Hip Dysplasia: Prevalence, Associated Findings, and Procedures From Large Multicenter Arthroscopy Study Group

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Purpose: To report observational findings of patients with acetabular dysplasia undergoing hip arthroscopy. **Methods:** We performed a comparative case series of multicenter registry patients from January 2014 to April 2016 meeting the inclusion criteria of isolated hip arthroscopy, a documented lateral center-edge angle (LCEA), and completion of preoperative patient-reported outcome measures. A retrospective analysis compared range of motion, intra-articular pathology, and procedures of patients with dysplasia (LCEA $\leq 25^\circ$) and patients without dysplasia (LCEA $>25^\circ$). **Results:** Of 1,053 patients meeting the inclusion criteria, 133 (13%) had dysplasia with a mean LCEA of 22.8° (standard deviation, 2.4°) versus 34.6° (standard deviation, 6.3°) for non-dysplasia patients. There were no statistically significant differences in preoperative modified Harris Hip Score, International Hip Outcome Tool-12 score, or visual analog scale score (pain). Cam deformity occurred in 80% of dysplasia patients. There was a significant difference in internal rotation between the dysplasia (21°) and non-dysplasia groups (16°, $P < .001$). Mean internal rotation (33.5°; standard deviation, 15.6°) of the dysplastic subjects without cam morphology was greater than that of the dysplastic patients with cam morphology (18.5°; standard deviation, 11.6°; $P < .001$). Hypertrophic labra were found more commonly in dysplastic (33%) than non-dysplastic hips (11%, $P < .001$). Labral tears in patients with dysplasia were treated by repair (76%), reconstruction (13%), and selective debridement (11%); labral treatments were not significantly different between cohorts. The most common nonlabral procedures included femoroplasty (76%) and synovectomy (73%). There was no significant difference between the dysplasia and non-dysplasia groups regarding capsulotomy types and capsular closure rates (96% and 92%, respectively). **Conclusions:** Dysplasia, typically of borderline to mild severity, comprises a significant incidence of surgical cases (13%) by surgeons performing high-volume hip arthroscopy. Despite having similar preoperative pain and functional profiles to patients without dysplasia, dysplasia patients may have increased flexed-hip internal rotation. Commonly associated cam morphology significantly decreases internal rotation. Arthroscopic labral repair, femoroplasty, and closure of interportal capsulotomy are the most commonly performed procedures. **Level of Evidence:** Level III, therapeutic comparative case series.

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Hip arthroscopy is a recognized surgical option for patients with symptomatic femoroacetabular impingement (FAI).[1-3] However, divergent findings from patients with dysplasia render its optimal arthroscopic treatment less clear.[4-10] Variables that appear to influence surgical outcomes include but may not be limited to severity of dysplasia deformity, associated cam deformity and its treatment, and labral and capsular preservation.

Surgical options for patients with dysplasia include arthroscopic labral repair, arthroscopic labral repair with capsular closure, arthroscopic labral repair and/or capsular closure with cam resection, or periacetabular osteotomy (PAO) with or without concomitant arthroscopic labral repair. The treatment chosen is influenced by multiple factors including patient age, patient preference, and whether the surgeon believes the hip is primarily unstable because of lack of bony coverage (favoring coverage procedure) or has adequate bony coverage and is unstable because of labral damage and/or loss of suction seal and soft-tissue laxity (favoring hip arthroscopy). The risk of hip arthroscopy in the setting of inadequate bone coverage is persistent pain due to microinstability, hip dislocation, or arthritic progression of the joint.[11] This must be balanced with a higher rate of major complications with PAO even when performed by experienced surgeons and lower incremental clinical improvement in patients with mild dysplasia.[12]

As investigation and understanding grow, it is important to determine the influence of these evolving and divergent findings on current practice. Because there is high interest but limited evidence-based information pertaining to the arthroscopic treatment of dysplasia, the purpose of this study was to add observational findings regarding prevalence, associated findings, and procedures obtained from a large multicenter registry of hip arthroscopic surgeons. We hypothesized that high-volume hip arthroscopic surgeons would commonly treat more mild degrees of dysplasia and concurrent cam morphology with hip arthroscopy including femoroplasty, labral preservation, and capsular closure performed through smaller capsulotomies.

Methods

An institutional review board–approved retrospective case series of prospectively obtained data from a multicenter hip arthroscopy registry compared hip range of motion, frequency of intra-articular pathology, and surgical procedures of patients with hip dysplasia versus patients without hip dysplasia. Seven surgeons (D.K.M., S.J.N., D.S.C., A.B.W., J.P.S., J.J.C., and T.J.E.) from 7 independent centers in the United States contributed to the prospective database. All surgeons perform more than 100 hip arthroscopy cases per annum and have been performing hip arthroscopy for a minimum of 7 years. With the exception of two (D.K.M., T.J.E.; predating fellowships with hip arthroscopy training), all investigators have had formal fellowship training including hip arthroscopy. A total of 2,238 subjects were enrolled from January 2014 to April 2016. Patients consented to the use of their deidentified data for the purpose of this retrospective analysis. The inclusion criteria were consenting patients who underwent isolated hip arthroscopy during the study period, underwent no other previous or concurrent hip surgery including but not limited to PAO, underwent a radiologic evaluation with a documented lateral center-edge angle (LCEA), and had successful completion of preoperative patient-reported outcome measures (modified Harris Hip Score, International Hip Outcome Tool-12, and visual analog scale for pain). These patients were divided into 2 groups: patients with dysplasia (LCEA $\leq 25^\circ$) and patients without dysplasia (LCEA $>25^\circ$) of the acetabulum. Subjects not meeting all of the inclusion criteria were excluded from the study.

