Hips With Acetabular Retroversion Can Be Safely Treated With Advanced Arthroscopic Techniques Without Anteverting Periacetabular Osteotomy

Midterm Outcomes With Propensity-Matched Control Group

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Background: Different options, from reverse (anteverting) periacetabular osteotomy to hip arthroscopy, have been proposed for surgical treatment of femoroacetabular impingement syndrome (FAIS) in the setting of acetabular retroversion.

Purpose: (1) To report and analyze midterm patient-reported outcome scores (PROs) in patients with FAIS and labral tears in the setting of acetabular retroversion after isolated hip arthroscopy and (2) to compare these PROs with those of a propensity-matched control group without acetabular retroversion.

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

Methods: Prospectively collected data were retrospectively reviewed for patients who underwent hip arthroscopy for FAIS and labral tear treatment between June 2008 and March 2014. Inclusion criteria were as follows: acetabular retroversion, pre- and postoperative PROs for modified Harris Hip Score (mHHS), Non-arthritic Hip Score, Hip Outcome Score–Sports Specific Scale (HOS-SSS), and visual analog scale (VAS). Propensity score matching was utilized to identify a control group without acetabular retroversion matched 1:1 with similar age, sex, body mass index, acetabular and femoral head Outerbridge grade, preoperative lateral center-edge angle, and labral treatment. Patient acceptable symptomatic state (PASS) and/or minimal clinically important difference (MCID) for the mHHS, HOS-SSS, International Hip Outcome Tool–12, and VAS was calculated.

Results: A total of 205 hips with acetabular retroversion were matched to a control group. The groups showed no difference in demographic variables. The retroversion group was composed of 139 female and 66 male hips, with a mean ± SD age of 23.81 ± 7.28 years and follow-up time of 65.24 ± 20.31 months. Intraoperative diagnostic data and procedures performed were similar between groups, except more femoroplasties were performed in the retroversion group. Significant improvements for the mHHS, Non-arthritic Hip Score, HOS-SSS, and VAS were seen for both groups at a mean 5-year follow-up. The proportion of patients who reached the PASS and MCID were similar.

Conclusion: In the setting of FAIS and labral tears, patients with acetabular retroversion can be safely treated with advanced hip arthroscopic techniques without reverse (anteverting) periacetabular osteotomy in a high-volume surgeon's hands. Patients with acetabular retroversion demonstrated favorable PROs at midterm follow-up. Furthermore, the proportion of patients reaching the MCID and PASS for several PROs were comparable with those of a propensity-matched control group without acetabular retroversion.

Keywords: hip arthroscopy; acetabular retroversion; outcomes; femoroacetabular impingement

Global acetabular retroversion is characterized by anterolateral acetabular overcoverage that may lead to impingement and can coexist with dysplasia.[67] Reverse (anteverting) periacetabular osteotomy (rPAO) has been the gold standard for surgical treatment in patients with retroverted acetabula, with or without dysplasia, with good results at short- and midterm follow-up.[53,64,66] Nevertheless, in cases of acetabular retroversion without severe dysplasia, a minimally invasive approach with hip arthroscopy has been proposed as an alternative that can achieve favorable outcomes and results in the short term.[27] Potential benefits of hip arthroscopic management include less morbidity and the ability to assess and treat intra-articular

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pathologies.[39,61] Posterior wall deficiency (undercoverage) is one of the structural characteristics of acetabular retroversion, and the addition of arthroscopic anterolateral rim trimming brings the concern for potential iatrogenic instability.[55,68]

The purposes of the current study were to (1) report and analyze midterm patient-reported outcome (PRO) scores in patients with femoroacetabular impingement syndrome (FAIS) and labral tear in the setting of acetabular retroversion after isolated hip arthroscopy and (2) compare these PROs with a propensity-matched control group without acetabular retroversion.

It was hypothesized that after hip arthroscopy without rPAO, patients with acetabular retroversion would experience significant and favorable PROs at midterm follow-up and that midterm PROs in this group would be comparable with those of a propensity-matched control group without acetabular retroversion.

METHODS

Patient Selection

Prospectively collected as part of the American Hip Institute Hip Preservation Registry, data were retrospectively reviewed for patients who underwent hip arthroscopy between June 2008 and March 2014. All patients aged ≤40 years were considered eligible if they received primary arthroscopic treatment for labral tears and FAIS during this period. Acetabular retroversion was defined radiographically in the supine anteroposterior (AP) pelvis view by the presence of acetabular crossover >20%, the presence of ischial spine sign, and posterior wall sign (Figure 1).[27] Patients were included if they had pre- and postoperative PROs for the following outcome measures: modified Harris Hip Score (mHHS),[1] Non-arthritic Hip Score (NAHS),[12] Hip Outcome Score–Sports Specific Scale (HOS-SSS),[44] and visual analog scale (VAS).[9] Patients were excluded from analysis if they had Tönnis grade osteoarthritis ≥2 or a diagnosed ipsilateral hip condition, such as avascular necrosis, Legg-Calvé-Perthes disease, hip dysplasia (lateral center-edge angle [LCEA] ≤18°),[46] or slipped capital femoral epiphysis. Patients with workers' compensation status or those who underwent previous hip surgery were also excluded from the study.

