Sex-Dependent Differences in Preoperative, Radiographic, and Intraoperative Characteristics of Patients Undergoing Hip Arthroscopy: Results From the Multicenter Arthroscopic Study of the Hip Group

John P. Salvo, M.D., Shane J. Nho, M.D., Andrew B. Wolff, M.D., John J. Christoforetti, M.D., Geoffrey S. Van Thiel, M.D., M.B.A., Thomas J. Ellis, M.D., Dean K. Matsuda, M.D., Benjamin R. Kivlan, Ph.D., P.T., Zaira S. Chaudhry, M.P.H., and Dominic S. Carreira, M.D.

Purpose: To compare preoperative, radiographic, and intraoperative findings between male and female patients undergoing hip arthroscopy. **Methods:** We performed a retrospective review of a multicenter registry of patients undergoing hip arthroscopy between January 2014 and January 2017. Perioperative data from patients who consented to undergo surgery and completed preoperative patient-reported outcome questionnaires were analyzed to determine the effect of sex on preoperative symptoms, patient-reported outcomes, radiographic measures, and surgical procedures. **Results:** A total of 1,437 patients (902 female and 535 male patients) with a mean age of 34 years were enrolled in the study. Female patients reported greater pain preoperatively on a visual analog scale (55.42 vs 50.40, $P = .001$) and deficits in functional abilities as per the modified Harris Hip Score (53.40 vs 57.83, $P < .001$) and International Hip Outcome Tool 12 (31.21 vs 38.51, $P = .001$) than male patients. There was a significant difference in the alpha angle (67.6° in male patients vs 59.5° in female patients, $P < .001$) corresponding with a higher prevalence of cam deformity in male patients (94.6% vs 84.5%, $P < .001$). Male patients had less range of motion in flexion (−5.67°, $P < .001$), internal rotation (−8.23°, $P < .001$), and external rotation (−4.52°, $P < .001$) than female patients. Acetabular chondroplasty was performed in 58% of male patients versus 40.2% of female patients ($P < .001$). Acetabuloplasty was performed in 59.1% of male patients versus 43.9% of female patients ($P < .001$). **Conclusions:** Male and female patients undergoing hip arthroscopy differ statistically in terms of preoperative hip function, hip morphology, and self-reported functional deficits, as well as the prevalence of surgical procedures. However, they do not differ significantly in terms of symptom localization, duration, or onset. The observed differences in preoperative functional scores between sexes, although statistically significant, may not represent clinically meaningful differences. **Level of Evidence:** Level III, retrospective cross-sectional study.

From the Department of Orthopaedic Surgery, Division of Sports Medicine, Rothman Institute at Thomas Jefferson University (J.P.S.), Marlton, New Jersey; Department of Orthopaedic Surgery, Division of Sports Medicine, Rush University Medical Center (S.J.N., G.S.V.T.), Chicago, Illinois; Washington Orthopaedics and Sports Medicine (A.B.W.), Washington, DC; Department of Orthopaedic Surgery, Center for Athletic Hip Injury Allegheny Health Network/Drexel University School of Medicine (J.J.C.), Pittsburgh, Pennsylvania; Rockford Orthopedic (G.S.V.T.), Crystal Lake, Illinois; Orthopedic One/Ohio Orthopedic Surgery Institute (T.J.E.), Dublin, Ohio; Hip Arthroscopy DISC Sports and Spine Center (D.K.M.), Marina Del Rey, California; Department of Physical Therapy, Rangos School of Health Sciences, Duquesne University (B.R.K.), Pittsburgh, Pennsylvania; Rothman Institute at Thomas Jefferson University (Z.S.C.), Philadelphia, Pennsylvania; and Department of Orthopaedic Surgery, Nova Southeastern University (D.S.C.), Fort Lauderdale, Florida, U.S.A.

The authors report the following potential conflict of interest or source of funding: J.P.S. receives support from Arthroscopy Association of North America, Stryker Endoscopy. S.J.N. receives support from American Journal of Orthopedics, *Ossur, Stryker. A.B.W. receives support from Stryker. J.J.C. receives support from International Society for Hip Arthroscopy; Arthrex; Breg; employed physician, Allegheny Health Network; General Grant Funding, Allegheny Singer Research Institute. G.S.V.T. receives support from Smith & Nephew, Zimmer/Biomet, Vericel. T.J.E. receives support from Medacta. Grant to support database. D.K.M. receives support from Zimmer Biomet, Smith & Nephew. D.S.C. receives support from Biomet Sports Medicine. Education and product development. Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

Paper previously presented at: American Academy of Orthopaedic Surgeons Annual Meeting, San Diego, California, March 14–18, 2017.

Received April 21, 2017; accepted September 19, 2017.

