The Factors Affecting the Baker Cyst Volume, Emphasis on Cartilage Lesion Degree and Effusion in a Young and Middle-Aged Population

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Abstract

Background: The principal aim of this study was to investigate the presence of factors affecting the Baker's cyst volume in a young and middle-aged population.

Methods: 85 patients were treated with open cyst excision with valve and capsule repair, with knee arthroscopy. The cases were categorized in terms of age, effusion, chondral lesion degree, meniscal tear degree, and Lindgren scores. The USG device was used to calculate cyst volume. The IBM-SPSS 22 program was used for the statistical analysis and to assess the relationship between variables using the Spearman correlation tests.

Results: The degree of the chondral lesion was moderately and positively correlated with cyst volume in the total population. (Correlation coefficient: 0.469, $p<0.05$).

The degree of the chondral lesion was moderately and positively correlated with the effusion degree of effusion (correlation coefficient: 0.492, $p <0.005$). The cyst volume was weakly and positively correlated with the degree of effusion. (Correlation coefficient: 0.20, the correlation was at the limits of statistical significance $p=0,07<0,08$).

Conclusion: This study revealed that an increase in chondral lesion severity particularly increases the amount of effusion and cyst volume.

Introduction

Generally speaking, joint pathologies like chondral lesions and meniscal tears affect effusion, which leads to an increase in (the Baker) cyst's volume [1]. A cystic mass with large effusion within the popliteal region of the knee was first reported by Guillaume Dupuytren in 1829 [2]. In 1840, Robert Adams explained the correlation between rheumatoid arthritis and swelling of this cystic mass [3]. Subsequent anatomical dissection studies determined the mass to be the distension of the bursa, located between the semi membranous tendon and the medial head of the gastrocnemius muscle [4–6]. In 1856, Foucher also reported a case of recurrent cyst that became firm with full knee extension and softer with flexion, which subsequently resulted in the term "Foucher's Sign" being coined in such cases [7]. In 1877, Baker confirmed the entity as a "bursal distention" caused by the trapping of fluid in a bursa in direct relation to the semi-membranous tendon. Moreover, Baker explained that the communication between the cyst and joint synovium behaves as a one-way valve, with fluid leaking into the bursa with no possible flow in the reverse direction. He defined the possibility of a ruptured bursa, which resembled a venous thrombosis, and for that reason, Baker's name was incorporated in the clinical entity of a popliteal cyst, i.e. "Baker's Cyst" [8, 9].

Baker's Cyst is strongly associated with the existence of intra-articular pathologies like chondral lesions, meniscal tears, and osteoarthritis etc., with a reported incidence of approximately 94% in some series [10, 11]. Any pathology that causes significant and persistent joint effusion can lead to Baker's Cyst

[12], however this will depend not only on the presence, but also on the extent and severity of the pathology. The literature can be divided into two based on this: the first group of studies correlates the extent of pathologies with Baker's Cyst [13–15], while the other group correlated only the presence and absence of pathologies [16–23].

As seen in the literature review, there have been plenty of association reports; however, the quantification of cyst size (calculating the approximate volume) and a probable relationship between cartilage lesion degree, effusion degree and cyst volume, were only reported in one study by Balik et al.[14]. For their part, Rupp et al. reported that articular cartilage lesions were most often associated with a popliteal cyst [22], whereas Yuelong Cao et al. found that popliteal cyst, or subgastrocnemius bursitis, was significantly and positively associated with knee cartilage defects at the medial and lateral tibiofemoral sites, before and after adjustment for age, sex, BMI, disease status and knee radiographic features [21].

The main objective of this study was to assess the factors affecting Baker cyst volume, its importance on effusion, and degree of cartilage damage degree in the young and middle-aged population.

Material And Method

This retrospective study was properly submitted to and approved by the Ethics Committee of our institution and was duly registered under the protocol. The data from **164** patients with an identified Baker's cyst of at least ≥ 3 cm in diameter were gathered between January 2009 and December 2017. Screening included all patients with a popliteal mass or mass-like symptoms, including pain in the popliteal fossa and/or various degrees of joint limitation, consistent with physical findings of a probable Baker's Cyst. All information was obtained using ultrasound (USG) and magnetic resonance imaging (MRI). Twenty-eight (**28**) patients with seronegative and seropositive arthritis were

excluded from this study. All the remaining 136 patients received conservative treatment for approximately six months before the decision to proceed with surgical treatment was made. Conservative treatment included application of ice, rest, and the use of non-steroidal anti-inflammatory drugs. Among our study group, improvement in symptomology was achieved with conservative treatment in 16 patients, with another 15 patients improving with the use of intracity injections. Five patients were lost during follow-up, with the remaining 100 patients (combining 103 knees) resisting conservative treatment. In addition to the patients aged 60 years or older, patients who had developed osteophytes and advanced joint narrowing, indicating mild to severe osteoarthritis, identified through direct radiography examination and classified according to the Kellgren-Lawrence scale as well as the patients who had Kellgren-Lawrence grade 3–4 osteoarthritis, were excluded from the study in order to avoid bias resulting from probable aging-related osteoarthritis: a total of 15 patients combining 18 knees. In addition, the patients (young and middle-aged) who had chondral lesions resulting from a sprain or any other trauma to the knee were also included in our study.

