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Surgical Treatment of Femoroacetabular Impingement: Hip Arthroscopy Versus Surgical Hip Dislocation

A Propensity-Matched Analysis

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Background: Surgical treatment of femoroacetabular impingement (FAI) continues to evolve and is most commonly approached with either hip arthroscopy (HA) or surgical dislocation (SD) of the hip. The purpose of this study was to compare the outcomes of similar patients undergoing surgical treatment of FAI with either HA or SD.

Methods: A prospective multicenter cohort study of patients undergoing primary surgical treatment of FAI was performed. Follow-up at a minimum of 1 year (mean, 4.3 years) was available for 621 hips (81.7%), including 399 procedures with HA and 222 procedures with SD. Propensity scores were calculated and reflect the likelihood of surgical treatment with HA versus SD for a given set of covariates. Propensity scores allowed 1:1 matching to identify similar patients at baseline. After propensity matching, 128 matched pairs of patients who underwent HA and 128 matched pairs of those who underwent SD were included in the study. The primary outcome was the postoperative modified Harris hip score (mHHS); secondary outcomes included the Hip disability and Osteoarthritis Outcome Score (HOOS), the University of California Los Angeles (UCLA) activity score, and the Short Form-12 (SF-12) physical and mental subscores, as well as the rate of persistent symptoms, revision surgery, and total hip arthroplasty (THA).

Results: After propensity matching, the 2 groups exhibited similar distributions of all of the covariates that were included in the model. Both groups demonstrated significant improvements in all patient-reported outcomes (PROs). The final mHHS was not significantly different between the 2 matched groups (81.3 for the HA group versus 80.2 for the SD group, p = 0.67). Likewise, the HOOS pain subscale was similar at the time of final follow-up (77.6 versus 80.5, respectively, p = 0.32). No difference between the HA group and the SD group was identified in the rate of THA (0% and 3.1%, respectively, p = 0.41) and revision surgery (7.8% and 10.9%, respectively, p = 0.35); overall rates of persistent symptoms were 21.9% for the HA group and 24.4% for the SD group (p = 0.55).

Conclusions: In a propensity-matched analysis of patients who were treated with either approach, patients undergoing HA or SD demonstrated similar outcomes at a mean of 4 years postoperatively.

Level of Evidence: Therapeutic Level II. See Instructions for Authors for a complete description of levels of evidence.

Surgical treatment of femoroacetabular impingement (FAI) continues to evolve[1]. Surgical treatment of FAI is most commonly approached with either hip arthroscopy (HA) or surgical dislocation (SD) of the hip. HA offers advantages with its minimally invasive nature and quicker early rehabilitation[2], but inadequate deformity correction appears to be a common reason for surgical failure[3,4]. On the other hand, SD offers global access to hip deformities that may be

*A list of the ANCHOR Group members is included as a note at the end of the article.

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challenging or inaccessible by HA[5,6], but it requires a more invasive procedure, including trochanteric osteotomy. Decision-making between these 2 approaches has evolved substantially over the past decade[1]. However, the effect of surgical approach on outcomes is not well established.

The literature is limited with regard to rigorous, direct comparisons of the results of these 2 techniques. Several studies have demonstrated a relatively similar ability to achieve typical cam correction with HA and SD[6,7], although SD may have some advantages in more severe proximal femoral and acetabular deformities[5,6]. Several studies and systematic reviews have investigated the outcomes of HA and SD, with differing conclusions[2,8-10]. Comparisons are challenging given the potentially different patient characteristics (age, sex, preoperative patient-reported outcomes [PROs], deformity severity), which often are not controlled for, of patients undergoing these 2 distinct procedures. Additionally, a randomized controlled trial on this topic may not be feasible given the potential for lack of surgeon equipoise.

The purpose of the current study was to compare the outcomes of surgical treatment of FAI with HA and SD utilizing a propensity analysis to identify hips with similar characteristics at baseline to allow a valid comparison[11].

