Patients With a High Femoroepiphyseal Roof (FEAR) With Concomitant Borderline Hip Dysplasia and Femoroacetabular Impingement Syndrome Do Not Demonstrate Inferior Outcomes Following Arthroscopic Hip Surgery

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Purpose: The purpose of this study was to compare outcomes after hip arthroscopy for femoroacetabular impingement syndrome (FAIS) in patients with borderline hip dysplasia and hip instability defined radiographically using the femoroepiphyseal acetabular roof (FEAR) index and in patients without radiographic evidence of hip instability. **Methods:** Data from consecutive patients with borderline hip dysplasia (lateral center edge angle between 18°-25°) who underwent primary hip arthroscopy between April 2012 and June 2017 for the treatment of FAIS were analyzed. Baseline demographic data, radiographic parameters, preoperative, and 2-year postoperative patient-reported outcome measures were collected. The FEAR index was measured by 3 different observers. Patients with an average FEAR index ≥2° were categorized as having radiographic evidence of instability as previously published. The analysis was powered to detect a minimal clinically important difference (MCID) for each outcome score. Statistical analysis was performed as appropriate to compare patients with FEAR index ≥2 and <2°. **Results:** A total of 140 patients met the inclusion criteria. The average age and body mass index of included patients was 31.7 ± 13.2 ($P < .325$) years and 25.1 ± 5.6 kg/m^2 ($P < .862$). There were no statistically significant demographic differences between the groups. Nineteen (13.0%) patients were found to have a FEAR index of over 2°. The FEAR index <2° and FEAR index ≥2° groups had a mean preoperative FEAR index (standard deviation, range) of −7.0 (5.2, −26.8 to 1.9) and 4.8 (2.5, 2.0-11.8), respectively. The interrater intraclass correlation coefficient was 0.96. Postoperative patient-reported outcomes and rates of MCID and patient-acceptable symptomatic state achievement were not statistically different between the radiographically stable and unstable groups. (p>0.05 for all). **Conclusion:** Patients with borderline hip dysplasia and radiographic evidence of hip instability, as measured by the FEAR index (≥2°), achieve similar improvement in 2-year outcomes compared to those with radiographically stable hips after arthroscopic treatment of FAIS. **Clinical Relevance:** Retrospective Level III cohort study

Hip arthroscopy use has increased dramatically over the past decade in the United States.[1,2] Hip arthroscopy is an effective treatment for a variety of hip pathology, most commonly femoroacetabular impingement syndrome (FAIS).[3] However, the treatment of the adult borderline dysplastic hip is controversial. Results after hip arthroscopy for patients with concomitant FAIS and mild or borderline hip dysplasia vary, with some studies showing equivalent outcomes to an FAIS cohort[4,5] and other studies demonstrating inferior results.[6]

Historically, the lateral center edge angle (LCEA) of Wiberg is used to classify acetabular coverage in the coronal plane as normal with LCEA > 25°, borderline dysplastic with LCEA between 18° to 25°, or dysplastic with LCEA < 18°.[6] Although the LCEA is a commonly used radiographic measurement, it has been suggested that it may oversimplify a 3-dimensional problem. The degree of impingement is often determined using a combination of LCEA and the alpha angle; however,

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neither of these measurements directly predicts stability in the borderline dysplastic hip.[6]

Recently, a novel radiographic measurement, the femoroepiphyseal acetabular roof (FEAR) index is associated with instability in borderline dysplastic hips.[7] This measurement is based on the theory by Pauwels[8] that the epiphyseal plate orientation during growth is perpendicular to the joint reaction force. Therefore the angle between the closed epiphyseal plate of the femoral head and the acetabular index angle would result in a force vector that indicates stability of the borderline hip.[9] An angle that opens laterally, or a laterally-directed force vector, defined by a positive FEAR index value, is associated with hip instability, whereas a medially-directed force vector, defined by a negative FEAR index, is associated with hip stability.[7]

The purpose of this study was to compare outcomes after hip arthroscopy for FAIS in patients with borderline hip dysplasia and hip instability defined radiographically using the FEAR index and in patients without radiographic evidence of hip instability. The authors hypothesized that patients with borderline hip dysplasia and FEAR index defined, radiographic evidence of hip instability would achieve worse 2-year postoperative outcomes compared to those with radiographic evidence of a stable hip.