Range of motion was evaluated by visual estimation from a supine position. Previous research has shown good agreement between goniometry and visual estimates for hip range of motion.[13] The angle of hip flexion was determined as the angle between the bisection of the trunk and the bisection of the thigh as the knee was passively moved toward the ipsilateral shoulder until the end point that caused pelvic rotation. Internal and external rotation was performed with the knee and hip flexed to 90°. The angle formed by the bisection of the leg with the imaginary vertical axis determined the angle of internal-external rotation. Labral surgical indications were partial or complete detachment for labral repair, an irreparable and/or severely damaged labrum and/or insufficient restoration of the labral fluid seal with attempted repair for labral reconstruction, and flaps or fibrillation for selective debridement while retaining the labral fluid seal. Capsular treatment included release (no closure) versus closure by repair or plication if the hip was deemed at risk of microinstability or macroinstability.

Statistical Analysis

Descriptive statistics for anthropometric measures, patient-reported outcome scores (modified Harris Hip Score and International Hip Outcome Tool-12), and preoperative pain level (visual analog scale) were computed and compared between patients with dysplasia and those without dysplasia with an independent-samples t test. A multivariate analysis of variance tested the effect of hip dysplasia on hip range of motion with univariate post hoc analysis to determine specific differences in hip internal rotation, external rotation, and flexion between the 2 groups. An additional analysis on severity of hip dysplasia was

performed with an analysis of variance with an a priori α set at .05 being used to determine statistical differences between mild (LCEA of 20°-25°), moderate (LCEA <20°), and non-dysplastic hips (LCEA >25°). Although cam deformity was dichotomized to give a perspective of dispersion between the 2 groups, an independent *t* test was applied to continuous variables for the alpha angle. A χ^2 analysis was performed to determine the statistical relations of the presence of hip dysplasia and radiologic evidence of a cam deformity (alpha angle ≥55° on anteroposterior pelvis or 45° or 90° Dunn lateral radiographic view), as well as intraoperative findings of pathology of the labrum, ligamentum teres, and articular cartilage of the hip joint. A χ^2 analysis was also performed to determine the statistical differences in the frequency of surgical procedures performed on the femur, acetabulum, ligamentum teres, labrum, and capsule during hip-preservation surgery for patients with dysplasia versus non-dysplastic patients with an a priori α of .05.

Results

Subject Characteristics

A total of 1,053 total patients met the inclusion criteria. Of these patients, 133 (13%) presented with dysplasia (LCEA ≤25°). The dysplasia group had a mean LCEA of 22.8° (standard deviation, 2.4°), and the non-dysplasia group had a mean LCEA of 34.6° (standard deviation, 6.3°). The patients in the dysplasia group and non-dysplasia group were predominately female patients (65% and 62%, respectively). Table 1 compares the anthropometric and descriptive characteristics of the patients with dysplasia versus the patients without dysplasia. There was a statistical difference between the groups for age: The patients in the dysplasia group were younger (mean, 32 years) than the patients without dysplasia (mean, 36 years; $P = .008$).

Table 1. Characteristics of Subjects With Versus Without Dysplasia

	Dysplasia (n = 133)	Non-dysplasia (n = 920)	*P* Value
Female gender	87 of 133 (65%) (95% CI, 57%-73%)	572 of 920 (62%) (95% CI, 59%-65%)	.470
Age, yr	32 (13.8)	36 (12.8)	.008
Height, in	67.1 (3.9)	68.5 (5.4)	.449
Weight, lb	158.1 (35.1)	161.4 (49.7)	.481
BMI	25.0 (3.9)	25.4 (7.8)	.542
Modified Harris Hip Score	52 (3.9)	54 (14.3)	.352
iHOT-12 score	33.5 (18.6)	34.3 (18.3)	.695
Pain (VAS score, 0-100)	56 (25.3)	51 (22.3)	.052

NOTE. Data are presented as mean (standard deviation) or number of patients.

BMI, body mass index; CI, confidence interval; iHOT-12, International Hip Outcome Tool-12; n, number of valid cases; VAS, visual analog scale.

