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ORIGINAL ARTICLE

Effect of the presence of cysts in the hip joint on hip arthroscopy

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ABSTRACT

Objectives: The aim of this study was to investigate whether the presence and size of fibrous cysts affected postoperative results in patients undergoing hip arthroscopy.

Patients and methods: Between January 2010 and December 2019, a total of 261 patients (138 males, 123 females; mean age: 39.5±11.9 years; range, 18 to 66 years) who underwent hip arthroscopy with the diagnosis of cam-pincer-mixed-type femoroacetabular impingement (FAI) and labral pathologies were retrospectively analyzed. The study groups (impingements and labral pathologies) and the presence of cyst (or cyst size: <5 mm, 5-8 mm, >8 mm) were used as the fixed effects, and the analysis was adjusted for baseline age, sex, and preoperative scores. Pre- and postoperative modified Harris Hip Score (mHHS) and Visual Analog Scale (VAS) scores that were applied to all patients were used as an indication of clinical results.

Results: The mean preoperative mHHS score of the patients with a cyst was significantly lower compared to the patients without a cyst (56.8±12.3 *vs*. 60.3±12.7, p=0.026). The mean change in the mHHS score and the mean percentage change in VAS score were significantly higher in the patients with a cyst compared to the patients without a cyst (mHHS score: 28.1±14.0 *vs*. 22.5±14.1, p=0.002; VAS score: 61.9±30.2 *vs*. 52.6±47.4, p=0.038). The increase in mHHS score over time for patients with a cyst was significantly higher than the patients without cysts in the pincer group (38.1±11.1 *vs*. 19.3±13.5, p<0.001). The patients with a cyst size of >8 mm had a significantly higher increase in the mHHS scores compared to the patients with a cyst size of <5 mm (29.5±12.9 *vs*. 23.5±13.8, p=0.043).

Conclusion: Subchondral cysts in the femoral head and neck junction accompanied cam-type and mixed-type FAI, while subchondral cysts in the acetabulum accompanied pincer-type impingement. In all groups, the mean increase in mHHS scores and the mean decrease in VAS scores were higher in patients with subchondral cysts than in patients without cysts. In patients with subchondral cysts, if the lesion causing FAI is treated arthroscopically, it can positively affect the functional results.

Keywords: Acetabular cyst, femoral cyst, hip arthroscopy, impingement, subchondral cyst.

Abnormal contact caused by femoroacetabular impingement (FAI) contributes to labral and cartilage damage.[1] In the treatment of all FAI types, treatment planning is made by considering the patient's age, activity level, accompanying lesions. Randomized clinical trials comparing arthroscopic and conservative management have shown the superiority of arthroscopic resection.[2] Arthroscopic treatment of FAI may result in reduced pain, increased range of motion, and non-progression of cartilage damage in selected cases. The presence of degenerative arthritis and advanced age are the main factors affecting the results of arthroscopic surgery.[3] Successful results

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of hip arthroscopy in the short term have been demonstrated in studies in which patients were evaluated using functional and pain scores.[4] The need for total hip replacement after arthroscopy is accepted as a failure criterion in the long term. A systematic review showed that at 5- and 10-years of follow-up, the need for arthroplasty ranged from 3% to 17.9% and 2.4% to 32.5%, respectively.[5]

Previous studies have shown that fibrous cysts in the femoral head-neck junction are more common in patients with FAI (33%) and are located close to the lesion.[6] Although these cysts have a mean diameter of 5 mm, larger cysts have also been reported in the literature.[6,7] The cysts are more commonly observed in anterosuperior location. It has been emphasized that FAI should be investigated in the presence of these cysts, whether accompanied by bone marrow edema. Although the presence, prevalence and characteristics of these cysts have been investigated, the effect on clinical outcomes after arthroscopic FAI resection has not been evaluated yet.[8]

In the present study, we hypothesized that the presence of fibrous bone cysts did not negatively affect the results of hip arthroscopy. We, therefore, aimed to investigate whether the presence and size of fibrous cysts affected postoperative results in patients undergoing hip arthroscopy with various diagnoses and without chondral injury.