Methods

Patient Selection

After approval was obtained from the Institutional Review Board, a prospectively collected hip arthroscopy repository from the senior surgeon (S.J.N.) was retrospectively reviewed. Patients who had a hip arthroscopic surgery for FAIS between April 2012 and June 2017 were extracted from the database. All patients met the senior surgeon's surgical indications for arthroscopic surgery, including clinical and radiographic evidence of FAIS, failure of conservative treatment (i.e., physical therapy, lifestyle modification, anti-inflammatory medications, or steroid hip injections), LCEA $>18^{\circ}$, and a Tönnis grade <2. Additionally, patients were included in the study only if they had borderline hip dysplasia indicated by a LCEA of 18° to 25°. Patients were excluded if they underwent revision surgery, had a history of contralateral hip surgery, underwent concomitant hip procedures (e.g., trochanteric bursectomy, psoas release, gluteus medius repair, iliotibial band lengthening, or decompression of subspine impingement), or had a history of pediatric hip conditions (e.g., slipped capital femoral epiphysis, avascular necrosis, development of hip dysplasia).

Surgical Technique

All hip arthroscopies were performed by a single fellowship-trained hip surgeon at a high-volume academic hospital. Patients were placed in the supine position on a traction table, and both the anterolateral and midanterior portals were established. An interportal capsulotomy was performed connecting the 2 portals, and diagnostic arthroscopy was performed. A distal anterolateral accessory portal was established under direct visualization, and pathology in the central compartment was addressed. A 5.5 mm arthroscopic burr was used to create a healthy vascular bony base for labral repair. Labral tears were repaired using 2 to 4 polyetheretherketone suture anchors. Traction was then released, and attention turned to the peripheral compartment. A T-capsulotomy was performed to expose the femoral head-neck junction and identify cam deformities. A femoral osteochondroplasty was performed using an arthroscopic burr until an adequate femoral head-neck offset was obtained. Fluoroscopic imaging and dynamic examination were used to confirm appropriate correction of cam morphology. Both limbs of the capsulotomy were routinely closed at the end of each case, with 3 simple sutures through the longitudinal portion of the T cut and 2 to 3 simple sutures to close the interportal portion of the capsulotomy.

Rehabilitation Protocol

All patients underwent a standard rehabilitation protocol starting on postoperative day 1 as previously described.[10] Patients went through a 4-phase rehabilitation protocol lasting an average of 16 to 18 weeks. The surgical limb was limited to 20 pounds flatfoot weightbearing with crutch assistance for the first 3 to 4 weeks. During this time, hip range of motion was also limited from 0° to 90° of flexion with a hip orthosis. The goal of this phase is to protect the joint and perform soft tissue mobilization techniques. Patients would then progress to phase 2 lasting 4 to 6 weeks focusing on normal gait and avoiding compensatory motion. Active range of motion exercises are initiated. Patients would then progress through phases 3 and 4 with a focus on return to sport. In phase 3, which lasts 4 to 6 weeks, patients focus on returning to preinjury function. Agility drills and hip rotational activities are generally avoided until 10 weeks after surgery. At week 12, patients are focused on muscle strengthening and range of motion goals. Progression to return to sports with agility and cardiovascular exercises are begun. The frequency of physical therapy varies throughout the rehabilitation process from twice a week for the first 3 months to once a week in the following 3 months.

