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Original Research Article

Assessment of Internal Knee Injuries Using Magnetic Resonance Imaging

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Abstract:

Background: The knee joint is an intricate structure, sensitive to injury, due to its muscles and ligaments, and the capability to tolerate quite significant loads. In sport physiotherapy practice, for proper management of clinical knee joint injuries, accurate diagnosis is essential. MRI has become established as the gold standard of non-invasive assessment of scope and detail of soft tissue structures.

Objectives: To assess the frequency, nature, and parameters of internal knee injuries via the use of MRI in patients with internal derangement.

Methods: A prospective observational study was conducted with 90 patients (69 men, 21 women) ages 14 - 72 years from Narayan Medical College and Hospital, Bihar, India. Patients underwent MRI with a 1.5 Tesla scanner with standard MRI protocols. The studies were reviewed with regard to frequency, nature, site, and grade of ligamentary and meniscal injuries.

Results: The most common injury pattern was ACL injury (63.30%). MM tear (56.70%) and LM tear (36.70%) were also common. For ACL injury - most were complete (47.40%) and mid-substance (43.90%). The nature of PCL injuries (15.60%) noted identification of some tibial avulsions. MM horizontal grade II injuries were the most frequent (56.90%); LM horizontal grade II (63.60%) was the next most common injuries identified. MCL and LCL injuries were less common and were generally grade I.

Conclusion: MRI is a very sensitive and specific modality to assess internal knee injuries and gives a detailed description of ligament and meniscal pathology. Because MRI can also characterize the extent and features of these types of injuries, it increases diagnostic confidence and helps to guide clinical and surgical treatment decisions.

Keywords: Anterior Cruciate Ligament, Internal Derangement. Knee Injuries, Ligament Tear, Meniscal Tear, MRI, Non-Invasive Imaging,

Introduction

The human knee joint, also called the tibiofemoral joint, is the largest and one of the most complicated joint structures in the human body. Its role in locomotion and weight-bearing, combined with its structural complexity, lends itself to injury. The bony articular surfaces of the knee, without the supporting soft tissue structures, have inherent bony instability-meaning that the knee is inherently unstable and relies upon its ligamentous and cartilaginous stabilizers for function and integrity. Because of this, injuries involving these stabilizing structures, in particular the ligaments and menisci, are not only common but among the most prevalent sources of morbidity in all ages; from youth and adolescent athletes to the elderly [1].

Accurate diagnosis of knee injuries in clinical practice is an important consideration for good patient outcomes. Knee injuries may be acute traumatic or chronic degenerative process, and early and accurate evaluation of internal derangements of the knee is very important for optimal management of the injured knee. Physical examination is an important part of any clinical approach but is frequently complemented by imaging studies in order to reach a definitive diagnosis. A variety of imaging techniques have been used for this purpose including standard radiograph, fluoroscopy, ultrasonography, or

nuclear medicine for the diagnosis of internal derangements of the knee. All techniques have their own benefits, but none have the overall sensitivity and specificity for soft tissue structures of the knee as Magnetic Resonance Imaging (MRI) [2].

The advent of MRI has represented a tremendous change in the diagnosis and management of internal knee injuries. This technology was initially heralded as a game-changing technology, and MRI has emerged as an incredibly useful, non-invasive imaging modality that serves as an adjunct to clinical examination [3]. MRI represents an important non-invasive imaging modality with arguably superior contrast resolution for soft tissue and multiplanar imaging, provides a more complete view of the complex knee anatomy and assists in definitively diagnosing injuries to tendons, ligaments, menisci and articular cartilage. MRI is particularly useful for identifying subtle abnormalities such as peripheral and inferior surface meniscal tears as well as early presentations of osteochondral lesions that conventional radiograph may miss [4,5].

One of the notable benefits of MRI is its capacity to detect intra-articular pathology without invasiveness. This is especially relevant given the substantial morbidity of diagnostic procedures like arthroscopy as diagnostic intervention. Although arthroscopy remains the gold standard for definitive diagnosis and treatment of many internal derangements of the knee, it is invasive and carries clinical risk including those of infection, bleeding, and joint stiffness [6,7]. MRI is safe for initial workups and reduces patient risk and therefore improves patient safety and gives clinicians a wealth of detailed anatomical and pathological information at one time. MRI is also an important factor in surgical planning, allowing orthopedic surgeons to assess the extent of injury pre-operatively, and, thereby, lessen operative time and Enhance outcomes [8].