Address correspondence to John P. Salvo, M.D., Department of Orthopaedic Surgery, Division of Sports Medicine, Rothman Institute at Thomas Jefferson University, 999 Rte 73 N, Marlton, NJ 08053, U.S.A. E-mail: John.Salvo@rothmaninstitute.com

0749-8063/17573/$36.00

https://doi.org/10.1016/j.arthro.2017.09.044

Femoroacetabular impingement (FAI) and associated intra-articular pathology (e.g., labral tears and chondral damage) have become an increasingly recognized cause of hip pain among young and middle-aged adults.[1] Considering that FAI is thought to be a precursor to hip osteoarthritis, hip arthroscopy may be indicated in patients in whom conservative treatment fails. Advances in arthroscopy along with the growing interest in minimally invasive surgery have led to increased use of arthroscopic hip procedures in recent years, particularly among young and middle-aged adults.[2,3] Considering that preoperative findings and morphologic characteristics can affect surgical decision making and influence prognosis, it is important for hip arthroscopists to be aware of any sex-dependent differences that may exist. To date, a number of sex-dependent differences among patients undergoing hip arthroscopy have been noted in the literature.[4-11]

In particular, differences in the incidence, clinical presentation, and outcomes between male and female patients with FAI have been reported.[4-9] Young adult men have been noted to have a higher incidence of cam deformity, which is defined as an alpha angle greater than 50° to 55°,[4-7] whereas middle-aged women have been noted to have a higher incidence of pincer deformity, which is defined as a lateral center-edge angle (CEA) greater than 40° or Tönnis angle less than 0°.[8,9] Women presenting with hip pain and labral tears have been noted to have smaller alpha angles, increased acetabular version, and increased femoral anteversion compared with their male counterparts.[10] Moreover, among patients with symptomatic labral tears, female patients have shown increased range of motion and greater functional deficits based on patient-reported outcome (PRO) scores compared with male patients.[11]

In an effort to further elucidate gender disparities among patients undergoing arthroscopic hip surgery, we sought to evaluate sex differences through a multicenter study. We sought to compare preoperative, radiographic, and intraoperative findings between male and female patients undergoing hip arthroscopy. On the basis of prior findings, we hypothesized that cam deformity would be more prevalent in male patients, pincer deformity would be more prevalent in female patients, and female patients would have greater self-reported functional deficits despite having better preoperative range of motion relative to male patients.

Methods

We performed a retrospective review of a multicenter registry of patients undergoing arthroscopic hip surgery between January 1, 2014, and January 1, 2017. Perioperative data from patients who consented to undergo arthroscopic treatment within the aforementioned time frame and completed demographic and preoperative PRO questionnaires were included in the study. The indications for surgery and inclusion criteria were synonymous for our patient database. The indications for surgery included pincer-type impingement deformities, acetabular labral lesions, articular cartilage lesions, cam-type impingement deformities, chondral lesions, loose bodies, synovitis, or benign intra-articular neoplasms. The exclusion criteria were patients not eligible for hip arthroscopy, including patients with arthritis, septic arthritis, and previous hip arthroplasty. In addition, patients with incomplete demographic information regarding sex, age, height, and weight were excluded from the study. Patient data were entered into the multicenter registry from the practices of 8 experienced hip arthroscopists at 7 facilities. All surgeons contributing data to the registry (J.P.S., S.J.N., A.B.W., J.J.C., G.S.V.T., T.J.E., D.K.M., and D.S.C.) have performed a minimum of 300 hip arthroscopies, perform at least 100 hip arthroscopies annually, and hold board certification from the American Board of Orthopaedic Surgery.

All surgeons in the group obtained institutional review board approval for the multicenter patient registry from their respective institutions. All patient data were protected and stored through a commercially available database software system and stored remotely through a secure server. The registry data that were produced for analysis were deidentified and stripped of sensitive personal health information. Multiple data points were collected to determine the effect of sex on patient demographics, preoperative symptoms, PROs, radiographic measures, and surgical procedures performed. Independent continuous variables were obtained for each patient, including age, weight, and height at the time of surgery, as well as preoperative patient-reported functional scores and preoperative pain level on a visual analog scale (VAS). Hip-specific functional scales that have established psychometric properties and have been previously used in studies of patients undergoing hip arthroscopy, including the modified Harris Hip Score (mHHS),[12] Hip Outcome Score—Activities of Daily Living (HOS-ADL),[13-15] Hip Outcome Score—Sport (HOS-Sport),[13-15] and International Hip Outcome Tool 12 (iHOT-12),[16] were collected before surgery. General health forms that have been previously used to describe the general health of patients undergoing hip arthroscopy—the Short Form 12 physical and mental health surveys—were also collected preoperatively.[17] Postoperative PROs for the entire group of included patients were not available at the time of analysis.

The onset, location, and duration of symptoms were recorded from the patient's subjective history. The onset

Table 1. Demographic Characteristics of Subjects

	Male Patients (n = 446)			Female Patients (n = 765)			
	Mean (Range)	SD	95% CI	Mean (Range)	SD	95% CI	*P* Value
Age, yr	34.2 (14-66)	12.3	30.6-37.8	34.8 (11-72)	13.6	33.8-35.8	.447
Height,* m	1.76 (1.5-2.03)	0.15	1.75-1.77	1.62 (1.4-1.8)	0.06	1.61-1.62	<.001
Weight,* kg	84.8 (49.5-153)	15.7	83.3-86.3	65.9 (41.6-141.8)	13.4	64.9-67.0	<.001
Body mass index*	27.0 (16.2-44.5)	13.9	25.71-28.3	24.8 (16.2-52.0)	4.6	24.5-25.1	<.001

CI, confidence interval; SD, standard deviation.
*Significant difference ($P < .001$).

was defined as the attributing factor that the patient reported as the initiation of his or her symptoms. It was categorized as acute or traumatic if a singular physical event was attributable to the onset of his or her symptoms. A patient without a specific physical event that could explain the onset of his or her symptoms was categorized as having an insidious, atraumatic onset. The duration of symptoms was categorized by the time frame from when the symptoms began to the date of the patient's evaluation by the hip arthroscopist. Range of motion (flexion, internal rotation at 90° of flexion, and external rotation at 90° of flexion) was also recorded.

