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RESEARCH PAPER

Sonographic Evaluation of Internal Derangements of Knee Joint in Comparison to Magnetic Resonance Imaging (MRI)

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Abstract

Background: Knee is the most complex joint and prone to injury. Ligament and meniscal injuries are common and a major cause of morbidity. Accurate diagnosis requires clinical history, examination and imaging. Magnetic resonance imaging (MRI) is the non invasive gold standard for detecting knee injuries, but ultrasonography (USG) is emerging as a cost-effective, non-invasive and dynamic alternative.

Objectives: To evaluate role of sonographic assessment of internal derangements of knee joint in comparison to Magnetic Resonance Imaging.

Methods: A Cross sectional study of 61 patients with knee joint pathology underwent USG & MRI for the diagnosis of internal derangements of knee joint between the period of October 2022 to September 2024 was conducted in Department of Radiology and Imaging, BIRDEM General Hospital, Dhaka, Bangladesh. Procedure details were recorded on specifically designed pro-forma.

Results: A total of 61 patients (62.3% male; mean age 40 years) were included, with the 21–30-year age group most commonly affected. Right-knee involvement predominated (62.3%). The most frequent pathology identified by both USG and MRI was knee joint effusion (90.2% and 93.4%, respectively). Ultrasound showed good diagnostic performance overall, with good sensitivity and specificity for medial collateral ligament (MCL) tear, lateral collateral ligament (LCL) tear, and baker's cyst, and good accuracy for anterior cruciate ligament (ACL) tear, posterior cruciate ligament (PCL) tear, and patellar tendinopathy.

Conclusions: Knee USG is highly accurate in diagnosing joint effusion, patellar tendinopathy, posterior cruciate ligament tear, medial collateral ligament tear, medial meniscal tear, lateral collateral ligament tear, osteophytes and baker's cyst. MRI should be reserved for patients with inconclusive USG results. Therefore, USG should be used as the first-line modality for detecting knee pathologies.

Key words: Ligaments, Menisci, Joint effusion, Baker's cyst.

Introduction

The knee joint is one of the body's most complex and vulnerable joint, frequently affected by a wide spectrum of pathological conditions involving its tendons, ligaments, muscles, synovial space, and articular cartilage. These disorders, collectively known as internal derangement of the knee, are a leading cause of pain, instability, and morbidity across all age groups.[1,2,3] Early and accurate detection of these abnormalities is crucial for effective intervention and to prevent further joint degeneration.[4]

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Clinical diagnosis is challenging; even experienced practitioners find clinical examination alone insufficient for a definitive diagnosis, necessitating advanced imaging.[3] A myriad of imaging modalities are employed, including conventional radiography, ultrasound, computed tomography, and Magnetic Resonance Imaging (MRI).[5]

Sonography (ultrasound) is a widely used, non-invasive, and dynamic tool that offers excellent visualisation of superficial and extra-articular structures. It is highly effective for evaluating tendon and ligament injuries, muscle trauma, synovial lesions, bursitis, and for the detection of knee effusion.[6,7] Its significant advantages include portability, real-time dynamic assessment, low cost, and the ability to image patients with metallic implants. It also allows for a

direct clinical correlation by the radiologist during the examination.[2,8] However, its utility for a comprehensive intra-articular examination remains a subject of debate.

In contrast, Magnetic Resonance Imaging (MRI) has become the cornerstone for non-invasive evaluation of the knee's internal structures. It excels in visualizing intra-articular lesions—including those of the cruciate ligaments, menisci, and articular cartilage—with high accuracy, serving as a primary alternative to diagnostic arthroscopy.[9] Its multi-planar capabilities, superior soft-tissue contrast, and lack of ionizing radiation have overcome the limitations of other modalities, making it the most frequently studied articulation on MRI.[10,11]

While arthroscopy remains the invasive gold standard for diagnosis, MRI is accepted as the best non-invasive imaging modality. Both ultrasound and MRI are valuable, though each has its strengths: ultrasound for extra-articular and dynamic evaluation, and MRI for a detailed intra-articular assessment. This study is therefore planned to conduct a sonographic evaluation of internal derangement of the knee joint and to systematically compare its findings with those of MRI.

Materials and methods

This cross-sectional study was conducted in the Department of Radiology and Imaging, BIRDEM General Hospital, Dhaka, Bangladesh from October 2022 to September 2024. The study included 61 purposively selected adult patients (≥18 years) with history of knee joint related complaints like pain, swelling, limitations of movements and external injury. Patients with neoplasms, infection, post-operative cases, metallic implants, claustrophobia or those unwilling to consent were excluded.

