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Original Research Article

MRI-Based Retrospective Analysis of Knee Joint Injuries: Patterns and Prevalence

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Abstract:

Background: Knee injuries are common musculoskeletal problems affecting stability, weight-bearing, and movement. Trauma, sports activities, overuse, and degenerative changes contribute to internal derangements, and accurate diagnosis is essential to prevent chronic pain, joint instability, and osteoarthritis. MRI is the preferred imaging modality due to its ability to visualize both soft tissue and bony structures in multiple planes.

Objective: To retrospectively analyze MRI findings in patients with knee injuries and determine the frequency, pattern, and associated abnormalities.

Methods: A retrospective observational study was conducted on 120 patients who underwent MRI for knee injuries at Sonoscan Pvt.Ltd, Malda, West Bengal, India. Data on age, gender, clinical history, side of injury, and MRI findings were collected using a structured data sheet. Standard MRI protocols including T1, T2, Proton Density, and fat-suppressed sequences in sagittal, coronal, and axial planes were used. Descriptive statistics were applied to assess the frequency and distribution of injuries.

Results: Most patients were males (65%), and the 21–30 years age group was most affected (30%). Right knee injuries were slightly more frequent (56.7%). ACL tears (38.3%) and medial meniscus tears (33.3%) were the most common injuries. Joint effusion (43.3%) and bone marrow edema (28.3%) were frequently associated findings, while cartilage injuries were observed in 16.7% of cases.

Conclusion: MRI provides a detailed evaluation of knee injuries, aiding diagnosis and management. ACL and medial meniscus injuries are predominant in young adults, and MRI detection of associated abnormalities helps guide treatment and improve patient outcomes.

Keywords: Knee injuries, MRI, ACL tear, Meniscus injury, Joint effusion, Retrospective study.

Introduction

Knee injuries are among the most common musculoskeletal problems encountered in orthopedic and sports medicine practice. The knee joint serves three primary functions which include supporting body weight, providing stability, and enabling lower limb movement and this combination of functions makes the joint highly susceptible to different types of injuries which include traumatic events and overuse conditions and age-related changes to the joint [1]. People sustain knee injuries from their participation in sports activities and their experience with road traffic accidents and their development of occupational stress and their performance of daily activities which include twisting and making sudden directional changes. The knee joint injuries which occur in the human body can affect multiple knee joint structures which include ligaments and menisci and cartilage and tendons and surrounding soft tissues [2]. The medical community requires both immediate and precise injury assessment because misdiagnosed or untreated knee injuries result in chronic pain and unstable conditions and restricted movement and subsequent osteoarthritis development.

The first examination of knee injuries used standard medical tests together with X-ray imaging methods. X-ray imaging primarily shows details about bone structures while it fails to show knee joint soft tissue elements [3]. Common radiographic methods fail to show major injuries which include ligament tears and meniscal injuries and cartilage damage [4]. Magnetic Resonance Imaging (MRI) has become an essential diagnostic tool for assessing knee injuries during the last few years. The detailed imaging of bone and soft tissue structures through MRI enables doctors to determine the specific type and location of injuries and their severity. The imaging method provides non-invasive diagnostics through its ability to create images in multiple planes while displaying soft tissue details which makes it suitable for orthopedic medical assessments [5].

The retrospective study of MRI results from knee injuries shows its value because it reveals how various types of knee injuries occur and spread among a defined group of people [6]. Researchers can find common injuries through the examination of past MRI scans and medical records which show anterior cruciate ligament ACL tears and posterior cruciate ligament PCL injuries and meniscal tears and collateral ligament injuries and bone contusions and cartilage abnormalities. The analysis helps to assess how clinical symptoms match radiological results which leads to better diagnostic methods and treatment development [7].

Retrospective studies bring benefits through their use of existing medical records and imaging data which results in more efficient and cost-effective research processes according to [8]. Through these studies researchers can examine multiple cases during a specific time frame which delivers important epidemiological information about knee injuries that occur in different age groups and genders and through various trauma mechanisms. Clinicians who comprehend MRI findings for knee injuries gain the ability to forecast related injuries and complications which results in enhanced patient care and better clinical results [9,10].