Finally, 85 patients (53 women and 32 men) who were treated with open cyst excision with valve and capsule repair using knee arthroscopy that targeted associated intra-articular pathologies, were included in this study. The patients were categorized in terms of age, sex, effusion level, chondral lesion degree, meniscal tear degree, and the Rauschning-Lindgren scores **(see** Table 1**)**. The mean age of the total population was determined to be 46.9 ± 9.2, from a range of 22 to 59 and the chondral lesion degree was graded by applying the modified Outerbridge [24] classification (**See Fig. 1,2 and see** Table 2**)**; the graded results were confirmed with arthroscopy (See Fig. 1).

Table 1
Rauschning and Lindgren grading of knee joint symptoms

Rauschning and Lindgren grading of knee joint symptoms *				
	Grade 0	Grade 1	Grade 2	Grade 3
Swelling and pain	no swelling or pain	slight swelling and discomfort after strenuous exercise	moderate swelling and pain following moderate exertion	considerable and tense swelling, severe pain interfering with activities of daily living, pain at rest
Range of motion	no limitation of range of motion	some giving-way or weakness, muscular atrophy < 1 cm	limitation of range of motion between 10 and 20 degrees	limitation of range of motion > 20 degrees
Instability and weakness	no instability or weakness	negligible limitation of range of motion (< 10 degrees)	slight or moderate instability, locking, and muscular atrophy 1–2 cm	disabling instability, contractures, and muscular atrophy > 2 cm
Situation at work or sports participation	no limitation in work or sports participation	no hard labor, no elite sports participation	no physical work, limited participation in sports	stopped working due to knee derangement, no participation in sports
* Rauschning W, Lindgren PG. Popliteal cysts (Baker's cysts) in adults. I. Clinical and roentgenological results of operative excision. Acta Orthop Scand. 1979;50(5):583–591.				

Table 2
Outerbridge classification.

Grade	**Description**
Grade 0	normal cartilage
Grade 1	signal intensity alterations with an intact surface of the articular cartilage compared with the surrounding normal cartilage
Grade 2	partial thickness defect of the cartilage
Grade 3	fissuring of the cartilage to the level of the subchondral bone
Grade 4	exposed subchondral bone

Using MR images, the meniscal tears were classified as normal meniscus, Grade 0, with Grades I and II having an intra-meniscal signal that does not extend the free edge. Grade III had a signal shift that abuts the meniscus free border, suggesting a meniscal tear [25]. The Lindgren score value change and distribution of the patients regarding age, chondral lesion, effusion, and the meniscal injury degree, were thus recorded. (**See** Table 3)

Table 3
For analysis, cases were categorized in terms of age, sex,effusion,chondral lesion degree, mensical tear degree and the Rauschning-Lindgren knee scores.

Lindgren score value change &distribution of the patients regarding to age, chondral lesion, effusion and meniscal degree .									
	Age	Gender	Meniscal Tear	Chondral Lesion Degree (Notice the text, about the chondral lesion degree determination)	Effusion	Three dimensions of cyst	Cyst Volume (cm^3)	Lindgren pre op	Lindgren postop
1	49	F	2	5	moderate	5 × 3 × 3	23,535	3	1
2	53	F	2	1	minimal	4 × 2,5 × 1.8	9.414	1	0
3	44	M	0	4	moderate	6 × 3 × 4	37.656	2	0
4	43	F	2	0	minimal	4 × 2,5 × 3	15.69	1	0
5	44	F	3	5	severe	5,5 × 2,5 × 1,1	7.91	3	1
6	53	F	2	0	moderate	5 × 3 × 2,5	19.61	2	0
7	53	M	2	0	minimal	3,5 × 2 × 3	10.983	1	0
8	58	M	3	2	severe	3 × 2 × 1,5	4.707	2	0
9	45	F	2	2	minimal	4 × 2 × 2,5	10.46	1	0
10	54	F	2	5	severe	7.2 × 3,5 × 2,5	32.949	2	1
11	34	F	2	2	minimal	5.2 × 2 × 3	16.317	1	0
12	50	F	2	3	severe	3,5 × 1,5 × 2	5,491	2	1
13	50	F	2	2	moderate	4,5 × 3 × 2,5	17.651	2	0
14	31	F	0	3	moderate	3,5 × 2 × 3	10.983	2	1
15	34	M	1	2	moderate	5 × 1.7 × 2	8.891	2	0
16	56	M	1	3	severe	5 × 1.6 × 2	8,368	3	1
17	46	M	1	2	moderate	3,5 × 2 × 1,5	5.491	1	0
18	47	F	1	3	minimal	3 × 2 × 6	18.828	2	0
19	44	M	0	4	moderate	4.2 × 2 × 1,5	6.589	2	0
20	31	F	1	3	minimal	3.2 × 2,5 × 2	8.368	1	0
21	39	F	0	3	moderate	5.8 × 3.7 × 2.3	25,814	2	1
22	54	M	1	4	severe	4 × 2,5 × 2,1	10.983	2	0
23	33	M	2	3	moderate	3.8 × 2 × 1.8	7.154	2	0
24	50	M	2	4	severe	6 × 2,5 × 1,5	11.767	2	1
25	30	F	2	1	minimal	4,5 × 3 × 1,5	10.59	1	0
26	43	F	0	2	minimal	4,5 × 3 × 2	14.121	1	0
27	22	M	2	0	severe	4 × 3 × 2,5	15.69	1	0
28	51	F	2	4	severe	4 × 2,5 × 2	10.46	2	1
29	57	F	2	4	moderate	6.2 × 2,5 × 3,5	28,372	2	1
30	44	F	1	7	severe	10,5 × 2,5 × 3	41.186	3	0