Materials and Methods

This study utilized data from a prospective multicenter cohort study of patients undergoing primary surgical treatment of FAI. The entire cohort included 1,130 patients (1,076 hips); all patients had a primary clinical diagnosis of FAI and had failure of nonoperative treatment lasting at least 3 months[12]. Inclusion criteria for the present study were primary surgery and a diagnosis of FAI. Exclusion criteria included previous surgery or residual pediatric hip disease (including residual slipped capital femoral epiphysis and deformities from Legg-Calvé-Perthes disease). A total of 760 hips undergoing surgical treatment of FAI met the inclusion criteria for this study. Eleven experienced surgeons at 9 sites contributed to the enrollment of the prospective cohort. Contributing surgeons had varying skill sets and surgical approach preferences, and included those performing only HA (n = 1), those performing only SD (n = 4), or surgeons performing both procedures (n = 6). SD was performed with trochanteric osteotomy, as described by Ganz et al.[13]. HA was performed with the patient in the supine position in all of the cases. The presence of cam and/or pincer FAI was determined by the clinical diagnosis by the treating surgeon. The maximum alpha angle was determined on anteroposterior, 45° Dunn, or frog-leg/cross-table lateral radiographs.

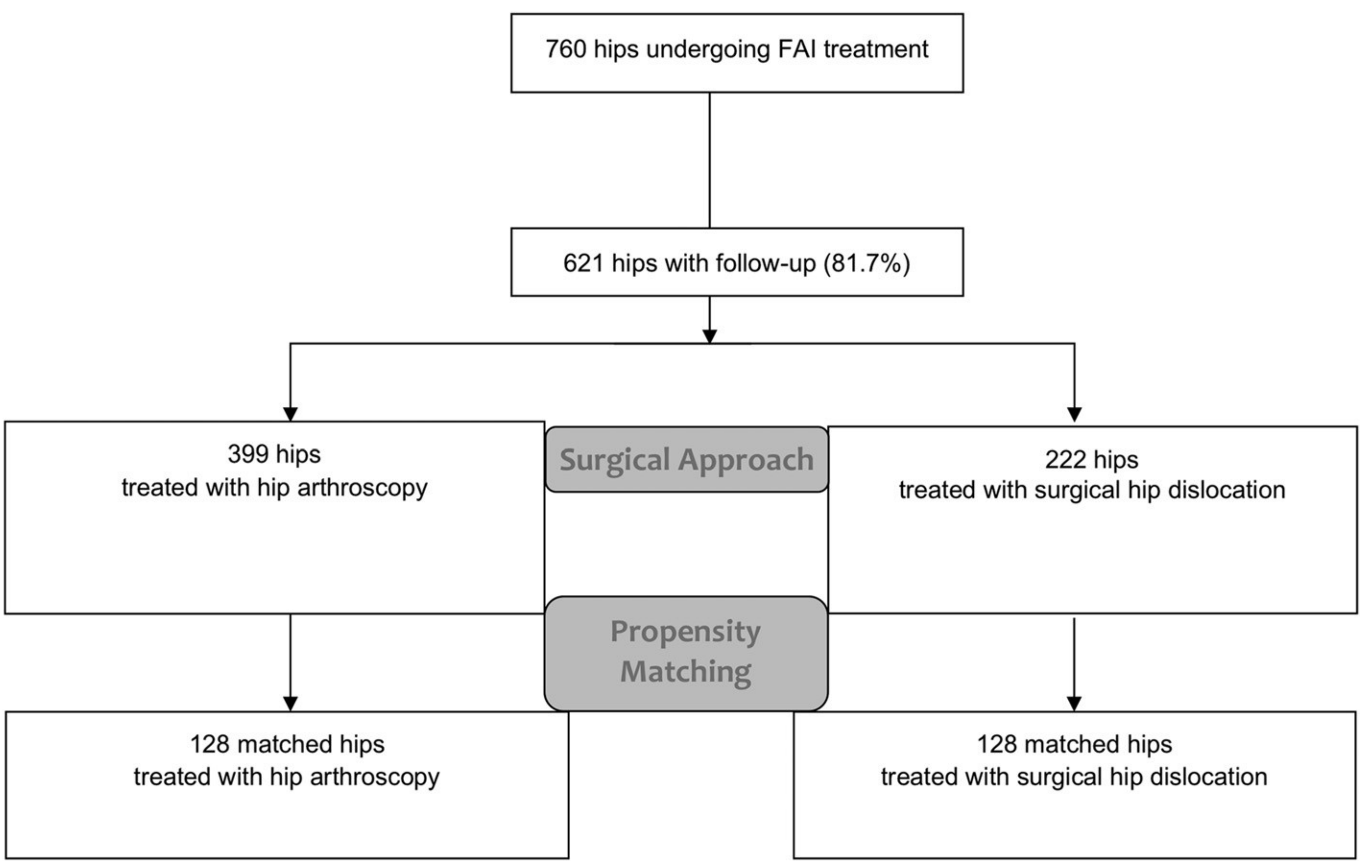

Fig. 1

Study flow diagram. The initial enrolled cohort included 760 hips; 621 hips with appropriate follow-up were eligible for inclusion. Propensity matching was performed to identify 256 hips (128 matched pairs) for inclusion in the study cohort.

TABLE I Baseline Characteristics of Matched and Unmatched Groups for Variables Utilized in Propensity Matching*

	Propensity Matched				Unmatched			
Variable	Surgical Dislocation (N = 128)	Hip Arthroscopy (N = 128)	P Value	Absolute Standardized Difference	Surgical Dislocation (N = 222)	Hip Arthroscopy (N = 399)	P Value	Absolute Standardized Difference