Data were collected using a structured pro-forma including demographic information, clinical history and findings from ultrasonography and MRI. Informed written consent was obtained from the selected patients. A structured pre-prepared case proforma was used to enter the patient details, detailed clinical history, symptoms and physical examination of patients who meet the inclusion criteria. Patients with knee joint disorders like pain, swelling, limitations of movements and external injury was included in this study. All patients, fulfilling the inclusion criteria were subjected to MRI examination. The diagnosis was confirmed by Philips INGENIA 1.5 tesla MRI machine, using knee extremity circumferential coil. Before magnetic resonance imaging examination, ultrasound examination was done by sonologist by using PHILIPS Afifiniti 50G machine with the 7.5 to 12 MHz multi-frequency linear array probe for real time B mode scanning. And findings of cruciate ligaments, collateral ligaments, meniscal tears, tendinopathy, fluid collection, osteophyte baker's cyst and others pathologies were recorded.

MRI was performed by radiologist on a Philips INGENIA 1.5 Tesla machine with a dedicated knee coil, using T1-Weighted Image, T2-Weighted Image, Proton Density Fat-Suppressed (PDFS), and Short Tau Inversion Recovery (STIR) sequences in axial, sagittal and coronal planes. Sonologist was blinded about the diagnosis given by radiologist and vice versa.

Ethical approval was obtained from the Institutional Review Board. Data were compiled and analyzed using SPSS version 25. Descriptive statistics summarized demographic and clinical characteristics, while chi-square tests assessed associations. A p-value <0.05 was considered statistically significant.

Results

The 61 study subjects had a mean age of 40.7 ± 16.2 years, with the largest age groups being 21–30 years (32.8%) and 51–65 years (31.1%) (Table I).

Table I: *Demographic characteristics of the study subject (n=61)*

Characteristics	Frequency	Percentage	Mean±SD
Age in years			
18-20	4	6.6	40.70±16.2
21-30	20	32.8	
31-40	5		
41-50	13	21.3	
51-65	19	31.1	

Males comprised 62.3% and females 37.7%, giving a male-to-female ratio of 1.6:1. Side effects were reported more on the right side (62.3%) than the left (37.7%).

Table II: *Sonographic findings of affected knee joint of the study subject (n=61)*

Sonographic findings	Frequency	Percentage (%)
Joint Effusion	55	90.2
Patellar tendinopathy	4	6.6
Anterior cruciate ligament (ACL) tear	36	59.0
Posterior cruciate ligament (PCL) tear	3	4.9
Medial Collateral Ligament (MCL) tear	4	6.6
Medial Meniscal Tear	17	27.9
Lateral Collateral Ligament (LCL) tear	2	3.3
Lateral Meniscal Tear	7	11.5
Osteophytes	20	32.8
Baker's cyst	9	14.8

Table II presents the sonographic findings detailing the prevalence of various knee joint abnormalities among the 61 study subjects. The most commonly reported finding is joint effusion, observed in 55 subjects (90.2%), indicating a high incidence of fluid accumulation within the joint. Specific tendon and ligament pathologies include patellar tendinopathy in 4 subjects (6.6%), ACL tear in 36 subjects (59.0%), PCL tear in 3 subjects (4.9%), MCL tear in 4 subjects (6.6%), and LCL tear in 2 subjects (3.3%). Meniscal tears were identified with medial meniscal tears in 17 subjects (27.9%) and lateral meniscal tears in 7 subjects (11.5%). Osteophytes were present in 20 subjects (32.8%), while Baker's cyst, a fluid-filled sac behind the knee, was found in 9 subjects (14.8%). MRI findings included joint effusion in 57 subjects (93.4%), ACL tears in 42 (68.9%), patellar tendinopathy in 5 (6.6%), PCL tears in 4 (6.6%), MCL tears in 5 (8.2%), LCL tears in 2 (3.3%), medial meniscal tears in 19 (31.1%), lateral meniscal tears in 9 (14.8%), osteophytes in 16 (26.2%), and Baker's cyst in 9 (14.8%) (Table III).

Ultrasound (USG) evaluation demonstrated excellent performance for joint effusion with sensitivity 96%, specificity 100%, accuracy 96.7%, positive predictive value 100%, and negative predictive value 67%. For patellar tendinopathy, USG showed sensitivity 80%, specificity 100%, accuracy 98%, and both positive and negative predictive values very high (100% and 98%, respectively) (Table IV). These results indicate that USG is a reliable, non-invasive tool, particularly effective in confirming positive cases of joint effusion and patellar tendinopathy.