All surgeons in the group independently reviewed their respective patients' preoperative radiographs according to Clohisy et al.[18] Anteroposterior-view radiographs were obtained to record the lateral CEA and presence of the crossover sign. Anteroposterior and Dunn views were obtained to record the alpha angle, and a false-profile—view radiograph was used to determine the anterior CEA. Previous research by Mast et al.[19] has shown acceptable inter-rater reliability of the alpha angle (intraclass correlation coefficient, 0.83), lateral CEA (intraclass correlation coefficient, 0.73), and presence of the crossover sign (κ coefficient, 0.95). Intraoperative data points recorded included the types of surgical procedures performed.

All analyses were performed using SPSS Statistics (version 21; IBM, Armonk, NY). Multivariate analysis of variance (ANOVA) with an a priori α set at .05 compared pain, functional scores, range of motion, and morphologic characteristics according to sex. Nominal data were compared between sexes with χ^2 analysis with an a priori α set at .05 and Bonferroni correction for multiple comparisons. All data points collected were considered part of the standard of care among patients undergoing hip arthroscopy. Missing or incomplete data were excluded from the respective statistical analysis.

Results

Patient Demographics and Characteristics

A total of 1,437 patients (902 female and 535 male patients) with a mean age of 34 years, ranging in age from 11 to 72 years, were enrolled in the study from January 2014 until January 2017. Multivariate ANOVA showed a statistically significant difference in anthropometric measures based on sex: $F_{3,1207} = 344.79$, $P < .001$, Wilks $\Lambda = 0.539$, partial $\eta^2 = 0.46$. Male patients presented with a greater height, weight, and body mass index ($P < .001$) than female patients, as noted in Table 1. The results of the χ^2 analyses of the primary indication for surgery are listed in Table 2. The most common indication for surgery for both male patients (30.1%) and female patients (28.5%, $P = .52$) was a labral tear. Pincer-type impingement was not significantly different between male patients (19.1%) and female patients (19.4%, $P = .88$); however, there was a significant difference between male patients (27.9%) and female patients (23.1%, $P = .04$) for cam-type impingement. For 18.3% of male patients and 27.9% of female patients, the primary indication for surgery was not recorded in the database. There were a total of 1,199 subjects (760 female and 439 male patients) who had been referred to undergo physical therapy before surgery. The overall success rate of physical therapy was poor, with conservative care through physical therapy ultimately failing in 79.6% of patients. There was a statistical difference between sexes showing that failure of physical therapy occurred at a higher rate in female patients (82.9%) than in male patients (74%, $P < .001$).

PRO Measures

Multivariate ANOVA showed a significant effect for baseline PRO measures according to sex: $F_{9,768} = 5.098$, $P = .001$, Wilks $\Lambda = 0.944$, partial $\eta^2 = 0.056$. Female patients reported significantly greater pain on a VAS preoperatively (55.42, $P = .001$) than male patients (50.40) and reported a greater impact on functional abilities as per the mHHS (53.4 in female patients vs 57.8 in male patients, $P < .001$), HOS-ADL (60.9 in female patients vs 67.1 in male patients, $P < .001$), and iHOT-12 (31.2 in female patients vs 38.5 in male patients, $P = .001$). Table 3 outlines the comparison of PROs between sexes.

Radiographic Evaluation

Multivariate ANOVA showed a significant difference for radiographic measures including the alpha angle

Table 2. Primary Indication for Surgery by Sex

	Male Patients (n = 535)		Female Patients (n = 902)		
	%	95% CI, %	%	95% CI, %	*P* Value
Labral tear	30.1	26.21 to 33.99	28.5	25.55 to 31.45	.52
Cam-type impingement	27.9	24.1 to 31.7	23.1	20.35 to 25.85	.04
Pincer-type impingement	19.1	15.77 to 22.43	19.4	16.82 to 21.98	.88
Articular cartilage defect	1.9	0.74 to 3.06	0.2	−0.9 to 0.49	.001
Acetabular chondrosis	1.9	0.74 to 3.06	0.1	−0.11 to 0.31	<.001
Avascular necrosis	0.4	−0.13 to 0.93	0.2	−0.9 to 0.49	.60
Loose body	0.2	−0.18 to 0.58	0.1	−0.11 to 0.31	.71
Ischiofemoral impingement	0.2	−0.18 to 0.58	0.1	−0.11 to 0.31	.71
Abductor tear	0	—	0.4	−0.01 to 0.81	.12
Femoral chondrosis	0	—	0	—	—
Unidentified	18.3	15.02 to 21.58	27.9	24.97 to 30.83	—

CI, confidence interval.

and CEAs: $F_{4,558} = 14.97$, $P < .001$, Wilks $\Lambda = 0.903$, partial $\eta^2 = 0.097$. Table 4 shows the results of radiographic measures between male and female patients. The mean anterior alpha angle was larger in male patients, at 67.6°, than in female patients, at 59.5° ($P < .001$). Likewise, the mean Dunn alpha angle was 66.1° and 59.0° in male and female patients, respectively ($P < .001$). This corresponded with a higher prevalence of cam deformity in male patients (94.6%, $P < .001$) than in female patients (84.5%) as defined by an alpha angle greater than or equal to 55°. The anterior CEA was also greater in male patients (35.0°) versus female patients (32.7°, $P = .003$), but no statistical difference in the lateral CEA was noted between male patients (33.4°) and female patients (32.4°, $P = .11$). Radiographic evidence of focal pincer-type FAI as shown by a positive crossover sign was more prevalent in male patients (40.7%) versus female patients (33.8%, $P = .045$). Combined cam- and pincer-type FAI occurred in 37.4% of male patients versus 26.4% of female patients ($P = .001$), as shown in Figure 1. There was also a significant difference between sexes in the incidence of hip dysplasia, with evidence of hip dysplasia noted in 12.4% of female patients and 8.3% of male patients: χ^2 (1, n = 1,055) = 4.366, $P = .037$. The radiographic findings are presented in Table 4.

