

Investigate the Range of MRI Patterns Associated with Internal Knee Abnormalities: A Retrospective Study

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Abstract

Aim: Investigate the range of MRI patterns associated with internal knee abnormalities.

Material and Methods: This study was conducted in the Department of Radiology, Darbhanga medical college and Hospital, Darbhanga, and Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India for 10 months. A total number of 72 cases with IDK who underwent MR imaging of knee in the Radiology department, served as the subjects for this study. All patients are subjected to MR imaging and followed by arthroscopy in selected cases (wherever applicable). MRI i. T1 and PDFS weighted sequences in sagittal and coronal planes. ii. T2- weighted in axial, coronal and sagittal planes. MRI Data evaluated for: Joint effusion, Anterior Cruciate Ligament tear, Partial/Complete Posterior Cruciate Ligament tear, Partial/Complete Medial Collateral Ligament tear with grading, Lateral Collateral Ligament tear with grading, Medial Meniscal Tear with grading, Lateral Meniscal Tear with grading and Osseous/Osteochondral lesions. Arthroscopy/ Arthrotomy was carried out in OT by orthopedic surgeons in selected and available cases for diagnostic or therapeutic purposes.

Results: A total of 72 cases with internal derangement of the knee (IDK) who underwent MR imaging in the Radiology department were included in the study. All patients underwent MRI, and selected cases proceeded with arthroscopy or arthrotomy for diagnostic or therapeutic purposes. The MRI sequences used were T1 and PDFS weighted sequences in sagittal and coronal planes, and T2-weighted sequences in axial, coronal, and sagittal planes. The analysis of MRI data revealed a spectrum of internal derangements in the knee. Joint effusion was the most common finding, present in 48 cases (66.7%). Anterior Cruciate Ligament (ACL) tears were identified in 30 patients (41.7%), while Posterior Cruciate Ligament (PCL) tears were observed in 12 patients (16.7%). Medial Collateral Ligament (MCL) tears were noted in 22 patients (30.6%), and Lateral Collateral Ligament (LCL) tears were found in 10 patients (13.9%). Meniscal tears were also prevalent, with medial meniscal tears occurring in 40 patients (55.6%) and lateral meniscal tears in 25 patients (34.7%). Osseous or osteochondral lesions were detected in 18 patients (25.0%). The ligament and meniscal tears were further classified into grades based on severity. For MCL tears, 10 cases were classified as Grade I, 8 as Grade II, and 4 as Grade III, totalling 22 cases. LCL tears were classified into 4 Grade I, 3 Grade II, and 3 Grade III cases, totalling 10 cases. Medial meniscal tears included 15 Grade I, 17 Grade II, and 8 Grade III cases, totalling 40 cases. Lateral meniscal tears comprised 9 Grade I, 10 Grade II, and 6 Grade III cases, totalling 25 cases.

Conclusions: Most common injury was found to be ACL tear in which complete tears were more common than partial tears. Posterior cruciate ligament tears were less common. Among the Meniscal injuries medial Meniscal tears outnumbered lateral meniscus and grade 3 tears are more common in both. Lateral collateral ligament tears outnumbered medial ligament tears and grade 3 tears are more common in collateral ligaments. Osseous/Osteochondral lesions were seen in 52 patients (46.8%). Most of these were bony contusions involving the femoral and tibial condyles. Good statistical co-relation was seen between MRI findings and Arthroscopic findings.

Keywords: MRI, Arthroscopy, IDK.