Patient-Reported Outcome Evaluation

Demographic data were collected from all patients, including age, sex, body mass index (BMI), and operative extremity. Physical activity was determined by chart review, and patients were defined as physically active if they participated in at least recreational sports

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or exercise. Additionally, all patients completed hip-specific patient-reported outcome (PRO) surveys before and 2 years after surgery, including the Hip Outcome Score-Activities of Daily Living (HOS-SS), sport subscale (HOS-SS), modified Harris Hip Score (mHHS), and the visual analog scale for pain and satisfaction. Questionnaires were completed using an electronic data collection service (Outcome Based Electronic Research Database; Universal Research Solutions, Columbia, MO).

To quantify clinical significance in additional to statistical significance, the principles of minimal clinically important difference (MCID) and patient-acceptable symptomatic state (PASS) were applied for all outcome scores. The MCID was calculated using half of the standard deviation of the change score from preoperative to postoperative levels. The PASS thresholds were obtained from the previously published literature specific to a borderline hip dysplasia patient population.[11] These were defined to be 87.9, 76.4, and 78.1 for HOS-ADL, HOS-SS, and mHHS, respectively. PASS values for visual analog scale (VAS) Pain were not available for this specific population.

Radiographic Analysis

All patients had a series of preoperative anteroposterior (AP) pelvis and Dunn lateral radiographs and a series of follow-up radiographs. The LCEA and Tönnis angle were measured on AP pelvis and alpha angle was measured on the Dunn lateral radiographs. These measurements were made by 2 research assistants (A.C.N. and D.M.W.) trained by a fellowship-trained orthopaedic surgeon (F.B.). Additionally, the FEAR index was measured by the same two research assistants (A.C.N. and D.M.W.), as well as a fellowship-trained orthopaedic surgeon (F.B.), as previously described by Wyatt et al.[7] on the AP pelvis radiographs. Briefly, the first line is drawn over the central third of the femoral epiphyseal growth plate and a second line is drawn connecting the most medial and lateral points of the sourcil (Fig. 1). The FEAR index is the angle between these 2 lines. An angle that opens laterally is defined as positive, whereas an angle that opens medially is defined as negative.

A FEAR index of $+2^{\circ}$ was used to distinguish between hips with radiographic evidence of hip stability, where a value $\geq 2^{\circ}$ was considered unstable. This value was identified by Batailler et al.[12] as the cutoff value and correctly classifies 90% of hips as stable or unstable defined radiographically or by magnetic resonance arthrography.[12] Therefore patients were allocated into 2 groups: FEAR index $<2^{\circ}$ and FEAR index $\geq 2^{\circ}$. Reliability testing was performed by calculating the interrater intraclass reliability coefficient. Values less than 0.50 were considered poor, between 0.5 and 0.75 were considered moderate, between 0.75 and 0.90 were considered good, and greater than 0.90 were considered excellent.[7]

Statistical Analysis

Statistical analysis was performed using JMP statistical software (SAS institute, Cary, NC). Descriptive statistics for all continuous variables are reported as means with standard deviation, and frequency statistics are reported for all noncontinuous variables. Normality assumptions for continuous variables were confirmed using the Shapiro-Wilks test allowing the use of parametric tests. Independent samples *t*-tests were used for demographic comparisons between the stable and unstable groups. A mixed-model repeated measures analysis was used to test the effect of hip instability according to a high FEAR index on PROs over time. The Pearson χ^2 test was used to compare categorical variables between the 2 groups and achievement of MCID or PASS. Statistical significance was set at $\alpha \leq 0.05$ level.

Results

Patient Characteristics and Radiographic Findings

A total of 160 patients with borderline hip dysplasia were eligible for the study, of which 20 underwent concomitant arthroscopic procedures including 3 who underwent iliotibial band lengthening, 1 who underwent gluteus medius repair, and 14 who underwent trochanteric bursectomy. These patients were excluded because of concomitant procedures. An additional 2 patients were undergoing revision surgery and were excluded. In total, 140 patients met inclusion and exclusion criteria and were included in the study. Nineteen patients demonstrated radiographic evidence of hip instability (FEAR index $\geq 2^{\circ}$), whereas 121 patients did not (FEAR index $<2^{\circ}$). All patients completed preoperative and 2-year postoperative patient-reported outcome scores. The average age and BMI for these patients were 31.7 ± 13.2 years and 25.1 ± 5.6 kg/m^2, respectively. Overall, 75.7% of the patients included were female.

