Prevalence and Associated Injuries in Patients with Knee Cysts: An Epidemiological Study

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Introduction

With the growing utilization of magnetic resonance imaging (MRI) for assessing the knee joint, the findings of cystic and "cyst-like" lesions have also seen an increase. [1-3,10,11] Associated symptoms vary depending on the size, location, and association with adjacent anatomic structures and span a diverse group of entities ranging from benign cysts to complications of underlying disease processes. [3,4] These lesions can be further subclassified into true cysts (synovial cysts, bursae, ganglia, and meniscal cysts) and lesions that mimic cysts (hematomas, seromas, abscesses, vascular lesions, and neoplasms). [8] Of the various types of lesions within the knee, Baker's cysts are among the most prevalent in the general population, reaching incidence rates of 5% to 38% and increasing with age. [5,6] While these cysts can be incidental, they are encountered frequently in adults with traumatic knee history or association with degenerative knee joint diseases such as osteoarthritis (OA), rheumatoid arthritis (RA), or pigmented villonodular synovitis. [9]

Beaman et al. report that MR is the gold standard for visualizing cystic lesions.[3] Although MRI can identify a multitude of lesions, from benign cysts, ganglia, and bursae to long term sequalae of underlying conditions such as arthritis, infection, or malignancy, a majority of these lesions are benign and exhibit characteristic imaging.[3-5] However, while most cystic lesions of the knee arise from either herniating ganglia from ligaments and tendons, fluid extravasation from the bursae, or pooled synovium in the joint, there are other processes that can manifest as "cyst-like" findings on MRI, which can result in misdiagnosis.[6-9] Therefore, it is imperative to emphasize the importance of knowledge of various knee cysts to direct therapy and prevent unnecessary arthroscopic procedures.[5]As the detection of these cystic structures within the knee increases, it is essential to emphasize the knowledge of the various types of lesions within the knee as they can present similarly to other pathologic findings. [7] Such that, visualization of cystic masses in atypical locations on MRI should raise concern for neoplasm and warrant further evaluation and intervention [8]. Therefore, determining the associated factors, symptoms and findings that correspond to these various cystic and cyst-like lesions within the knee joint, compared to more advanced pathologies, is clinically important.

Aims and Objectives

The aim of this study is to assess the incidence of various cysts in the knee and evaluate associated injuries, such as cartilage pathology, meniscal tears, and ligamentous tears. Our study will aid physicians in appropriate characterization of cysts within the knee and prevention of misdiagnosis or unnecessary clinical work up.

Methods

A search was performed to identify cyst and "cyst like" lesions around the knee. A retrospective review of patients who underwent magnetic resonance imaging (MRI) of the knee for any reason between January 1, 2022, and January 1, 2023, at a single academic institution was conducted. The search was completed via query of the medical health records for all patients who underwent MRI of the knee during this time period to evaluate for internal derangement of the knee. There was no specific ICD9 code utilized. Each MRI report was obtained and thoroughly investigated. Each cyst type and any pathology described was recorded. Inclusion criteria were patients greater than 18 years old with a description of a cystic knee lesion on the MRI report. Exclusion criteria were patients who are younger than 18 years old and MRIs which did not demonstrate an identifiable cystic structure as read by radiology.

Recorded variables from each patient included: age, sex, race, body mass index (BMI), and past medical history which was extracted from the electronic heath record (EHR). Each MRI report was manually reviewed for the presence of a cystic lesion, and the following were also recorded: laterality, MRI indication, cyst type, and associated injuries. Cyst types that were considered included popliteal (baker's) cyst, parameniscal cyst, meniscal cyst and ganglion cyst. The meniscal cyst is defined as synovial fluid within the meniscal material and when it extends outside the meniscus it is defined as a parameniscal cyst.

Associated injuries were further categorized as demonstrated in the right column of table 2: anterior cruciate ligament (ACL) pathology, bone lesion (described as benign per radiologist), bone marrow edema/pathology, bursitis, cartilage defect/chondromalacia, effusion, Hoffa fat pad edema, lateral collateral ligament (LCL)/ fibular collateral ligament (FCL) pathology, lipoma arborescence, loose bodies, medial meniscus tear, lateral meniscus tear, posterior cruciate ligament (PCL) pathology, , medial collateral ligament (MCL) pathology, osteoarthritis, popliteus pathology, tendinopathy (of any muscle surrounding the knee), plica, subchondral fracture, osteonecrosis, and synovitis.