Lindgren score value change &distribution of the patients regarding to age, chondral lesion, effusion and meniscal degree .									
31	49	F	1	2	minimal	3,5 × 2,5 × 3	13.728	2	0
32	31	M	2	2	minimal	3,5 × 4,5 × 2	16.474	1	0
33	53	F	1	2	minimal	6 × 1,5 × 2	9.414	1	0
34	57	F	2	**8**	severe	8,5 × 4 × 3	53.346	2	1
35	59	F	1	3	minimal	3,5 × 4 × 4,5	32.949	1	0
36	43	M	1	4	minimal	3,5 × 4,5 × 3	24.711	2	1
37	42	F	0	**7**	severe	9 × 3,5 × 2,5	41.186	1	0
38	28	M	2	2	minimal	3 × 5 × 2	15.69	1	0
39	59	F	2	4	severe	6 × 1,5 × 2,5	11.767	2	1
40	56	F	1	3	moderate	5 × 4 × 2,5	26.15	2	1
41	41	M	2	2	minimal	3,5 × 2 × 2,5	9.152	2	0
42	45	F	2	4	severe	6 × 3,5 × 1	10.983	2	1
43	49	M	0	2	minimal	5 × 3 × 2,5	19.61	1	0
44	59	M	3	4	minimal	5 × 2,48 × 2,**3**	**14.915**	3	1
45	58	M	2	2	minimal	3,5 × 1.7 × 1,5	4.66	2	0
46	50	F	2	2	minimal	3,5 × 2.8 × 2.3	11.788	1	0
47	26	F	0	0	minimal	3 × 3.2 × 2.2	11.045	1	0
48	58	F	3	**6**	severe	3,5 × 7 × 2,5	32.03	3	1
49	38	M	2	2	minimal	3 × 3 × 2,5	11.767	1	0
50	54	M	1	4	minimal	6 × 3 × 1	9.41	3	1
51	43	F	1	**8**	moderate	12 × 5 × 2,5	78.45	2	0
52	44	M	2	2	severe	8,5 × 4,5 × 1,5	30.007	1	0
53	56	M	1	2	moderate	5 × 2 × 2	10.46	1	0
54	43	M	2	0	minimal	5 × 1,5 × 1,**2**	4.707	1	0
55	37	M	2	0	minimal	3 × 6,5 × 2	20.39	1	0
56	34	M	2	2	minimal	6,5 × 2,5 × 2	16.997	1	0
57	53	M	2	**7**	severe	8,5 × 4 × 3	53.346	2	0
58	48	F	2	2	minimal	3 × 6 × 2,5	23.535	3	1
59	48	M	2	0	moderate	3.2 × 2.8 × 1,5	7.029	1	0
60	31	M	2	3	moderate	4,5 × 1.7 × 3	12.002	2	0
61	48	F	2	2	minimal	5 × 3 × 2	15.69	1	0
62	58	F	2	2	minimal	6.1 × 2 × 1.7	10.847	3	0
63	58	F	3	5	severe	3.1 × 6.9 × 2,**1**	**23.492**	3	1