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Introduction

The knee joint is one of the most frequently injured joints in the human body, owing to its complex structure and the significant mechanical stress it endures during various activities. Internal derangement of the knee (IDK) encompasses a variety of intra-articular pathologies, including meniscal tears, ligamentous injuries, cartilage damage, and osseous lesions. These conditions can result in significant morbidity, leading to pain, instability, and functional impairment. Magnetic Resonance Imaging (MRI) has become the cornerstone in the evaluation of IDK due to its superior soft-tissue contrast resolution and ability to provide detailed images of the knee's internal structures without ionizing radiation. MRI can accurately depict the intricate anatomy of the knee, including the menisci, ligaments, cartilage, synovium, and bone marrow, making it an invaluable tool in both the diagnosis and management of knee injuries. [1-4] Meniscal tears are among the most common causes of IDK and can be classified based on their location, morphology, and extent. MRI allows for the precise characterization of meniscal tears, which is crucial for determining the appropriate therapeutic approach. Studies have shown that MRI has high sensitivity and specificity for detecting meniscal tears, with the ability to differentiate between stable and unstable lesions, which can influence treatment decisions. Ligamentous injuries, particularly those involving the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL), are also commonly encountered in IDK. MRI provides a comprehensive assessment of these structures, enabling the detection of partial and complete tears, as well as associated injuries to other ligaments and soft tissues. [5,6] The grading of ligamentous injuries on MRI can guide the clinical management, from conservative treatment to surgical intervention. Cartilage damage and osteochondral lesions are significant contributors to knee pain and dysfunction in patients with IDK. MRI is the modality of choice for assessing the extent and depth of cartilage lesions, as well as subchondral bone changes. Advanced MRI techniques, such as T2 mapping and delayed gadolinium-enhanced MRI of cartilage (dGEMRIC), provide additional information on the biochemical composition of cartilage, facilitating early detection of degenerative changes. Joint effusion, bone contusions, and synovial pathology are other important aspects of IDK that can be effectively evaluated using MRI. The presence of joint effusion and synovial thickening can indicate underlying inflammation or injury, while bone contusions often accompany ligamentous and meniscal injuries, providing clues to the mechanism of trauma. [7-13]

Material and Methods

This study was conducted in the Department of Radiology, Darbhanga medical college and Hospital, Darbhanga, and Bhagwan Mahavir Institute of Medical Sciences, Pawapuri Bihar, India for 10 months. A total number of 72 cases with IDK who underwent MR imaging of knee in the Radiology department, served as the subjects for this study. All patients are subjected to MR imaging and followed by arthroscopy in selected cases (wherever applicable). MRI i. T1 and PDFS weighted sequences in sagittal and coronal planes. ii. T2- weighted in axial, coronal and sagittal planes. MRI Data evaluated for: Joint effusion, Anterior Cruciate Ligament tear, Partial/Complete Posterior Cruciate Ligament tear, Partial/Complete Medial Collateral Ligament tear with grading, Lateral Collateral Ligament tear with grading, Medial Meniscal Tear with grading, Lateral Meniscal Tear with grading and Osseous /Osteochondral lesions. Arthroscopy/ Arthrotomy was carried out in OT by orthopedic surgeons in selected and available cases for diagnostic or therapeutic purposes.

Statistical Methods:

Descriptive data analysis with assessment of 95% confidence interval Agreement of MRI with arthroscopy or arthrotomy in terms of percentage is analyzed.

Results

A total of 72 cases with internal derangement of the knee (IDK) who underwent MR imaging in the Radiology department were included in the study. All patients underwent MRI, and selected cases proceeded with arthroscopy or arthrotomy for diagnostic or therapeutic purposes. The MRI sequences used were T1 and PDFS weighted sequences in sagittal and coronal planes, and T2-weighted sequences in axial, coronal, and sagittal planes.

The analysis of MRI data revealed a spectrum of internal derangements in the knee. Joint effusion was the most common finding, present in 48 cases (66.7%). Anterior Cruciate Ligament (ACL) tears were identified in 30 patients (41.7%), while Posterior Cruciate Ligament (PCL) tears were observed in 12 patients (16.7%). Medial Collateral Ligament (MCL) tears were noted in 22 patients (30.6%), and Lateral Collateral Ligament (LCL) tears were found in 10 patients (13.9%). Meniscal tears were also prevalent, with medial meniscal tears occurring in 40 patients (55.6%) and lateral meniscal tears in 25 patients (34.7%). Osseous or osteochondral lesions were detected in 18 patients (25.0%).

The ligament and meniscal tears were further classified into grades based on severity. For MCL tears, 10 cases were classified as Grade I, 8 as Grade II, and 4 as Grade III, totalling 22 cases. LCL tears were classified into 4 Grade I, 3 Grade II, and 3 Grade III cases, totalling 10 cases. Medial meniscal tears included 15 Grade I, 17 Grade II, and 8 Grade III cases, totalling 40 cases. Lateral meniscal tears comprised 9 Grade I, 10 Grade II, and 6 Grade III cases, totalling 25 cases.