Range of Motion

The range of motion of the subjects with dysplasia versus the subjects without dysplasia is shown in Figure 1. A multivariate analysis of variance showed a significant effect for hip dysplasia on hip range of motion ($F_{3,791} = 5.6$, $P < .001$, Wilks $\Lambda = 0.979$, partial $\eta^2 = 0.021$). Univariate analysis with post hoc tests showed there was a significant difference in flexed-hip internal rotation between the dysplasia group (21°; standard deviation, 14°) and the group without dysplasia (16°; standard deviation, 12°; $F_{1,793} = 2{,}065$; $P < .001$). There was also a significant effect for internal rotation and the severity of hip dysplasia ($F_{2,863} = 10.5$, $P < .001$). Mean internal rotation was 16° (standard deviation, 12°) for the non-dysplasia group, 19.6° (standard deviation, 13°) for the mild dysplasia group, and 26° (standard deviation, 17°) for the moderate dysplasia group. There was a significant effect for internal rotation and the presence of a cam lesion within the group of patients with dysplasia ($t_{100} = 3.7$, $P < .001$). The mean internal rotation of the dysplastic subjects without a cam lesion (34°; standard deviation, 16°) was greater than that of the dysplastic patients with a cam lesion (19°; standard deviation, 12°). There was no statistical difference for flexion ($P = .628$) or external rotation ($P = .078$).

Associated Radiologic and Intraoperative Findings

Figure 2 and Tables 2 to 4 show the associated radiologic findings of the subjects with dysplasia versus the subjects without dysplasia. The most common associated finding was a cam deformity, which occurred in 80% of patients with dysplasia. Cam deformities occurred in 82% of non-dysplastic patients; the difference was not statistically significant ($P = .718$) compared with the dysplasia group. There was no significant difference ($P = .195$) between the groups with non-dysplasia (81.9%), mild dysplasia (81.6%), and moderate dysplasia (64.7%) for the presence of cam deformity. There was no statistical difference in the alpha angle for patients with dysplasia (65.8°; standard deviation, 21.5°) and patients without dysplasia (67.5°; standard deviation, 16.6°; $t_{699} = -0.93$; $P = .35$). However, there was a statistical difference between the groups for the acetabular index (AI) ($t_{718} = -10.7$, $P < .001$). The AI was 9.8° (standard deviation, 3.8°) for patients with dysplasia versus 4.0° (standard deviation, 5.4°) for patients without dysplasia. There was also a significant difference in the anterior center-edge angle (ACEA): Patients with dysplasia had a lesser ACEA (27.3°; standard deviation, 10.0°) than patients without dysplasia (35.2°; standard deviation, 10.0°; $t_{646} = -7.5$;

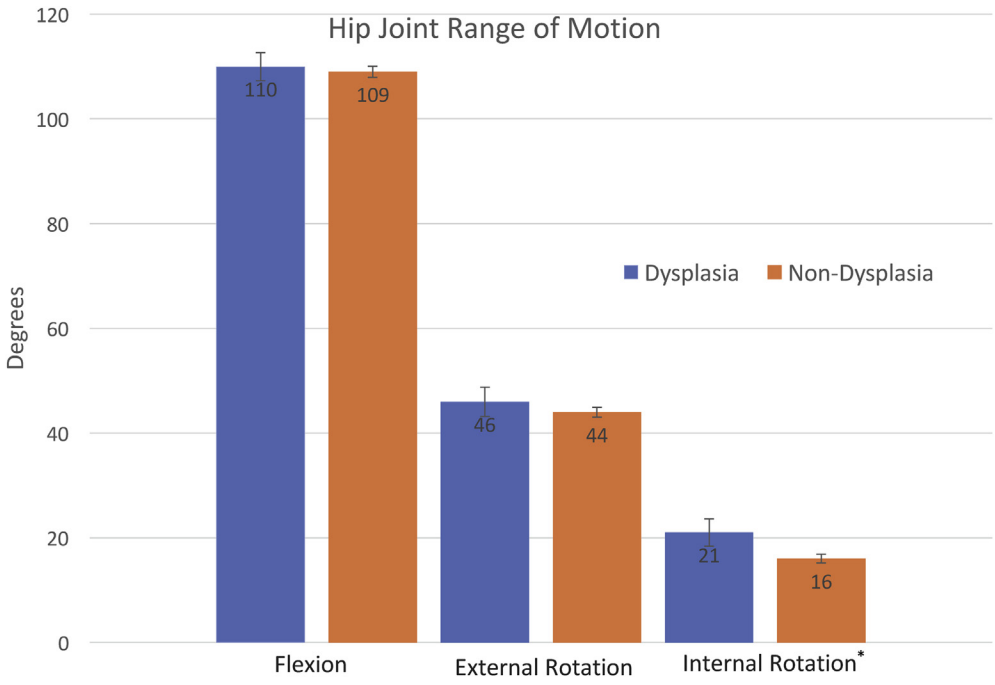

Fig 1. Hip range of motion in dysplasia versus non-dysplasia cohort. The asterisk indicates a statistically significant comparative finding. Error bars represent 95% confidence intervals.