PATIENTS AND METHODS

This single-center, retrospective cohort study was conducted at Gazi University Faculty of Medicine, Department of Orthopedics and Traumatology between January 2010 and December 2019. Study groups include impingements (cam, pincer and mix) types and labral pathologies. The characteristics of the patients in cam-type impingement (n=100), pincer-type impingement (n=47), mixed-type impingement (n=33), and labral pathologies (n=81) are presented in Table I. Patients who underwent hip arthroscopy with a diagnosis of cam-pincer-mixed-type FAI and labral pathology were included. Medical data were retrieved from the clinical archive including, demographic characteristics, side of affected hip, symptom duration before surgery, follow-up time, pre- and postoperative clinical scores, surgical video images, and pre- and postoperative radiological images. The pre- and postoperative modified Harris Hip Score (mHHS) and Visual Analog Scale (VAS) that were applied to all patients were used as an indication of clinical results. All postoperative scores were recorded during minimum three years of follow-up. Patients with missing clinical information and radiological images, who did not accept to participate in the study, who had a previous surgical operation, who had a history of previous trauma and infection, and who were diagnosed with avascular necrosis and chondral injury were excluded from the study. Finally, a total of 261 patients (138 males, 123 females; mean age: 39.5±11.9 years; range, 18 to 66 years) were included.

Radiological evaluation

Cysts were evaluated on preoperative magnetic resonance imaging (MRI) (Figures 1 and 2). The imaging protocol included T1-weighted and T2-weighted (coronal, sagittal, axial sections). It was localized as anterior, posterior, superior and inferior according to the location of the cysts in the femoral head-neck junction and acetabulum. In addition, the maximum diameter of the cysts was measured with the help of digital program RadiAnt DICOM viewer version 1.9.16, 32-bit (Medixant Company, Poland).

Surgical technique

All surgical procedures were performed by a single surgeon in the supine position on a traction table under fluoroscopy. The operated hip was positioned at 20 degrees of abduction and 15 degrees of internal rotation. The other hip was abducted to 40 to 45 degrees for comfortable fluoroscopy use. The hip joint was dislocated approximately 1 cm with the help of a traction table. Then, intraarticular pathologies were detected by entering the joint through the appropriate anterolateral and mid-anterior portals. Treatment of any labral, femoral or acetabular pathology was performed. Afterwards, traction was terminated and peripheral examination was started. Cam, pincer, or mixed-type FAI lesions were detected under fluoroscopy control, and osteoplasty was performed. The cysts in the femoral head-neck junction, which were detected in the preoperative MRI examination, were not intervened.

Postoperative rehabilitation

Postoperatively, the patients were given partial weight-bearing with a four-week arm-chair. A rehabilitation program was initiated immediately after the surgery to maintain the range of the motion of the joint. Strengthening exercises were started at six weeks. In addition, compulsive activities were not allowed for six months.

Statistical analysis

Statistical analysis was performed using the R version 4.1.1 software (R Foundation for Statistical