The preoperative FEAR index demonstrated excellent interobserver agreement with an interobserver intraclass correlation coefficient (ICC) of 0.963 (CI:.947-.974). The ICC for preoperative LCEA and Tönnis angle were 0.885 (confidence interval [CI]: 0.772-0.934) and 0.924 (CI: 0.883-0.949), respectively. Overall, the average FEAR index was $-5.4^{\circ} \pm 6.4^{\circ}$. The data were further categorized according to whether patients had a preoperative FEAR index $\geq 2^{\circ}$ (Table 1). The preoperative and postoperative Tönnis angle was significantly higher among patients with unstable hips.

Clinical Patient Reported Outcomes

The preoperative and postoperative outcome scores are presented in Table 2. All outcome scores improved significantly from before to 2 years after surgery for both the $\geq 2^{\circ}$ and $<2^{\circ}$ groups ($P < .001$ for all). On mixed-model repeated measures analysis, hip stability by FEAR index categorization had no significant effect

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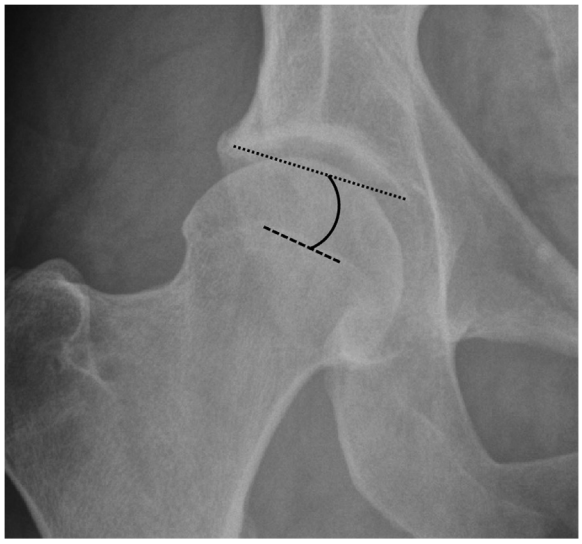

Fig 1. Representative anteroposterior view of a right hip showing the measurement of the femoroepiphyseal acetabular roof (FEAR) index. The FEAR index is measured with one line drawn over the central third of the femoral epiphyseal growth plate (dashed line) and a second line drawn connecting the most medial and lateral points of the sourcil (dotted line). The Cobb angle between these two lines reflects the FEAR index. Angles that open laterally are positive, and angles that open medially are negative. Here, the FEAR angle is opening medially, implying a stable hip.

on postoperative outcome scores ($P = .1873$ for HOS-ADL, .6073 for HOS-SS, .7245 for mHHS, and .2779 for VAS Pain). A *t*-test was performed to compare postoperative satisfaction, given the lack of preoperative values for this score, and no differences were found ($P = .8933$).