Lindgren score value change &distribution of the patients regarding to age, chondral lesion, effusion and meniscal degree .									
64	54	F	2	**3**	moderate	6.1 × 2.6 × 2,**3**	**19.077**	2	0
65	27	F	2	0	moderate	4.2 × 1.8 × 1,**8**	7.116	1	0
66	50	F	1	4	minimal	6,5 × 3 × 2	20.397	2	0
67	35	M	2	0	minimal	5 × 1.2 × 1,**1**	3.451	1	0
68	53	F	2	5	severe	5.9 × 2,5 × 2,**4**	**18.51**	2	1
69	54	F	1	3	severe	6 × 2,5 × 1,**5**	**11.767**	3	2
70	47	F	2	0	minimal	7.8 × 2 × 1,**1**	**8.974**	1	0
71	58	F	2	2	severe	8.4 × 1.3 × 1,2	6.853	1	0
72	57	F	2	2	minimal	5.7 × 2,5 × 2	**14,905**	2	1
73	50	F	2	3	severe	8,5 × 4 × 1,**2**	**21.338**	2	1
74	49	F	2	2	severe	4,5 × 2 × 1,**9**	**8.943**	1	0
75	41	F	0	2	moderate	7,5 × 2 × 2	**15.69**	1	0
76	51	F	0	3	severe	5 × 2,8 × 2,7	**19.769**	2	0
77	47	M	2	0	minimal	5 × 3 × 2,**1**	16.474	1	0
78	58	F	2	2	minimal	5 × 2 × 1,**3**	**6, 799**	2	0
79	50	F	2	**7**	severe	9 × 4,5 × 2	42.363	2	0
80	50	M	2	4	severe	5 × 4,5 × 2,**1**	**24.711**	3	2
81	44	F	2	2	moderate	3.2 × 1,5 × 1,**4**	**3.514**	1	0
82	58	F	0	**4**	minimal	3.6 × 1.7 × 1,**6**	**5.121**	2	1
83	50	K	2	2	severe	9.2 × 3 × 1,**2**	**17,321**	2	0
84	48	M	2	0	minimal	5 × 2.29 × 1	**5.988**	1	0
85	54	F	2	4	minimal	8 × 5 × 1,**1**	**23.012**	2	0

For a linear statistical evaluation, cases with two or more separate chondral lesions, such as combined patellofemoral and femoral medial condyle lesions, were assessed. In other words, a case with a Grade 3 medial femoral condyle Grade 3 lesion and an additional patellar cartilage Grade 2 lesion was recorded as Grade 5, suggesting that each chondral lesion had the potential to generate effusion of their own.

For cyst volume calculation, the cyst radius was measured in three dimensions and these measurements were entered into the USG device (Samsung HS50TM, South Korea). The device calculated the volumes automatically using the standard formula for calculating of the volume of the ellipsoid objects [25]. The degree of effusion was graded according to Martí-Bonmatí L et al.'s study [14]. Effusion was classified either as minimal: Grade 1 (liquid within lateral recesses or the suprapatellar bursa), moderate: Grade 2 (mild effusion, with both the lateral and suprapatellar recesses filled) or severe: Grade 3 (severe effusion associated with marked distension of the joint cavity).

All raw data after the calculations and measurements are listed in Table 3. The average values and standard deviations of meniscal tear and chondral lesion degree, effusion, cyst volume, age, Lindgren pre-op, post-op and Lindgren changes are listed in Table 4.

Table 4
The avarege values and standard deviations of mensical tear, chondral lesion degree, effusion, Cyst volume, age, Lindrgen pre-op,post-op, and Lindgren change

Descriptive Statistics				
	Minimum	Maximum	Mean	Std. Deviation
Meniscal tear	1,00	4,00	2,58	0,82
Chondral lesion degree	1,00	8,00	2,94	1,71
Effusion	1,00	3,00	1,88	0,86
Cyst volume	3,45	78,45	17,25	12,63
Age	22,00	59,00	46,86	9,17
Lindgren preop	1,00	3,00	1,73	0,70
Lindgren postop	0,00	1,00	0,29	0,46
Lindgren change	1,00	3,00	1,40	0,54

The IBM-SPSS 22 software was used for the statistical analysis and to assess the relationship between variables, using Spearman correlation tests and to determine the strength and direction of those relationships. The Kolmogorov-Smirnov test was used to assess the normality of the distribution of data, whereas the preoperative and postoperative Lindgren values were evaluated using the Wilcoxon signed ranks test. Chondral lesion and cyst volume variables were recorded and analyzed for a possible relationship, where the statistical significance level was set as $p < .05$. Correlations (denoted as “r”) have different strengths [27]. The relationship between the degrees of the chondral lesion and cyst volume was evaluated using the Spearman correlation test (total population).