Female†	50.8% (65)	49.2% (63)	0.80	0.03	51.4% (114)	59.6% (238)	**0.046**	0.19
Involved in competitive sports†	22.7% (29)	22.7% (29)	1.00	0.00	20.7% (46)	11.8% (47)	**0.003**	0.23
Alpha angle >70°†	32.8% (42)	33.6% (43)	0.894	0.02	34.2% (76)	28.3% (113)	0.12	0.11
Lateral center-edge angle >40°†	7.8% (10)	7.0% (9)	0.812	0.03	14% (31)	6% (24)	**0.001**	0.34
FAI subtype†			0.876				**<0.001**	
Cam	35.9% (46)	37.5% (48)		0.03	23.9% (53)	57.4% (229)		0.66
Combined	56.3% (72)	56.3 (72)		0	64.0% (142)	38.3% (153)		0.46
Pincer	7.8% (10)	6.3% (8)		0.06	12.2% (27)	4.3% (17)		0.3
Tönnis osteoarthritis grade†			0.804				**<0.001**	
0	48.4% (62)	50.0% (64)		0.03	54.1% (120)	36.3% (145)		0.43
1	50.8% (65)	48.4% (62)		0.05	42.8% (95)	61.9% (247)		0.45
2	0.8% (1)	1.6% (2)		0.05	3.2% (7)	1.8% (7)		0.05
Age‡ *(yr)*	24.9 ± 9.0	24.9 ± 9.2	0.98	0.003	22.9 ± 8.3	33.7 ± 11.8	**<0.001**	1.01
Preop. mHHS‡	61.4 ± 14.7	62.5 ± 15.9	0.54	0.08	62.4 ± 14.3	60.1 ± 15.6	0.08	0.16

*Significant p values are bolded. FAI = femoroacetabular impingement, and mHHS = modified Harris hip score. †The values for the 2 groups are given as the percentage, with the number in parentheses. ‡The values for the 2 groups are given as the mean and standard deviation.

In general, during the study period, pincer FAI was felt to be present in the setting of global acetabular overcoverage (lateral center-edge angle [LCEA] of >40°) or a positive crossover sign, while cam FAI was defined by an alpha angle of >50°. Surgical procedure type (HA or SD) was determined by the treating surgeon. Labral and cartilage pathology were classified using the modified Beck classification[14-16]. Follow-up at a minimum of 1 year was available with 621 hips (81.7%) (mean, 4.3 ± 2.4 years), including assessment of PROs (the modified Harris hip score [mHHS], the University of California Los Angeles (UCLA) activity score, 5 Hip disability and Osteoarthritis Outcome Score [HOOS] subscales, and the Short Form-12 [SF-12] physical and mental subscores) as well as reoperations (including total hip arthroplasty [THA] and revision surgery) (Fig. 1).