$P < .001$). Most dysplasia patients had no osteoarthritis (Tönnis grade 0 in 92%) or mild osteoarthritis (Tönnis grade I in 7%), and there was no significant difference compared with the patients without dysplasia. There were no patients with severe arthritis (Tönnis grade III) who underwent hip arthroscopy in either cohort.

Labral pathology was extremely common in both the dysplasia group (88%) and non-dysplasia group (94%, $P = .252$). The incidence of hypertrophic labra in the dysplasia group (33%) was significantly greater than that in non-dysplastic hips (11%, $P < .001$), but other characteristics of labral pathology were not significantly different. The incidence of ligamentum teres tears (27%, $P = .342$) and articular cartilage defects (27%, $P = .132$) was not significantly different from patients without dysplasia.

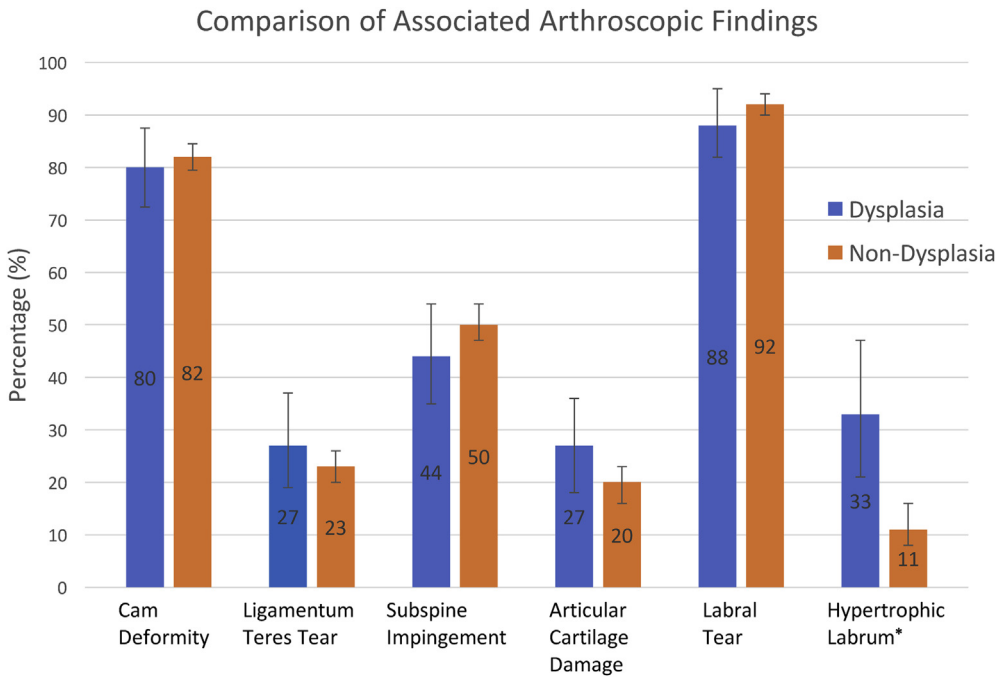

Fig 2. Associated arthroscopic findings in dysplasia versus non-dysplasia cohort. The asterisk indicates a statistically significant comparative finding. Error bars represent 95% confidence intervals.

Table 2. Comparison of Prevalence of Radiographic Findings for Subjects With Versus Without Dysplasia

	Dysplasia	Non-dysplasia	*P* Value
Lateral center-edge angle, °	Mean, 22.8 (SD, 2.4); range, 12-25 (n = 133)	Mean, 34.6 (SD, 6.3); range, 25-60 (n = 920)	<.001
Anterior center-edge angle, °	Mean, 27.3 (SD, 10); range, 10-69	Mean, 35.2 (SD, 10); range, 0-70	<.001
Acetabular index, °	Mean, 9.8 (SD, 3.8); range, −2 to 22 (n = 107)	Mean, 4.0 (SD, 5.4); range, −15 to 30 (n = 613)	<.001
Tönnis grade			.220
0	108 of 133 (81%) (95% CI, 74%-87%)	678 of 920 (74%) (95% CI, 71%-77%)	
I	8 of 133 (6%) (95% CI, 3%-12%)	58 of 920 (6%) (95% CI, 5%-8%)	
II	2 of 133 (2%) (95% CI, 0.2%-5%)	13 of 920 (2%) (95% CI, 0.8%-2%)	
III	0 of 133 (0%) (95% CI, 0%-3%)	0 of 920 (0%) (95% CI, 0%-0.4%)	
Unknown	15 of 133 (11%) (95% CI, 6%-18%)	171 of 133 (19%) (95% CI, 16%-21%)	
Joint space narrowing			
Medial joint space (n = 14)	3 of 118 (3%) (95% CI, 0.5%-7%)	11 of 731 (2%) (95% CI, 0.8%-3%)	.412
Central joint space (n = 12)	3 of 118 (3%) (95% CI, 0.5%-7%)	9 of 728 (1%) (95% CI, 0.6%-2%)	.266
Lateral joint space (n = 27)	4 of 118 (3%) (95% CI, 0.9%-8%)	23 of 730 (3%) (95% CI, 2%-5%)	.891

CI, confidence interval; n, number of valid cases; SD, standard deviation.