Range of Motion

Multivariate ANOVA showed a significant differences in range of motion between sexes: $F_{3,1167} = 62.38$, $P < .001$, Wilks $\Lambda = 0.862$, partial $\eta^2 = 0.138$. Male patients had less range of motion in flexion (105.89°, $P < .001$), internal rotation (11.37°, $P < .001$), and external rotation (41.02°, $P < .001$) than female patients, who had 111.56° of flexion, 19.60° of internal rotation, and 45.54° of external rotation, as shown in Table 5.

Duration and Onset of Symptoms

There was no observed effect for duration of symptoms (χ^2 [3, n = 1,209] = 4.833, $P = .184$) or onset of symptoms (χ^2 [1, N = 1,437] = 0.841, $P = .359$) between sexes. Most male patients (78.1%) and female patients (80.2%, $P = .359$) reported an atraumatic, insidious onset of symptoms, whereas 21.9% of male patients and 19.8% of female patients reported a traumatic or acute onset of symptoms. Regardless of sex, greater than 36% of subjects reported a duration of symptoms greater than 2 years (Fig 2).

Location of Symptoms

There was no statistically significant difference between male and female patients in the primary location of symptoms: χ^2 (11, n = 1,134) = 15.671, $P = .154$.

Table 3. Preoperative Patient-Reported Outcome Measures

	Male Patients (n = 297)			Female Patients (n = 481)			
	Mean (Range)	SD	95% CI	Mean (Range)	SD	95% CI	*P* Value
Modified Harris Hip Score (total)	57.83 (5-91)	13.68	56.27-59.39	53.40 (12-91)	12.93	52.24-54.56	<.001
HOS-ADL	67.11 (13.24-100)	16.53	65.23-68.99	60.93 (3.13-95.59)	16.97	59.41-62.45	<.001
HOS-Sport	45.15 (0-97.22)	22.15	42.63-47.66	39.37 (0-100)	20.80	37.51-41.23	<.001
SF-12							
Mental health	51.51 (18.75-71)	10.56	49.95-52.35	52.09 (20.72-71.33)	10.07	51.19-52.99	.45
Physical health	36.97 (14.96-63.32)	8.26	36.03-37.91	34.18 (14.47-60.78)	8.03	33.46-34.90	<.001
iHOT-12	38.51 (0-99.32)	19.77	36.26-40.76	31.21 (0-84.97)	16.42	29.74-32.68	.001
VAS score for pain	50.40 (0-100)	21.72	47.93-52.87	55.42 (0-100)	19.72	53.6-57.18	<.001

CI, confidence interval; HOS-ADL, Hip Outcome Score—Activities of Daily Living; HOS-Sport, Hip Outcome Score—Sport; iHOT, International Hip Outcome Tool 12; SD, standard deviation; SF-12, Short Form 12; VAS, visual analog scale.

Table 4. Preoperative Radiographic Measures

	Male Patients (n = 224)			Female Patients (n = 339)			
	Mean (Range)	SD	95% CI	Mean (Range)	SD	95% CI	*P* Value
Anterior alpha angle, °	67.6 (29-120)	13.6	65.4-69.8	59.5 (21-120)	18.7	57.7-61.3	<.001
Dunn alpha angle, °	66.1 (20-90)	10.5	64.4-67.8	59.0 (20-90)	14.1	57.6-60.4	<.001
Anterior CEA, °	35.0 (10-70)	9.1	33.8-36.2	32.7 (12.1-70)	9.4	31.7-33.7	.003
Lateral CEA, °	33.4 (10-56)	7.2	32.1-34.0	32.4 (11.1-60)	7.5	31.2-32.8	.11

CEA, center-edge angle; CI, confidence interval; SD, standard deviation.

Table 6 lists the primary location of symptoms according to sex. Groin pain was the most common location of symptoms for male patients (47.4%) and female patients (39.1%), followed by anterior hip pain, which was reported by 28.3% of female patients and 25.5% of male patients. The C-sign was reported in 10.7% of male patients and 11.2% of female patients.

Surgical Procedures

Differences were noted in the frequency of surgical procedures performed in male and female patients. The prevalence rates of surgical procedures according to sex are presented in Table 7. Acetabular chondroplasty was performed in 58% of male patients versus 40.2% of female patients: χ^2 (1, N = 1,437) = 43.142, $P < .001$. Acetabuloplasty was performed in 59.1% of male patients and 43.9% of female patients: χ^2 (1, N = 1,437) = 43.142, $P < .001$. Femoroplasty was performed in 83.6% of male patients versus 69.3% of female patients: χ^2 (1, N = 1,437) = 36.043, $P < .001$. Female patients had a greater incidence of trochanteric bursectomy, with 6.5% of female patients undergoing this procedure versus 1.1% of male patients: χ^2 (1, N = 1,437) = 22.839, $P < .001$. Moreover, gluteus repairs were performed in 3.9% of female patients versus 0.2% of male patients: χ^2 (1, N = 1,437) = 18.755, $P < .001$. There was no statistical difference in the prevalence of ligamentum teres debridement, synovectomy, iliotibial band release, psoas release, femoral chondroplasty, and femoral microfracture, as shown in Table 7.