Participation in the American Hip Institute Hip Preservation Registry

While the present study represents a unique analysis, data on some patients may have been reported in other studies. All data collection received institutional review board approval.[27,34]

Physical Examination

All patients underwent a physical examination by the senior author (B.G.D.) pre- and postoperatively. This examination assessed range of motion, gait, alignment, and strength. Impingement testing was used to assess FAIS. Specifically, the anterior impingement test put the hip through forced flexion, adduction, and internal rotation. The lateral impingement test put the hip through forced abduction and external rotation, and the posterior impingement test put the hip through extension, followed by external rotation.[14] The Trendelenburg test was used to assess abductor function[71] and the Beighton test for ligamentous laxity.[42,62]

Radiographic Imaging

A series of radiographic images were obtained on all patients before surgery, which included the following views: supine AP, modified 45° Dunn, and false profile.[13,21,48,69] Evaluations of these images were performed with General Electric Healthcare's Picture Archiving and Communication System. The institution's radiographic measurements have demonstrated good interobserver reliability in previous studies.[20,27,34,60]

The supine AP pelvis view was used to measure the extent of osteoarthritis according to Tönnis grade, ischial spine sign, crossover sign, posterior wall sign, acetabular inclination, LCEA, and 3 measures of joint space (lateral, central, and medial sourcil).[3,13,18,30,31] The anterior

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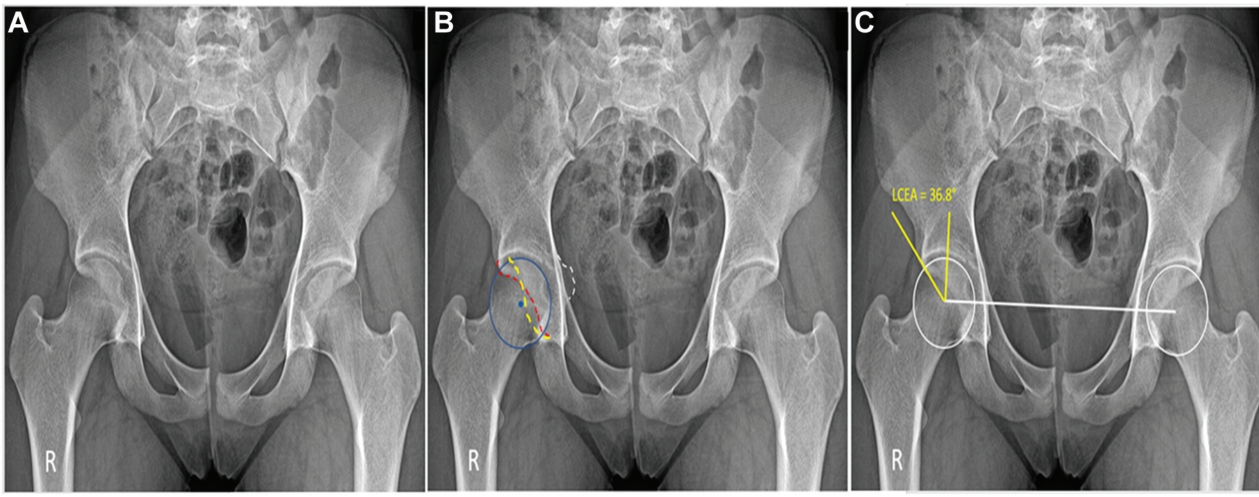

Figure 1. Radiographic assessment of acetabular retroversion in the supine anteroposterior pelvis view. All images correspond to the same patient. R, right hip. (A) Supine anteroposterior pelvis view. (B) Red dotted line, anterior acetabular wall; yellow dotted line, posterior acetabular wall. Intersection between the walls indicate a positive crossover sign. Blue dot, center of the femoral head lateral to the posterior wall (positive wall sign); white dotted line, positive ischial spine sign. (C) LCEA (lateral center-edge angle) was measured.

center-edge angle, a measure of acetabular anterior coverage, was determined from the false-profile view.[33] The modified 45° Dunn view was used to measure alpha angle and head-neck offset to quantify cam impingement, defined as alpha angle >55° or offset <0.8 cm.[26,41] Additionally, labral tears and other potential extra- and intra-articular defects were determined with magnetic resonance arthrography for all patients.

Surgical Indication and Technique

Patients were indicated for arthroscopic surgery if their radiographic imaging, history, and physical examination demonstrated evidence of symptomatic FAIS and labral tears; if they experienced moderate to severe pain that was unresponsive to at least 3 months of nonsurgical treatment, including physical therapy, nonsteroidal anti-inflammatory medication, and activity modification; and if no evidence of advanced arthritis based on preoperative diagnostic imaging was found.[5,24]

Careful surgical indications and planning were completed in patients with acetabular retroversion (Table 1). Attention was paid to preoperative ranges of motion, bony anatomy, and location of chondrolabral damage.[27]

All hip arthroscopies were performed by the senior author. Patients received general anesthesia and were placed in the modified supine position with a well-padded perineal post.[32] Traction was applied and the hip joint vented under fluoroscopy.[16,36] After placement of the anterolateral and midanterior portals and connection by an interportal capsulotomy, a diagnostic arthroscopy of the central compartment was performed to assess the labrum, intra-articular cartilage, and ligamentum teres. Labral tears were classified according to Seldes et al.[63] The chondrolabral junction was graded by the acetabular labrum articular disruption, and the acetabular or femoral head chondral damage was recorded per the Outerbridge classifications.[45,52] Ligamentum teres damage was graded by the Domb and Villar classifications.[4,23]

TABLE 1
Indications and Contraindications for Isolated Arthroscopic Treatment of Femoroacetabular Impingement Syndrome, Labral Tear, and Acetabular Retroversion[a]

Indications	Contraindications
No evidence of severe chondral damage evidence on dGEMRIC	LCEA <18°
dGEMRIC indices indicating acceptable cartilage health	Advanced osteoarthritis, Tönnis grade ≥2

[a]dGEMRIC, delayed gadolinium-enhanced magnetic resonance imaging of cartilage; LCEA, lateral center edge angle.