Propensity score matching is a powerful method to adjust for confounding variables and reduce, although not completely eliminate, selection bias in nonrandomized studies. Matching on propensity scores identifies similar patients undergoing HA and SD based on the set of included variables (e.g., preoperative clinical characteristics) in order to compare outcomes between the surgical treatment types[11]. Propensity scores were calculated (possible range, 0.00 to 1.00) using a logistic regression model with surgical treatment type (HA versus SD) as the outcome, and independent variables included factors that were felt to play a role in surgical approach decision-making based on clinical experience or univariate statistical analysis (Table I), as well as to play a role in the pathophysiology and outcome of treatment of FAI. Covariates that were included were sex, age, participation in competitive sports, preoperative mHHS, FAI subtype, moderate cam morphology (defined as a maximum alpha angle of >70°), global acetabular overcoverage (defined as an LCEA of >40°), and Tönnis osteoarthritis classification. HA and SD patients were randomly matched 1:1 based on propensity scores (within an absolute distance of 0.01) to allow for a comparison of similar patients who were commonly treated with either procedure. Standardized differences were used to assess the quality of the matching results, where an after-matching standardized difference of 0.1 implied that there was a

TABLE II Baseline Characteristics of Matched and Unmatched Groups for Variables Not Utilized in Propensity Matching*

	Propensity Matched			Unmatched		
Variable	Surgical Dislocation (N = 128)	Hip Arthroscopy (N = 128)	P Value	Surgical Dislocation (N = 222)	Hip Arthroscopy (N = 399)	P Value
Alpha angle	63.2 ± 12.5	63.1 ± 12.8	0.93	63.2 ± 13.3	62.5 ± 11.6	0.50
LCEA	30.2 ± 6.9	29.0 ± 6.3	0.13	31.9 ± 7.6	28.7 ± 6.6	**<0.001**
Acetabular inclination	4.1 + 5.6	5.5 ± 5.7	**0.047**	3.8 ± 5.8	6.4 ± 6.9	**<0.001**
Preop. PROs						
HOOS domain						
Pain	55.1 ± 20.0	58.1 ± 21.0	0.25	57.0 ± 19.9	55.6 ± 21.1	0.42
ADL	65.9 ± 20.2	67.7 ± 21.3	0.49	66.8 ± 19.8	64.9 ± 22.2	0.28
QOL	29.2 ± 19.5	33.7 ± 20.8	0.08	30.3 ± 19.1	30.7 ± 20.0	0.83
Symptoms	53.8 ± 19.5	57.9 ± 21.8	0.12	55.5 ± 19.0	56.0 ± 21.4	0.75
Sport	46.5 ± 23.6	45.5 ± 22.8	0.73	47.3 ± 23.8	44.0 ± 25.0	0.11
UCLA activity score	7.2 ± 2.8	7.6 ± 2.7	0.22	7.1 ± 2.7	6.9 ± 2.8	**<0.001**
SF-12 Physical	38.4 ± 10.7	38.8 ± 10.8	0.79	38.6 ± 10.0	37.5 ± 10.7	0.22
SF-12 Mental	54.2 ± 10.2	52.7 ± 9.0	0.23	54.2 ±10.1	51.8 ± 11.0	**0.008**

*LCEA = lateral center-edge angle, PROs = patient-reported outcomes, HOOS = Hip disability and Osteoarthritis Outcome Score, ADL = activities of daily living, QOL = quality of life, UCLA = University of California Los Angeles, and SF-12 = Short Form-12. The values are given as the mean. Significant p values are bolded.

negligible correlation and good balance between the group and each covariate[17]. The cohort initially included 621 patients (399 who underwent HA and 222 who underwent SD). After propensity matching, a total of 256 patients (128 matched pairs of patients undergoing HA and SD) were included in the current study and subsequent analysis (Fig. 1).