Considering the increasing use of MRI in musculoskeletal imaging and the need to continually assess its value as a diagnostic tool, the study was undertaken as a prospective observational study of internal knee injuries in traumatic and degenerative circumstances. The aims of the current study are to describe the prevalence, types, and features of internal knee injuries using MRI, in order to improve clinical decision-making and patient care decisions. The outcomes will hopefully support MRI as the modal choice for the non-invasive assessment of internal derangement of the knee joint and add to the dialogue regarding best practice in musculoskeletal imaging and radiology.

Methodology

Study Design: This study was a prospective observational study aimed at assessing internal knee injuries using Magnetic Resonance Imaging (MRI).

Study Area: The research was conducted in the Department of Radiology, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India.

Study Duration: The study was carried out over a period of one year

Sample Size: A total of 90 patients were included in the study.

Sample Population: The study population consisted of 69 males and 21 females, aged between 14 and 72 years, all presenting with clinical suspicion of internal knee injuries.

Inclusion Criteria

- Patients with clinical suspicion of internal knee derangement (e.g., pain, swelling, restricted movement, instability).
- Patients referred by the Orthopaedic Department for knee MRI.
- Patients aged 14–72 years.
- Patients who provided informed consent.

Exclusion Criteria

- Patients with contraindications to MRI (e.g., metallic implants, pacemakers).
- Patients with previous knee surgery.
- Patients with external trauma where MRI is not indicated for internal evaluation.
- Patients are unwilling to provide informed consent.

Ethical Considerations: The study was conducted in accordance with the ethical principles of the institutional research committee. Ethical approval was received before the study began. Participants were fully informed about the research purpose and research procedures. Written informed consent was obtained.

Procedure: MRI assessment followed a written protocol for patients with clinical considerations of knee internal derangement. After an introduction, informed consent was obtained from each participant. MRIs were performed utilizing the 1.5 Tesla MRI scanner with subjects in the supine position, using a dedicated knee coil and positioning for optimal image quality. Enhancing visualization of specific knee structures required bending the knee slightly (approximately 5–10 degrees) to enhance visualization of the patellofemoral compartment and patellar alignment; and then externally rotating the knee (approximately 10–15 degrees) for complete visualization of the anterior cruciate ligament (ACL) on the sagittal images.

The MRI protocol included Proton Density Fat Saturation (PDFS) sequences in axial, sagittal, coronal views, T2-weighted (T2-W) sequences in sagittal views, and T1-weighted (T1-W) sequences in coronal views. All images were acquired at 4 mm slice

thickness to allow appropriate spatial resolution for detecting intra-articular pathologies.

Each MRI scan was closely analyzed for any internal knee injuries. We aimed to verify possible internal knee injuries unique to the individual data, whether that be a meniscal injury (tear/degenerated), collateral ligament injuries (medial/lateral) or cruciate ligament tears (anterior/posterior). All exam readings were performed by a trained, professional radiologist, specializing in musculoskeletal images.

Statistical Analysis: The data were analyzed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics to summarize categorical variables included frequencies and percentages. Descriptive statistics that summarized continuous variables included mean and standard deviation (SD). The level of significance for statistical analysis was set at $p < 0.05$ (or an alpha error of 5% and beta error of 20%), meaning that the study had an 80% statistical power."

Result

"Table 1 presents the spectrum of MRI findings in knee injuries among 90 patients. The most common injury observed was to the anterior cruciate ligament (ACL), affecting 57 patients (63.30%), followed by medial meniscus (MM) injury in 51 patients (56.70%). Lateral meniscus (LM) injuries were noted in 33 patients (36.70%). Posterior cruciate ligament (PCL) injuries occurred in 14 patients (15.60%), while medial collateral ligament (MCL) and lateral collateral ligament (LCL) injuries were less frequent, affecting 9 (10.00%) and 6 (6.70%) patients, respectively. These findings highlight the predominance of ACL and MM injuries in knee trauma as detected by MRI.