Surgical Preferences

The most common surgical procedures performed in patients with dysplasia included femoroplasty (76%), synovectomy (73%), acetabuloplasty (56%), acetabular chondroplasty (44%), and ligamentum teres debridement (27%). There were statistical differences in the prevalence of these procedures in the dysplasia group versus the non-dysplasia group, as shown in Figure 3 and Table 5. The data showed that there was no effect for the surgical preferences in the treatment of the labrum for patients with dysplasia versus those without dysplasia (χ^2 [2, n = 876] = 12.27, $P = .140$; Table 6). Surgeons from the MASH (Multicenter Arthroscopic Study of the Hip) study group treated labral tears with repair in 76%, reconstruction in 13%, and debridement in 11% of patients with dysplasia. The surgical preferences regarding the type of capsulotomy performed (none in 0%, interportal in 51%, extended interportal in 3%, and T-type in 46%) were not statistically different between patients with and without hip dysplasia (χ^2 [3, n = 383] = 0.926, $P = .629$; Table 7). There was no effect for intraoperative closure of the capsule (released in 4%, repaired in 55%, and plicated in 41%) based on the presence of hip dysplasia (χ^2 [2, n = 855] = 1.798, $P = .407$; Table 8).

Discussion

The main findings of this observational study include the relatively significant incidence of patients with borderline or mild dysplasia undergoing hip arthroscopy (13% of cases) by high-volume arthroscopic hip surgeons in the United States with a high prevalence of coexistent cam deformity (80%) associated with a significant adverse effect on hip range of motion. Labral repair, femoroplasty, and capsular closure were the most commonly rendered procedures in these patients. On the basis of a review of the orthopaedic literature written in the English language (PubMed, MEDLINE), this multicenter case series is a comparatively large study investigating dysplasia versus non-dysplasia patients treated with isolated arthroscopic treatment.[4-10,12] Although definitive indications for arthroscopic treatment of dysplasia have not been established, the study findings suggest that this group of surgeons considers symptomatic borderline to mild dysplasia with no or minimal osteoarthritis as being an indication for hip arthroscopy, especially in the presence of concurrent cam impingement. These patients present with similar preoperative pain and functional profiles to non-dysplastic patients. Arthroscopic femoroplasty, labral-preservation procedures, and closure of interportal capsulotomy were most commonly performed. Our hypothesis was supported by these findings.

Ross et al.[14] reported clinical and radiographic characteristics that tend toward failed hip arthroscopy requiring subsequent PAO. Young female patients with dysplasia with a mean LCEA of 14.7° and acetabular

Table 3. Comparison of Prevalence of Associated Findings for Subjects With Versus Without Dysplasia

	Dysplasia	Non-dysplasia	*P* Value
Cam deformity (n = 787)	94 of 117 (80%) (95% CI, 72%-87%)	693 of 848 (82%) (95% CI, 79%-84%)	.718
Ligamentum teres tear (n = 208)	29 of 107 (27%) (95% CI, 19%-37%)	179 of 780 (23%) (95% CI, 20%-26%)	.342
Subspine impingement (n = 432)	49 of 111 (44%) (95% CI, 35%-54%)	383 of 764 (50%) (95% CI, 47%-54%)	.238
Articular cartilage damage (n = 136)	22 of 82 (27%) (95% CI, 18%-38%)	114 of 580 (20%) (95% CI, 16%-23%)	.132
Labral tear (n = 790)	91 of 103 (88%) (95% CI, 81%-94%)	699 of 762 (92%) (95% CI, 90%-94%)	.252
Hypertrophic labra (n = 47)	18 of 54 (33%) (95% CI, 21%-47%)	29 of 260 (11%) (95% CI, 8%-16%)	<.001

CI, confidence interval; n, number of valid cases.

Table 4. Comparison of Labral Pathology for Subjects With Versus Without Dysplasia

	Dysplasia	Non-dysplasia	*P* Value
Labral tear (n = 790)	91 of 103 (88%) (95% CI, 81%-94%)	699 of 762 (92%) (95% CI, 90%-94%)	.252
Complexity of tear (n = 621)			.687
Mild	35 of 83 (42%) (95% CI, 31%-54%)	242 of 538 (45%) (95% CI, 41%-49%)	
Moderate	31 of 83 (37%) (95% CI, 27%-49%)	200 of 538 (37%) (95% CI, 33%-41%)	
Severe	10 of 83 (12%) (95% CI, 6%-21%)	68 of 538 (13%) (95% CI, 10%-16%)	
Labral degeneration (n = 133)	22 of 84 (26%) (95% CI, 17%-37%)	111 of 538 (21%) (95% CI, 17%-24%)	.248
Labral tear length (n = 490)	Mean, 3.2 cm (SD, 1.0 cm) (n = 58)	Mean, 3.5 cm (SD, 1.0 cm) (n = 432)	.067