The primary outcome was the final mHHS, while secondary outcomes included the HOOS, the UCLA activity score, and the SF-12 score. Secondary outcomes also included the rates of revision surgery or THA and persistent symptoms. Persistent symptoms were defined as reoperation (for continued symptoms) or a symptomatic hip. A "symptomatic" hip was defined as improvement in the mHHS of <8 (minimal clinically important difference [MCID])[18] and an mHHS of <74 (patient acceptable symptom state [PASS])[19]; symptomatic hips reached neither the MCID nor the PASS. Reoperation was defined as revision surgery or THA and did not include hardware removal. Outcomes were compared in propensity-matched groups. Categorical variables were analyzed with the McNemar test (or Fisher exact test). Continuous variables were analyzed with paired t tests (a positive difference indicated a larger value for SD, and a negative value indicated a larger value for HA). Patients with a missing postoperative mHHS prior to undergoing a reoperation (revision

TABLE III Characteristics of HA and SD Patients Who Were Included and Excluded from Propensity-Matched Analysis*

	Hip Arthroscopy			Surgical Dislocation		
	Included (N = 128)	Excluded (N = 271)	P Value	Included (N = 128)	Excluded (N = 94)	P Value
Female†	49.2% (63)	64.6% (175)	0.004	50.8% (65)	52.1% (49)	0.84
Competitive sports†	22.7% (29)	6.6% (18)	<0.001	22.7% (29)	18.1% (17)	0.41
Alpha angle‡ *(°)*	63.1	62.2	0.52	63.2	63.2	1.00
Alpha angle >70°†	33.6% (43)	25.8% (70)	0.11	32.8% (42)	36.2% (34)	0.56
LCEA‡ *(°)*	28.9	28.5	0.55	30.2	34.2	<0.001
LCEA >40°†	7.0% (9)	5.5% (15)	0.56	7.8% (10)	22.3% (21)	0.002
Age‡ *(yr)*	24.8	37.8	<0.001	24.9	20.1	<0.001
Preoperative mHHS‡	62.5	59	0.034	61.4	63.8	0.23

*LCEA = lateral center-edge angle, and mHHS = modified Harris hip score. †The values for the 2 groups are given as the percentage, with the number in parentheses. ‡The values are given as the mean.

TABLE IV Intraoperative Disease Characteristics for the Hip Arthroscopy and Surgical Dislocation Groups*

	Hip Arthroscopy	Surgical Dislocation		Hip Arthroscopy	Surgical Dislocation	P Value
Modified Beck labral grade			Labral treatment			0.001
Normal	3.9% (5)	8.6% (11)	None	6.3% (8)	21.9% (28)	
Degeneration	12.5% (16)	25.0% (32)	Debridement	23.4% (30)	24.2% (31)	
Full-thickness tear	3.1% (4)	6.3% (8)	Repair	70.3% (90)	53.9% (69)	
Detachment	76.6% (98)	47.7% (61)				
Ossification	3.9% (5)	12.5% (16)				
Modified Beck acetabular cartilage grade			Acetabular cartilage treatment			<0.001
Normal	7.8% (10)	27.3% (35)	None	32.0% (41)	57.0% (73)	
Malacia	22.7% (29)	15.6% (20)	Chondroplasty	63.3% (81)	33.6% (43)	
Debonding	32.8% (42)	19.5% (25)	Microfracture	4.7% (6)	9.4% (12)	
Cleavage	29.7% (38)	27.3% (35)				
Defect	7.0% (9)	10.2% (13)				
Modified Beck femoral cartilage grade			Femoral cartilage treatment			0.046
Normal	89.1% (114)	71.9% (92)	None	95.3% (122)	90.6% (116)	
Malacia	7.8% (10)	23.4% (30)	Chondroplasty	4.7% (6)	4.7% (6)	
Debonding	0% (0)	0.8% (1)	Microfracture	0% (0)	4.7% (6)	
Cleavage	1.6% (2)	0.8% (1)				
Defect	1.6% (2)	3.1% (4)				

*N = 128 for each group. The values for the 2 groups are given as the percentage, with the number in parentheses.

or THA) were assigned an imputed mHHS value of 55 (n = 15 of 256, 5.9%) based on existing data in similar patients rather than excluding such patients from the analysis. Regarding cases of incomplete secondary PRO data, only matched pairs with complete data for each metric were included (n = 108 to 121).