To assess clinical significance, the percentage of patients in each group achieving MCID and PASS was determined (Table 3). The values for MCID were found to be 9.5, 13.2, 10.5, and 15.2 for HOS-ADL, HOS-SS, mHHS, and VAS Pain, respectively. The PASS threshold scores were obtained from previous literature on patients with borderline hip dysplasia. Patients with FEAR $\geq 2^{\circ}$ achieved MCID at similar rates as patients with FEAR $<2^{\circ}$ (p=.5836 for HOS-ADL, .8409 for HOS-SS, .5386 for mHHS, and .346 for VAS Pain). On the other hand, patients with FEAR $\geq 2^{\circ}$ achieved PASS at lower rates for all outcome scores than patients with FEAR $<2^{\circ}$, although this did not reach statistical significance ($P = .4682$ for HOS-ADL, .8911 for HOS-SS, .7746 for mHHS). Additionally, by latest follow-up, 1 patient in the FEAR $\geq 2^{\circ}$ group and 1 patient in the FEAR $<2^{\circ}$ group underwent a total hip arthroplasty of the affected hip. No patients in either group required revision hip arthroscopy. A Pearson χ^2 test indicated that our cohort was underpowered. Using 1 *df*, the results of the Pearson χ^2 test indicated the following: MCID HOS-ADL (n = 17, 0.168, $P = .682$); MCID HOS-SS (n = 16, 2.05, $P = .152$); MCID mHHS (n = 16, 0.137, $P = .712$); MCID iHOT-12 (n = 9, 3.94, $P = .047$); MCID VAS Pain (n = 12, 0.099, $P = .753$); PASS HOS-ADL (n = 20, 0.202, $P = .653$); PASS HOS-SS (n = 18, 0.281, $P = .596$); PASS mHSS (n = 20, 1.98, $P = .160$); PASS iHOT-12 (n = 12, 1.03, $P = .310$).

Discussion

The results of our study demonstrate that patients with borderline hip dysplasia and FEAR index ≥ 2 may achieve improvements in outcome scores similar to a cohort of patients with a normal FEAR index. After dividing patients into groups using the cutoff of a FEAR index $\geq +2^{\circ}$, both groups had similar baseline demographics, activity level, and preoperative and postoperative radiographic measurements that included alpha angle, LCEA, Tönnis angle, and joint space. Marginal increases in postoperative Tönnis angle were observed as a result of decortication of the acetabular rim for anchor placement. Functional and pain-related outcome scores improved for both FEAR $\geq 2^{\circ}$ and FEAR $<2^{\circ}$ groups. Both groups of patients had high levels of satisfaction after surgery. Patients achieved MCID at similar rates for HOS-ADL, HOS-SS, mHHS, and VAS pain scores.

Although it is well established that suboptimal outcomes and postoperative complications can result from treating true hip dysplasia with hip arthroscopy,[5,13] the treatment of FAIS in patients with borderline hip dysplasia is controversial. Some authors propose that

Table 1. Patient Demographics, Radiographic Measurements, and Arthroscopic Procedures Performed

	FEAR $<2^{\circ}$	FEAR $\geq 2^{\circ}$	
N	121	19	*P* Value
Age (y)	31.5 ± 12.9	33.5 ± 16	.325
BMI (kg/m^2)	24.9 ± 5.5	25.5 ± 6.1	.8622
% female	74.4%	83.3%	.4097
Physical activity	80.2%	68.4%	.2461
Preoperative FEAR index	−7 ± 5.2	4.9 ± 2.5	**<.0001***
Preoperative alpha angle (Dunn)	63.7 ± 11.9	67 ± 17.9	.2458
Preoperative LCEA	22.1 ± 2.2	21.8 ± 2.8	.1957
Preoperative Tönnis angle	10.8 ± 2.5	11.7 ± 3.5	**.0459***
Preoperative joint space width (mm)	12.8 ± 2.2	12.7 ± 2.9	.95
Postoperative alpha angle (Dunn)	38.5 ± 8.3	42 ± 10.6	.2559
Postoperative LCEA	21.5 ± 2.4	21 ± 3.7	.1623
Postoperative Tönnis angle	11.1 ± 2.9	12.4 ± 4	**.0191***
Femoral version (CT)	12.2 ± 10.4	12 ± 7	.7196
Labral repair	95.9%	94.7%	.821
Capsular closure	100.0%	100.0%	1
Femoroplasty	100.0%	100.0%	1
Acetabular microfracture	2.5%	5.3%	.4983

BMI, body mass index; LCEA, lateral center edge angle; FEAR, femoro-epiphyseal acetabular roof.
*Significance.