Descriptive statistics were used to summarize all variables. Mean and standard deviation calculations for continuous variables were performed. Continuous variables were also compared with independent samples t-test. Pearson's Chi-Square goodness of fit and tests of independence were performed on categorical variables. The level of significance was set at $p<0.05$.

Results

Of 4,764 MRIs evaluated we identified, 1208 patients (same number of knees) matched the inclusion and exclusion criteria. The prevalence of knee cysts was 25.4%

The most common cysts in the knee with decreasing order of prevalence include baker's cyst (76.4%), ganglion cyst (21.3%), meniscal cyst (21.3%), parameniscal cyst (14.2%). Significantly associated injuries in the presence of a baker's cyst are bursitis (0.027), cartilage defect/chondromalacia (0.017), effusion (0.006), medial meniscus tear (0.032), PCL pathology (0.002), and subchondral fracture (0.004). In addition, baker's cysts were associated with older individuals (<0.001) and female gender (0.042). Significantly associated injuries in the presence of a ganglion cyst are ACL pathology (0.002), PCL pathology (<0.001), medial meniscus tear (0.002), osteoarthritis (0.009), plica (0.024), and tendinopathy (<0.001). Significantly associated injuries for meniscal cyst include medial meniscus tear (0.002). Significantly associated injuries for paramenisical cyst include bursitis (0.001), effusion (<0.001), lateral meniscus tear (<0.001), medial meniscus tear (<0.001) and osteoarthritis (0.008). In addition, paramenisical cyst were associated with younger individuals (0.039) and male gender (<0.001).

Results continued

Table 1. Patient characteristics by Baker's Cyst Presence

	No Baker's Cyst (N=285)	Baker's Cyst (N=923)	Total (N=1208)	P-value
Age, Mean (SD)	57.75 (14.01)	61.49 (12.01)	60.61 (12.60)	**<0.001**
Sex				**0.042**
Female	162 (57.2%)	591 (64.0%)	753 (62.4%)	
Male	121 (42.8%)	332 (36.0%)	453 (37.6%)	
Race				**0.031**
White or Caucasian	223 (78.8%)	791 (85.7%)	1014 (84.1%)	
Black or African American	25 (8.8%)	65 (7.0%)	90 (7.5%)	
Asian	9 (3.2%)	13 (1.4%)	22 (1.8%)	
Native Hawaiian/Pacific Islander	2 (0.7%)	1 (0.1%)	3 (0.2%)	
American Indian/Alaska Native	2 (0.7%)	5 (0.5%)	7 (0.6%)	
Other	22 (7.8%)	48 (5.2%)	70 (5.8%)	
BMI, Mean (SD)	30.36 (6.70)	30.44 (6.56)	30.42 (6.59)	0.765

Table 2. Associated Injury by Baker's Cyst Presence.

	No Baker's Cyst (N=285)	Baker's Cyst (N=923)	Total (N=1208)	P-value
ACL Injury	34 (11.9%)	127 (13.8%)	161 (13.3%)	0.485
Bone Lesion	3 (1.1%)	20 (2.2%)	23 (1.9%)	0.322
Bone Marrow Injury	42 (14.7%)	117 (12.7%)	159 (13.2%)	0.368
Bursitis	30 (10.5%)	59 (6.4%)	89 (7.4%)	**0.027**
Cartilage Defect	186 (65.3%)	672 (72.8%)	858 (71.0%)	**0.017**
Effusion	165 (57.9%)	619 (67.1%)	784 (64.9%)	**0.006**
Hoffa Fat Pad Edema	29 (10.2%)	76 (8.2%)	105 (8.7%)	0.336
LCL Injury	9 (3.2%)	23 (2.5%)	32 (2.6%)	0.530
Lipoma Arborescence	0 (0.0%)	5 (0.5%)	5 (0.4%)	0.597
Loose Body	10 (3.5%)	24 (2.6%)	34 (2.8%)	0.415
MCL Injury	23 (8.1%)	122 (13.2%)	145 (12.0%)	0.021
Lateral Meniscus Tear	109 (38.2%)	332 (36.0%)	441 (36.5%)	0.483
Medial Meniscus Tear	185 (64.9%)	661 (71.6%)	846 (70.0%)	**0.032**
Osteoarthritis	135 (47.4%)	458 (49.6%)	593 (49.1%)	0.542
PCL Injury	18 (6.3%)	22 (2.4%)	40 (3.3%)	**0.002**
Plica	4 (1.4%)	11 (1.2%)	15 (1.2%)	0.762
Subchondral Fracture	5 (1.8%)	53 (5.7%)	58 (4.8%)	**0.004**
Synovitis	34 (11.9%)	100 (10.8%)	134 (11.1%)	0.591
Tendinopathy	54 (18.9%)	151 (16.4%)	205 (17.0%)	0.321