TABLE I

Comparision of characteristics of the patients in different study groups

	Cam group (n=100)					Pincer group (n=47)					Mixed group (n=33)					Labrum group (n=81)					
	n	%	Mean±SD	Median	25th-75th percentile	n	%	Mean±SD	Median	25th-75th percentile	n	%	Mean±SD	Median	25th-75th percentile	n	%	Mean±SD	Median	25th-75th percentile	*p*
Age (year)			39.1±10.9					43.2±11.9					37.3±9.2					38.7±13.8			0.107
Sex																					**0.002**
Male	62	62.0				25	53.2				22	66.7				29	35.8				
Female	38	38.0				22	46.8				11	33.3				52	64.2				
Side																					0.054
Right	51	51.0				32	68.1				14	42.4				50	62.5				
Left	49	49.0				15	31.9				19	57.6				30	37.5				
Femoral cyst (yes)	63	63.0				26	55.3				25	75.8				39	48.1				**0.034**
Cyst size (mm)				6.3	4.8-8.1				7.4	5.1-10				6.2	4.2-7.6				6.8	4.7-8.1	0.337
Cyst location																					0.331
Anterosuperior	39	39.0				15	31.9				15	45.5				18	22.2				
Anteroinferior	4	4.0				2	4.3				3	9.1				4	4.9				
Posterosuperior	12	12.0				6	12.8				4	12.1				12	14.8				
Posteroinferior	8	8.0				3	6.4				3	9.1				4	4.9				
No cyst	37	37.0				21	44.7				8	24.2				43	53.1				
2nd Cyst (yes)	13	13.0				4	8.5				4	12.1				4	4.9				0.274
2nd Cyst size (mm)				6.1	3.4-7.5				5.7	2.1-10.1				4.6	3.3-5.7				6.4	3.6-6.7	0.517
2nd Cyst location																					0.167
Anterosuperior	1	1.0				1	2.1				1	3.0				0	0				
Anteroinferior	5	5.0				2	4.3				1	3.0				4	4.9				
Posterosuperior	7	7.0				1	2.1				1	3.0				0	0				
Posteroinferior	0	0				0	0				1	3.0				0	0				
No cyst	87	87.0				43	91.5				29	87.9				77	95.1				
Asetabular cyst (yes)	29	29.0				25	53.2				12	36.4				29	35.8				**0.044**

For categorical variables Pearson chi-square or Fisher exact tests are used. For continuous variables, where means ± sd is given, one-way ANOVA is used; where median (25th and 75th percentile) is given Kruskal Wallis test is used. Bold indicates statistical significance at $p<0.05$