The relationship between the degree of the chondral lesion and age, the relationship between the chondral lesion degree and the change between the Lindgren score, the relationship between the degree of the chondral lesion and the degree of effusion as well as the relationship between the degree of effusion and cyst volume, was all evaluated using the Spearman Rank Correlation (Spearman's Rho) test **(see** Table 5**).**

Table 5
Correlations among age, imaging, and arthroscopic findings

Correlations [c]								
			Meniscal tear degree	Chondral lesion degree	Effusion	Cyst Volume	Age	Lingdren change value
Spearman's rho	Meniscal tear degree	Correlation Coefficient	1,00	-0,13	0,09	-0,10	0,19	0,04
		Sig. (2-tailed)		0,22	0,40	0,35	0,08	0,73
	Chondral lesion degree	Correlation Coefficient	-0,13	1,00	0,492**	0,469**	0,324**	0,345**
		Sig. (2-tailed)	0,22		0,00	0,00	0,00	0,00
	Effusion	Correlation Coefficient	0,09	0,492**	1,00	0,20***	0,19	0,11
		Sig. (2-tailed)	0,40	0,00		0,07***	0,08	0,32
	Cyst Volume	Correlation Coefficient	-0,10	0,469**	0,20	1,00	0,07	0,13
		Sig. (2-tailed)	0,35	0,00	0,07		0,53	0,24
	Age	Correlation Coefficient	0,19	0,324**	0,19	0,07	1,00	0,232*
		Sig. (2-tailed)	0,08	0,00	0,08	0,53		0,03
	Lingdren change value	Correlation Coefficient	0,04	0,345**	0,11	0,13	0,232*	1,00
		Sig. (2-tailed)	0,73	0,00	0,32	0,24	0,03	
(**) Correlation is significant at the 0.01 level (2-tailed).								
(*) Correlation is significant at the 0.05 level (2-tailed).								
c. Listwise N = 85								
(***) The correlation was at the limits of statistical significance (p = 0,07 < 0,08)								
r: Coreelation coefficent, r = 0.100 to 0.300 = Weak correlation/relationship								
r = 0.300 to 0.500 = Moderate (Fair) relationships/Medium correlation								
r = 0.600 and above = Strong relationship/high correlation.								

Results

Over the 4-year follow-up period, US and MRI imaging was performed only on symptomatic patients. Overall, 9 patients reported discomfort and pain over the follow-up period, with four patients undergoing US imaging and four more undergoing MR imaging. A recurrent cyst was identified in two of these patients, with an overall incidence rate of 2.3%. The preoperative and postoperative Lindgren values showed a significant improvement (Wilcoxon signed ranks test, p < 0,05).

The degree of the chondral lesion showed a moderate positive correlation with cyst volume in the total population (Spearman's Rho, Correlation Coefficient: 0.469, statistically significant at p = 0,000 < 0.05, see Table 2). The degree of the chondral lesion also showed a moderate positive correlation with age (Spearman's Rho, Correlation Coefficient: 0.324, statistically significant at p = 0,000 < 0.05). The degree of the chondral lesion showed a moderate positive correlation with Lindgren's value change (Spearman's Rho, Correlation Coefficient: 0.345, statistically significant at p = 0,000 < 0.05). The degree of the chondral lesion showed a moderate positive correlation with the degree of effusion (Spearman's Rho, Correlation Coefficient: 0.492, p < 0.005). The cyst volume showed a weak positive correlation with the degree of effusion (Spearman's Rho, Correlation Coefficient: 0.20, the correlation being at the limits of statistical significance p = 0,07 < 0,08). There was no statistically significant relationship between age and cyst volume (Spearman's Rho, p > 0,05). No significant connection was found between the meniscal tear and the cyst volume, effusion degree and change in Lindgren's value. (Spearman's rho, p > 0,05). There was no

statistically significant relationship between Lindgren value changes and cyst volume, effusion degree and chondral lesion degree (Spearman's Rho, $p > 0,05$).

Discussion

The possible correlation between cyst and intraarticular pathologies is a long-debated issue within the medical community. Our literature review, which found many articles about associations or relations between the intra-articular pathologies and Baker's Cyst, brought us to divide the results into two groups. The first group included studies on the relationship between the cartilage lesions [13–15], effusion degree, meniscal tear degree and cyst volume, while the second group included studies on the association between cartilage lesions, effusion, meniscal tear, and cysts [16–23]. (**see** Table 6)

Table 6
The literature that were concerning about associations/ relations between the intraarticular pathologies and Baker cyst.