Table III: MRI findings of affected knee joint of the study subject (n=61)

MRI findings	Frequency	Percentage (%)
Joint Effusion	57	93.4
Patellar tendinopathy	5	6.6
Anterior cruciate ligament (ACL) tear	42	68.9
Posterior cruciate ligament (PCL) tear	4	6.6
Medial Collateral Ligament (MCL) tear	5	8.2
Medial Meniscal Tear	19	31.1
Lateral Collateral Ligament (LCL) tear	2	3.3
Lateral Meniscal Tear	9	14.8
Osteophytes	16	26.2
Baker's cyst	9	14.8

Table IV: Diagnostic performance of ultrasound compared to MRI for detecting various knee pathologies (n=61)

Sonographic findings	Sensitivity	Specificity	PPV	NPV	Accuracy
Joint Effusion	96.0	100.0	100.0	67.0	96.7
Patellar tendinopathy	80.0	100.0	100.0	98.0	98.0
Anterior cruciate ligament (ACL) tear	78.0	78.0	78.0	78.0	78.0
Posterior cruciate ligament (PCL) tear	75.0	100.0	100.0	98.0	98.0
Medial Collateral Ligament (MCL) tear	80.0	100.0	100.0	98.0	98.0
Medial Meniscal Tear	79.0	95.0	88.0	90.0	90.0
Lateral Collateral Ligament (LCL) tear	100.0	100.0	100.0	100.0	100.0
Lateral Meniscal Tear	77.0	100.0	100.0	96.0	97.0
Osteophytes	100.0	91.1	80.0	100.0	93.4
Baker's cyst	100.0	100.0	100.0	100.0	100.0