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Table 2. Preoperative and 2-Year Postoperative Outcome Scores and Repeated Measures Analysis Between Patients With Stable and Unstable Hips According to a FEAR Index of 2

	FEAR <2°		FEAR ≥2°		
	Preoperative	Postoperative	Preoperative	Postoperative	*P* Value
HOS-ADL	65 ± 17.8	87.1 ± 16.5	57.2 ± 21.5	87 ± 12.9	.1873*
HOS-SS	43.7 ± 20	76 ± 24.9	41.3 ± 23.2	74.5 ± 23.6	.6073*
mHHS	56.2 ± 14.3	79.7 ± 18.2	55.2 ± 14.9	78.5 ± 17.6	.7245*
VAS Pain	64.7 ± 19.9	19.3 ± 21.3	70.1 ± 23.2	22.8 ± 26.8	.2779*
Satisfaction	—	76.4 ± 29	—	85.3 ± 20.3	.8933†

FEAR, femoro-epiphyseal acetabular roof; HOS-ADL, Hip Outcome Score-Activities of Daily Living; HOS-SS, Hip Outcome Score-Sport Subscale; mHHS, modified Harris Hip Score; iHOT-12, International Hip Outcome Tool-12; VAS, Visual Analog Scale.

*Mixed-model repeated measures analysis.

†Paired Student *t*-test.

labral pathology in the setting of dysplasia may be better treated with periacetabular osteotomy to correct the underlying acetabular dysplasia that causes persistent, abnormal loading of the acetabular labrum.[14] However, hip arthroscopy offers a less-invasive, lower-morbidity surgical option. Determining which patients with borderline hip dysplasia would benefit from hip arthroscopy compared with those in whom hip arthroscopy may fail and for whom periacetabular osteotomy should be considered is of the utmost importance.

Studies have shown favorable outcomes when treating FAIS with hip arthroscopy in patients with borderline hip dysplasia. Our group has recently published a case-control study showing similar rates of achieving clinical success based on HOS-ADL, HOS-SS, and mHHS in patients with borderline hip dysplasia (LCEA 20-25) compared to those with normal acetabular coverage at 5 years.[15] Domb et al.[16] also reported on successful treatment of borderline hip dysplasia (LCEA 18-25) with hip arthroscopy, labral preservation, and capsular plication surgery.[16] Their study demonstrated similar improvements in outcome scores (mHHS, VAS pain, and Non-Arthritic Hip Score) at 5.7 years.

A multicenter study by McQuivey et al.[17] identified radiographic measures that predict failure of arthroscopy in borderline hip dysplasia. This study concluded that patients with higher Tönnis angles had higher risk for revision hip arthroscopy, with 84% of patients with Tönnis angle greater than 10° requiring a secondary operation. In contrast, our cohort of patients had average Tönnis angles of 11.1° in the FEAR <2° group and 12.3° in the FEAR ≥2° group, and 2 patients required secondary surgery (1 in the FEAR ≥2° group, and 1 in the FEAR <2° group). These 2 studies[17] otherwise had groups that were demographically similar and underwent routine capsular closure. One possible reason for the difference in failure rates between these 2 studies is the inability of the Tönnis angle alone to account for the 3-dimensional morphological changes that may be present in patients with FAIS and borderline hip dysplasia. The FEAR index provides additional radiographic information about the stability of the borderline dysplastic hip. We emphasize routinely assessing multiple radiographic parameters, as done in this study, including the FEAR index, to understand the complex anatomy and direct the best clinical treatment. Additional measurements to consider include the anterior center edge angle[18] and acetabular wall indexes,[19] which represent anterior and posterior coverage, in addition to lateral coverage as measured using the LCEA. The use of 3-dimensional hip modeling can also assist in truly understanding patient-specific morphology.