CI, confidence interval; n, number of valid cases; SD, standard deviation.

inclination (AI) of 16.3°, major functional limitations, and associated intra-articular abnormalities comprised the majority of patients with failed hip arthroscopies. In a study from Japan, which has a relatively high prevalence of hip dysplasia, Uchida et al.[15] recently reported clinical and radiographic predictors of poorer outcomes after arthroscopic labral preservation and capsular closure in patients with symptomatic dysplasia. A broken Shenton line, femoral neck-shaft (FNS) angle greater than 140°, LCEA of less than 19°, or body mass index greater than 23 at the time of surgery were predictors of poorer arthroscopic outcomes. The findings of our study are, in general, consistent with proper patient selection for arthroscopic treatment, with a mean LCEA of 22.8°, mean AI of 9.8°, and mean ACEA of 27.3°, although mean body mass index was 25.0, slightly higher than recommended in the study of Uchida et al. The FNS angle and Shenton line were not recorded.

Furthermore, it is conceivable that failed hip arthroscopies (or failed PAOs) may result from a mismatch of procedure and primary pathomechanism. Beyond classic radiographic measures (e.g., LCEA, ACEA, and AI), a recent study introduced a radiographic measurement called the Femoro-Epiphyseal Acetabular Roof (FEAR) index,[16] which may provide a more functional assessment as to whether the primary pathomechanism in dysplasia is instability (in which case acetabular reorientation such as PAO may be indicated) or FAI (in which case arthroscopic or open FAI surgery may be indicated). Some patients with even borderline dysplasia may have a primary

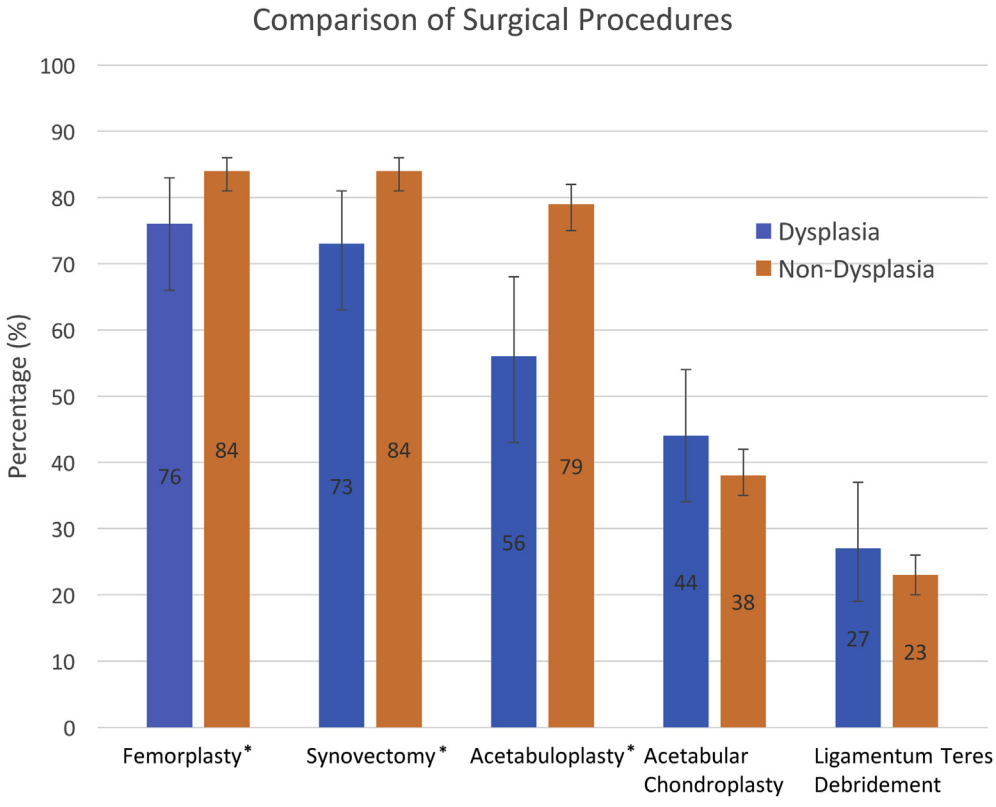

Fig 3. Arthroscopic surgical procedures in dysplasia versus non-dysplasia cohort. The asterisks indicate statistically significant comparative findings. Error bars represent 95% confidence intervals.

Table 5. Comparison of Prevalence of Surgical Procedures (Nonlabral) for Subjects With Versus Without Dysplasia

	Dysplasia	Non-dysplasia	*P* Value
Femoroplasty (n = 736)	81 of 107 (76%) (95% CI, 66%-83%)	655 of 780 (84%) (95% CI, 81%-86%)	.033
Synovectomy (n = 730)	78 of 107 (73%) (95% CI, 63%-81%)	652 of 780 (84%) (95% CI, 81%-86%)	.007
Acetabuloplasty (n = 504)	38 of 68 (56%) (95% CI, 43%-68%)	466 of 591 (79%) (95% CI, 75%-82%)	<.001
Acetabular chondroplasty (n = 347)	47 of 107 (44%) (95% CI, 34%-54%)	300 of 780 (38%) (95% CI, 35%-42%)	.277
Ligamentum teres debridement (n = 208)	29 of 107 (27%) (95% CI, 19%-37%)	179 of 780 (23%) (95% CI, 20%-26%)	.342

CI, confidence interval; n, number of valid cases.

instability pathomechanism. Conversely, some patients with even moderate dysplasia may have a primary FAI component.