TABLE V Differences in Postoperative PROs Between the Hip Arthroscopy and Surgical Dislocation Groups*

Postop. PRO	Difference†	P Value‡
mHHS	−1.0 (26.8)	0.67
HOOS domain		
ADL	0.9 (28.1)	0.75
Pain	2.9 (30.6)	0.32
QOL	3.7 (40.6)	0.34
Sport	5.8 (38.7)	0.12
Symptoms	2.8 (28.3)	0.30
SF-12 Mental	1.2 (11.8)	0.30
SF-12 Physical	1.5 (17.2)	0.36
UCLA activity score	0.1 (3.2)	0.63

*PRO = patient-reported outcome, mHHS = modified Harris hip score, HOOS = Hip disability and Osteoarthritis Outcome Score, ADL = activities of daily living, QOL = quality of life, SF-12 = Short Form-12, and UCLA = University of California Los Angeles. †The pairwise difference was calculated as surgical dislocation − hip arthroscopy, and is given as the mean and standard deviation. A positive difference indicates a larger value for surgical dislocation and a negative value indicates a larger value for hip arthroscopy. ‡Paired-sample t test.

Results

The cohort included 256 hips (128 with HA, 128 with SD) with a patient mean age of 24.9 years (range, 13 to 52 years) and a mean follow-up (and standard deviation) of 4.3 ± 2.4 years. FAI was classified as cam in 36.7%, combined cam/pincer in 56.3%, and isolated pincer in 7.0% of cases, including moderate cam morphology in 33.2% and global acetabular overcoverage in 7.4% of cases.

Prior to propensity matching, the standardized differences in baseline characteristics were generally high between hips undergoing HA versus SD (Table I). After propensity matching, the standardized differences were <0.1 for all covariates that were included in the match (Tables I and II). Hips included in the propensity-matched analysis had significantly different patient characteristics than those that were not included in the match (those without an appropriate match) (Table III). The patients who were treated with HA in the propensity analysis included greater proportions of men, those involved in competitive sports, those with combined FAI, those with a Tönnis osteoarthritis grade of 0, younger patients, and those with a higher preoperative mHHS score than the non-matched HA cases (all $p < 0.05$). The hips that were treated with SD in the propensity analysis included those with less global acetabular overcoverage,

TABLE VI Patient-Reported Outcomes at Preoperative and Postoperative Time Points*

		Surgical Dislocation			Hip Arthroscopy		
	N	Preop.†	Postop.†	Change	Preop.†	Postop.†	Change
mHHS	128	61.4 (14.7)	80.2 (19.5)	18.8	62.5 (15.9)	81.3 (20.4)	18.8
HOOS domain							
Pain	111	55.8 (20.1)	80.5 (22.3)	24.7	57.1 (21.1)	77.6 (22.3)	20.5
ADL	111	66.0 (20.7)	85.8 (21.1)	19.8	66.9 (21.7)	84.9 (20.8)	18.0
QOL	110	29.1 (19.8)	65.9 (28.1)	36.8	32.2 (19.8)	62.2 (30.6)	30.0
Symptoms	111	53.9 (18.8)	76.3 (21.5)	22.4	57.3 (22.3)	73.5 (21.8)	16.2
Sport	108	45.3 (22.8)	73.2 (27.7)	27.9	43.8 (21.6)	67.3 (30.1)	23.5
UCLA activity score	121	7.5 (2.7)	7.8 (2.2)	0.3	7.5 (2.7)	7.6 (2.6)	0.1
SF-12 Physical	111	38.7 (10.7)	47.6 (12.0)	8.9	38.2 (10.5)	46.1 (12.7)	7.9
SF-12 Mental	111	54.1 (10.1)	54.8 (7.9)	0.7	53.3 (8.7)	53.7 (8.4)	0.4

*mHHS = modified Harris hip score, HOOS = Hip disability and Osteoarthritis Outcome Score, ADL = activities of daily living, QOL = quality of life, UCLA = University of California Los Angeles, and SF-12 = Short Form-12. †The values are given as the mean and standard deviation.

more severe cam FAI, and older patient age than non-matched hips that were treated with SD (all $p < 0.05$). Intraoperative classification of labral, acetabular cartilage, and femoral cartilage lesions by the modified Beck classification demonstrated some differences between HA and SD in the matched groups (Table IV). Hips undergoing HA (when compared with those undergoing SD) were more likely to be classified with labral and acetabular cartilage pathology and undergo labral repair or acetabular chondroplasty, and less likely to report femoral head cartilage treatment (all $p < 0.05$) (Table IV).