Table 1: Spectrum Of MRI Findings in Knee Injuries

MRI Findings	Number of Patients	Percentage
LM injury	33	36.70%
MM injury	51	56.70%
LCL injury	6	6.70%
MCL injury	9	10.00%
PCL injury	14	15.60%
ACL injury	57	63.30%

Table 2 details the distribution of ACL and PCL tears based on type and site among the affected patients. For ACL tears (n = 57), complete tears were the most common (47.40%), followed by partial tears (42.10%) and avulsion injuries (10.50%). In contrast, PCL tears (n = 14) showed a higher proportion of complete tears at 50.00%, with avulsion injuries at 28.60% and partial tears at 21.40%. Regarding the site of tears, ACL injuries most frequently involved mid substance (43.90%), followed by tibial (33.30%) and femoral sites (22.80%). Similarly, PCL tears were most commonly located at the tibial site (42.90%), followed by the mid substance (35.70%) and femoral site (21.40%). This indicates that while complete tears are predominant in both ligaments, avulsion injuries are relatively more common in PCL tears.

Table 2: Distribution Of PCL and ACL Tears According to Type and Site of Tears

Type of Tear				
Type of Tear	**ACL Tear**	**%**	**PCL Tear**	**%**
Avulsion	6	10.50%	4	28.60%
Complete	27	47.40%	7	50.00%
Partial	24	42.10%	3	21.40%
Total	57	100%	14	100%
Site of Tear				
Site of Tear	**ACL Tear**	**%**	**PCL Tear**	**%**
Tibial	19	33.30%	6	42.90%
Mid Substance	25	43.90%	5	35.70%
Femoral	13	22.80%	3	21.40%
Total	57	100%	14	100%

Table 3 illustrates the distribution of medial meniscus (MM) and lateral meniscus (LM) tears based on grade and type. Among MM tears (n = 51), Grade II tears were the most prevalent (56.90%), followed by Grade III (37.20%) and Grade I (5.90%). A similar trend was observed in LM tears (n = 33), with Grade II being the most common (63.60%), followed by Grade III (27.30%) and Grade I (9.10%). In terms of tear types, horizontal tears dominated both MM and LM injuries, accounting for 60.80% and 72.70%, respectively. Vertical tears made up 31.40% of MM and 18.20% of LM tears, while complex tears were

the least common, observed in 7.80% of MM and 9.10% of LM cases. These findings highlight the predominance of Grade II and horizontal meniscal tears in knee injuries.

Table 3: Distribution Of Medial and Lateral Meniscus Tears by Grade and Type				
Grade of Tear				
Grade	**MM Tears**	**%**	**LM Tears**	**%**
Grade III	19	37.20%	9	27.30%
Grade II	29	56.90%	21	63.60%
Grade I	3	5.90%	3	9.10%
Total	51	100%	33	100%
Type of Tear				
Type	**MM Tears**	**%**	**LM Tears**	**%**
Complex	4	7.80%	3	9.10%
Vertical	16	31.40%	6	18.20%
Horizontal	31	60.80%	24	72.70%
Total	51	100%	33	100%