Various procedures were carried out according to a patient's intra-articular and peritrochanteric damage. Acetabuloplasty and femoral osteoplasty were performed under fluoroscopic guidance to treat anterolateral overcoverage and cam deformity, respectively.[50,59] The comprehensive method for acetabular bone resection in the setting of retroversion was published elsewhere; nonetheless, an LCEA between 30° and 35° was the goal.[15,27] Resection of cam deformity was completed with the goal of re-creating appropriate head-neck offset, spherical contour of the femoral head, and impingement-free range of motion.[41]

TABLE 2
Pearls and Pitfalls for Isolated Arthroscopic Treatment of Femoroacetabular Impingement Syndrome, Labral Tear, and Acetabular Retroversion

Pearls	Pitfalls
Only judicious anterolateral acetabular trimming	Minimal experience in advanced arthroscopy techniques may result in a nonreproducible procedure
Minimal acetabular trimming with care to avoid significant decrease in acetabular volume	Excessive acetabular rim trimming
Restoration of labral anatomy and function	Creation of a low-volume acetabulum causing increased load per unit area of cartilage
Preservation of the capsule for further capsular plication	Inadequate femoral cam correction

Based on the extent of tearing, labral size, and labral characteristics, labral tears were debrided, repaired, or reconstructed.[11,19,38] Labral repairs were conducted through either a simple loop or a base refixation technique.[29] For labral reconstruction, a segmental technique with either auto- or allograft was used.[8,38,58] Ligamentum teres injuries were debrided with a radiofrequency device and shaver.[40] Iliopsoas fractional lengthening was performed on patients with painful internal snapping hip syndrome.[37] The capsule was plicated; however, in surgical procedures before 2009, capsular plication was not yet performed in a routine fashion.[10]

Table 2 presents the pearls and pitfalls for arthroscopic treatment of acetabular retroversion.

Rehabilitation Protocol

The postoperative protocol was tailored to the specific procedures performed. All patients wore braces for stability (DJO Global) and were limited to 20 lb of flat-foot weightbearing activity with crutches for at least 2 weeks. A stationary bike was used daily for 8 weeks postoperatively. Physical therapy began as early as 1 day after surgery.

Surgical Outcome Tools

Patients completed the mHHS, NAHS, HOS-SSS, and VAS outcome questionnaires preoperatively within a month of their surgery and postoperatively at 3 months, 1 year, and annually thereafter. Outcomes were recorded at clinical visits, through encrypted email, or by telephone interviews. Postoperative patient satisfaction on a scale from 0 to 10 and surgical complications were also recorded. The percentage of patients achieving the patient acceptable symptomatic state (PASS) for the mHHS ($\geq$74 points) and minimal clinically important difference (MCID) for the mHHS ($\Delta \geq 8$ points) was calculated.[6] The PASS ($\geq$65 points) and MCID ($\Delta \geq 6$ points) were also found for the HOS-SSS,[6] as were the PASS of the International Hip Outcome Tool–12 (iHOT-12; $\geq$63 points)[49] and the MCID of the VAS ($\Delta \leq -1.5$ points).[43] Postoperative iHOT-12, Veterans RAND 12-Item Health Survey (VR-12), and 12-Item Short Form Health Survey (SF-12) questionnaires were implemented at the end of the study period. Rates of secondary surgical procedures, such as secondary arthroscopy and conversion to total hip arthroplasty (THA), were recorded for patients at 5-year and latest follow-up.

Statistical Analysis and Matching Process

Patients were matched on the logit of the propensity score via a nearest-neighbor (Euclidean distance) match algorithm. Matching was performed without replacement, and a caliper was set to 0.4 of the SD to restrict the donor pool. The covariates selected for included age at surgery, body mass index (BMI), acetabular and femoral head Outerbridge grade, preoperative LCEA, and labral treatment.[2,28] Descriptive statistics were reported for demographic data, procedures performed, and PROs. A statistical significance was considered as $P < .05$. For continuous variables, normal distribution and equal variance were assessed with the Shapiro-Wilk test and F test. Normally distributed data with equal variance were analyzed with a 2-tailed t test, whereas nonparametric data were compared with the Wilcoxon signed rank or Mann-Whitney test, depending on the size of the samples. An a priori power analysis was calculated to find the number of patients necessary in each group to detect 80% power with a 1:1 matching ratio. Based on an expected mean difference in the mHHS of 8 points, the power analysis determined that 55 patients would be required for each group.[54] A chi-square or Fisher exact test was used for all categorical variables. This statistical analysis was performed with Python (v 3.7) and R Software (v 3.6.0).