The mean mHHS was similar at baseline between the 2 matched groups (62.5 with HA versus 61.4 with SD). Both groups demonstrated significant improvements in all PRO measures. The final mHHS was not significantly different between the 2 groups (81.3 versus 80.2, $p = 0.67$). Similarly, the HOOS pain subscale was not significantly different at the time of final follow-up (77.6 versus 80.5, $p = 0.32$). Also, the HOOS subscales for sport and recreation, activities of daily living, quality of life, and symptoms demonstrated no significant differences at the time of the final follow-up (Tables V and VI). No differences in the SF-12 physical and mental subscores were noted at the time of final follow-up

No significant difference between groups was present for the rates of the 3 defined outcome states. The rate of THA conversion was 0% for the HA group versus 3.1% for the SD group ($p = 0.12$) (Table VII). The rate of revision surgery was 7.8% for the HA group and 10.9% for the SD group ($p = 0.35$). The overall rate of persistent symptoms (reoperation or symptomatic hip) was 21.9% for the HA group and 24.4% for the SD group ($p = 0.55$).

Discussion

FAI is a common cause of hip pain and a recognized precursor to hip osteoarthritis[20-22]. HA is increasingly being utilized for the treatment of FAI. Montgomery et al. found a 365% increase in HA from 2004 to 2009[23], while Maradit Kremers et al. saw an increase of 3.6 to 16.7 per 100,000 individuals per year from 2005 to 2013[24]. Bozic et al. reported a fivefold increase in the use of HA to treat FAI from 2006 to 2010[25]. While utilization of HA for the treatment of FAI continues to rise, SD continues to be used for the more severe or complex cases. There remains a lack of consensus regarding the indications for each procedure, and rigorous, direct comparisons between the outcomes of HA and SD are limited. Direct comparison studies are challenging and may be biased by differences in the patients in whom these procedures are performed. Thus, large patient populations with similar patients being treated with the 2 different procedures are required for meaningful outcome comparisons.

TABLE VII Differences Between Postoperative Outcome States for the Hip Arthroscopy and Surgical Dislocation Groups*

Outcome Variable	Surgical Hip Dislocation	Hip Arthroscopy	P Value
THA	3.1%	0%	0.12†
THA or revision	10.9%	7.8%	0.35
Persistent symptoms	24.4%	21.9%	0.55

*THA = total hip arthroplasty. †Analyzed with the Fisher exact test.

In our large multicenter study, after propensity matching to allow comparison of similar patients who were treated with HA and SD, no significant differences in PROs or rates of failure were seen. Our failure rate, as defined by reoperations or conversion to THA, was 7.8% for HA and 10.9% for SD and was not significantly different (p = 0.35) between the groups. Our findings were comparable with those reported in a systematic review that reported 90.5% survival for HA and 93.0% survival for SD[8].

The literature directly comparing the outcome of HA versus SD remains sparse and often fails to control for differing patient populations undergoing the 2 procedures. Domb et al. compared the outcomes of the 2 treatment approaches in a single-surgeon cohort, with 10 patients undergoing SD and 20 age and sex-matched patients undergoing HA, but they failed to control for deformity severity and other differences in the groups[8]. They found no difference in the mHHS, but there were differences in the Non-Arthritic Hip Score (NAHS) (p = 0.01) and the Hip Outcome Score sport-specific subscale (p = 0.047), with HA patients scoring higher. The senior author performed the 10 SDs over a nearly 4-year study period during which 785 HAs were performed. Zingg et al. compared outcomes of 15 patients undergoing SD with 23 patients undergoing HA in a 2-surgeon study[2]. They found a higher mHHS in the HA group compared with the SD group at 1 year postoperatively (93.4 versus 84.9, p = 0.027). Rego et al. compared the outcomes of 102 patients undergoing HA with those of 96 undergoing SD for FAI and found no difference in clinical outcomes between the groups as assessed by the NAHS[9]. Nwachukwu et al. performed a systematic review comparing 600 hips treated with SD at 57.0 months of follow-up with 1,484 hips treated with HA at 50.8 months of follow-up[10]. With conversion to THA as an end point, 93% survival was seen in the SD group and 90.5% (p = 0.06) survival was seen in the HA group. This large systematic review data set is very consistent with the findings of our large multicenter study.