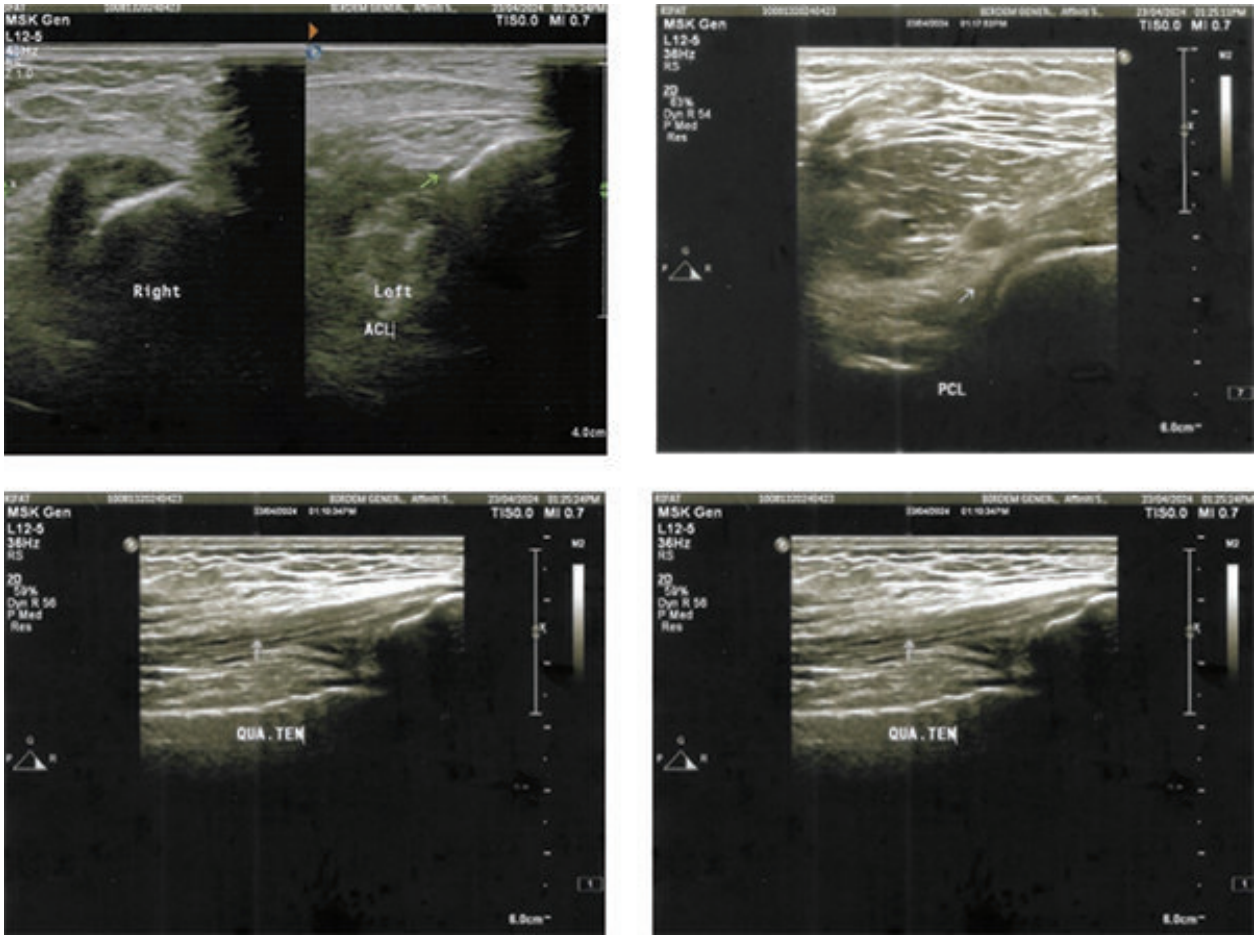

Figure 1: Ultrasonogram of right knee joint of a 26 years old male patient showing anterior cruciate ligament (ACL) is swollen. Minimal anechoic fluid collection around right knee joint.