RESULTS

Patient Demographics

During the study period, 681 patients satisfied the inclusion criteria, of which 666 had an mean 5-year follow-up (89.19%).[27] The patient selection flowchart is depicted in Figure 2. Of the 666 hips (517 patients), 205 had acetabular retroversion by preoperative radiograph. All 205 hips were matched 1:1 to control patients without acetabular retroversion. Patient data are presented in Table 3. The matched groups showed no difference in demographic variables ($P > .05$). The retroversion group was composed of 139 female hips and 66 male hips, with mean ± SD age, BMI, and follow-up time being 23.81 ± 7.28 years, 23.89 ± 4.44 kg/m^2, and 65.24 ± 20.31 months.

Intraoperative Findings and Procedures

Intraoperative diagnostic data (Table 4) demonstrated no difference between groups in labral tear type, acetabular or femoral head cartilage damage, or ligamentum teres injuries ($P > .05$). The frequencies of treatments performed between groups were similar, except for femoroplasties ($P = .003$) (Table 5).

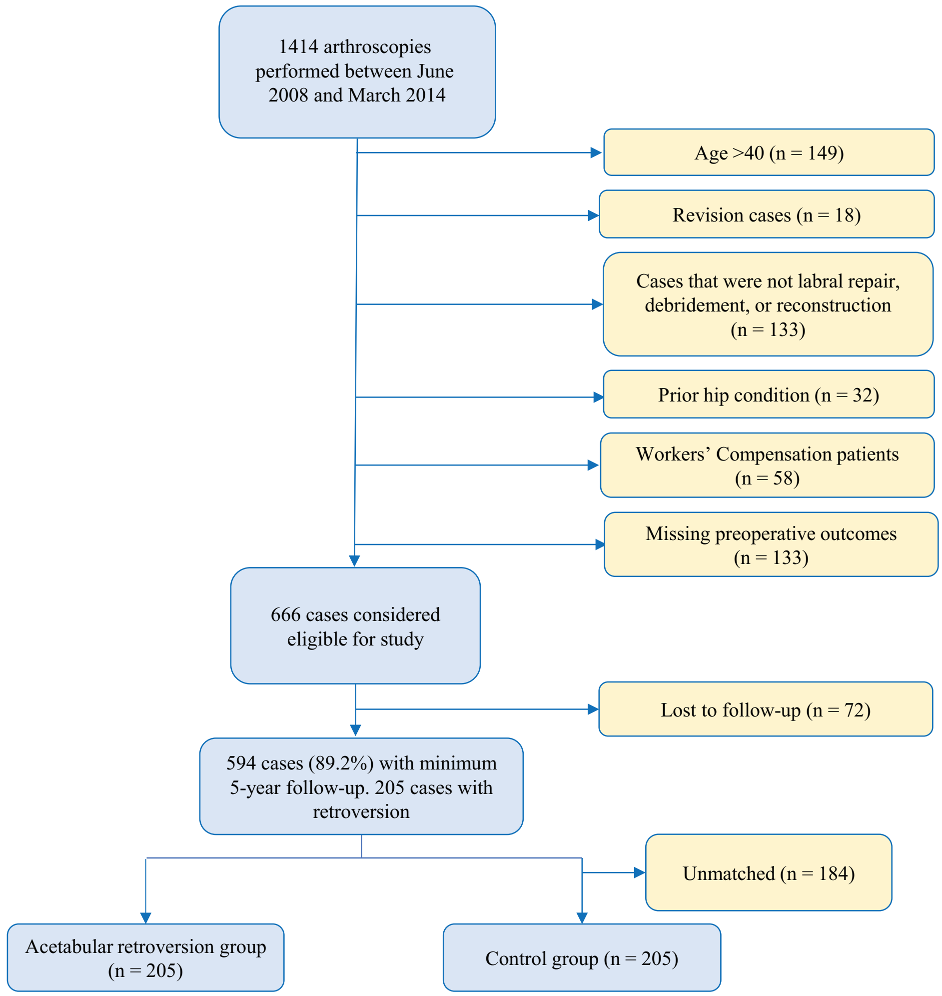

Figure 2. Patient selection flowchart.

TABLE 3
Characteristics of Acetabular Retroversion and Control Groups[a]

	Retroversion	Control	*P* Value
Hips included in study			
Left	107 (52.2)	96 (46.8)	.323
Right	98 (47.8)	109 (53.2)	
Sex			
Female	139 (67.8)	128 (62.4)	.300
Male	66 (32.2)	77 (37.6)	
Age at surgery, y	23.81 ± 7.28 (22.81-24.81)	24.61 ± 7.60 (23.56-25.66)	.351
BMI, kg/m^2	23.89 ± 4.44 (23.27-24.50)	23.98 ± 4.73 (23.33-24.64)	.903
Follow-up time, mo	65.24 ± 20.31 (62.44-68.04)	65.61 ± 17.83 (63.15-68.06)	.554

[a]Values are presented as No. (%) or mean ± SD (95% CI). BMI, body mass index.

Radiographic Findings

There were no significant differences between the retroverted and control groups in any pre- or postoperative radiographic measurement (Table 6). There were significant pre- to postoperative changes for LCEA and alpha angle for the control group, while for the retroversion group there were significant changes for LCEA, acetabular index, anterior center-edge angle, and alpha angle.