The importance of capsular management and closure has been increasingly recognized in recent years, with a shift toward capsular closure over leaving the capsule unrepaired.[20] Biomechanical data clearly demonstrate the importance of both the labrum and hip capsule in stabilizing the hip joint, particularly in those with acetabular undercoverage.[21,22] Capsular closure, compared to unrepaired capsulotomy, has been associated with lower risk of conversion to total hip arthroplasty.[20]

Table 3. Achievement of MCID and PASS at 2-Year Follow-Up

	FEAR <2°	FEAR ≥2°	*P* Value
MCID			
HOS-ADL	73.4%	80.0%	.5836
HOS-SS	74.0%	71.4%	.8409
mHHS	78.6%	85.7%	.5386
VAS Pain	78.9%	90.9%	.346
PASS			
HOS-ADL	64.4%	55.6%	.4682
HOS-SS	60.7%	62.5%	.8911
mHHS	59.1%	55.6%	.7746

FEAR, femoroepiphyseal acetabular roof; MCID, minimum clinical important differences; PASS, patient acceptable symptomatic state; HOS-ADL, Hip Outcome Score—Activities of Daily Living; HOS-SS, Hip Outcome Score-Sport Subscale; mHHS, modified Harris Hip Score; iHOT-12, International Hip Outcome Tool-12; VAS, Visual Analog Scale.

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Techniques for capsulotomy, as well as capsular closure, vary greatly. Our technique for capsular closure includes 3 sutures in the longitudinal limb of the T capsulotomy and 2 to 3 sutures in the proximal leaflets to close the interporal capsulotomy (or the horizontal limb of the T capsulotomy). One hundred percent of patients in this study had a robust capsular closure performed. Capsular plication was performed in cases for which the senior surgeon (S.J.N.) had concerns of postoperative instability based on intraoperative findings and degree of borderline hip dysplasia. Outcomes in other studies of patients with borderline hip dysplasia may be associated with lack of capsular closure or insufficient capsular closure. Chahla et al.[23] showed that the failure torque for hip capsule closure with 2 and 3 side-to-side suture constructs was superior to a 1-suture closure. Additionally, it is our standard practice to protect hip range of motion after surgery with a hip orthosis, which limits hip motion from 0° to 90° of flexion and maintains the hip in neutral rotation for 4 weeks after surgery. The importance of protecting hip motion is underlined by the biomechanical study by Chahla et al.,[23] which demonstrates disruption of all hip capsular closures at time 0 with hip external rotation past 36°. In addition, determining which patients with borderline hip dysplasia that should undergo capsular repair in situ versus capsular plication has yet to be determined in the literature.

Reoperation rates in our study were low. Our study demonstrates that some patients with FAIS and borderline hip dysplasia can be safely and effectively treated with hip arthroscopy. We suggest comprehensive evaluation of hip pathology and underlying anatomy, especially in patients with borderline dysplasia, including analysis of multiple radiographic parameters (LCEA, Tönnis angle, FEAR index, Tönnis grade, and alpha angle), and routine capsular closure. Directions for future research include determining whether a threshold for the FEAR index exists that predicts worse outcomes after hip arthroscopy.

Limitations

There are several limitations of this study. There was a smaller number of patients in the unstable group (n = 19), compared to the stable group (n = 121), which could possibly lead to both type-I and type-II errors. A Pearson χ^2 test revealed the cohort to be underpowered, which could suggest why there was no difference observed between cohorts. We believe, however, that the 2 groups are representative of the population in terms of patients with borderline hip dysplasia and subsequent radiographic evidence of instability (i.e., FEAR index $\geq 2°$). In addition, the groups were not explicitly matched using standard methods. We used LCEA to define borderline hip dysplasia, a common method of defining acetabular undercoverage. LCEA has been critiqued as a 1-dimensional measurement for a 3-dimensional problem. As this study and others indicate, other radiographic measures can contribute to the definition of hip dysplasia, including the FEAR index. Our definition of borderline hip dysplasia was LCEA between 18° to 25°, whereas some definitions of borderline dysplasia differ and describe it as an LCEA between 20° to 25°. The LCEA and Tönnis angles were only measured by 2 trained observers, fewer than the FEAR index.

Conclusions

Patients with borderline hip dysplasia and radiographic evidence of hip instability, as measured by the FEAR index ($\geq 2°$), may achieve similar improvement in 2-year outcomes compared to those with radiographically stable hips after arthroscopic treatment of FAIS.

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