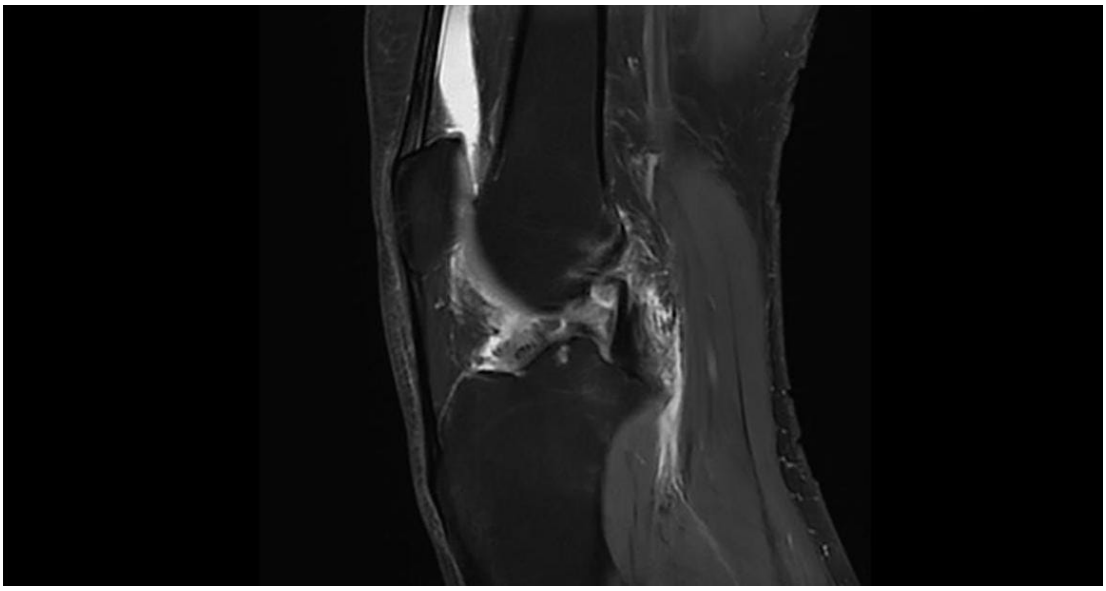

Figure 1: Complete tear ACL ligament femoral attachment with retracted fibres in intercondylar region. Few subchondral cystic change tibia spines

Figure 2: Complete tear ACL ligament femoral attachment with retracted fibres in intercondylar region. Few subchondral cystic change tibia spines

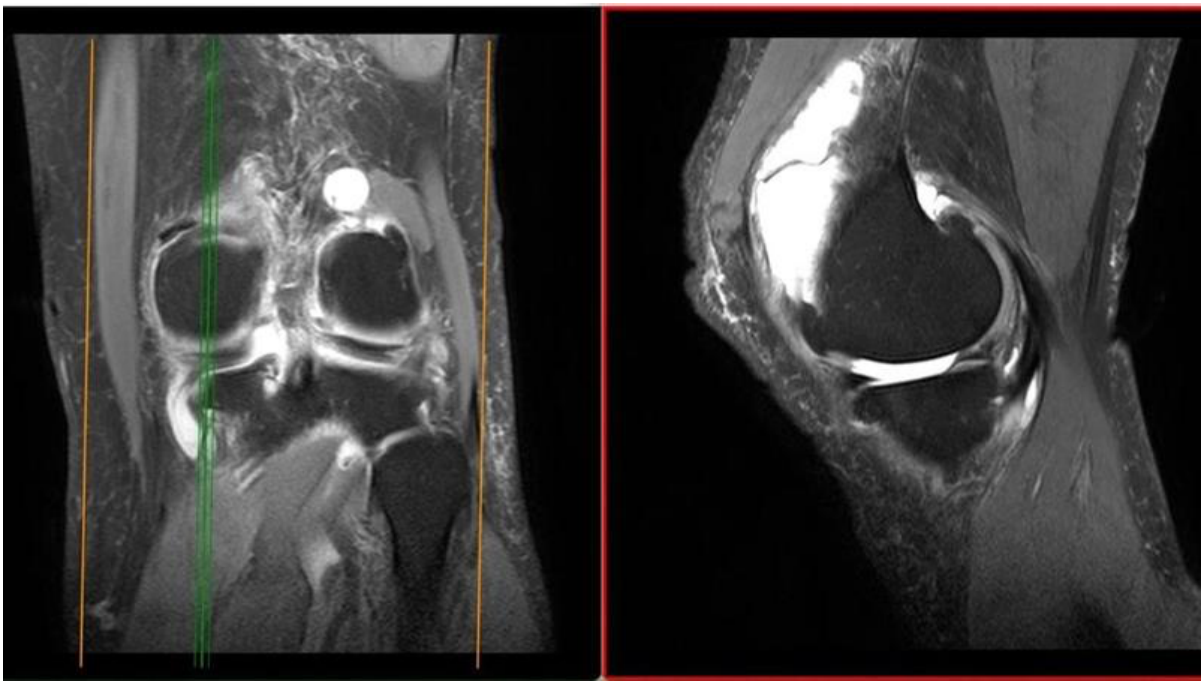

Figure 3: Complex medial meniscus body tears with joint effusion

Table 4 presents the distribution of medial collateral ligament (MCL) and lateral collateral ligament (LCL) tears by grade. Among MCL tears (n = 9), Grade I injuries were the most common (44.40%), followed by Grade II (33.30%) and Grade III (22.30%). Similarly, for LCL tears (n = 6), Grade I was also the most frequent (50.00%), with Grade II accounting for 33.30% and Grade III for 16.70%. These results indicate that lower-grade (Grade I) tears are the most prevalent in both MCL and LCL injuries.