In our study, the similar ultimate outcomes of patients undergoing treatment of FAI with either HA or SD support the continued use of both of these surgical procedures. It is important to recognize that this conclusion was applicable to the subgroup of patients commonly treated with either procedure during the study period. Additional research is needed to better define if other subsets of FAI patients are better treated with a specific technique. HA allows advantages in postoperative patient recovery and is the preferred method of treatment for most mild and moderate deformities. However, rates of failure with arthroscopic treatment remain at approximately 10% to 20%. This underscores the need for better understanding of the patient subgroups that are at risk for poor outcomes. Previous studies also have shown that inadequate deformity correction is a common reason for HA failure[3,4] and emphasize the continued need for improved surgeon education and skills training. Severe FAI deformities, both cam and pincer, can be difficult to fully correct with HA even though the technical aspects of HA continue to improve[5,6]. Inadequate osseous correction remains a common reason for failure of hip preservation surgery. Severe deformities may be more consistently corrected with SD. Decision-making regarding HA versus SD is likely best undertaken with the expertise of the individual surgeon. The ability to perform adequate deformity correction is perhaps more important than the actual surgical approach. In cases where access for arthroscopic deformity correction is questionable, SD provides a very effective alternative with the potential for more comprehensive access to the FAI deformity. On the other hand, in hips with deformities that are adequately assessed by HA, HA may have advantages with respect to perioperative recovery and avoidance of a potential need for later hardware removal. With improved arthroscopic techniques, the limits of HA have improved and will continue to improve, although this remains surgeon-dependent.

The current study has several limitations. A randomized trial would be the optimal research design to answer the proposed questions but is likely not feasible given limited surgeon equipoise in this area. Through propensity matching, the current study provides a relevant comparison across a large number of patients at early postoperative time points. Propensity matching allows for limiting the bias between groups at baseline by controlling for known differences that cause bias. However, it is unable to control for unknown sources of bias that may still exist to some degree. The current multicenter study included a variety of hip preservation surgeons, including surgeons who perform HA, surgeons who perform open SD of the hip, and surgeons who perform both arthroscopic and open procedures. Although these different surgeon groups may influence the treatment and decision-making procedure, we saw no major effects in the current study. All surgeons treating patients in the current study were very experienced in the utilized surgical approach, which is important to understand when applying the results of the current study. In this study, we lacked radiographic confirmation of deformity correction, which may be influenced by surgical approach and affect outcomes. Thus, we were unable to assess the role of osseous correction in the outcomes. The study had a mean 4-year follow-up, and longer-term results may be needed to adequately demonstrate the differences between the 2 groups over time. Despite propensity matching, the study demonstrated significant differences in labral and cartilage pathology between the 2 groups. Given the highly matched baseline characteristics, we feel that this finding is likely due to arthroscopic visualization being more sensitive to early labral and cartilage disease in the central compartment than visualization during SD, while visualization during SD may be more sensitive to femoral head cartilage abnormalities. To our knowledge, the direct comparability of disease classification with HA or SD has not been previously established. However, the need to treat these earlier findings is unclear given the similar outcomes in the 2 groups in the current study. Additionally, the results of this study apply to hips that were able to be matched in the propensity analysis, whereas more extreme or very mild FAI cases may not have had adequate matching. In a propensity-matched study, the study design precludes the ability to perform subgroup analyses of all individual factors (as not all hips are matched on each factor used in the matching, such as moderate cam or global overcoverage deformities) without losing the benefit of the propensity matching.

Conclusions

In a propensity-matched analysis, similar patients undergoing HA or SD demonstrated similar outcomes at a mean of 4 years postoperatively. Results of this multicenter study reinforce that both HA and SD of the hip are acceptable methods of treatment for FAI. ■

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