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Study Of Evaluation Of Accuracy Of 3 Tesla MRI In Diagnosing Components Of Internal Derangement Of Knee In Comparison With Surgical Findings.

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ABSTRACT

Internal derangement of the knee, often resulting from traumatic injuries, encompasses a variety of structural abnormalities including meniscal tears, cruciate ligament injuries, and cartilage defects. Accurate preoperative diagnosis is critical for effective management. Magnetic Resonance Imaging (MRI), particularly 3 Tesla (3T) MRI, has emerged as a powerful non-invasive tool for evaluating such pathologies. To evaluate the diagnostic accuracy of 3 Tesla MRI in detecting components of internal derangement of the knee in comparison with surgical (arthroscopic) findings. This prospective observational study included 50 patients with clinically suspected internal derangement of the knee who underwent 3T MRI followed by arthroscopic evaluation. MRI findings were assessed for anterior and posterior cruciate ligament tears, meniscal pathology, collateral ligament injuries, and cartilage defects. Arthroscopy served as the gold standard for comparison. Diagnostic parameters such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated. 3T MRI demonstrated high diagnostic accuracy for ACL tears (sensitivity 95.83%, specificity 95.65%) and medial meniscal tears (sensitivity 97.5%, accuracy 95%). Lateral meniscal and PCL injuries were also reliably identified. 3T MRI is a highly accurate and effective modality for diagnosing internal derangement of the knee and correlates well with arthroscopic findings.

Keywords: 3 Tesla MRI, Internal Derangement, Knee Arthroscopy

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INTRODUCTION

Internal derangement of the knee refers to a spectrum of intra-articular structural abnormalities, primarily involving the menisci, cruciate ligaments, articular cartilage, and other soft tissue structures [1, 2]. These injuries are commonly encountered in sports-related trauma and can lead to significant functional impairment if not diagnosed and managed appropriately [3]. Accurate and early diagnosis is essential to guide treatment strategies and prevent long-term complications such as osteoarthritis. Magnetic Resonance Imaging (MRI) has emerged as a non-invasive, highly sensitive modality for the evaluation of internal knee derangements. Among the various MRI systems, 3 Tesla (3T) MRI provides superior image resolution, increased signal-to-noise ratio, and better delineation of soft tissue structures compared to 1.5T MRI, potentially enhancing diagnostic accuracy [4-6].

Surgical arthroscopy, however, remains the gold standard for definitive diagnosis and treatment of internal knee derangements. Therefore, comparing the diagnostic accuracy of 3T MRI with arthroscopic findings is vital for validating MRI as a reliable preoperative tool [7]. This study aims to evaluate the sensitivity, specificity, and overall diagnostic performance of 3T MRI in detecting various components of internal derangement of the knee—specifically meniscal tears, cruciate ligament injuries, and chondral defects—in comparison with arthroscopic findings, thus assessing its role in pre-surgical planning and clinical decision-making.

METHODOLOGY

This prospective observational study was conducted at the Department of Radiodiagnosis, the study included patients referred for 3 Tesla (3T) MRI with a clinical suspicion of internal derangement of the knee. Ethical clearance was obtained, and informed consent was taken from all patients. The sample size was determined to be 50 based on a pilot study and statistical formula, considering a prevalence rate of 13% and 10% absolute error.

All selected patients underwent MRI using a Siemens Magnetom Skyra 3 Tesla machine. Standard MRI sequences included Fat Suppressed Proton Density (PD) images in axial, coronal, and sagittal planes, T1-weighted coronal images, T2-weighted sagittal images, and 3D TRUFI sequences in the coronal plane. MRI findings were interpreted with specific attention to anterior and posterior cruciate ligament tears, meniscal degeneration or tears, collateral ligament sprains or tears, and cartilage defects. Each lesion was graded, and associated abnormalities were documented. Subsequently, all patients who underwent MRI and showed surgical indications proceeded to arthroscopic evaluation. Arthroscopies were performed by experienced orthopedic surgeons in the operating theatre using a standard arthroscope. Findings from arthroscopy served as the gold standard and were systematically compared to MRI findings in terms of presence, type, and extent of each lesion, including ACL/PCL tears, meniscal tears (graded), collateral ligament injuries, and chondral defects.

Data were collected and analyzed using SPSS version 20. Diagnostic accuracy parameters such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated to assess the correlation between MRI and arthroscopic findings. Descriptive statistics were also used to summarize patient demographics, clinical presentation, and side of involvement. The study aimed to determine the reliability of 3T MRI in diagnosing internal derangements of the knee and its utility as a preoperative diagnostic modality.