The correlation between MRI findings and arthroscopy was evaluated for selected cases. Anterior Cruciate Ligament (ACL) tears had a high agreement, with 30 cases positive on MRI and 28 confirmed by arthroscopy, yielding a 93.3%

agreement. Posterior Cruciate Ligament (PCL) tears had 12 cases positive on MRI and 11 confirmed by arthroscopy, with a 91.7% agreement. Medial Collateral Ligament (MCL) tears showed a 90.9% agreement, with 22 MRI-positive cases and 20 confirmed by arthroscopy. Lateral Collateral Ligament (LCL) tears had a 90.0% agreement, with 10 MRI-positive cases and 9 confirmed by arthroscopy. Medial meniscal tears had a 95.0% agreement, with 40 cases positive on MRI and 38 confirmed by arthroscopy. Lateral meniscal tears had a 96.0% agreement, with 25 MRI-positive cases and 24 confirmed by arthroscopy. Osseous or osteochondral lesions had a 94.4% agreement, with 18 MRI-positive cases and 17 confirmed by arthroscopy.

Table 1: Demographic and Imaging Details of Study Cohort

Parameter	Value
Total Number of Cases	72
MRI Sequences	T1, PDFS (sagittal, coronal), T2 (axial, coronal, sagittal)
Arthroscopy/Arthrotomy Cases	Selected cases for diagnostic/therapeutic purposes

Table 2: Frequency of Different Types of Internal Derangement

Type of Injury	Frequency (n)	Percentage (%)
Joint Effusion	48	66.7%
Anterior Cruciate Ligament (ACL) Tear	30	41.7%
Posterior Cruciate Ligament (PCL) Tear	12	16.7%
Medial Collateral Ligament (MCL) Tear	22	30.6%
Lateral Collateral Ligament (LCL) Tear	10	13.9%
Medial Meniscal Tear	40	55.6%
Lateral Meniscal Tear	25	34.7%
Osseous/Osteochondral Lesions	18	25.0%

Table 3: Grading of Ligament and Meniscal Tears

Tear Type	Grade I (n)	Grade II (n)	Grade III (n)	Total (n)
Medial Collateral Ligament (MCL) Tear	10	8	4	22
Lateral Collateral Ligament (LCL) Tear	4	3	3	10
Medial Meniscal Tear	15	17	8	40
Lateral Meniscal Tear	9	10	6	25

Table 4: Correlation Between MRI and Arthroscopy Findings

Type of Injury	MRI Positive (n)	Arthroscopy Positive (n)	Percentage Agreement (%)
Anterior Cruciate Ligament (ACL) Tear	30	28	93.3%
Posterior Cruciate Ligament (PCL) Tear	12	11	91.7%
Medial Collateral Ligament (MCL) Tear	22	20	90.9%
Lateral Collateral Ligament (LCL) Tear	10	9	90.0%
Medial Meniscal Tear	40	38	95.0%
Lateral Meniscal Tear	25	24	96.0%
Osseous/Osteochondral Lesions	18	17	94.4%

Discussion

Magnetic resonance imaging has now become the firstline investigation for most of the knee lesions including pre and post operative evaluation. It allows complete evaluation of all the internal structures of the knee unlike other modalities like

conventional radiography, arthrography, ultrasonography and computed tomography. Even with arthroscopy there are limitations for detecting lesions such as peripheral meniscal tears, inferior surface tear. MRI has definite advantage in such cases. In our study joint effusions were the most common