TABLE 4
Intraoperative Findings per Group[a]

	Hips, No. (%)		
	Retroversion	Control	*P* Value
Seldes: labral tear type			.101
I	114 (55.6)	96 (46.8)	
II	39 (19)	56 (27.3)	
I and II	52 (25.4)	53 (25.9)	
ALAD			.850
0	23 (11.2)	28 (13.7)	
1	89 (43.4)	79 (38.5)	
2	50 (24.4)	50 (24.4)	
3	37 (18)	41 (20)	
4	6 (2.9)	7 (3.4)	
Outerbridge: acetabulum			.819
0	17 (8.3)	22 (10.7)	
1	93 (45.4)	84 (41)	
2	53 (25.9)	51 (24.9)	
3	33 (16.1)	38 (18.5)	
4	9 (4.4)	10 (4.9)	
Outerbridge: femoral head			.260
0	184 (89.8)	191 (93.2)	
1	3 (1.5)	1 (0.5)	
2	8 (3.9)	4 (2)	
3	4 (2)	7 (3.4)	
4	6 (2.9)	2 (1)	
LT percentile class: Domb			.139
0%	132 (64.4)	124 (60.5)	
>0% to <50%	50 (24.4)	56 (27.3)	
50% to <100%	22 (10.7)	18 (8.8)	
100%	1 (0.5)	7 (3.4)	
LT Villar class			.134
No tear	135 (65.9)	123 (60)	
Complete tear	2 (1)	9 (4.4)	
Partial tear	65 (31.7)	68 (33.2)	
Degenerative tear	3 (1.5)	5 (2.4)	

[a]ALAD, acetabular labral articular disruption; LT, ligamentum teres.

Surgical Outcomes

The PROs measured pre- and postoperatively are presented in Table 7. Both groups saw a significant increase in PROs from presurgery to the latest follow-up. The mean mHHS, NAHS, and HOS-SSS scores for the acetabular retroversion group increased by 22.04, 22.12, and 30.59 points, respectively ($P < .001$). The VAS scores decreased by 3.54 ($P < .001$). Similar findings were found for the control group. Across all recorded postoperative scores, no differences were found between groups. As shown in Table 8, 156 (76.1%) patients in the retroversion group reported improvement that met the threshold for the MCID, and 167 (81.5%) achieved the PASS for the mHHS questionnaire. There were 153 (74.6%) and 142 (69.3%) patients who met the MCID and PASS for the HOS-SSS, respectively, and 145 (70.7%) who met the PASS for iHOT-12. The proportion of patients who achieved the MCID and PASS for these outcomes did not differ significantly from the control group.

TABLE 5
Intraoperative Procedures per Group[a]

	Retroversion	Control	*P* Value
Labral treatment			.430
Debridement	22 (10.7)	18 (8.8)	
Reconstruction	2 (1)	5 (2.4)	
Repair	181 (88.3)	182 (88.8)	
Capsular treatment			.741
No repair	55 (26.8)	59 (28.8)	
Repair	150 (73.2)	146 (71.2)	
Acetabuloplasty	173 (84.4)	165 (80.5)	.364
Femoroplasty	136 (66.3)	164 (80)	**.003**

[a]Values are presented as No. (%). Bold indicates statistical significance ($P < .05$).

Secondary Hip Preservation Surgery and Conversion to THA

At 5-year follow-up, 91.2% (95% CI, 87.3%-95.3%) of hips in the acetabular retroversion group and 88.9% (95% CI, 84.6%-93.4%) in the control group had not required any secondary hip procedures (Figure 3). At latest follow-up, 21 hips in the acetabular retroversion group and 22 in the control group required a secondary hip preservation procedure ($P = .86$). Of the 21 patients in the acetabular retroversion group, 1 required an open procedure to treat a femoral neck stress fracture, while the remaining 20 underwent secondary hip arthroscopy. Of the 22 patients in the control group, 2 required a secondary arthroscopy in addition to an open procedure for the removal of heterotopic ossification. Mean time to secondary hip preservation surgery for the acetabular retroversion and control groups was 31.7 ± 28.6 months and 22.2 ± 15.0 months, respectively ($P = .183$).

Of the patients who required a secondary hip preservation procedure, 17 in each group had minimum 1-year follow-up after their secondary procedure. The mean follow-up times were 56.4 ± 26.0 months and 54.9 ± 26.0 months for the acetabular retroversion and control groups, respectively ($P = .864$). At latest follow-up after the secondary procedure, the control group scored significantly higher for the SF-12 Physical (47.7 ± 7.9 vs 38.5 ± 9.9; $P = .006$) and VR-12 Physical (49.2 ± 7.7 vs 41.0 ± 10.3; $P = .020$). No other PROs yielded significant differences.

Regarding rates of conversion to THA, there was 100% survivorship in the study group and the control group at 5-year follow-up. At latest follow-up, 3 (1.5%) hips in the acetabular retroversion group and 2 (1.0%) in the control group required THA ($P = .54$). The mean time to conversion to THA was 72.2 ± 2.5 months and 99.2 ± 9.9 months for the acetabular retroversion and control groups, respectively.