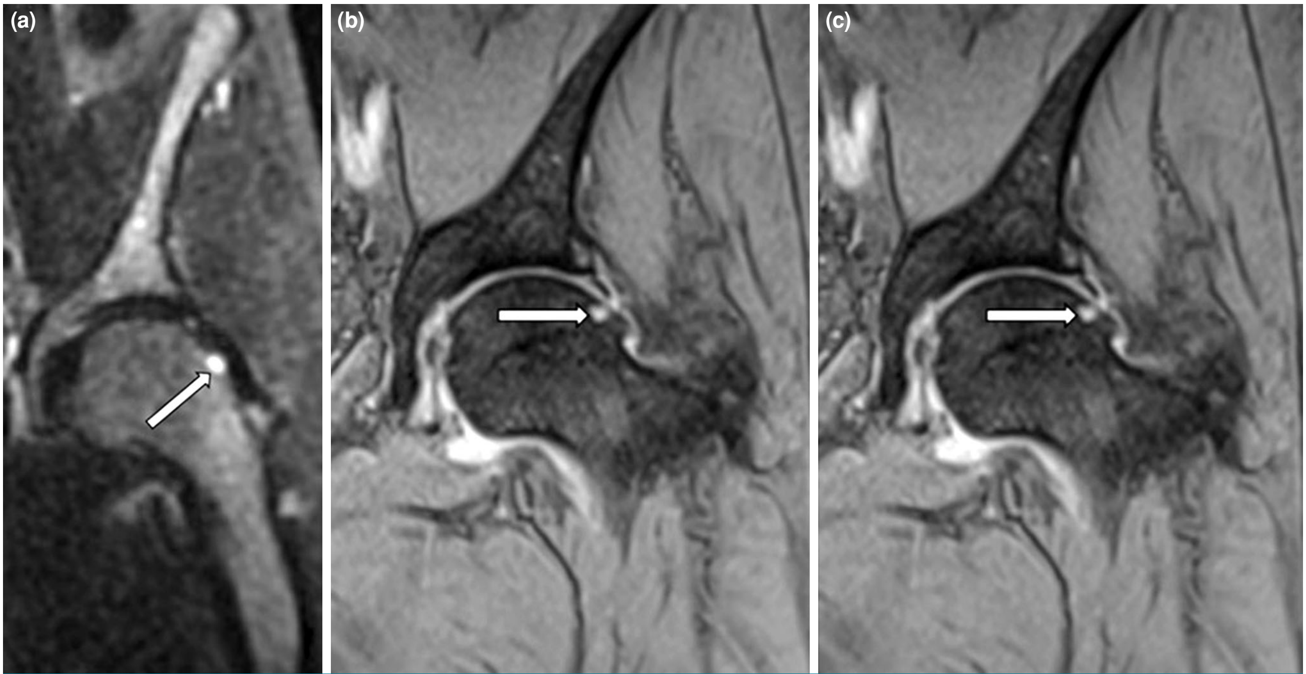

FIGURE 1. Magnetic resonance imaging of a left hip showing a subchondral cyst in the femoral head neck junction (arrows). **(a)** Coronal T1-weighted sequence, **(b)** coronal T1-weighted sequence, **(c)** axial T1-weighted sequence.

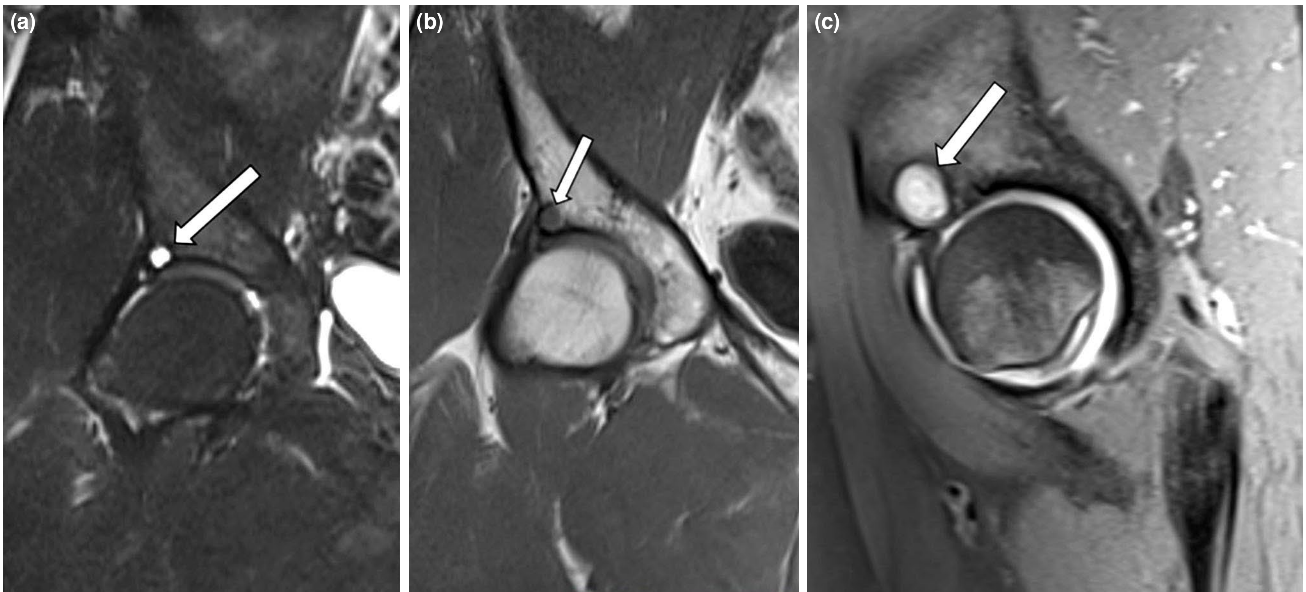

FIGURE 2. Magnetic resonance imaging of a right hip are showing subchondral cyst in the acetabular bone (arrows). **(a)** Coronal T2-weighted sequence, **(b)** Coronal T1-weighted sequence, **(c)** Sagittal T2-weighted sequence.