Table 3. Patient characteristics by Ganglion Cyst Presence

	No Ganglion Cyst (N=951)	Ganglion Cyst (N=257)	Total (N=1208)	P-value
Age, Mean (SD)	60.75 (12.71)	60.09 (12.20)	60.61 (12.60)	0.360
Sex				0.128
Female	582 (61.3%)	171 (66.5%)	753 (62.4%)	
Male	367 (38.7%)	86 (33.5%)	453 (37.6%)	
Race				0.907
White or Caucasian	798 (84.1%)	216 (84.0%)	1014 (84.1%)	
Black or African American	73 (7.7%)	17 (6.6%)	90 (7.5%)	
Asian	17 (1.8%)	5 (1.9%)	22 (1.8%)	
Native Hawaiian/Pacific Islander	2 (0.2%)	1 (0.4%)	3 (0.2%)	
American Indian/Alaska Native	6 (0.6%)	1 (0.4%)	7 (0.6%)	
Other	53 (5.6%)	17 (6.6%)	70 (5.8%)	
BMI, Mean (SD)	30.47 (6.56)	30.26 (6.72)	30.42 (6.59)	0.496

Table 4. Associated Injury by Ganglion Cyst Presence.

	No Ganglion Cyst (N=951)	Ganglion Cyst (N=257)	Total (N=1208)	P-value
ACL Injury	111 (11.7%)	50 (19.5%)	161 (13.3%)	**0.002**
Bone Lesion	19 (2.0%)	4 (1.6%)	23 (1.9%)	0.800
Bone Marrow Injury	127 (13.4%)	32 (12.5%)	159 (13.2%)	0.756
Bursitis	70 (7.4%)	19 (7.4%)	89 (7.4%)	1.000
Cartilage Defect	682 (71.7%)	176 (68.5%)	858 (71.0%)	0.315
Effusion	618 (65.0%)	166 (64.6%)	784 (64.9%)	0.941
Hoffa Fat Pad Edema	78 (8.2%)	27 (10.5%)	105 (8.7%)	0.261
LCL Injury	21 (2.2%)	11 (4.3%)	32 (2.6%)	0.079
Lipoma Arborescence	5 (0.5%)	0 (0.0%)	5 (0.4%)	0.591
Loose Body	27 (2.8%)	7 (2.7%)	34 (2.8%)	1.000
MCL Injury	121 (12.7%)	24 (9.3%)	145 (12.0%)	0.160
Lateral Meniscus Tear	350 (36.8%)	91 (35.4%)	441 (36.5%)	0.715
Medial Meniscus Tear	687 (72.2%)	159 (61.9%)	846 (70.0%)	**0.002**
Osteoarthritis	448 (47.1%)	145 (56.4%)	593 (49.1%)	**0.009**
PCL Injury	19 (2.0%)	21 (8.2%)	40 (3.3%)	**<0.001**
Plica	8 (0.8%)	7 (2.7%)	15 (1.2%)	**0.024**
Subchondral Fracture	47 (4.9%)	11 (4.3%)	58 (4.8%)	0.744
Synovitis	91 (9.6%)	43 (16.7%)	134 (11.1%)	**0.002**
Tendinopathy	143 (15.0%)	62 (24.1%)	205 (17.0%)	**<0.001**

Results continued

Table 5. Patient characteristics by Meniscal Cyst Presence

	No Meniscal Cyst (N=1185)	Meniscal Cyst (N=23)	Total (N=1208)	P-value
Age, Mean (SD)	60.57 (12.62)	62.70 (11.87)	60.61 (12.60)	0.464
Sex				0.191
Female	742 (62.7%)	11 (47.8%)	753 (62.4%)	
Male	441 (37.3%)	12 (52.2%)	453 (37.6%)	
Race				0.394
White or Caucasian	994 (84.0%)	20 (87.0%)	1014 (84.1%)	
Black or African American	90 (7.6%)	0 (0.0%)	90 (7.5%)	
Asian	22 (1.9%)	0 (0.0%)	22 (1.8%)	
Native Hawaiian/Pacific Islander	3 (0.3%)	0 (0.0%)	3 (0.2%)	
American Indian/Alaska Native	7 (0.6%)	0 (0.0%)	7 (0.6%)	
Other	67 (5.7%)	3 (13.0%)	70 (5.8%)	
BMI, Mean (SD)	30.45 (6.61)	29.08 (5.19)	30.42 (6.59)	0.481

Table 6. Associated Injury by Meniscal Cyst Presence.