TABLE 6
Radiographic Findings per Group[a]

	Retroversion	Control	*P* Value
LCEA, deg			
Preoperative	30.16 ± 5.72 (29.37-30.95)	30.13 ± 5.95 (29.31-30.95)	.953
Postoperative	28.10 ± 5.64 (27.21-29.00)	29.14 ± 4.84 (28.38-29.90)	.132
P value	**<.001**	**.037**	
ACEA, deg			
Preoperative	32.77 ± 7.22 (31.65-33.90)	31.83 ± 7.47 (30.72-32.95)	.120
Postoperative	29.93 ± 7.75 (28.69-31.16)	30.63 ± 6.51 (29.60-31.66)	.389
P value	**<.001**	.178	
Acetabular inclination, deg			
Preoperative	3.51 ± 4.22 (2.85-4.17)	3.85 ± 4.14 (3.23-4.47)	.339
Postoperative	4.50 ± 4.20 (3.83-5.17)	3.88 ± 3.93 (3.26-4.51)	.143
P value	**.025**	.981	
Alpha angle, deg			
Preoperative	58.14 ± 11.34 (56.36-59.92)	61.25 ± 12.61 (59.36-63.14)	**.028**
Postoperative	44.57 ± 7.58 (43.36-45.79)	43.97 ± 7.27 (42.82-45.13)	.6
P value	**<.001**	**<.001**	

[a]Values are presented as mean ± SD (95% CI). Bold indicates statistical significance ($P < .05$). ACEA, anterior center-edge angle; LCEA, lateral center-edge angle.

TABLE 7
Patient-Reported Outcomes per Group[a]

	Retroversion	Control	*P* Value
mHHS			
Preoperative	65.08 ± 15.12 (63.00 to 67.16)	66.12 ± 14.38 (64.14 to 68.10)	.882
Latest	87.06 ± 14.22 (85.10 to 89.02)	86.86 ± 14.50 (84.87 to 88.86)	.855
P value	**<.001**	**<.001**	
Δ	22.04 ± 19.46 (19.36 to 24.72)	20.74 ± 19.27 (18.09 to 23.39)	.496
NAHS			
Preoperative	63.74 ± 16.99 (61.40 to 66.08)	64.71 ± 16.39 (62.45 to 66.96)	.720
Latest	85.80 ± 15.41 (83.67 to 87.93)	85.93 ± 14.53 (83.93 to 87.93)	.981
P value	**<.001**	**<.001**	
Δ	22.12 ± 20.05 (19.36 to 24.89)	21.23 ± 19.13 (18.59 to 23.86)	.643
HOS-SSS			
Preoperative	5.52 ± 2.23 (5.21 to 5.82)	5.44 ± 2.26 (5.13 to 5.75)	.685
Latest	76.15 ± 24.88 (72.50 to 79.80)	74.92 ± 24.71 (71.41 to 78.43)	.588
P value	**<.001**	**<.001**	
Δ	30.59 ± 31.31 (26.18 to 35.00)	27.01 ± 29.37 (22.87 to 31.14)	.244
VAS			
Preoperative	5.52 ± 2.23 (5.21 to 5.82)	5.44 ± 2.26 (5.13 to 5.75)	.685
Latest	1.89 ± 2.16 (1.57 to 2.20)	2.23 ± 2.26 (1.91 to 2.56)	.134
P value	**<.001**	**<.001**	
Δ	–3.54 ± 2.78 (−3.93 to −3.15)	–3.24 ± 2.93 (−3.65 to −2.83)	.234
iHOT-12	77.22 ± 23.26 (73.87 to 80.56)	76.50 ± 20.77 (73.60 to 79.41)	.409
SF-12			
Mental	56.15 ± 6.91 (55.13 to 57.16)	56.42 ± 7.70 (55.33 to 57.52)	.207
Physical	50.25 ± 8.31 (49.02 to 51.47)	50.13 ± 8.52 (48.91 to 51.34)	.709
VR-12			
Mental	61.03 ± 6.69 (60.05 to 62.02)	61.44 ± 7.13 (60.42 to 62.45)	.364
Physical	51.56 ± 7.78 (50.42 to 52.71)	51.68 ± 7.64 (50.59 to 52.77)	.788
Patient satisfaction	8.07 ± 2.39 (7.72 to 8.42)	8.28 ± 1.77 (8.02 to 8.53)	.341

[a]Values are presented as mean ± SD (95% CI). Bold indicates statistical significance ($P < .05$). HOS-SSS, Hip Outcome Score–Sports Specific Scale; iHOT-12, International Hip Outcome Tool; mHHS, modified Harris Hip Score; NAHS, Non-arthritic Hip Score; SF-12, 12-Item Short Form Health Survey; VAS, visual analog scale; VR-12, Veterans RAND 12-Item Health Survey.