Computing, Vienna, Austria) and run in RStudio Desktop version R 4.2.2 (RStudio, USA). Figures were generated by using the ggplot2 package in R.[9] Descriptive data were expressed in mean ± standard deviation (SD), median (25th-75th percentile) or number and frequency, where applicable. Characteristics were compared between the groups using one-way analysis of variance (ANOVA), Pearson's chi-square or Fisher exact tests depending on the data distribution. Pre- and postoperative comparisons of the mHHS and VAS scores were compared using the paired samples t-tests. The effects of group and the presence of cyst on the mean differences of the mHHS and VAS scores were evaluated with the analysis of covariance (ANCOVA). In the ANCOVA models, the dependent variables were defined as the change scores from the baseline. Group and the presence of cyst (or cyst size: <5 mm, 5-8 mm, >8 mm) were used as the fixed effects, and the analysis was adjusted for baseline age, sex, and preoperative scores. The percentage change in the VAS score was used in the ANCOVA models, as it was found to be less biased than the absolute change scores.[10] Effect sizes using partial eta-squared (ηp2) values were calculated for evaluating the strength of statistical significance. When any significant ANOVA effects were observed, Bonferroni corrected post-hoc analyses were carried out to perform the different subgroup comparisons. A *p* value of <0.05 was considered statistically significant with 95% confidence interval (CI).

RESULTS

The mean follow-up was 43.2±4.4, 46.1±5.2, 43.8±5.4, and 45.5±4.1 months for cam, pincer, mixed-type and labrum groups, respectively. The minimum follow-up period in all the groups was three years. There was no significant difference among the groups regarding the follow-up duration (p=0.914). However, there were statistically significant differences among the groups in the presence of a femoral cyst (p=0.034) and the presence of an acetabular cyst (p=0.044) and in terms of sex (p=0.002). No significant differences were observed in any other characteristics of the patients among the groups (Table I).

Femoral cysts were most commonly located in the anterosuperior quadrant (cam group 39%, pincer group 31.9%, mixed group 45.5%, labrum group 22.2%) and secondly in the posterosuperior quadrant (cam group 12.0%, pincer group 12.8%, mixed group 12.1%, labrum group 14.8%) in all groups. Subchondral cysts at the femoral head-neck junction were found to be statistically significantly higher, particularly in the cam (63%) and mixed-type (75%) FAI groups (p=0.034) (Table I).

The mHHS and VAS scores were significantly different between pre-and postoperative time points (p<0.001); however, pre- and postoperative scores, and the mean change scores did not significantly differ

TABLE II
Comparison of mHHS and VAS scores

	mHHS score			VAS score					
	Preoperative	Postoperative	Mean change	Preoperative		Postoperative		% Change	
	Mean±SD	Mean±SD	Mean±SD	Median	25th-75th percentile	Median	25th-75th percentile	Median	25th-75th percentile
Study groups									
Cam	59.4±13.6	83.5±11.2[a]	24.1±14.4	8	7-9	2[a]	2-4	70	50-77.8
Pincer	57.4±12.1	87.1±8.8[a]	29.7±15.3	8	7-9	3[a]	2-4	70	55.6-77.8
Mixed	56.9±11.8	82.8±8.8[a]	26.8±13.0	9	8-9	3[a]	2-5	62.5	40.2-75
Labrum	57.9±12.0	83.0±11.3[a]	25.2±13.8	8	7-9	3[a]	2-4	66.7	50-77.8
p	0.688	0.148	0.158	0.352		0.319		0.356	
Femoral cyst									
Yes	56.8±12.3	84.8±10.2[a]	28.1±14.0	8	8-9	3[a]	2-4	70	52.8-77.8
No	60.3±12.7*	82.8±11.1[a]	22.5±14.1*	8	7-9	3[a]	2-5	62.5	42.8-75
p	**0.026**	0.141	**0.001**	0.112		**0.046**		**0.040**	
Acetabular cyst									
Yes	57.5±12.6	84.1±10.9[a]	26.7±14.7	8	8-9	3[a]	2-5	66.7	50-77.8
No	58.7±12.6	83.9±10.4[a]	25.3±14.1	8	7-9	3[a]	2-4	66.7	50-77.8
p	0.483	0.860	0.421	0.061		0.449		0.766	

mHHS: Modified Harris Hip Score; VAS: Visual Analog Scale; SD: Standard deviation; a: Statistically significant difference at p<0.001 between pre- and postoperative time points. Bold values indicate a significant difference at p<0.05 between patients with and without a femoral cyst.