	No Meniscal Cyst (N=951)	Meniscal Cyst (N=257)	Total (N=1208)	P-value
ACL Injury	158 (13.3%)	3 (13.0%)	161 (13.3%)	1.000
Bone Lesion	21 (1.8%)	2 (8.7%)	23 (1.9%)	0.069
Bone Marrow Injury	155 (13.1%)	4 (17.4%)	159 (13.2%)	0.531
Bursitis	88 (7.4%)	1 (4.3%)	89 (7.4%)	1.000
Cartilage Defect	845 (71.3%)	13 (56.5%)	858 (71.0%)	0.161
Effusion	770 (65.0%)	14 (60.9%)	784 (64.9%)	0.665
Hoffa Fat Pad Edema	104 (8.8%)	1 (4.3%)	105 (8.7%)	0.714
LCL Injury	32 (2.7%)	0 (0.0%)	32 (2.6%)	1.000
Lipoma Arborescence	5 (0.4%)	0 (0.0%)	5 (0.4%)	1.000
Loose Body	33 (2.8%)	1 (4.3%)	34 (2.8%)	0.485
MCL Injury	143 (12.1%)	2 (8.7%)	145 (12.0%)	1.000
Lateral Meniscus Tear	434 (36.6%)	7 (30.4%)	441 (36.5%)	0.664
Medial Meniscus Tear	837 (70.6%)	9 (39.1%)	846 (70.0%)	**0.002**
Osteoarthritis	579 (48.9%)	14 (60.9%)	593 (49.1%)	0.296
PCL Injury	39 (3.3%)	1 (4.3%)	40 (3.3%)	0.542
Plica	15 (1.3%)	0 (0.0%)	15 (1.2%)	1.000
Subchondral Fracture	57 (4.8%)	1 (4.3%)	58 (4.8%)	1.000
Synovitis	129 (10.9%)	5 (21.7%)	134 (11.1%)	0.167
Tendinopathy	204 (17.2%)	1 (4.3%)	205 (17.0%)	0.156

Table 7. Patient characteristics by Parameniscal Cyst Presence

	No Paramenisical Cyst (N=1036)	Paramenisical Cyst (N=172)	Total (N=1208)	P-value
Age, Mean (SD)	61.02 (12.29)	58.15 (14.14)	60.61 (12.60)	**0.039**
Sex				**<0.001**
Female	669 (64.6%)	84 (49.4%)	753 (62.4%)	
Male	367 (35.4%)	86 (50.6%)	453 (37.6%)	
Race				**0.071**
White or Caucasian	873 (84.3%)	141 (82.9%)	1014 (84.1%)	
Black or African American	82 (7.9%)	8 (4.7%)	90 (7.5%)	
Asian	18 (1.7%)	4 (2.4%)	22 (1.8%)	
Native Hawaiian/Pacific Islander	2 (0.2%)	1 (0.6%)	3 (0.2%)	
American Indian/Alaska Native	4 (0.4%)	3 (1.8%)	7 (0.6%)	
Other	57 (5.5%)	13 (7.6%)	70 (5.8%)	
BMI, Mean (SD)	30.45 (6.64)	30.23 (6.26)	30.42 (6.59)	0.879

Table 8. Associated Injury by Paramenisical Cyst Presence.

	No Paramenisical Cyst (N=1036)	Paramenisical Cyst (N=172)	Total (N=1208)	P-value
ACL Injury	146 (14.1%)	15 (8.7%)	161 (13.3%)	0.068
Bone Lesion	21 (2.0%)	2 (1.2%)	23 (1.9%)	0.761
Bone Marrow Injury	138 (13.3%)	21 (12.2%)	159 (13.2%)	0.808
Bursitis	65 (6.3%)	24 (14.0%)	89 (7.4%)	**0.001**
Cartilage Defect	746 (72.0%)	112 (65.1%)	858 (71.0%)	0.070
Effusion	696 (67.2%)	88 (51.2%)	784 (64.9%)	**<0.001**
Hoffa Fat Pad Edema	95 (9.2%)	10 (5.8%)	105 (8.7%)	0.187
LCL Injury	28 (2.7%)	4 (2.3%)	32 (2.6%)	1.000
Lipoma Arborescence	4 (0.4%)	1 (0.6%)	5 (0.4%)	0.537
Loose Body	26 (2.5%)	8 (4.7%)	34 (2.8%)	0.132
MCL Injury	127 (12.3%)	18 (10.5%)	145 (12.0%)	0.612
Lateral Meniscus Tear	354 (34.2%)	87 (50.6%)	441 (36.5%)	**<0.001**
Medial Meniscus Tear	707 (68.2%)	139 (80.8%)	846 (70.0%)	**<0.001**
Osteoarthritis	525 (50.7%)	68 (39.5%)	593 (49.1%)	**0.008**
PCL Injury	35 (3.4%)	5 (2.9%)	40 (3.3%)	1.000
Plica	12 (1.2%)	3 (1.7%)	15 (1.2%)	0.461
Subchondral Fracture	53 (5.1%)	5 (2.9%)	58 (4.8%)	0.251
Synovitis	119 (11.5%)	15 (8.7%)	134 (11.1%)	0.358
Tendinopathy	179 (17.3%)	26 (15.1%)	205 (17.0%)	0.583