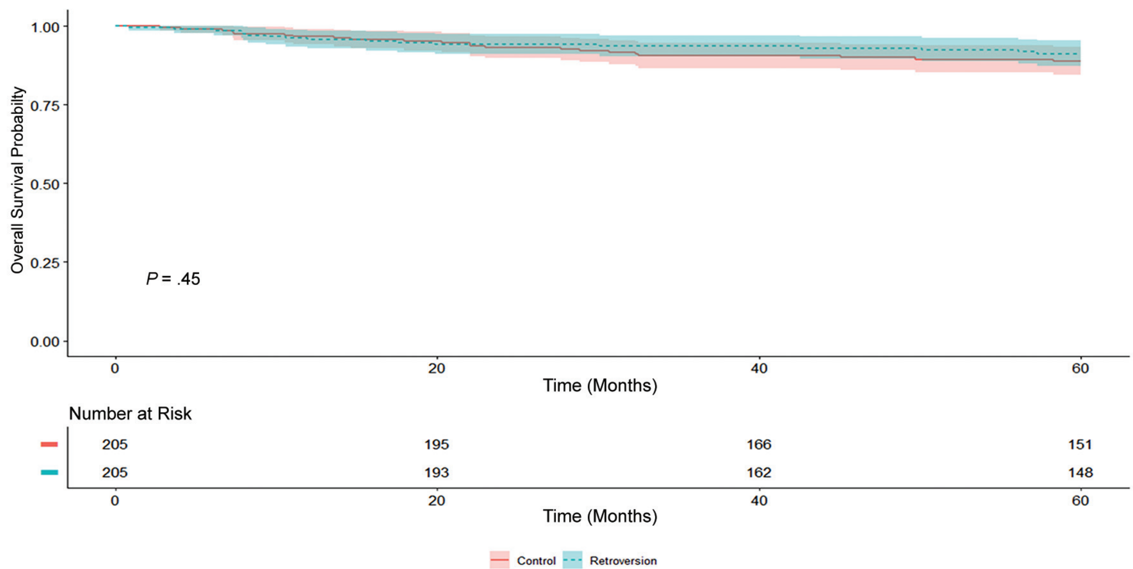

Figure 3. Kaplan-Meier survival curve with secondary hip preservation surgery as an endpoint. Shaded area spans the 95% CIs around the survival probabilities for each group.

TABLE 8
MCID and PASS per Group[a]

	Hips, No. (%)		
	Retroversion	Control	*P* Value
mHHS			
MCID Δ≥8	156 (76.1)	154 (75.1)	.476
PASS, ≥74	167 (81.5)	168 (82)	.602
HOS-SSS			
MCID Δ≥ 6	153 (74.6)	159 (77.6)	.737
PASS, ≥65	142 (69.3)	136 (66.3)	.597
iHOT-12			
PASS, ≥63	145 (70.7)	150 (73.2)	.660
VAS			
MCID Δ≤ −1.5	162 (79)	150 (73.2)	.203

[a]Δ, change from pre- to postoperative; HOS-SSS, Hip Outcome Score−Sports Specific Scale; iHOT-12, International Hip Outcome Tool; MCID, minimal clinically important difference; mHHS, modified Harris Hip Score; PASS, patient acceptable symptomatic state; VAS, visual analog scale.

DISCUSSION

The present study reports the following findings: (1) patients who underwent isolated hip arthroscopy surgery for FAIS correction and labral tear treatment in the presence of acetabular retroversion experienced favorable results and significant improvement in several PROs at midterm follow-up; (2) as compared with a propensity-matched control without acetabular retroversion and similar baseline PROs, patients with acetabular retroversion reported comparable scores at midterm follow-up in regard to mHHS, NAHS, and HOS-SSS, in addition to VAS; (3) matched groups demonstrated similar midterm postoperative results for iHOT-12, SF-12 Mental and Physical, VR-12 Mental and Physical, and, importantly, patient satisfaction; and (4) the proportion of patients in matched groups that reached the MCID/PASS for mHHS and HOS-SSS, the PASS for iHOT-12, and the MCID for VAS demonstrated no significant difference.

Vahedi et al[70] recently published their results on the treatment of FAIS and labral tears in patients with acetabular retroversion using a mini-open approach in a series of 51 patients. The authors compared outcomes between these patients and 550 without dysplasia or retroversion who also underwent FAIS treatment through a mini-open approach. At minimum 2-year follow-up, the study group reached significant postoperative improvement in mHHS. However, such improvement was significantly inferior to that of the control group. They concluded that FAIS in the context of acetabular retroversion may be treated by femoroplasty and acetabuloplasty with a mini-open approach, but the outcome appears to be inferior when compared with patients with FAIS and no evidence of dysplasia or acetabular retroversion. As presented, the current study reached different conclusions. In the study by Vahedi et al, the acetabular retroversion group was formed by 51 patients, and an a priori power analysis was not performed. Additionally, a comparison was made with a nonmatched group, and numerous confounding variables could be affecting those results. Patients with Tönnis grade 2 osteoarthritis were included in the study group (11.7%). Only 1 hip preservation design questionnaire was used (mHHS), which could compromise the generalizability of the results. Furthermore, MCID and PASS were not provided, which may make it difficult to distinguish a clinical difference between the groups. These limitations were overcome by the present study.

Flores et al[22] presented their results for arthroscopic management of global acetabular retroversion, reporting and comparing PROs at 1 year postoperatively. In total, 39 patients with acetabular retroversion were matched on the basis of sex, age, and BMI to 39 patients with focal pincer-type FAIS. Similar to the ongoing study, the authors reported significant improvement in mHHS, Hip Disability and Osteoarthritis Outcome Score (HOOS), 12-Item Short-Form Health Survey, and VAS for pain ($P < .001$) when comparing the results of the study group (acetabular retroversion) with the control group (focal pincer-type FAIS). Furthermore, no difference was found in the mean change of PROs between groups. Interestingly, subspine decompression in the acetabular retroversion group was associated with a significantly higher score for HOOS–Quality of Life and HOOS–Pain, although the reasons or clinical relevance behind this finding were not determined. Flores et al proposed that limited anterior acetabuloplasty is key to avoid iatrogenic instability, a concept with which we agree.[27] A greater decrease in LCEA after acetabuloplasty has been associated with failure of arthroscopic treatment of acetabular retroversion.[57] The current study supports the findings presented by Flores et al regarding arthroscopic management of FAIS and labral tears in the setting of global acetabular retroversion without frank dysplasia (LCEA <18°), with the critical addition of longer follow-up and greater clinical relevance by providing the MCID and/or PASS for several PROs and VAS.