TABLE III
Comparisons of change in the mHHS and VAS scores between pre- and postoperative time points across study groups

ANCOVA models[a]	F	*p*	η^2	Adjusted R^2
ΔmHHS score				
Group	1.534	0.206	0.018	
Cyst	9.350	**0.002**	0.036	0.512
Group × cyst	2.650	**0.049**	0.031	
ΔmHHS score				
Group	2.401	0.068	0.028	
Cyst	3.043	**0.049**	0.024	0.498
Group × cyst	0.799	0.572	0.019	
% ΔVAS score				
Group	0.795	0.498	0.009	
Cyst	4.083	**0.044**	0.016	0.325
Group × cyst	0.731	0.534	0.009	
% ΔVAS score				
Group	0.275	0.843	0.003	
Cyst	2.984	0.052	0.024	0.211
Group × cyst	0.612	0.721	0.015	

mHHS: Modified Harris Hip Score; VAS: Visual Analog Scale; ANCOVA analysis was adjusted for the baseline preoperative scores, age, and sex as the covariates. Δ Difference of the scores between the pre- and postoperative measurements; a Group effect: cam, pincer, mixed-type, and labrum; Cyst effect: Yes and No; Cyst size effect: <5 mm, 5-8 mm, and >8 mm; η^2: Partial eta-squared. Bold values indicate statistical significance at α=0.05.

across the study groups (Table II). When patients were evaluated independently of the groups, the mean preoperative mHHS score of the patients with cyst was significantly lower compared to the patients without cyst (58.8±12.3 *vs.* 60.3±12.7, p=0.026). No significant difference was observed in the baseline VAS scores of the patients with and without cyst. The mean change in the mHHS score and the mean percentage change in VAS score were significantly higher in the patients with femoral cyst compared to the patients without femoral cyst (mHHS score: 28.1±14.0 *vs.* 22.5±14.1, p=0.002; VAS score: 61.9±30.2 *vs.* 52.6±47.4, p=0.038). No significant differences in the change mHHS (p=0.421) and VAS (p=0.766) scores were observed between the patients with and without acetabular cysts (Table II).

For the change over time in mHHS score, the ANCOVA model identified a significant main effect of cyst (F (1, 250)=9.350, p=0.002) and a two-way interaction between group and cyst (F (3, 250)=2.650, p=0.049), based on the adjustment for baseline mHHS score, age, and sex (Table III). The significant interaction term indicated that the effect of group on the change in mHHS score over time depended on the presence of a cyst. In cam, pincer, and mixed groups, the mean increase in mHHS scores were higher in the patients with cyst (Figure 3a). The post-hoc analyses revealed that, particularly in the pincer group, the increase in the mHHS score over time for patients with cysts was significantly higher than the patients without cysts (38.1±11.1 *vs.* 19.3±13.5, p<0.001). In the ANCOVA model using cyst size, the main effect of the cyst size was found to be significant on the change in mHHS score over time (F(2, 246)=3.043, p=0.049). The post-hoc analysis revealed that, in overall the patients with a cyst size of >8 mm, had a significantly higher increase in mHHS scores compared to those with a cyst size of <5 cm (29.5±12.9 *vs.* 23.5±13.8, p=0.043).