The expanding use of MRI in medical settings has brought better detection capabilities for hidden complex knee joint problems which would remain undetected without this technology. The development of new imaging methods has made MRI essential for doctors because they use it to diagnose knee injuries and create treatment plans and make surgical choices and assess patients after treatment. A systematic retrospective evaluation of MRI findings can therefore contribute to the existing body of knowledge by highlighting common injury patterns, improving diagnostic protocols, and guiding clinicians in selecting appropriate management strategies.

The current research investigates MRI findings from knee injury patients through a retrospective evaluation to determine which MRI abnormalities exist and to establish how this imaging method helps diagnose and assess knee joint injuries. The study will establish which types of knee injuries occur most frequently and which present common characteristics, while helping doctors enhance their patient assessment and treatment success.

Methodology

Study Design: The present study will be conducted as a retrospective observational study to evaluate MRI findings in patients with knee injuries. The study will involve reviewing previously recorded MRI scans and medical records to identify the types and patterns of knee joint injuries.

Study Duration: The duration of the study will be 9 months, during which data collection, evaluation of MRI findings, data analysis, and interpretation of results will be carried out.

Study Setting: The study will be conducted in the Department of Radiology, Sonoscan Pvt. Ltd, Malda, West Bengal, India

Study Population: The study population will include patients who underwent MRI examination of the knee joint due to complaints such as knee pain, trauma, instability, sports injury, or suspected internal derangement of the knee.

Sample Size: The total sample size will be 120 patients. MRI records of 120 patients with knee injuries that meet the inclusion criteria will be selected and analyzed retrospectively.

Sampling Technique: A record-based sampling method will be used. MRI records available in the radiology database during the selected study period will be reviewed, and 120 eligible cases will be included in the study.

Selection Criteria

Inclusion Criteria

- Patients who underwent MRI of the knee joint for evaluation of knee injury.
- Patients of both genders and all age groups.
- MRI scans with complete imaging records and radiological reports.
- Patients showing internal derangement of the knee such as ligament tears, meniscal injuries, cartilage damage, or bone injuries on MRI.

Exclusion Criteria

- Patients with incomplete clinical or MRI records.
- Poor-quality MRI images not suitable for evaluation.
- Patients with history of previous knee surgery.
- MRI scans performed for conditions not related to knee injury.

Data Collection: Data for the present study will be collected in a retrospective manner from MRI records maintained in the radiology department. A total of 120 patients who underwent MRI for knee injuries will be selected, and their MRI reports along with available clinical records will be reviewed. A structured data collection sheet will be prepared to systematically record all relevant information for each patient. The data will include demographic details such as age and gender, clinical history, the indication for MRI, and the side of the affected knee (right or left). In addition, detailed MRI findings will be documented, including the presence or absence of anterior cruciate ligament tears, posterior cruciate ligament injuries, medial meniscus tears, lateral

meniscus tears, medial collateral ligament injuries, lateral collateral ligament injuries, bone contusions or bone marrow edema, cartilage injuries, joint effusion, and any other associated abnormalities of the knee joint.

Procedure: At the beginning of the study, permission will be obtained from the radiology department Subsequently, the hospital database will be used to identify patients who underwent MRI for the evaluation of knee injuries. Based on the predefined inclusion and exclusion criteria, a total of 120 eligible cases will be selected for the study. The selected MRI scans and reports will be systematically reviewed, and all relevant information for each case will be recorded in a structured data collection sheet. The data collected will then be organized and prepared for statistical analysis. This process will allow the analysis of the frequency, distribution, and pattern of various knee injuries observed on MRI in the study population.

