51 ± 2.77	2.21 ± 2.37	**.0042**
Δ			
mHHS	19.15 ± 20.13	25.61 ± 16.66	**.0451**
HOS ADL	15.80 ± 18.98	23.46 ± 21.94	.0926
HOS Sport	24.74 ± 31.20	33.26 ± 30.82	.1215
HOOS Daily Living	16.15 ± 18.77	17.19 ± 20.40	.7950
HOOS Sports	24.79 ± 28.00	31.54 ± 27.97	.1898
VR-12 Physical	9.94 ± 12.75	10.64 ± 12.92	.5590
VR-12 Mental	1.25 ± 13.88	0.47 ± 8.11	.2339
VAS	3.32 ± 2.45	3.38 ± 3.35	.5280
	Athlete	Nonathlete	
Preoperative			
mHHS	62.56 ± 12.55	54.78 ± 16.79	**.0007**
HOS ADL	68.81 ± 17.54	62.19 ± 22.25	.1408
HOS Sport	47.23 ± 21.93	34.81 ± 26.86	**.0091**
HOOS Daily Living	76.27 ± 18.62	65.42 ± 23.27	**.0052**
HOOS Sports	48.38 ± 21.33	40.00 ± 26.10	.0815
VR-12 Physical	37.41 ± 10.58	33.35 ± 10.29	**.0117**
VR-12 Mental	57.57 ±10.02	50.95 ± 13.71	**.0043**
VAS	5.97 ±1.72	6.59 ± 1.79	**.0426**
Postoperative			
mHHS	84.19 ± 16.47	76.38 ± 20.43	**.0132**
HOS ADL	87.40 ± 16.45	82.16 ± 18.68	.0836
HOS Sport	74.11 ± 26.11	64.19 ± 30.78	**.0486**
HOOS Daily Living	91.49 ± 14.48	85.07 ± 17.00	**.0036**
HOOS Sports	74.78 ± 23.66	68.29 ± 28.50	.215
VR-12 Physical	48.13 ± 10.11	42.91 ± 12.11	**.0004**
VR-12 Mental	55.93 ± 9.73	54.94 ± 11.37	.763
VAS	3.10 ± 2.76	3.02 ± 2.66	.8994
Δ			
mHHS	21.44 ± 17.80	21.54 ±20.21	.9096
HOS ADL	19.54 ± 18.92	19.95 ± 21.52	.6247
HOS Sport	27.67 ± 30.27	28.16 ± 32.10	.7015
HOOS Daily Living	18.49 ± 18.37	14.99 ± 19.97	.2759
HOOS Sports	27.66 ± 29.46	26.88 ± 27.12	.8936
VR-12 Physical	9.28 ± 12.08	10.92 ± 13.34	.5764
VR-12 Mental	3.62 ± 11.21	1.77 ± 12.44	**.0063**
VAS	3.71 ± 2.63	3.04 ± 2.94	.1517

NOTE. Bold values indicate statistically significant ($P < .05$).

ADL, Activities of Daily Living; HOS, Hip Outcome Scale; HOOS, Hip Disability and Osteoarthritis Outcome Score; modified Harris Hip Score; VAS, visual analog scale; VR-12, Veterans RAND-12.

follow-up, with comparable numbers reaching the MCID for multiple PROs. Our study is consistent with established literature, demonstrating overall improvement in postoperative outcomes after hip arthroscopy in this patient population.

Symptomatic acetabular retroversion traditionally has been addressed with open surgical techniques, including both surgical hip dislocation and anteverting ("reverse") PAO.[20,25-27] Parry et al.[12] retrospectively reviewed patients with acetabular retroversion and FAI who underwent anteverting PAO and found significant improvements in both radiographic measurements and Harris Hip Scores at two years postoperatively. Zurmühle et al.[28] compared survivorship in patients with acetabular retroversion who underwent surgical hip dislocation with rim trimming with those who underwent anteverting PAO from 1997 to 2012 and found increasing survivorship at 10 years after anteverting PAO (79% vs 23%). Further study is needed directly comparing arthroscopic and open approaches in patients with acetabular retroversion has been completed.

Athlete Status and Return to Play

Hip arthroscopy in athletes with global retroversion is not well studied. A previous systematic review found 49.5% of athlete hips had asymptomatic pincer deformity (often referred to interchangeably as acetabular retroversion), and asymptomatic cam morphology was 3 times more common in athletes than nonathletes.[29] Review of previous studies examining athlete PROs suggest athletes tend to have greater PROs than nonathletes after hip arthroscopy, although these studies did not delineate those with acetabular retroversion.[30,31] Furthermore, return to play after hip arthroscopy in professional athletes is high across multiple sports, ranging from 88% to 96%.[32-36] Between sports, hockey athletes tend to play significantly fewer years and fewer games per season after hip arthroscopy compared with those in the NFL, MLB, and NBA.[33] Frank et al.[37] assessed outcomes after hip arthroscopy in female athletes, reporting greater PROs in athletes compared to non-athletes, as well as a 92.5% return to sport rate at the same or greater level than preoperatively. In the athlete population, further study in needed to determine if correlation exists between global acetabular retroversion and outcomes after hip arthroscopy.