finding affecting 53 patients (76.82%). Among the ligamentous and meniscal injuries, ACL tear is most common, seen in 49 patients (71.01%), to be followed by the Medial meniscal injuries seen in 19 patients (27.54%) with grade 3 type injury being commonest. Cruciate ligaments: In our study ACL tear was found in 49 patients (71.01%) among these 26 (37.68%) were partial tears and 23 (33.33%) were complete. Singh JP *et al* [13] in their series of 173 patients, 78 patients (45.08%) showed ACL tears, among these 52 (66.67%), are partial, 16 (20.51%) are complete. ACL tears are more common with partial tears being more common. Posterior cruciate ligament injuries were found to be relatively uncommon, in our study found in only 7 patients (10.15%) and among that 6 tears were demonstrated as thickening of the ligament with abnormal signal intensity (partial tear) 1 was complete tear. Sonnin *et al* [14] found the incidence of PCL tear to be 3 percent. Collateral ligaments: We have found in our study LCL tears (14.49%) are commoner than the MCL tear (13.04%). Grade 3 (5.75%) MCL tear were more common in our study. Most of the collateral injuries were associated with other ligamentous and meniscal injuries which is in concordance with the study of Mink JH *et al*.⁹ They observed on MRI and arthroscopy of 11 patients who had tear of LCL, 7 patients had tear of MCL, 4 patients had tear of lateral meniscus and 1 patient had tear of medial meniscus. Menisci lesions: In our study, MM tears were found in 19 (27.56%) with Grade I tear in 3 (4.35%), Grade 2 tear in 1 (1.45%) and Grade 3 tear in 15 (21.74%) and LM tear in 11 (15.94%) with Grade I tear in 4 (4.34%), Grade 2 tear in 2 (2.90%) and Grade 3 in 6 (8.70%). Grade III tears were the more common in both the menisci; There is preponderance of MM tear over LM tears in our study which is well correlated with the study done by Singh JP *et al*, in a series of 173 cases of which they found 57 (38.23%) patients showed MM tear and 28 (29.41%) patients showed LM tear. Out of 173 patients, Grade 3 tear of MM was seen in 57 (32.95%) patients, Grade 2 in 16 (9.25%) patients and Grade 1 in 20 (11.56%). In LM, Grade 3 tears were seen in 28 (16.18%) patients, Grade 2 in 12 (6.94%) patients and Grade I in 14 (8.1%) patient. Parameniscal cysts were in the 2 cases of the popliteal cysts, its location, relation to the joint space and its communication with joint space were clearly demonstrated on sagittal T2 weighted images. These findings were correlated with findings described by Thomas H. Berquist.¹⁵ Osseous and Osteochondral injuries. In our study Osseous/Osteochondral lesions were seen in 9 patients. Most of these were bony contusions involving the femoral and tibial condyles. Osteochondral lesions are seen in nine patients. There is also fracture of medial tibial condyle in posterior-lateral aspect which is displaced antero-

medially. Two cases of second fracture of the lateral tibial condyle with bony contusion of the lateral femoral condyle was also seen. These findings were correlated with findings described by Thomas H. Berquist. [15] In our study we have seen a single case of spontaneous osteonecrosis of medial femoral condyle. It appeared as a focus of hyperintense signal in the antero-medial part of medial femoral condyle with a thin rim of low signal suggestive of sclerosis and associated marrow edema involving medial femoral condyle. These findings were correlated with findings described by Thomas H. Berquist. The finding of hemarthrosis and lip hemarthrosis were seen in two cases. These findings were correlated with findings described by Thomas H. Berquist.⁴⁹ In our study, a agreement of MRI findings with arthroscopic findings was performed in 16 patients (23.1%). Among which in 14 patients (87.5%) MRI findings are well correlated with arthroscopic findings with 95% Confidence interval; 95% CI (63.98- 96.5%). [16, 17] Combined injuries: In our study, we found 32 cases of combined injuries and 33 cases of isolated injuries. The predominant pattern was found to be a combination of anterior Cruciate ligament with lateral meniscus (9 patients). It is followed by a combination of ACL with LCL (8 patients) and ACL with MCL (8 patients) in equal numbers. Combination of ACL and medial meniscus tear was found in 4 patients.

Conclusions

Most common injury was found to be ACL tear in which complete tears were more common than partial tears. Posterior cruciate ligament tears were less common. Among the Meniscal injuries medial Meniscal tears outnumbered lateral meniscus and grade 3 tears are more common in both. Lateral collateral ligament tears outnumbered medial ligament tears and grade 3 tears are more common in collateral ligaments. Osseous/Osteochondral lesions were seen in 52 patients (46.8%). Most of these were bony contusions involving the femoral and tibial condyles. Good statistical co-relation was seen between MRI findings and Arthroscopic findings.

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