MRI Technique: MRI scans included in the study will be performed using standard knee MRI protocols available at the radiology department. During the examination, the patient will be positioned supine with the affected knee placed in a dedicated knee coil to obtain optimal image quality. The MRI evaluation of the knee joint will be carried out using routine imaging sequences such as T1-weighted, T2-weighted, Proton Density (PD), and fat-suppressed sequences. These sequences will be obtained in multiple planes, including sagittal, coronal, and axial planes, to allow comprehensive visualization of the knee joint structures. This imaging approach helps in detailed assessment of ligaments, menisci, articular cartilage, bone marrow, and surrounding soft tissues, thereby enabling accurate identification of various knee injuries and associated abnormalities.

Data Analysis: The collected data will be compiled, organized, and analyzed using appropriate statistical methods. All information obtained from the MRI records of the selected 120 patients will be entered into a data sheet and checked for accuracy and completeness. Descriptive statistical analysis will be performed to determine the frequency and percentage distribution of different types of knee injuries identified on MRI. The data will also be analyzed to observe the distribution of injuries according to age group, gender, and side of the affected knee. The results will be presented in the form of tables and charts to clearly illustrate the pattern of MRI findings. This analysis will help in identifying the most common knee injuries and associated abnormalities detected through MRI in the study population.

Results

A total of 120 patients who underwent MRI examination for knee injuries were included in the present study. The MRI records of these patients were retrospectively reviewed and analyzed to identify the pattern and frequency of various knee joint injuries. The demographic and clinical details of the patients were also taken into consideration during the analysis. The results were evaluated based on age distribution, gender distribution, and the side of the knee involved in the injury. In addition, detailed analysis of MRI findings was carried out to identify different types of internal derangements of the knee joint. These included ligament injuries such as anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), and lateral collateral ligament (LCL) injuries, as well as meniscal injuries involving the medial and lateral menisci. Furthermore, associated MRI findings such as bone marrow edema, bone contusions, cartilage injuries, and joint effusion were also evaluated.

Table 1: Age Distribution of Patients (n = 120)

Age Group (Years)	Number of Patients	Percentage (%)
10–20	18	15%
21–30	36	30%
31–40	28	23.30%
41–50	22	18.30%
>50	16	13.40%
Total	120	100%

The age distribution of patients shows that knee injuries were most observed in the 21–30 years age group, which accounted for 36 patients (30%) of the total sample. This indicates that young adults are more prone to knee injuries, possibly due to higher physical activity, sports participation, and occupational strain. The second most affected group was 31–40 years with 28 patients (23.3%). Patients aged 41–50 years accounted for 22 cases (18.3%), showing a moderate occurrence of injuries in middle-aged individuals. The 10–20 years age group represented 15% of cases, which may be associated with sports and outdoor activities. The lowest number of cases was observed in patients over 50 years (13.4%). Overall, the findings suggest that knee injuries are more prevalent in the active and working-age population.

Table 2: Gender Distribution		
Gender	**Number of Patients**	**Percentage (%)**
Male	78	65%
Female	42	35%
Total	120	100%

The gender distribution of patients in the study indicates that males were more commonly affected by knee injuries compared to females. Out of the total 120 patients, 78 patients (65%) were male, while 42 patients (35%) were female. This higher prevalence in males may be attributed to greater involvement in physically demanding activities, sports, and occupational work that increases the risk of knee trauma. Additionally, males are more likely to experience high-impact injuries such as road traffic accidents and sports-related incidents. Although females also presented with knee injuries, their proportion was comparatively lower in this study. The findings suggest that gender may play a role in the occurrence of knee injuries, with males being at a relatively higher risk.

Table 3: Side of Knee Involved		
Side of Injury	**Number of Patients**	**Percentage (%)**
Right Knee	68	56.70%
Left Knee	52	43.30%
Total	120	100%

The analysis of the side of knee involvement shows that the right knee was more frequently affected than the left knee in the study population. Out of 120 patients, 68 patients (56.7%) had right knee injuries, while 52 patients (43.3%) had left knee injuries. This difference may be related to the dominance of the right leg in most individuals, which is often used more during activities such as walking, running, sports, and sudden movements. As a result, the right knee may be more exposed to stress and trauma. However, injuries to the left knee were also significant and cannot be overlooked. The findings indicate that knee injuries can occur on either side, although the right knee shows slightly higher involvement.