Impact of Gender on Postoperative Outcomes

Gender is established as a risk factor for patients undergoing hip arthroscopy for FAI. Previous study has shown cam pathology to be more common in young athletic males, and pincer pathology to be more common in active middle-age women.[38,39] Female

Table 5. Patient-Reported Outcomes in Patients With Varying Femoral Version

Patient-Reported Outcome Measure	Femoral Version			*P* Value
	<5°	5-10°	> 10°	
N	8	93	53	
Preoperative				
mHHS	63.50 ± 7.42	61.00 ± 14.55	56.122 ± 15.73	.2024
HOS ADL	67.60 ± 20.57	67.51 ± 18.51	63.22 ± 19.73	.4321
HOS Sport	51.60 ± 27.59	44.74 ± 26.25	38.96 ± 21.34	.3184
HOOS Daily Living	80.67 ± 23.79	72.00 ± 28.82	70.27 ± 20.33	.3405
HOOS Sports	55.17 ± 22.01	46.23 ± 25.01	41.10 ± 20.75	2477
VR-12 Physical	34.71 ± 6.17	37.95 ± 10.56	32.88 ± 10.02	**.0222**
VR- Mental	62.56 ± 6.47	53.21 ± 12.80	56.33 ± 11.29	.0897
VAS	6.60 ± 1.87	6.18 ± 1.91	6.42 ± 1.35	.9752
Postoperative				
mHHS	89.5 ± 18.27	82.10 ±18.51	77.21 ± 19.51	.0566
HOS ADL	93.63 ± 15.34	86.89 ± 16.31	80.45 ± 20.06	**.0077**
HOS Sport	86.38 ± 24.30	72.24 ± 28.82	64.04 ± 27.09	**.0135**
HOOS Daily Living	94.50 ± 9.89	89.92 ± 14.57	84.94 ± 12.19	.0860
HOOS Sports	85.25 ±16.83	75.67 ± 24.80	63.87 ± 28.17	**.0177**
VR-12 Physical	47.93 ±10.26	45.95 ± 11.08	45.18 ± 12.25	.7037
VR-12 Mental	60. 75 ± 5.60	56.34 ± 8.93	53.53 ± 12.97	.1590
VAS	2.66 ± 3.67	2.85 ± 2.62	3.48 ± 2.75	.3773

NOTE. Bold values indicate statistically significant ($P < .05$).

ADL, Activities of Daily Living; HOS, Hip Outcome Scale; HOOS, Hip Disability and Osteoarthritis Outcome Score; modified Harris Hip Score; VAS, visual analog scale; VR-12, Veterans RAND-12.

gender has been associated with lower quality of life scores (pre- and postoperatively), increased pain postoperatively, and lower function-based scores.[40,41] Poehling-Monaghan et al.[42] demonstrated female patients with acetabular retroversion undergoing hip arthroscopy were more likely to have poorer outcomes than men, measured by an mHHS score <80. In our study, female gender was associated with lower pre- and postoperative mHHS scores, as well as less improvement after hip arthroscopy. A similar proportion of male and female patients recorded mHHS scores <70 (indicating failure after the procedure), although more female than male patients were included in the cohort. Female gender also was associated with greater pain scores pre- and postoperatively, similar to previous studies. This seems to lend credence to the idea that while those with retroverted acetabula exhibit overall improvement after hip arthroscopy, females do so to a lesser degree than males. This may be secondary to a greater prevalence of instability presentation in females in comparison with impingement for males.