Labral pathology was arthroscopically confirmed in 98.9% of male patients and 96.1% of female patients. Female patients were treated with labral debridement in 19.2% of cases compared with 13.8% of male patients: χ^2 (1, N = 1,437) = 6.747, $P = .009$. However, there was no effect of sex on labral repair or reconstruction. Labral repairs were performed in 78.5% of female patients and 77.6% of male patients: χ^2 (1, N = 1,437) = 0.167, $P = .683$. Labral reconstruction was performed in 2.1% of male patients and 1.6% of female patients: χ^2 (1, N = 1,437) = 0.499, $P = .480$.

Discussion

This study found greater preoperative pain and self-reported functional deficits in female patients; a greater mean alpha angle in male patients

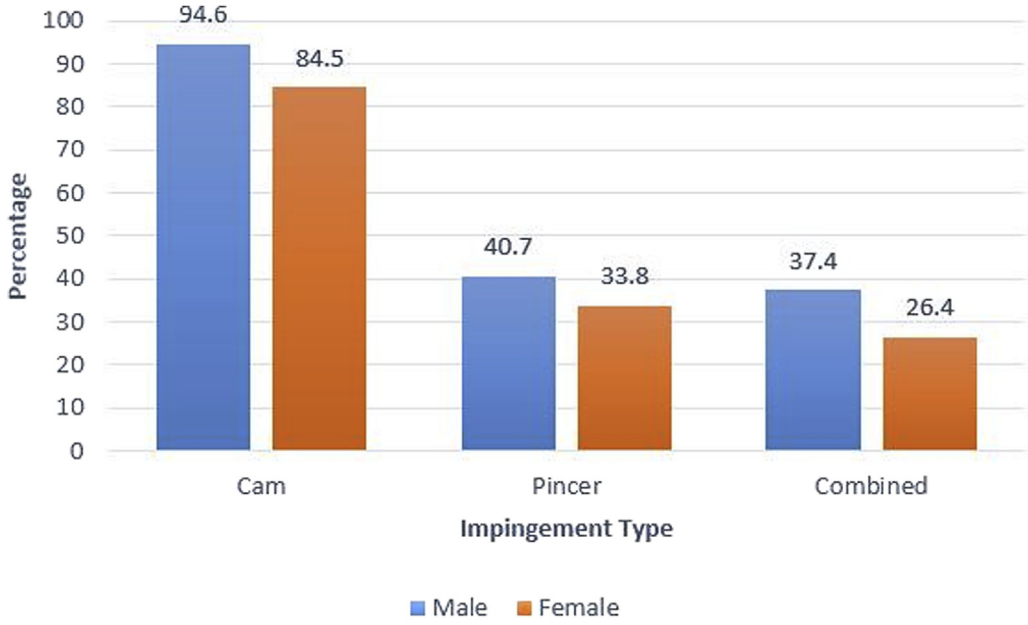

Fig 1. Type of impingement according to sex.

Table 5. Preoperative Range of Motion

	Male Patients (n = 437)			Female Patients (n = 734)			
	Mean (Range)	SD	95% CI	Mean (Range)	SD	95% CI	*P* Value
Flexion, °	105.89 (30 to 135)	12.7	104.7 to 107.1	111.56 (30 to 140)	13.2	110.6 to 112.5	<.001
External rotation, °	41.02 (0 to 90)	13.3	39.7 to 42.3	45.54 (10 to 90)	13.4	44.6 to 46.5	<.001
Internal rotation, °	11.37 (−20 to 60)	11.6	10.3 to 12.4	19.60 (−20 to 70)	11.0	18.8 to 20.4	<.001

CI, confidence interval; SD, standard deviation.

corresponding with a higher prevalence of cam deformity; a higher prevalence of hip dysplasia in female patients; and decreased preoperative range of motion in flexion, external rotation, and internal rotation in male patients. Moreover, differences in the frequency of procedures performed were noted: Male patients were more likely to undergo acetabular chondroplasty, acetabuloplasty, and femoroplasty, whereas female patients were more likely to undergo trochanteric bursectomy and gluteus repairs. The sex disparities in preoperative self-reported functional deficits and pain scores were statistically significant; however, these findings may not represent clinically meaningful differences. Although we have only reported preoperative and intraoperative procedural data for the patients in this study, we hope to report postoperative outcomes as they become available with further follow-up. Nevertheless, our findings highlight important sex-based differences in preoperative parameters, radiographic measures, and intraoperative findings in a large study of patients undergoing hip arthroscopy. Various sex-specific differences among patients undergoing hip arthroscopy have been reported in the literature.[10,11,20-23] Although our findings confirm many of these previously published sex disparities, there are also some notable differences.