Table 4: Ligament Injuries Detected on MRI		
Type of Ligament Injury	**Number of Patients**	**Percentage (%)**
ACL Tear	46	38.30%
PCL Injury	12	10%
MCL Injury	26	21.70%
LCL Injury	10	8.30%
No Ligament Injury	26	21.70%
Total	120	100%

The evaluation of ligament injuries on MRI revealed that Anterior Cruciate Ligament (ACL) tears were the most common ligament injury, observed in 46 patients (38.3%). This suggests that ACL injuries are a major cause of knee instability and are frequently associated with trauma and sports-related activities. Medial Collateral Ligament (MCL) injuries were the second most common, found in 26 patients (21.7%). Posterior Cruciate Ligament (PCL) injuries were less common and observed in 12 patients (10%). Similarly,, Lateral Collateral Ligament (LCL) injuries were identified in 10 patients (8.3%). A total of 26 patients (21.7%) showed no ligament injury on MRI. These findings highlight the important role of MRI in detecting ligamentous injuries of the knee joint.

Table 5: Meniscal Injuries		
Type of Meniscal Injury	**Number of Patients**	**Percentage (%)**
Medial Meniscus Tear	40	33.30%
Lateral Meniscus Tear	22	18.30%
Both Menisci Injured	10	8.40%
No Meniscal Injury	48	40%
Total	120	100%

The analysis of meniscal injuries showed that medial meniscus tears were more common compared to lateral meniscus tears. Out of the total patients, 40 patients (33.3%) had tears of medial meniscus, indicating that the medial meniscus is more susceptible to injury due to its limited mobility and greater load-

bearing function. Lateral meniscus tears were observed in 22 patients (18.3%). Additionally, 10 patients (8.4%) had injuries involving both menisci, suggesting more severe or complex knee injuries. However, 48 patients (40%) did not show any meniscal injury on MRI. The findings emphasize that meniscal injuries are common in patients with knee trauma and can be effectively detected using MRI.

Table 6: Other MRI Findings in Knee Injuries

MRI Finding	Number of Patients	Percentage (%)
Bone Marrow Edema / Contusion	34	28.30%
Cartilage Injury	20	16.70%
Joint Effusion	52	43.30%
Normal MRI Findings	14	11.70%
Total	120	100%

The assessment of other MRI findings revealed that joint effusion was the most common associated finding, observed in 52 patients (43.3%). This indicates the presence of fluid accumulation within the knee joint, often associated with trauma or internal derangement. Bone marrow edema or bone contusions were detected in 34 patients (28.3%), suggesting underlying bone injury due to impact or stress. Cartilage injuries were identified in 20 patients (16.7%), which may contribute to long-term joint problems if left untreated. Additionally, 14 patients (11.7%) showed normal MRI findings, despite clinical symptoms of knee pain or injury. These results demonstrate that MRI is useful in identifying both primary injuries and associated abnormalities within the knee joint.

Discussion

The present study retrospectively analyzed 120 patients who underwent MRI for knee injuries, focusing on the frequency, pattern, and associated findings of internal derangements. Arundale et al., (2018) demonstrated that Knee injuries are common in both active and sedentary populations, with trauma, sports-related activities, and occupational stress being the primary contributors [11]. Accurate diagnosis is crucial to prevent long-term complications such as joint instability, chronic pain, and degenerative changes like osteoarthritis. MRI has emerged as the imaging modality of choice due to its ability to visualize both bony and soft tissue structures non-invasively and in multiple planes.

In this study, the age distribution revealed that the majority of injuries occurred in the 21–30 years age group (30%), followed by 31–40 years (23.3%) . Mathur et al., (2018) suggested that young and middle-aged adults are at higher risk of knee injuries, likely due to increased physical activity, sports participation, and occupational strain [12]. Patients over 50 years had a lower incidence (13.4%), possibly reflecting reduced exposure to high-impact activities.