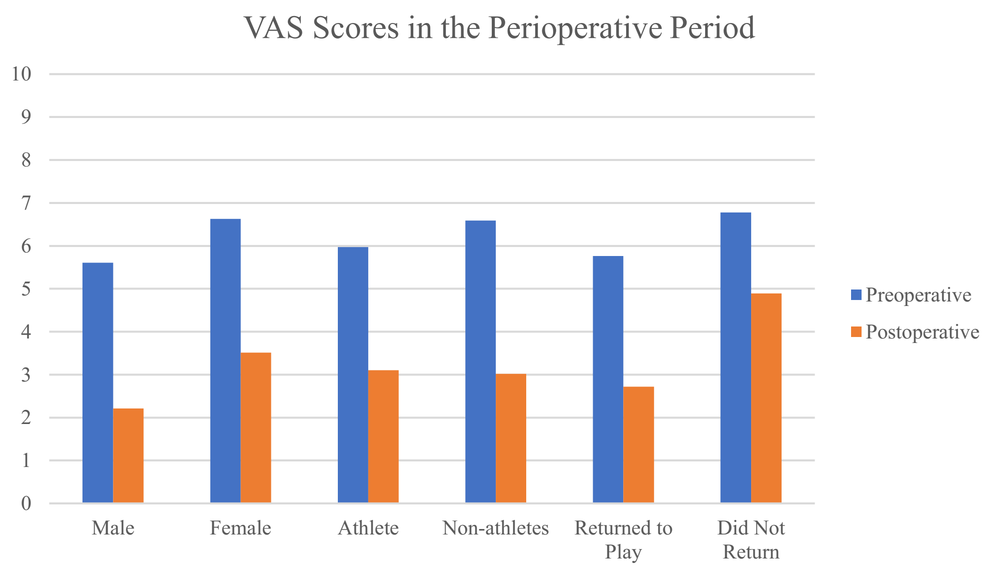

Fig 1. Visual analog scores in the perioperative period. Male subjects, athletes, and those who return to play report significantly lower pre- and postoperative visual analog scale scores than female subjects, nonathletes, and those that do not return to play (all $P < .05$).

Table 6. Reoperation Demographics

Reoperation	Hips, n	%
Procedures	9	
Revision arthroscopy	6	66.67%
Revision arthroscopy, hardware removal	1	11.11%
Reverse periacetabular osteotomy	1	11.11%
Surgical hip dislocation	1	11.11%
Athlete		
Yes	5*	55.56%
No	4	44.44%
Return to play		
Yes	1	25.00%
No	4*	75.00%
Hip related?		
Yes	4*	100.00%
No	0	0.00%

*These values included the hip that underwent 2 procedures and were therefore counted twice.

Femoral Version

Femoral version and the effect on PROs has been previously identified in the literature, with multiple studies reporting less improvement in outcomes and less range of motion in patients with reduced femoral version.[43,44] Kelly et al.[44] demonstrated that those with reduced femoral version have more restricted internal rotation preoperatively, but experience a similar change after cam decompression as those with more standard version. Fabricant et al.[43] showed patients with $<5°$ femoral anteversion made smaller improvements in PROs after hip arthroscopy than those with greater anteversion. Our study demonstrated those with lower version to have greater postoperative scores in multiple PROs; however, this may be confounded due to the small sample size in that subset ($n = 9$).

Complications/Revision

Previous studies have described revision hip arthroscopy rates between 1.8% and 5.3%, independent of acetabular version.[45,46] Systematic review of outcomes after hip arthroscopy in FAI found a 5.5% cumulative risk of reoperation after hip arthroscopy, including both conversion to total hip arthroplasty and revision arthroscopy.[47] Maldonado et al.[18] reported 10.2% of retroverted hips required reoperation at 5-year follow-up, with the vast majority (20/21) requiring revision arthroscopy. A 5.3% rate of conversion to total hip arthroplasty was described by Bedard et al.[48] in a cohort of 1,577 of hip arthroscopy patients. Hartigan et al.[17] described a single reoperation (total hip arthroplasty) in their cohort of 82 hips with acetabular retroversion (1.2%) at minimum 2-year follow up. Further research into outcomes after revision arthroscopy demonstrate rates from 5% to 8% for re-revision procedures.[49,50] The current study showed a reoperation rate of 5.63% (9/160) at an average follow up of 30 months, 7 of which included revision arthroscopy, consistent with previous literature. The current study had one patient (0.63%) requiring re-revision.

In the light of poorer postoperative outcomes after isolated hip arthroscopy for FAI in the female nonathletic population, consideration may be given for different approaches to addressing their pathology, including open pelvic osteotomy. Further study into FAI in the globally retroverted population can continue to elucidate outcomes after surgical intervention for this cohort. Further inquiry may delve into evaluation of the effect of combined version (both femoral and acetabular) on postoperative outcomes. A more specific description of coverage (anterior vs posterior) may also further delineate patients that may benefit from different surgical approaches based on postoperative outcomes.

Limitations

There are several limitations to the present study. First, length of follow-up varied over the time period, ranging from 5.98 to 88.89 months. This does not allow for assessment of a possible "ceiling effect," or postoperative time by which patient's reach their maximal improvement. Standardization of follow up times would allow for better quantification of this. The terms "athlete" and "return to play" are not consistent within the literature, and it is possible our definition limits generalizability with external cohorts. We tried to use specific criteria to define not only level of competition but also the return to sport. Finally, some patients did not complete all PROs at every postoperative timepoint (Table 3). This may limit the analysis of the MCID and may not have captured the true improvements of the cohort.

Conclusions

Patients with global acetabular retroversion and FAI treated with hip arthroscopy report good outcomes at short-term follow up. Males and athletes had superior outcomes in comparison with a female and non-athletes. Radiographic measurements did not correlate with outcomes with exception of low femoral version. Athletes reported lower preoperative pain scores and greater postoperative PROs than nonathletes.

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