In terms of patient-reported clinical scores, female patients in our study reported significantly greater preoperative pain and functional deficits as per the mHHS, HOS-ADL, HOS-Sport, iHOT-12, and Short Form 12 physical and mental health forms. Similar sex disparities in self-reported functional scores have been noted in prior studies. However, in their multicenter study of 1,401 patients, Lindner et al.[11] reported no significant difference in preoperative pain among patients with symptomatic labral tears, with the average preoperative pain score noted to be 5.7 and 5.9 on a 10-point VAS for male and female patients, respectively ($P = .43$). Lindner et al. also reported an average preoperative mHHS of 62.6 for male patients and 59.9 for female patients ($P = .033$) and a lower preoperative HOS-ADL in female patients (60.7 in female patients vs 64.3 in male patients, $P = .03$); however, they found no significant sex differences in HOS-Sport ($P = .06$). In their study of 229 patients with FAI, Joseph et al.[20] noted that female patients reported poorer hip function than their male counterparts preoperatively ($P \leq .003$) on both the HOS-ADL (67.4 in male patients vs 60.5 in female patients) and International Hip Outcome Tool 33 (38.0 in male patients vs 30.9 female patients). Moreover, Malviya et al.[21] noted significantly lower preoperative quality-of-life scores in female patients than in male patients in a study of patients undergoing hip arthroscopy for FAI. Overall, our findings are in accordance with prior studies indicating that female patients tend to report greater functional deficits than male patients before hip arthroscopy. Although these differences reached statistical significance, caution should be used when interpreting the clinical significance of the differences. The minimal clinically important difference (MCID) has not been established for the mHHS and iHOT-12. The HOS-ADL and HOS-Sport

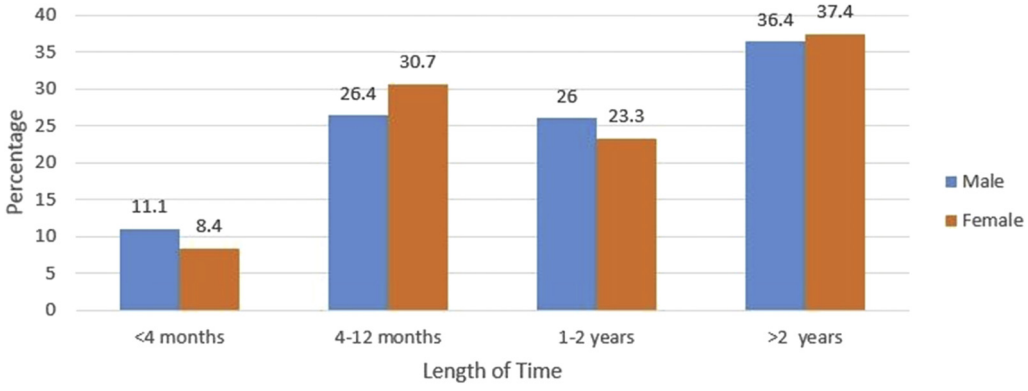

Fig 2. Duration of symptoms by sex.

Table 6. Primary Location of Symptoms by Sex

	Male Patients (n = 420)		Female Patients (n = 714)	
	%	95% CI, %	%	95% CI, %
Groin	47.4	46.62 to 52.18	39.1	35.52 to 42.68
Anterior hip	25.5	21.33 to 29.67	28.3	25 to 31.6
Lateral hip	10.5	7.57 to 13.43	12.5	10.07 to 14.93
Buttock	2.1	0.73 to 3.47	3.4	2.07 to 4.73
Posterior hip	2.4	0.94 to 3.86	2.9	1.67 to 4.13
Sacroiliac joint	0.5	−0.17 to 1.17	0.1	−0.13 to 0.33
Adductors	0.2	−0.23 to 0.63	0.4	−0.06 to 0.86

NOTE. There was no statistical difference between male and female patients in the primary location of symptoms ($P = .154$).
CI, confidence interval.

subscales have MCID values of 9 and 6, respectively. The differences noted between the sexes for the Hip Outcome Score subscales did not exceed the MCID and must be interpreted with caution regarding the clinical significance.[24]

In our study the anterior alpha angle and Dunn alpha angle were both larger among male patients. Hetsroni et al.[10] noted similar findings in a study of 217 young adults with hip pain and labral tears, with significantly larger alpha angles observed on preoperative computed tomography in male patients versus females patients (63.6° vs 47.8°, $P < .001$). Using an alpha angle greater than or equal to 55° as the threshold for cam deformity as cited in most orthopaedic literature,[4-7] we found that male patients were more likely to present with cam-type morphology than female patients (94.6% vs 84.5%). Hooper et al.[22] noted an even greater sex disparity in FAI morphology, with adolescent male patients being nearly 40 times more likely to present with cam-type morphology than their female counterparts (38.9% vs 1%, $P < .0001$).

However, it is important to note that the findings of Hetsroni et al.[10] indicated that female patients may have more subtle cam-type lesions that are not detected using the commonly cited 55° threshold for the alpha angle, thereby potentially leading to an underestimation of the incidence of cam morphology in female patients. In our study, the anterior CEA was also greater in male patients versus female patients, but no statistical difference in the lateral CEA was noted between sexes. In their study of 177 adolescents with FAI, Hooper et al.[22] also noted no statistical difference in the lateral CEA between sexes. Moreover, in our study, radiographic evidence of pincer-type morphology as defined by a positive crossover sign was more prevalent in male patients versus female patients (40.7% vs 33.8%). In contrast to our findings, Frank et al.[23] noted no statistically significant difference in the presence of cam-type or pincer-type morphologies between male and female patients in their comparative matched-group analysis of 150 patients undergoing hip arthroscopy for FAI.