The Current Literature that were concerning the relation between the meniscal tear degree, cartilage lesion degree, effusion degree and cyst volume								
	The number of subjects	Chondral lesion degree & Cyst size (positive relationship)	Meniscal lesion degree & Cyst size (positive relationship)	Effusion degree & Cyst size (positive relationship)	Plica existence & Cyst size (positive relationship)	Statistical method	Quantification	
Vasilevska et al. [12]	66	+	+			Chi-square test and (Mann-Whitney U test	weak	
Balık MS et al. [13]	45	+		+	+	Kolmogorov–Smirnov test, Mann–Whitney U test and Kruskal–Wallis test	Strong	
Martí-Bonmatí L, et al. [14]	145		+	+	-	Pearson correlation test	weak	
Current study	85	+		+	-	Spearman Correlation test	Strong	
The Current Literature that were concerning the association between the cartilage lesion, effusion, meniscal tear existence and cyst existence								
	The number of subjects	Chondral lesion & cyst existence association	Meniscal tear & cyst existence association	Effusion existence & cyst existence association	Plica existence & Cyst size (positive relationship)	Statistical method	Quantification	
Peter Larking[19]	Review article	-	+	-	-	None (Because the article is report or review)	None	
Yuelong Cao et al [20]	105	+	-	-	-	Multivariate logistic regression	None	
Rupp S, et al.[21]	100	+	-	+	-	Maentel-Haenszel test.	None	
Childress HM (1970) [14]	36	-	+	-	-	None (observational study)	None	Early ages (There was no arthrscopy and MRI)
Miller et al. (1996)[18]	400	+	+	+	-	Multivariate logistic regression	None	
Sansone and De Ponti (1999) [16]	46	+	+	-	-	Chi-Square Statistic	None	
Stone KR, et al (1996) [17]	238	-	+	-	-	None	None	

Childress HM (1970) can be considered as one of the first authors to show a strong association of the medial meniscal tears with Baker' Cysts [16]. In their own evaluation of the MR images of some 400 knees, Miller et al. (1996) identified a significant relationship between the presence of a Baker's cysts and knee joint effusion, meniscal tears and degenerative arthropathy [18]. They reported, accurately, it seems that the coexistence of a Baker' Cysts in 80.5% of medial meniscal tears, 31% of ACL ruptures, 76.6% of cases of knee joint effusion, and 68% of cases of knee joint degenerative arthritis cases. Nonetheless, the coexistence of a Baker' Cysts with a medial plica, a medial femoral chondral lesion or a lateral meniscal tear was not evaluated, nor was the quantitative correlation between the cyst volume and the degree of the chondral lesion investigated.

Stone KR et al. (1996) and Sansone and De Ponti (1999) for their part, performed a study to investigate the association between the meniscal tear and the Baker' Cysts [17, 18]. They found that meniscal tears were seen in 90% and 83% (respectively) of the knees, in the presence of a popliteal cyst.

Although the literature has plenty of association reports, the quantification of cyst size, calculating the approximate volume, and a probable relationship between cartilage lesion degree, effusion degree and cyst volume, were reported in only one study. Rupp S et al. (2002) reported that articular cartilage lesions were most often associated with a popliteal cyst [22]. They suggested that lesions of the articular cartilage have an essential role in the pathogenesis of secondary popliteal cysts. In those cases, without or with low-grade articular cartilage lesions, the cysts disappeared after arthroscopy, yet there remained some high-grade chondral lesions. Low-grade chondral lesions and meniscal tears can be treated successfully by arthroscopic means, whereas arthroscopic surgery for high-grade chondral lesions often fails to eliminate effusion. This can be explained by the hypothesis that effusion facilitates the fluid leakage through the valve from knee to gastrocnemius-semimembranosus bursa, in adult patients.

Our study supports this hypothesis, with evidence of a direct correlation between cyst volume and the degree of the chondral lesion. Rupp S et al. [22] concluded that the grade of chondral lesions has a more critical effect on the outcome than the presence of meniscal lesions. In cases of degenerative osteoarthritis with grade III or grade IV lesions of the articular cartilage, addressing the intraarticular lesions with arthroscopic surgery to treat the popliteal cyst may be an unrealistic goal. Their findings have led us to conduct this study to determine any connection between the cyst quantity and chondral lesion grade.

Peter Larking, a senior research advisor, prepared a report in 2011 for the government of New Zealand [20]. Although this article is a report presented to a government, the author widely reviewed the literature and examined the possibility of coexistence of Baker' Cysts and other knee pathologies. He emphasized the association between effusion, meniscal tear, degenerative arthritis, and baker cyst [20].

A cross-sectional study published by the Arthritis Research and Therapy Group (2014) reported that cartilage defects were significantly and positively associated with popliteal cysts [21]. Yuelong Cao et al. (2014) found in their cross-sectional study that popliteal cysts or sub-gastrocnemius bursitis were significantly and positively associated with knee cartilage defects at the medial and lateral tibiofemoral sites, before and after adjustment for age, sex, BMI, disease status and knee radiographic features [21]. Moreover, they also reported that, in multivariable analysis, both were significantly associated with medial tibiofemoral BMLs, but not with lateral tibiofemoral bone marrow lesions (BMLs). They graded cartilage defects and investigated the association between the existence of cysts and the degree of cartilage defect [21]. The main difference with our study is that they targeted an older population, namely 50-79-year-old, and thus did not exclude patients who had probable established osteoarthritis.