Table 4: Distribution Of LCL And MCL Tears by Grade

Grade	MCL Tear	%	LCL Tear	%
Grade III	2	22.30%	1	16.70%
Grade II	3	33.30%	2	33.30%
Grade I	4	44.40%	3	50.00%
Total	9	100%	6	100%

Discussion

In our study, during magnetic resonance imaging (MRI), ACL injuries represented the majority of internal knee damage among 90 patients with a knee injury. It was to the tune of 63.3% of all imaging. This strongly correlates with the findings of Chavadaki RH et al. [9], who also found a high rate of ACL tears (68%) in imaging of knee injuries with complete being more than partial. Our data differs with Singh JP et al. and Josey Verghese et al. [10], who both found a higher % of partial ACL tears than complete (66.6% and 53.06% partial tears respectively). Our cohort had more complete instead of partial tears. We contend that this is due to the demographics of our patients, predominantly low-income laborers and farmers who seek care for these injuries either through awareness or access to care at the time of imaging will find their injury to be complete ruptures at that time."

Our study found a relatively low incidence of PCL injuries at 15.6%, similar findings to those of Josey Verghese et al. [10] and Chavadaki RH et al. [9], who both reported PCL injuries in 10.15% and 8% of patients respectively. In accordance with our findings, complete and avulsion-type PCL tears were greater than partial tears. This may be due to the large biomechanical threshold required to injure the PCL, which typically results in a severe injury pattern once PCL is disrupted.

Meniscal lesions were also extremely common in our cohort as medial meniscus (MM) tears occurred in 56.7% of patients—more common than lateral meniscus (LM) tears (36.7%). Similar to LaPrade et al., [11] who cited medial meniscal tears occurring about twice as often as lateral injuries, we identified Grade II meniscal tears to be most common in both MM and LM injuries and in line with Chavadaki RH et al, [9] who reported 52.6% of MM injuries were Grade II tears. Further, horizontal tears were most

common across both menisci (60.8% in MM, 72.7% in LM) lend support to the idea that the mechanisms of injury in the majority of these lesions are degenerative or related to shear, which is often seen in patients with repetitive stress and chronic instability.

In our study, collateral ligament injuries were less common than isolated tears of the anterior cruciate ligament and the posterior cruciate ligament. However, when we examined the specificity of these remaining injuries, we found that tears of the medial collateral ligament (10%) were more common than tears of the lateral collateral ligament (6.7%). This trend corresponded to that reported by Josey Verghese et al. [10], as well as according to Saurabh Chaudhuri et al. [12], who found that (13% medial vs. 7% lateral or 15% medial vs. 12% lateral) MCL injuries were more common than LCL injuries. In terms of grading, the majority of the collateral ligament injuries were Grade I sprains, which would likely mean that the severity of these injuries was less or were caught earlier due to localized pain or swelling inciting timely clinical evaluation.

Overall, our results confirm the diagnostic capabilities of MRI for detecting internal derangements of the knee, especially when there is a high clinical suspicion. The predominance of ACL and MM injuries in our study aligns with the literature, but the variation of tear type frequencies, especially with ACL, illustrates the heterogeneity of population characteristics, mechanism of injury, and availability of early medical care. With an understanding of these frequencies, we can not only add to our knowledge of accurate diagnosis and clinical classifications but also provide important information for treatment options and prognosis.

Conclusion

The investigation provides evidence that MRI is a precise and safe non-invasive tool for an overall assessment of internal knee injuries. The ACL injuries were the most commonly assessed, followed by MM tears and LM tears. The MRI was able to provide a complete assessment of the ACL and PCL tears (depicted, for example, in type and site) which were mainly classified as midsubstance and complete tears. In addition, the meniscal injuries were mainly classified as Grade II and horizontal. The medial and lateral collateral injuries were a minor component of the knee injuries and collided with Grade I injuries being the most common. In conclusion, MRI is valuable in assessing the extent, grade, and nature (e.g., horizontal or vertical) of internal derangements of the knee. Overall, MRI has a valuable role in assessing the extent of internal derangements of the knee, which assists in deciding clinical management, the extent of stability and weight bearing.

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