Poehling-Monaghan et al[57] reported that sex was a risk factor for failure of hip arthroscopy treatment for retroversion, with failure being defined as revision surgery, conversion to rPAO or THA, or mHHS <80. After femoral osteoplasty and acetabular osteoplasty, male patients were more likely to have successful outcomes. In fact, 90% of male patients had successful outcomes versus only 40% of female patients ($P < .03$) with a mean follow-up of 30 months. Furthermore, survivorship among male versus female patients at 1 year (100% vs 68%) and 2 years (72% vs 44%) was also significantly different postoperatively ($P < .02$). In the current study, sex was a variable part of the propensity matching process, and no difference regarding sex distribution was obtained for the study and control groups. The rate of failure reported by Poehling-Monaghan et al was surprisingly high at 50%, a finding that led the authors to indicate "overall poor results for the arthroscopic treatment of patients with acetabular retroversion." However, with a more representative number of patients, we obtained encouraging outcomes and significant improvement in midterm results that were similar to those of the control group, not only in terms of PROs, but in clinical significance.

In the absence of dysplasia, rPAO has traditionally been used for the treatment of global acetabular retroversion.[65,72] In a recent systematic review, Litrenta et al[34] concluded that PRO improvement was observed with open and arthroscopic approaches.[70] The authors also stated that direct comparison between rPAO and hip arthroscopy was not possible owing to the heterogeneity of the studies. Nevertheless, longer follow-up was obtained for the open option. The results presented here add data to the current literature paucity in regard to midterm arthroscopic follow-up, although it is critical to point out that frank hip dysplasia was implemented as an exclusion criterion. Therefore, it cannot be extrapolated to the specific retroverted acetabula of patients with frank dysplasia.

Strengths

Several strengths are present in the current study. First, this is one of the few studies to investigate and report PROs for patients with arthroscopically managed acetabular retroversion and midterm follow-up. Second, propensity matching allows these results to be compared with those of a propensity-matched control group without acetabular retroversion in an effort to limit the effect of confounding variables. Third, through the use of several PROs that were designed to detect outcomes in active patients with nonarthritic hips, we tried to limit the ceiling effect of single-PRO use. Fourth, as mentioned by Harris et al,[25] statistically significant findings are not equal to meaningful or relevant clinical results. Accordingly, the PASS and/or MCID was calculated for the mHHS, HOS-SSS, and iHOT-12, in addition to the MCID for VAS, for better interpretation of the study's results.[35] Fifth, we performed an a priori power analysis, which identified that the sample size was sufficiently representative to establish meaningful differences between the study and control groups, increasing the generalizability of the results.

Limitations

The present study is not without limitations. Confounding variables may have influenced the findings and results, as this study was nonrandomized. No comparison was performed with other advocated surgical alternatives to treat acetabular retroversion, such as rPAO.[53,70,73] Future research is necessary that compares, in a pair-match fashion, hip arthroscopy with rPAO in this population. Although this is a midterm follow-up study, longer follow-up is still needed to determine the durability of the results. The analysis of this study was based on patients from a single high-volume surgeon who specializes in hip preservation surgery, which may limit the generalizability of the results or lead to nonreproducible findings.[47] Furthermore, secondary hip preservation surgery was considered an endpoint outcome. In consequence, postoperative PROs for these patients were excluded from the matched-pair PRO analysis. However, the latest PROs of patients who required a secondary hip preservation procedure were compared between the groups. Surgical decision making, management, and treatment of labrum and capsule in hip arthroscopy have evolved and improved. Correspondingly, patients in the study and control groups who underwent labral debridement and capsulotomy without repair would be currently treated with labral restoration techniques, such as labral reconstruction/augmentation and capsular plication.[17,19,38,51,56] The study design is retrospective, which may introduce bias. However, this may be limited by the prospective data collection. Hip dysplasia is a multiplex tridimensional structural pathology, and assessment based only on LCEA may be oversimplistic.[3] Moreover, patients with borderline dysplasia, defined as LCEA between 19° and 25°, were not excluded from the present study, which may introduce heterogeneity in the patient cohort. Although this is a propensity-matched control study, several variables (eg, generalized ligamentous laxity and femoral version) were not included into the matching design and may introduce potential confounding bias.[7,62] Preoperative alpha angle and femoroplasty rate were statistically different between the groups, and the potential confounding effects cannot be elucidated by the present study. Finally, although the cutoff age value used (≤40 years) was based on previous research on this subject,[27] it is still arbitrary and may decrease the number of patients in the current investigation and consequently decrease the power of the study.

CONCLUSION

In the setting of FAIS and labral tears, patients with acetabular retroversion can be safely treated with advanced hip arthroscopic techniques without rPAO in a high-volume surgeon's hands. Patients with acetabular retroversion demonstrated favorable PROs at midterm follow-up. Furthermore, the improvement and proportion of patients reaching MCID and PASS for several PROs were comparable with those of a propensity-matched control group without acetabular retroversion.

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