The literature continues with the examination of the relationship between the intra-articular pathologies and cyst volume (see Table 6). Martí-Bonmatí L et al. (2000) did an MRI-based study in which they categorized the cyst and cartilage lesions [15]. Cyst volume was classified as absent, minimum, moderate and massive. In contrast, cartilage lesions were categorized as either absent, chondropathy, or arthrosis, yet no relationship was established between cyst volume and cartilage lesions.

In our study, the assessment of the cartilage lesions with the aid of the Outerbridge classification and measurement of cyst volume by using a formula to calculate the volume of ellipsoid objects, were both performed.

Initially, the Outerbridge classification was established to assess the degree of patellar cartilage lesions. In our study, we favoured the Outerbridge classification as Kumm J et al. reported that cartilage lesions were seen more commonly in patellar cartilage when they investigated the distribution of pathologies in their knee MRI study.[28]

Even though we had access to a relatively limited number of cases, we were able to gather more numerical data, which aided in avoiding bias and assisted in obtaining more accurate statistical results. In contrast with Marti-Bonmati L et al.'s study, our study demonstrated a direct and positive relationship between cartilage lesion degree and cyst volume.

We also noted that the amount of effusion and cyst volume was also reported as be directly and positively related. Vasilevska et al.'s (2008) study on 66 patients reported that the size of the Baker's Cyst is strongly correlated with degenerative changes of the cartilage and with the degree of meniscus degeneration [13]. However, contrary to both Martí-Bonmatí L et al. and Vasilevska et al., our results did not show an effect of meniscal tear degree over the amount of effusion and cyst volume. We attribute this outcome namely to the distribution of meniscal tears in our group, where the majority consisted of grades 0, 1 and 2 tears, in which the meniscal tears did not reach the joint surface and could not impair joint mechanics to cause effusion. In addition, these two studies did not quantify the Baker's cyst size by calculating the volume, but instead classified their size as either large or small. Furthermore, they measured cartilage thickness on the weight-bearing zone and classified the cartilage degeneration as total (complete), subtotal and absent. For our part, we quantified the size of the cyst by calculating the volume, which provided an advantage in statistical and mathematical accuracy. Additionally, our use of the Outerbridge classification with MRI and by direct vision of arthroscopy enabled us to quantify the degree of cartilage lesion degree. In contrast, finally, we were able to find a statistically significant influence between the knee effusion and cyst size.

Balık MS et al. performed a study (2019) to investigate the relationship between Baker's Cyst's volume and cartilage degeneration, effusion, and the existence of plica in 45 knees [14]. They concluded that an increase in the degree of cartilage degeneration and the existence of medial plicae could cause an increase in intra-articular effusion and cyst volume. This study was remarkably similar to ours and showed parallel results regarding the relationship between the effusion, cartilage lesion degree, and cyst volume [14]. They also showed a similar approach in their results in terms of quantifying cartilage lesions and cyst size. Like us, they did not detect a significant correlation between the meniscal tear degree and cyst volume, although we quantified the cartilage lesions using the Outerbridge classification and had access to a greater number of knees, which enabled some clearer study boundaries.

One important distinction with the Balık et al. analysis should be considered, namely the fact that we observed that some patients had more than one cartilage lesion, the combined impact was considered. We believe that this combination should be considered when looking at the association between Baker's Cyst's volume and cartilage injury.

Another distinct element of our research from the majority of the literature was the chosen patient population. Patients over the age of 60 were excluded from the study to avoid bias linked to age-related osteoarthritis.

In this study, the positive relationship between chondral lesion degree and Lindgren change value should be interpreted as an effective patient therapy since intra-articular issues such as chondral injury and meniscal tears have been carefully handled.

Evidence of the correlation between cyst volume and degree of the chondral lesion has been reported only once in the literature. In the light of this study, surgeons' decisions in the management of Baker's cyst associated with the chondral lesion may lean towards cystic excision and the elimination of the chondral lesion.

The association between internal knee derangements (such as a meniscal tear, cartilage lesions, etc.) and Baker cysts is known. However, this study adds new quantitative information regarding the positive correlation between the combined cartilage lesions (as a combination of patellar cartilage, femoral and tibial condylar cartilage lesion degrees), effusion degree, and cyst volume in the young and middle-aged population.

The limitations of this study are that the calculation of cyst volume yields approximate results, the retrospective nature of the study, and the relatively low number of patients.

Conclusion

Our results revealed that the degree of chondral lesion was significantly correlated with the amount of effusion and cyst volume in our young and middle-aged patients with Baker's Cyst. Moreover, the necessity of eliminating of the chondral lesions in addition to cyst excision in the treatment of Baker's cyst has also been confirmed.