Significant differences in range of motion were noted in our study, with greater range of motion observed in female patients than in male patients. In their study of patients with labral tears, Lindner et al.[11] also reported greater range of motion in female patients than in male patients and noted that the average range of motion fell within the normal range for both sexes. No significant differences were noted in the duration and onset of symptoms between male and female patients in our study. In contrast, Lindner et al. noted that an acute injury was documented in 39.6% of male patients and 27.6% of female patients in their study ($P < .05$).

Table 7. Frequency of Surgical Procedures by Sex

	Male Patients (n = 535)		Female Patients (n = 902)		
	%	95% CI, %	%	95% CI, %	*P* Value
Arthroscopic labral surgery					
Debridement*	13.8	10.9 to 16.7	19.2	16.6 to 21.8	.009
Repair	77.6	74.1 to 81.1	78.5	75.8 to 81.2	.683
Reconstruction	2.1	0.9 to 3.3	1.6	0.8 to 2.4	.480
Other procedures					
Femoroplasty*	83.6	80.5 to 86.7	69.3	66.3 to 72.3	<.001
Synovectomy	67.5	63.5 to 71.5	65.7	62.6 to 68.9	.867
Acetabuloplasty*	59.1	54.9 to 63.3	43.9	40.7 to 47.1	<.001
Acetabular chondroplasty*	58.1	53.9 to 62.3	40.2	37 to 43.4	<.001
Femoral chondroplasty	19.1	15.8 to 22.4	17.6	15.1 to 20.1	.766
Ligamentum teres debridement	14.8	11.8 to 17.8	18.2	15.7 to 20.7	.390
Gluteus medius or minimus repair*	0.2	−0.2 to 0.6	3.9	2.6 to 5.2	<.001
Acetabular microfracture*	5.8	3.8 to 7.8	2.1	1.2 to 3	<.001
Trochanteric bursectomy*	1.1	0.2 to 2.0	6.5	4.9 to 8.1	<.001
Loose body removal*	5.0	3.2 to 6.9	1.6	0.8 to 2.4	.002
Femoral microfracture	0.4	−0.1 to 0.9	0.8	0.2 to 1.4	.276
Psoas release	0.7	−0.1 to 1.4	0.6	0.1 to 1.1	.612
Iliotibial band release	0	—	0.1	−0.1 to 0.3	.441

CI, confidence interval.
*Significant difference ($P < .05$).

Moreover, our study did not find significant sex differences in the location of symptoms.

Several significant differences were noted in the rates of procedures performed within each sex group in our study; male patients underwent femoroplasty, acetabuloplasty, acetabular chondroplasty, acetabular microfracture, and loose body removal at a higher rate than female patients, whereas female patients underwent trochanteric bursectomy, gluteus medius or minimus repair, and labral debridement at a higher rate than male patients. Although labral repair and capsular closure were performed in the majority of both male and female patients in this study, labral debridement, performed in a minority of both sexes, reached statistical significance. Hooper et al.[22] also reported an increased frequency of femoroplasty and acetabuloplasty among male patients in their study of adolescent patients with FAI. Lindner et al.[11] reported a higher rate of femoral osteoplasty and microfracture in male patients, but they did not observe a statistically significant difference in the rate of acetabular osteoplasty between sexes ($P = .41$). Moreover, in contrast to our findings, Frank et al.[23] reported no significant sex difference in the rates of labral repair versus labral debridement in their matched-group analysis ($P = .472$).

Although sex differences among patients undergoing hip arthroscopy have been previously reported in the literature, our study adds to the current knowledge by confirming the existence of sex differences in a large multicenter sample of patients. Moreover, our study provides a more comprehensive assessment of baseline sex differences among patients undergoing hip arthroscopy than previously published studies. Whereas our results confirm many of the previously reported sex disparities, our findings also highlight some notable deviations from prior studies, as described earlier. Knowledge of these sex differences may assist hip arthroscopists as they are evaluating patients and deciding on appropriate treatment.

Limitations

Although this study highlights important sex differences among patients undergoing hip arthroscopy, it is not without its limitations. First, complete datasets were not available for all patients in this study, so the possibility of under-representation of certain groups in each respective analysis cannot be ruled out. Second, our study had a disproportionately greater number of female patients than male patients, which could have potentially influenced our results; however, despite this, the sample size for each sex was adequate for comparative statistical analysis. Third, the radiographic measures were performed by different surgeons, and inter-rater reliability was not assessed. Unfortunately, assessing inter-rater reliability for the radiographic measures was not feasible because our multicenter registry does not store radiographs. However, between-surgeon differences would not be expected to result in the observed sex differences in radiographic measures because the surgeons performed the radiographic measures for both their male and female patients. Moreover, previous research has shown acceptable inter-rater reliability of radiographic measures of the hip joint.[19] Fourth, we must consider the clinical significance of the differences that were found to be statistically significant between sexes. For instance, the results indicated that an approximate difference of 5 mm on the VAS for pain was statistically significant, but previous studies have suggested an MCID of greater than 13 mm for musculoskeletal conditions.[25] Finally, our analysis did not compare the incidence and types of prior surgical procedures between male and female patients in this study. If the female patients in our study had a higher incidence of prior hip arthroscopy procedures, this could explain, at least in part, the greater pain and functional deficits reported by female patients preoperatively.

Conclusions

Male and female patients undergoing hip arthroscopy differ in terms of preoperative hip morphology, hip function, and self-reported functional deficits, as well as the prevalence of surgical procedures. However, they do not differ significantly in terms of symptom localization, duration, or onset. The observed differences in preoperative functional scores between sexes, although statistically significant, may not represent clinically meaningful differences.