For the percentage change in VAS score over time, the main effect of cyst was found to be statistically significant (F(1, 250)=4.083, p=0.044), while the main effects of group and the interaction effect between group and cyst were not significant. In overall,

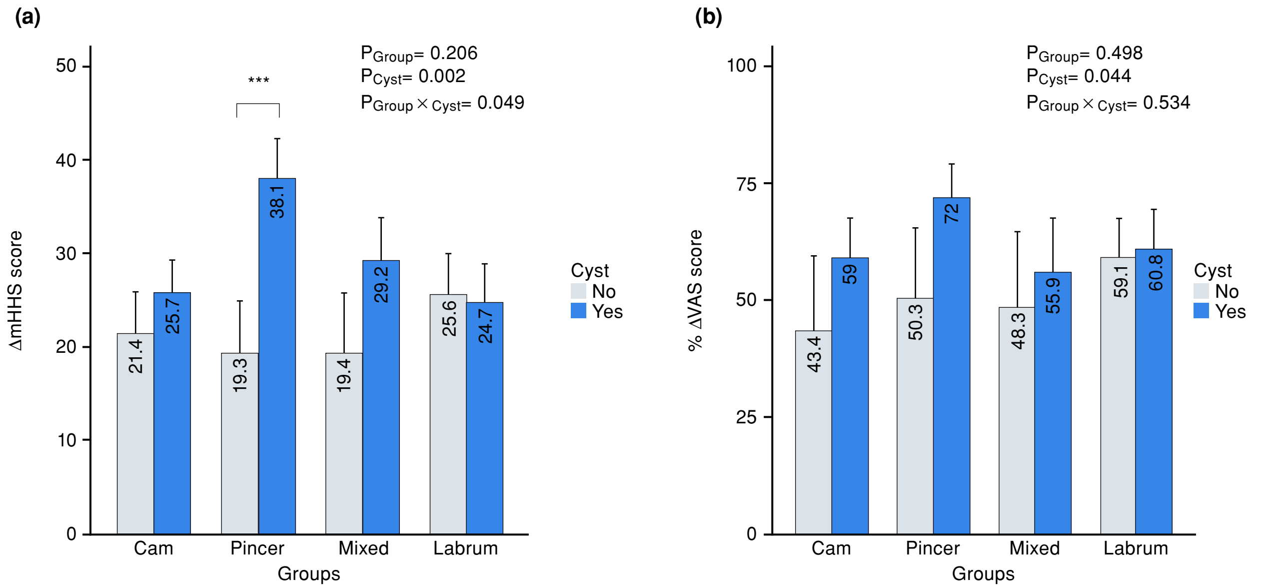

FIGURE 3. (a) Comparison of mean change of the mHHS scores in patients with and without a cyst across study groups. **(b)** Comparison of percentage mean change of VAS scores in patients with and without a cyst across study groups. Error bars represent 95% confidence interval of the mean.
mHHS: Modified Harris Hip Score; VAS: Visual Analog Scale.

the patients with cyst, had a significantly higher reduction in the VAS scores compared to those without a cyst (61.2±29.8% *vs.* 51.2±46.9%, p=0.044) (Figure 3b). Furthermore, when the cyst size was used in the ANCOVA model, the main effect of cyst size had borderline significance (F(2, 246)=2.984, p=0.052).

DISCUSSION

The formation process of subchondral cysts has not yet been definitively elucidated in the literature. Freund[11] and Landells[12] reported that increased intraarticular pressure might force the synovial fluid to pass from the damaged cartilage region to the subchondral region forming a subchondral cyst. McErlain et al.[13] showed the role of stress-induced bone resorption in subchondral cyst formation as a result of instability in their study with the unstable knee model they created in rodents. Similarly, Dürr et al.[14] used a finite element model of the hip joint and reported that microfractures in the subchondral region associated with increased stress could be effective in the formation of subchondral cysts. Although it is still unclear whether the formation of a subchondral cyst is primarily caused by articular cartilage or the subchondral bone failure, acetabular subchondral cyst has been found to be associated with cartilage lesions in the hip joint. Krych et al.[15] scanned the MRIs of patients undergoing hip arthroscopy and concluded that acetabular cysts were associated with full-thickness cartilage damage and low functional outcomes. In the current study, the effect of the presence of subchondral cysts in both the femur and the acetabulum on postoperative clinical scores was analyzed. Patients with subchondral cysts at the femoral head-neck junction had a higher increase in mHHS scores than those without cysts, while a statistically significant difference was found only in the pincer group.[16] This result may be due to the more severe preoperative symptoms in the pincer group patients.[17] In addition, the decrease in the VAS scores of patients with cysts was statistically higher than those without cysts. Another important finding is that patients with cysts larger than 8 mm benefited more from arthroscopic treatment. Considering the hypotheses in the formation of subchondral cysts, this result may have been obtained due to the decreased hip contact pressure after arthroscopy treatment of lesions seen in FAI.[18] In addition, although acetabular cysts were more common in the pincer group and, unlike the results obtained by Krych et al.,[15] no statistically significant difference in the postoperative clinical score changes was found between the patients with and without acetabular cysts in our study. We attribute this result to exclusion of patients with chondral lesion.