Abbreviations

F: Female

M: Male

MRI: Magnetic Resonance Imaging

USG: Ultrasonography

OA: Osteoarthritis

BMI: Bone mineral intensity

BMLs: Bone marrow Lesion

ACL: Anterior Cruciate Ligament

Declarations

Author Contribution section:

MS contributed to performing surgeries in the cases and collected the data. MS and KG, MSS contributed to the literature scan and established the discussion part together. MS, KG and MSS have been involved in drafting the manuscript or revising it critically for important intellectual content. MS came up with the main idea of the study. All authors have read and approved the final manuscript. All authors approved the final version of the manuscript.

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Informed consent

The written informed consents were obtained from all the patients.

Ethics Committee Approval:

This retrospective study was properly submitted to and approved by the Ethics Committee of our institution and was duly registered under the protocol.

Conflict of Interest.

The Author (s) declare(s) that there is no conflict of interest.

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Figures

Figure 1

The graded results were confirmed with arthroscopy (See Figure 1).

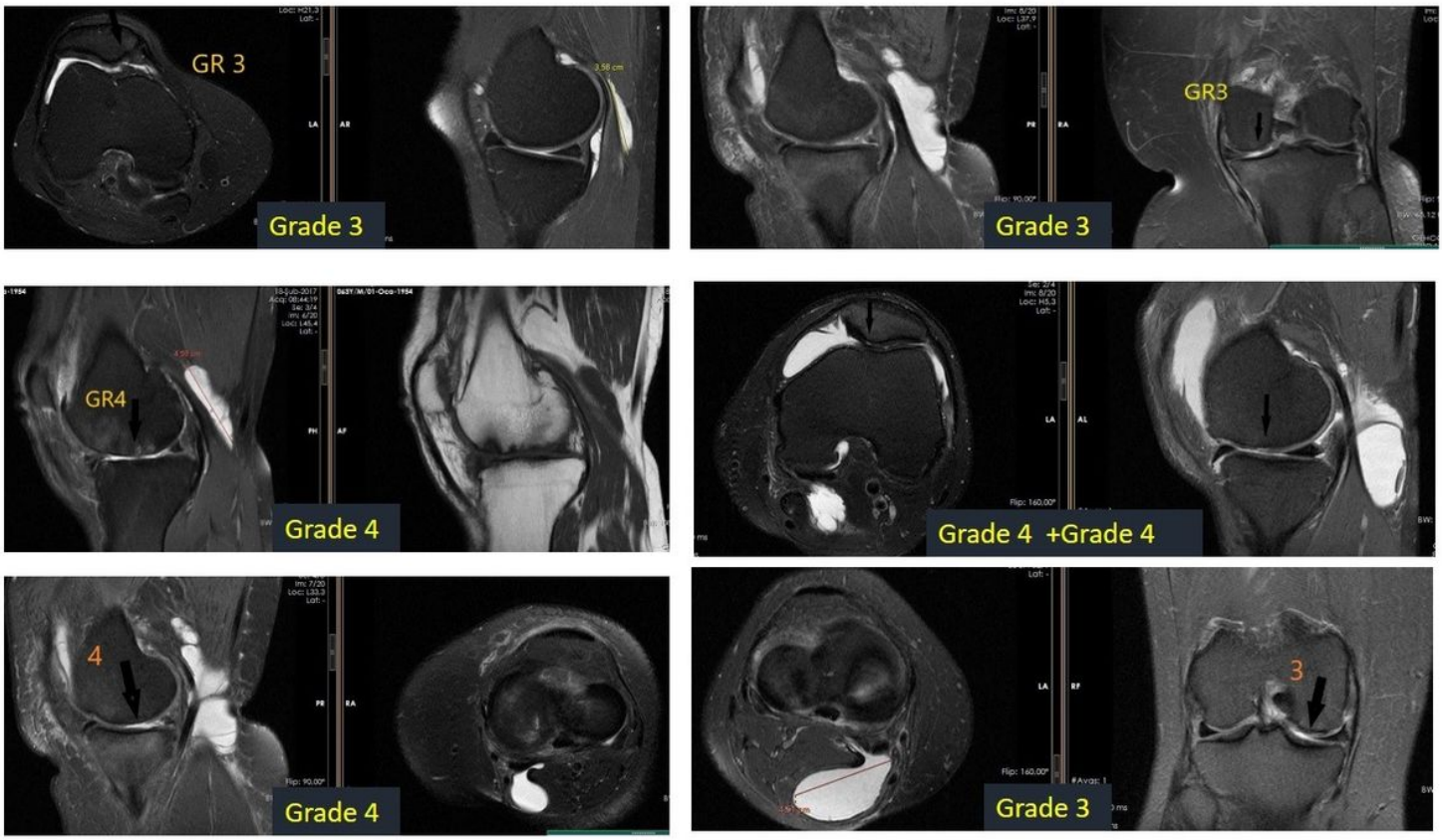

Figure 2

The mean age of the total population was determined to be 46.9±9.2, from a range of 22 to 59 and the chondral lesion degree was graded by applying the modified Outerbridge [24] classification (See figure 1)