Preoperatively, patients with hip dysplasia presented with greater flexed-hip internal rotation than those without dysplasia, and the effect increased with dysplasia severity. However, coexisting cam deformity was commonly observed in this study, occurring in 80% of the dysplasia group, which is consistent with the findings of several recent studies.[15,17-19] The prevalence of cam deformity did not increase with increasing dysplasia severity. When cam deformity was present, decreased flexed-hip internal rotation was observed in the dysplasia cohort. This finding is supported by a recent computer simulation study.[20] Although, intuitively, the shallow socket of dysplasia might be protective against early mechanical abutment between the proximal femur and anterosuperior acetabular rim, it does not appear to preclude restricted flexed-hip internal rotation in the common setting of dysplasia with cam FAI. Although hip range of motion may be decreased by many factors (e.g., inflammatory conditions, adhesions, chondrolabral pathology, or loose bodies), decreased flexed-hip internal rotation on anterior impingement testing in the dysplastic hip should arouse suspicion of coexisting cam deformity, and if detected, cam decompression should be considered.

Conversely, when cam morphology is absent, painful terminal internal rotation even above 30° may occur in symptomatic dysplasia patients with chondrolabral pathology; one should not necessarily rule out arthroscopic intervention in the presence of a "negative" anterior impingement test based on range of motion. It was interesting that, despite a similar prevalence of cam deformities between cohorts, femoroplasty was more commonly performed in the non-dysplasia group. This finding may reflect a similar prevalence of cam deformity but perhaps a lower prevalence of cam impingement in the dysplasia cohort based on arthroscopic dynamic examination.

Hypertrophic labra have been associated with dysplasia. The relatively low prevalence of hypertrophic labra (33%) in the dysplasia cohort may reflect the relative preponderance of borderline or mild dysplasia that, in turn, may reflect the patient selection and arthroscopic surgical indication influence of recent studies showing better arthroscopic outcomes with lesser degrees of dysplasia.[21] Patient selection may also have influenced the prevalence of cam deformities observed in the dysplasia patients undergoing arthroscopic intervention.

Labral repair, femoroplasty, synovectomy, and repair or plication of interportal capsulotomy were the most commonly performed arthroscopic procedures. There was no significant difference in the prevalence of labral tears, being present in 88% of the dysplasia group and 94% of the non-dysplasia group. There was also no significant difference between groups in rendered labral treatment, with labral preservation favored in both groups.[2,21-24] Although arthroscopic labral reconstruction has growing evidence-based support,[25-30] its efficacy in dysplasia is unknown. However, the findings from this observational study suggest that labral reconstruction is considered a reasonable treatment option for dysplasia patients with irreparable and/or insufficient labra. The relatively low incidence of acetabuloplasty in the dysplasia cohort may be attributed to surgeon caution for avoidance of iatrogenic worsening of dysplasia, but the incidence was higher than expected; this may be attributable, at least in part, to associated subspine decompression and/or may highlight the lack of consensus on appropriate surgical treatment in borderline to mild dysplasia.

Table 6. Comparison of Surgical Treatment of Labrum for Subjects With Versus Without Dysplasia

	Dysplasia	Non-dysplasia
Repair (n = 682)	86 of 111 (77%) (95% CI, 69%-85%)	607 of 765 (79%) (95% CI, 76%-82%)
Reconstruction (n = 126)	14 of 111 (13%) (95% CI, 7%-20%)	121 of 765 (16%) (95% CI, 13%-19%)
Selective debridement (n = 48)	11 of 111 (10%) (95% CI, 5%-17%)	37 of 765 (6%) (95% CI, 3%-7%)

NOTE. There was no statistical difference in labral treatment ($P = .140$) between the dysplasia and non-dysplasia groups.
CI, confidence interval; n, number of valid cases.

Table 7. Comparison of Capsulotomy Preferences for Subjects With Versus Without Dysplasia

	Dysplasia (n = 37)	Non-dysplasia (n = 346)
Interportal (n = 224)	19 of 37 (51%) (95% CI, 34%-68%)	205 of 346 (59%) (95% CI, 54%-64%)
Extended (n = 11)	1 of 37 (3%) (95% CI, 0.07%-14%)	10 of 346 (3%) (95% CI, 1%-5%)
T-type (n = 148)	17 of 37 (46%) (95% CI, 29%-63%)	131 of 346 (38%) (95% CI, 33%-43%)

NOTE. There was no statistical difference in capsulotomy type ($P = .629$) between the dysplasia and non-dysplasia groups.
CI, confidence interval; n, number of valid cases.