References

1. Ganz R, Leunig M, Leunig-Ganz K, Harris WH. The etiology of osteoarthritis of the hip: An integrated mechanical concept. *Clin Orthop Relat Res* 2008;466:264-272.
2. Montgomery SR, Ngo SS, Hobson T, et al. Trends and demographics in hip arthroscopy in the United States. *Arthroscopy* 2013;29:661-665.
3. Maradit Kremers H, Schilz SR, Van Houten HK, et al. Trends in utilization and outcomes of hip arthroscopy in the United States between 2005 and 2013. *J Arthroplasty* 2017;32:750-755.
4. Beaulé PE, Zaragoza E, Motamedi K, Copelan N, Dorey FJ. Three-dimensional computed tomography of the hip in the assessment of femoroacetabular impingement. *J Orthop Res* 2005;23:1286-1292.
5. de Sa D, Urquhart N, Philippon M, Ye JE, Simunovic N, Ayeni OR. Alpha angle correction in femoroacetabular impingement. *Knee Surg Sports Traumatol Arthrosc* 2014;22:812-821.
6. Kang AC, Gooding AJ, Coates MH, Goh TD, Armour P, Rietveld J. Computed tomography assessment of hip joints in asymptomatic individuals in relation to femoroacetabular impingement. *Am J Sports Med* 2010;38:1160-1165.

7. Rakhra KS, Sheikh AM, Allen D, Beaulé PE. Comparison of MRI alpha angle measurement planes in femoroacetabular impingement. *Clin Orthop Relat Res* 2009;467:660-665.
8. Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA. Femoroacetabular impingement: A cause for osteoarthritis of the hip. *Clin Orthop Relat Res* 2003;(417):112-120.
9. Cobb J, Logishetty K, Davda K, Iranpour F. Cams and pincer impingement are distinct, not mixed: The acetabular pathomorphology of femoroacetabular impingement. *Clin Orthop Relat Res* 2010;468:2143-2151.
10. Hetsroni I, Dela Torre K, Duke G, Lyman S, Kelly BT. Sex differences of hip morphology in young adults with hip pain and labral tears. *Arthroscopy* 2013;29:54-63.
11. Lindner D, El Bitar YF, Jackson TJ, Sadik AY, Stake CE, Domb BG. Sex-based differences in the clinical presentation of patients with symptomatic hip labral tears. *Am J Sports Med* 2014;42:1365-1369.
12. Potter BK, Freedman BA, Andersen RC, Bojescul JA, Kuklo TR, Murphy KP. Correlation of Short Form-36 and disability status with outcomes of arthroscopic acetabular labral debridement. *Am J Sports Med* 2005;33:864-870.
13. Martin RL, Kelly BT, Philippon MJ. Evidence of validity for the Hip Outcome Score. *Arthroscopy* 2006;22:1304-1311.
14. Martin RL, Philippon MJ. Evidence of validity for the Hip Outcome Score in hip arthroscopy. *Arthroscopy* 2007;23:822-826.
15. Martin RL, Philippon MJ. Evidence of reliability and responsiveness for the Hip Outcome Score. *Arthroscopy* 2008;24:676-682.
16. Griffin DR, Parsons N, Mohtadi NG, et al. A short version of the International Hip Outcome Tool (iHOT-12) for use in routine clinical practice. *Arthroscopy* 2012;28:611-616. quiz 616-618.
17. Larson CM, Giveans MR, Stone RM. Arthroscopic debridement versus refixation of the acetabular labrum associated with femoroacetabular impingement: Mean 3.5-year follow-up. *Am J Sports Med* 2012;40:1015-1021.
18. Clohisy JC, Carlisle JC, Beaulé PE, et al. A systematic approach to the plain radiographic evaluation of the young adult hip. *J Bone Joint Surg Am* 2008;90:47-66 (suppl 4).
19. Mast NH, Impellizzeri F, Keller S, Leunig M. Reliability and agreement of measures used in radiographic evaluation of the adult hip. *Clin Orthop Relat Res* 2011;469:188-199.
20. Joseph R, Pan X, Cenkus K, Brown L, Ellis T, Di Stasi S. Sex differences in self-reported hip function up to 2 years after arthroscopic surgery for femoroacetabular impingement. *Am J Sports Med* 2016;44:54-59.
21. Malviya A, Stafford GH, Villar RN. Impact of arthroscopy of the hip for femoroacetabular impingement on quality of life at a mean follow-up of 3.2 years. *J Bone Joint Surg Br* 2012;94:466-470.
22. Hooper P, Oak SR, Lynch TS, Ibrahim G, Goodwin R, Rosneck J. Adolescent femoroacetabular impingement: Gender differences in hip morphology. *Arthroscopy* 2016;32:2495-2502.
23. Frank RM, Lee S, Bush-Joseph CA, Salata MJ, Mather RC III, Nho SJ. Outcomes for hip arthroscopy according to sex and age: A comparative matched-group analysis. *J Bone Joint Surg Am* 2016;98:797-804.
24. Harris JD, Brand JC, Cote MP, Faucett SC, Dhawan A. Research pearls: The significance of statistics and perils of pooling. Part 1: Clinical versus statistical significance. *Arthroscopy* 2017;33:1102-1112.
25. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual analog scale for pain (VAS pain), numeric rating scale for pain (NRS pain), McGill Pain Questionnaire (MPQ), Short-Form McGill pain questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). *Arthritis Care Res* 2011;63:S240-S252 (suppl 11).