The gender distribution showed a higher prevalence in males (65%) compared to females (35%). This aligns with previous studies suggesting that males are more prone to traumatic knee injuries due to greater involvement in physically demanding activities, sports, and accidents. However, Arendt et al., (1995) revealed that females were not unaffected, emphasizing that knee injuries can occur across genders [13].

Analysis of the side of knee involvement indicated a slight predominance of the right knee (56.7%). This may be explained by Benjaminse et al., (2009) leg dominance, as the right leg is often used more in daily activities, sports, and weight-bearing movements, making it more susceptible to trauma. Additionally, the higher involvement of the dominant leg could be related to increased exposure to sudden twisting, pivoting, or impact injuries, which are common mechanisms for ligament and meniscal tears [14]. In contrast Hewett et al., (2005) highlights the importance of considering leg dominance when evaluating knee injuries and planning rehabilitation, as the dominant knee may be at greater risk for recurrent trauma or functional impairment' [15].

Among ligament injuries, ACL 'tears were the most common (38.3%), followed by MCL injuries (21.7%). PCL and LCL injuries were less frequent, consistent with the literature that reports ACL as the most injured ligament in the knee due to twisting and pivoting injuries. Meniscal injuries were also significant, with medial meniscus tears (33.3%) more prevalent than lateral meniscus tears (18.3%). Muller et al., (2012) revealed that Medial meniscus vulnerability may be attributed to its limited mobility and greater weight-bearing function [16].

Other MRI findings highlighted Buchbinder et al., (2007) the importance of detecting associated injuries. Joint effusion was the most common secondary finding (43.3%), indicating intra-articular inflammation or trauma. Bone marrow edema and contusions (28.3%) were also frequently observed, reflecting the impact of trauma on subchondral bone [17]. On the other hand, De et al., (2000) revealed that Cartilage injuries (16.7%) were detected in a subset of patients, highlighting the risk of long-term joint degeneration if left untreated. Interestingly, 14 patients (11.7%) had normal MRI findings despite clinical symptoms, suggesting that not all knee pain

is associated with detectable structural damage on MRI [18].

The study emphasizes the clinical utility of MRI in the comprehensive assessment of knee injuries, as it enables precise visualization and accurate diagnosis of ligamentous, meniscal, and other soft tissue injuries, along with associated bony abnormalities, cartilage defects, and joint effusion [19]. MRI provides detailed multiplanar imaging that helps clinicians not only confirm suspected injuries but also detect subtle or complex abnormalities that might be missed on clinical examination or conventional radiography. Furthermore, timely MRI evaluation can prevent misdiagnosis, reduce the risk of long-term complications such as joint instability, recurrent injury, and osteoarthritis, and ultimately contribute to better functional outcomes and faster rehabilitation for patients [20].

Overall, the findings of this study are consistent with previously published literature, confirming that young adult males are the most affected population due to higher physical activity levels, sports participation, and occupational demands. Among the different types of knee injuries, anterior cruciate ligament (ACL) tears and medial meniscus injuries were predominant, reflecting their vulnerability during high-impact movements, twisting, and pivoting activities. Additionally, joint effusion emerged as the most frequent associated finding, highlighting the presence of intra-articular inflammation and acute trauma.

Conclusion

MRI is an essential tool for evaluating knee injuries, providing detailed visualization of ligaments, menisci, cartilage, and bone structures. In this study, ACL tears and medial meniscus injuries were the most common, predominantly affecting young adult males, with the right knee slightly more involved. Associated findings such as joint effusion, bone marrow edema, and cartilage injuries were frequently observed. Early MRI assessment enables accurate diagnosis, guides treatment planning, and helps prevent long-term complications like joint instability and osteoarthritis. Retrospective analysis of MRI findings highlights common injury patterns, supporting improved patient care and management strategies.

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