Although controversial, there is emerging evidence suggesting better outcomes from arthroscopic capsular repair or plication in hip arthroscopy in general and in hip arthroscopy for dysplasia in particular.[8,9] In this study there were no significant differences in the prevalence of capsulotomy type or capsular closure (repair or plication) between the dysplasia and non-dysplasia groups; these findings may reflect the high incidence of capsular closures performed by this set of surgeons but do not explain why plication was not performed at a significantly higher rate in the dysplasia cohort. Because the definitions of capsular repair and plication were not specified, it is conceivable that similar closures were reported differently by various surgeons.

This large multicenter observational study reports a relatively common incidence of dysplasia treated with isolated hip arthroscopy (13%) by high-volume hip arthroscopy specialists. The preponderance of cases with lesser degrees of dysplasia (borderline or mild) is consistent with the influence of a few recent, small, short-term arthroscopic outcome studies suggesting some degree of clinical benefit in this subset.[4-10,12] The high incidence of coexistent cam morphology with decreased flexed-hip internal rotation when present and the high incidence of labral tears with increased flexed-hip internal rotation when absent may aid the clinical evaluation of the dysplastic hip. Arthroscopic repair of non-hypertrophic labra, arthroscopic femoroplasty, synovectomy, and closure of interportal capsulotomy were most commonly performed for patients with symptomatic dysplasia in this study.

Applying these study findings to clinical practice, one may consider the following: Borderline and mild dysplasia with no or minimal arthritis is currently being treated with isolated hip arthroscopy by high-volume surgeons. Although preoperative pain and functional profiles may not differentiate dysplasia from non-dysplasia patients, range of motion may. If increased flexed-hip internal rotation is observed, one may suspect dysplasia. Induced pain at terminal range may suggest chondrolabral pathology despite 30° of internal rotation or more on the anterior impingement test. If a dysplasia patient has decreased flexed-hip internal rotation, one should suspect an associated cam deformity on preoperative imaging studies. Intraoperative dynamic examination may clarify whether cam morphology is actually causing cam impingement. If so, arthroscopic femoroplasty may be indicated. In contrast, acetabuloplasty, in general, should be considered infrequently in the dysplastic hip unless used to treat concurrent subspine impingement. To minimize iatrogenic hip instability, labral-preservation procedures (i.e., repair, reconstruction, and/or selective debridement) and capsular-preservation procedures (e.g., small capsulotomies or capsular repair or plication) should be considered. Moreover, iliopsoas release causing at least partial compromise of an anterior dynamic stabilizer may be ill advised in dysplasia patients with anterosuperior undercoverage.

Limitations

There are several limitations of this study, not least of which is the lack of outcome data inherent in observational studies. Other limitations include the lack of formal definitions for hypertrophic labra, capsular repair and plication, acetabuloplasty, and subspine impingement, which could lead to subjective reporting differences. Although the LCEA is the most commonly used radiographic measure for dysplasia and was the sole radiographic inclusion criterion in this study, the only other radiographic measures recorded were the AI (Tönnis angle) and ACEA; others (e.g., Sharp angle, FNS angle, extrusion index, and Shenton line) were not used. Moreover, this study did not standardize standing

Table 8. Comparison of Surgical Technique for Capsular Closure for Subjects With Versus Without Dysplasia

	Dysplasia (n = 97)	Non-dysplasia (n = 758)
Release (n = 64)	4 of 97 (4%) (95% CI, 1%-10%)	60 of 758 (8%) (95% CI, 6%-10%)
Repair (n = 455)	53 of 97 (55%) (95% CI, 44%-65%)	402 of 758 (53%) (95% CI, 49%-57%)
Plication (n = 336)	40 of 97 (41%) (95% CI, 31%-51%)	296 of 758 (39%) (95% CI, 36%-43%)

NOTE. There was no statistical difference in capsular closure technique ($P = .407$) between the dysplasia and non-dysplasia groups.
CI, confidence interval; n, number of valid cases.

versus supine anteroposterior pelvis projections nor did it specify whether the LCEA or ACEA was measured at the bony or sourcil edge. Acetabular and femoral version was not evaluated, and inclusion of some patients with acetabular retroversion in the non-dysplasia group was likely. Furthermore, measures of soft-tissue laxity (e.g., Beighton score) were not included. Another limitation is the control group having a significant albeit small age difference (4 years older), which may compromise later comparison with an anticipated comparative outcome study once minimum 2-year follow-up is obtained.

Conclusions

Dysplasia, typically of borderline to mild severity, comprises a significant incidence of surgical cases (13%) by surgeons performing high-volume hip arthroscopy. Despite having similar preoperative pain and functional profiles to patients without dysplasia, dysplasia patients may have increased flexed-hip internal rotation. Commonly associated cam morphology significantly decreases internal rotation. Arthroscopic labral repair, femoroplasty, and closure of interportal capsulotomy are the most commonly performed procedures.

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