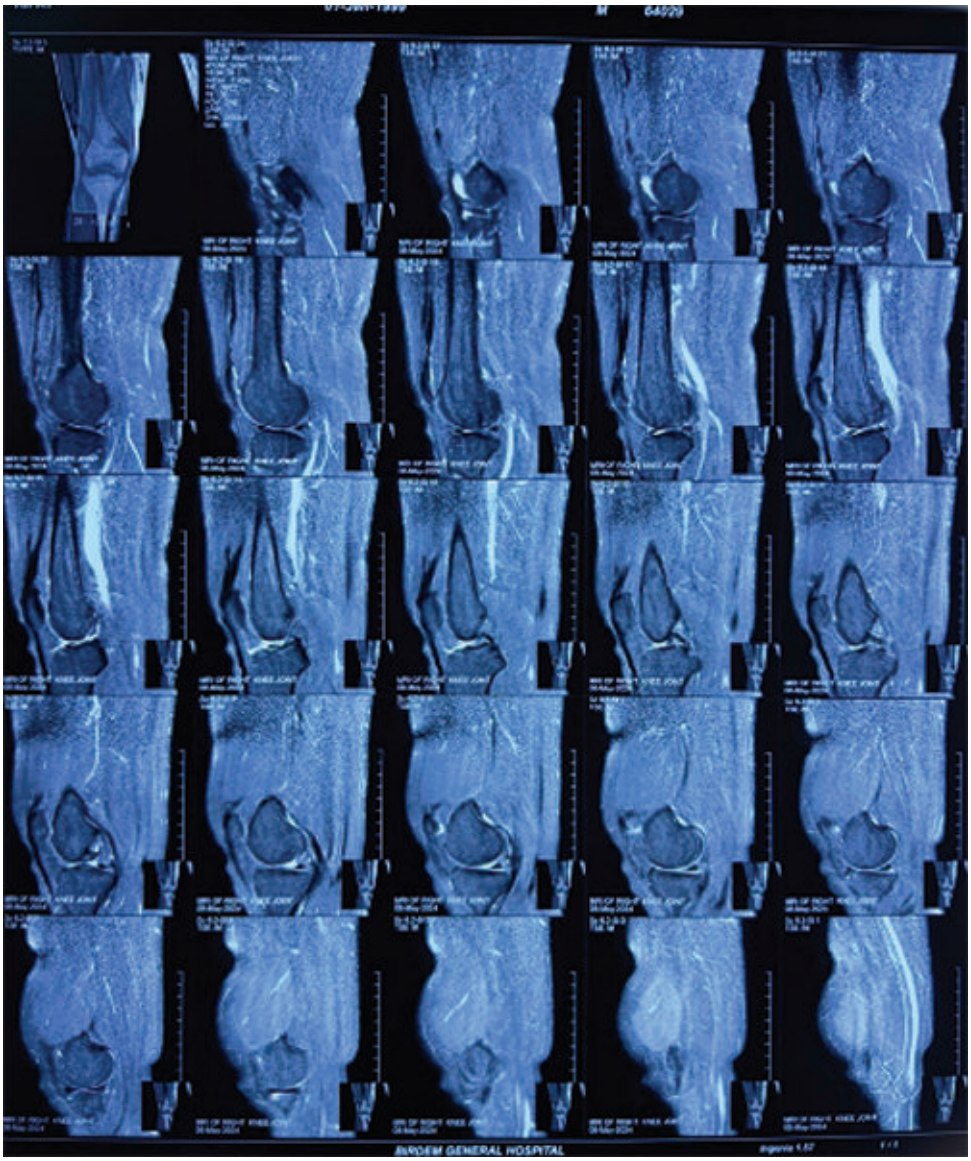

Figure 2: Sagittal PD fat sat sequences of MRI of right knee joint of a 26 years old male patient showing altered signal intensity at proximal attachment of ACL. Minimal PD fat sat hyperintense joint effusion is noted at intra articular joint cavity of right knee joint.

Discussion

MRI is the gold standard for knee evaluation[7,12] but is costly and static, while ultrasound is real-time, portable, affordable, and allows direct clinical correlation.[13] The study involved 61 participants, with an average age of 40.70±16.32 years. This aligns closely with findings from Singh et al.[14] whose participants had an average age of 39.4 years. The majority of cases occurred within the 21-30 age bracket, indicating a higher incidence of knee issues among young adults likely attributed to sports and athletic pursuits.[15] Similar study reported most frequent age group for both males and females was 21 to 30 years.[16]

In our study, 62.3% of the participants were male and 37.7% were female, resulting in a male-to-female ratio of 1.6:1. This finding is consistent with numerous other studies.[17-21] Similar sex ratios were also observed in studies by Singh et al.[16]

In our current study, 38 patients (62.3%) sustained injuries to their right knee, while 23 patients (37.7%)

sustained injuries to their left knee. Venkateshwaran[22] where the left knee was more frequently involved than the right knee.

This study found that knee joint effusion was the most frequently detected pathology on ultrasound in 55 cases (90.2%) and on MRI in 57 cases (93.4%). These findings are consistent with several other studies.[7,17-19,21,23]

Meniscal lesions are a major cause of knee pain and functional impairment. In our study, ultrasound (USG) showed strong agreement with MRI for detecting medial meniscus tears, with sensitivity 79%, specificity 95%, and accuracy 90%. These results align with Singh et al.[21]

This study found very good evidence between ultrasound and MRI in detecting medial collateral ligament tears. Ultrasound demonstrated a sensitivity of 80%, specificity of 100%, and accuracy of 98%. These findings are consistent with several other studies. In comparison, Singh et al[14] and Singh A et al.[21] reported ultrasound sensitivities of 83.3% and 84.6%, respectively, with similar specificity (97.7% and 98%) and accuracy (96% and 96.6%) for detecting medial collateral ligament tears using MRI as the gold standard.

In our study out of 61 cases examined, ultrasound detected ACL tears in 36 cases, of which 35 were confirmed by MRI, while 1 were found to be normal. Ultrasound in our study showed a sensitivity of 78%, specificity of 84%, and accuracy of 80%. In comparison, Sharma VK et al.[2] reported only slight agreement between ultrasound and MRI in detecting ACL tears, which was lower than in other studies.

In our study, employing a posterior approach for assessing PCL injuries, ultrasound demonstrated a sensitivity, specificity, and accuracy of 75%, 100%, and 98%, respectively. These results are consistent with findings from other studies.[17-19,21] In comparison, Sharma VK et al.[2] reported moderate agreement between ultrasound and MRI in detecting posterior cruciate ligament (PCL) tears.

In our study, ultrasound demonstrated a sensitivity, specificity, and accuracy of 100% in detecting Baker's cysts. These results align well with findings from other studies. Similarly, Singh B et al.[14], Sharma VK et al.[6] Ultrasound and MRI showed strong evidence in detecting osteophytes, sensitivity 100%, specificity 91.1% and accuracy of 93.4% compared to MRI as the gold standard. These findings are consistent with other studies.[8, 17,19,22,23]

The study has limitations, including a small sample size, single-center design, and lack of advanced imaging such as MR arthroscopy or arthrography, which may affect the generalizability and diagnostic precision of the findings.

Conclusion

Knee ultrasonogram is accurate in diagnosing joint effusion, patellar tendinopathy, posterior cruciate ligament tear, medial collateral ligament tear, medial meniscal tear, lateral collateral ligament tear, osteophytes and baker's cyst. MRI should be reserved for patients with inconclusive USG results. The accuracy of ultrasound is nearly comparable to MRI. Therefore, USG should be used as the first-line modality for detecting knee pathologies.

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