Discussion

This study assessed the incidence of various cysts in the knee and evaluated associated injuries. Our most important findings were that the most prevalent cyst was by far the baker's cyst, accounting for approximately one third of the study population, which has several important correlations to structures in the knee than can lead to internal derangement when injured or present. There were statistically significant associations found among several components of this study. Baker's cysts significantly correlated with older females, bursitis, cartilage defects, effusions, medial meniscus tears, PCL injuries, and subchondral fractures. Ganglion cysts were significantly associated with ACL pathology, PCL pathology, medial meniscus tear, osteoarthritis, plica and various forms of tendinopathy. Meniscal cysts were significantly associated with medial meniscus tears. Lastly, paramenisical cysts were significantly associated with younger males, bursitis, effusions, lateral meniscus tear, medial meniscus tear and osteoarthritis.

Discussion continued

Baker's cysts arise from a communication between the gastrocnemius – semimembranosus recess and the posterior joint capsule, leading to fluid collection.[10] Rytter et al.'s study notes fluid in the semimembranosus-gastrocnemius bursa to be an indication of weakness to the posteromedial corner of the knee joint, following the known pathogenesis of Baker's cysts.[11] We observed a similar trend in our study, as joint effusion occurred at a rate of 67.1% in Baker's cysts.

Our study reports that most of the cysts found in our patient population were comprised of Baker's cysts (19.4% of the total MRIs reviewed), which is supported by Marra et al.'s comprehensive review, which reports an approximate incidence of Baker's cysts from 4.7% to 19%. Additionally, their study notes how popliteal cysts are often accompanied by intra-articular disorders, such as ACL or meniscal tears.[5] We also observed a similar trend in our study, identifying that the most common associated pathology in patients with Baker's cysts was meniscal tears, occurring at a rate of 71% having medial meniscus tear and 36% having lateral meniscus tear. The second most commonly associated pathology with Baker's cysts was cartilage defect occurring at a rate of 72.8%.

Other notable less common cysts found in our study include ganglion, meniscal and parameniscal cysts. Parameniscal cysts often occurred with a medial meniscal tear as an associated pathology 80.8% of the time. This finding is similarly reported in Pathak et al., where identification of a parameniscal cyst often occurred adjacent to a meniscal tear.[12] Subchondral cysts are known to be associated with osteoarthritis, which is supported by Amirthalingam et al.'s study that reports how articular damage caused by osteoarthritis influences the subarticular bone to be more susceptible to pathology.[13] Therefore, it was considered as a process of osteoarthritis in our study, rather than a individual cyst type. Another study by Durr et al. suggested fractures of the subchondral bone due to stress could be inciting events in the progression of subchondral cysts in osteoarthritis, further supporting our results.[14]

The clinical relevance of this study is in part to aid in clinicians' diagnosis and to prevent missing associated injuries, in addition to describing clinical relevance of such findings.

Limitations of this study include a small sample size, reporting on data from orthopaedic patients with cystic lesions from one institution, reviews by several radiologists, and predominantly a white population. While this certainly affects the generalizability of our results, we maintain the merits of this study in large part due to the verification and validation of the cystic lesions in our patient population.

Conclusions

The findings of this study suggest new patterns and associations drawn between various cystic lesions of the knee and their corresponding injuries. While this study reports incidence of the cystic lesions, further studies need to be conducted to clarify the underlying mechanism of the associated injuries. Further research is certainly warranted to clarify the underlying mechanisms of injury associations. Ultimately, this study sets the path for similar studies to be conducted to ultimately uncover radiographic MRI findings and prevent misdiagnosis of cystic lesions of the knee.

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