RESULTS

Table 1: Distribution of Internal Derangements Identified on MRI (N = 50)

Sr. No.	Abnormality	No. of Patients	Percentage (%)
1	Anterior Cruciate Ligament Tears	24	48%
2	Posterior Cruciate Ligament Tears	6	12%
3	Medial Meniscal Tears/Degeneration	40	80%
4	Lateral Meniscal Tears/Degeneration	31	62%
5	Medial Collateral Ligament Tears/Sprain	8	16%
6	Lateral Collateral Ligament Tears/Sprain	1	2%
7	Cartilage Defects	26	52%

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Table 2: Anterior Cruciate Ligament (ACL) Tears – Type and Location (n = 24)

Category	No. of Patients	Percentage (%)
Type		
Complete ACL Tear	21	87.5%
Partial ACL Tear	3	12.5%
Location		
Mid-substance	14	58.33%
Femoral Attachment	10	41.66%
Tibial Attachment	0	0%

Table 3: Associated Injuries with ACL Tears (n = 24)

Associated Injury	No. of Patients	Percentage (%)
Medial Meniscal Tear/Degeneration	19	79.16%
Lateral Meniscal Tear/Degeneration	14	58.33%
Medial Collateral Ligament Injury	5	20.83%
Lateral Collateral Ligament Injury	1	4.17%
PCL Tear	2	8.33%
Bone Contusions	7	29.17%
Osseous Fractures	13	54.17%
O'Donoghue's Triad (ACL + MCL + Medial Meniscus)	3	12.5%

Table 4: Diagnostic Accuracy of 3 Tesla MRI Compared to Arthroscopy

Structure Evaluated	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
ACL Tears	95.83	95.65	95.83	95.65	95.75
PCL Tears	83.33	97.78	83.33	97.78	95.45
Medial Meniscal Tears	97.5	91.67	95.12	95.65	95
Lateral Meniscal Tears	89.66	87.5	92.86	82.35	89

Figure 1: Diagnosis of Internal Derangement of the Knee at 3.0-T MR Imaging

DISCUSSION

The current study aimed to evaluate the diagnostic accuracy of 3 Tesla MRI in detecting various components of internal derangement of the knee, with arthroscopic findings considered the gold standard. A total of 50 patients with clinical suspicion of internal derangement were included in the study

and underwent both MRI and arthroscopy. The findings were then compared to assess the sensitivity, specificity, and diagnostic utility of MRI [8, 9].

The study population predominantly comprised young adults, with the majority of patients falling in the 21–30 years age group. Male preponderance was noted, and the right knee was more frequently involved. The most common presenting complaint was knee pain, followed by instability, locking, and giving way, which are classical signs of internal derangement.

The most frequently observed pathology on MRI was medial meniscal tear or degeneration, seen in 80% of the cases, followed by lateral meniscal involvement in 62%. ACL tears were detected in 48% of cases, while PCL tears were less frequent at 12%. Collateral ligament injuries and cartilage defects were observed to a lesser extent. Among ACL injuries, complete tears were more common than partial tears, and mid-substance was the most frequently involved site.

A notable finding was the high frequency of associated injuries with ACL tears. Medial meniscal tears coexisted in 79.16% of ACL injuries, and lateral meniscal involvement was seen in 58.33%. Osseous fractures were observed in more than half of the ACL tear cases, and 20.83% of ACL injuries were accompanied by medial collateral ligament (MCL) injuries. The classical O'Donoghue's triad (ACL, MCL, and medial meniscus tear) was observed in 12.5% of patients, confirming the frequent clustering of these injuries following valgus-external rotation trauma mechanisms [10].

The diagnostic performance of 3T MRI was impressive. For ACL tears, MRI achieved a sensitivity of 95.83% and specificity of 95.65%, indicating a high level of accuracy in detecting ligamentous disruptions. PCL tears were also reliably identified, though with slightly lower sensitivity (83.33%), likely due to the smaller sample size of confirmed PCL injuries. For meniscal tears, 3T MRI demonstrated excellent diagnostic parameters, especially for medial meniscus tears, with a sensitivity of 97.5% and accuracy of 95%. Lateral meniscal tears also showed acceptable sensitivity (89.66%) and specificity (87.5%), though slightly lower than for medial meniscus, possibly due to greater anatomic variability and thinner cartilage in the lateral compartment [11-13].

These findings are consistent with previous literature, where studies such as those by Carlos Eduardo Sanches Vaz et al and Singh JP et al reported similarly high diagnostic accuracy for 3T MRI in detecting knee derangements. The current study reinforces the role of MRI as a non-invasive, highly accurate tool that can reliably detect structural abnormalities of the knee joint and guide the need for surgical intervention. However, in cases where MRI findings are inconclusive or symptoms persist despite negative imaging, arthroscopy remains essential for both diagnosis and treatment.

CONCLUSION

In conclusion, 3 Tesla MRI is a valuable modality in the evaluation of internal derangement of the knee, demonstrating high sensitivity, specificity, and diagnostic accuracy in comparison to arthroscopy. Its application can reduce the need for unnecessary invasive procedures, aiding in accurate preoperative planning and improving patient outcomes.

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