In a morphological study by Hetsroni et al.,[19] patients with hip pain were analyzed according to their sex. The authors found smaller alpha angle, increased acetabular anteversion, and increased femoral anteversion in women. This morphological difference also explains the indistinct and rarer occurrence of cam lesions in women. In a prospective comparative study, FAI types were more common in males[20] and labral tears were more common in females.[21] The sex distribution according to the pathologies in the present study is consistent with the literature. The number of male patients was higher in the FAI groups, while the majority of the cases with labral pathologies were females. Since we included all patients between a specific time period, the sex distribution differed across the groups.

In a retrospective study, Leunig et al.[22] evaluated the patients who underwent hip arthroscopy for FAI and reported that subchondral cysts were radiographically visible in 18% of the patients. Since the presence, localization, and size of these cysts can be analyzed in more detail with MRI,[22,23] we used preoperative MRI images of the patients for radiological evaluation. In addition, the location of the cysts in the femur was also analyzed. The anterosuperior quadrant has also been shown as the most common location in previous studies.[22] In our study, it was most commonly located in the anterosuperior quadrant, followed by the posterosuperior quadrant in all groups. The similarity of cyst locations in the groups also increases the reliability of the present study. However, the localization of the cyst was not related to the clinical score changes of the patients.

In a systematic review evaluating 904 patients with FAI in 18 studies, the postoperative mHHS was excellent in six studies (92.1-98.0), good in 10 studies (84.2-88.5), and in one study (77.1) found to be medium.[24] In addition, the rate of return to sports varied between 72.7% and 100%, with 74.2 to 100% of these athletes returning at a pre-injury or higher level. In another meta-analysis, the results of 16 studies using mHHS were examined and postoperative clinical score changes in all three types of FAI were similar.[25] Menge et al.[26] evaluated 79 patients who underwent labral repair and reported mHHS increased from 65 to 85. Di Benedetto et al.,[27] on the other hand, reported an increase in the mean mHHS scores from 67.21 to 82.17. In this study, an increase in mean mHHS and a decrease in VAS scores were detected in all study groups and control group, consistent with the literature.[24]

Nonetheless, there are some limitations to this study. First, this is a retrospective study in which the data were collected prospectively. Second, since we excluded patients with chondral lesions from the study, we did not give a definite opinion about patients with subchondral cysts and chondral injury together. Finally, since the follow-up MRIs of the patients were not available, the effect of the decreased hip contact pressure with arthroscopic treatment on the cyst could not be evaluated.

In conclusion, our study results showed that subchondral cysts in the femoral head and neck junction accompanied cam-type and mixed-type FAI, while subchondral cysts in the acetabulum accompanied pincer-type impingement. In all groups, the mean increase in mHHS scores and the mean decrease in VAS scores were higher in patients with subchondral cysts than in patients without cysts. Based on these findings, in patients with subchondral cysts, if the lesion causing FAI is treated arthroscopically, it can positively affect the functional results.

Ethics Committee Approval: The study protocol was approved by the Gazi University Clinical Research Ethics Committee (date: 18.10.2021, no: 15). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea, study design, figures: M.Ç., T.A., U.K.; Data collection, materials: M.Ç., A.V.; Control/supervision: M.Ö., U.K; Analysis and/or interpretation: O.K., T.A.;Literature review, critical review: M.Ç., A.Y.K., T.A.

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