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Original Research Article

MAGNETIC RESONANCE IMAGING EVALUATION OF POST-TRAUMATIC KNEE INJURIES: A PROSPECTIVE OBSERVATIONAL STUDY

Prateek Singh[1], Kajal[2], Ashish Arya[3], Seema[4], Swati Arya[5]

[1]Assistant Professor, Department of Radiology, KCGMC, Karnal, India.
[2]Senior Resident, Department of Radiology, KCGMC, Karnal, India.
[3]Assistant Professor, Department of Orthopedics, KCGMC, Karnal, India.
[4]Assistant Professor, Department of Anesthesiology, KCGMC, Karnal, India.
[5]Assistant Professor, Department of Anesthesiology, KCGMC, Karnal, India.

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Corresponding Author:
Dr. Prateek Singh,
Email: drprateek@gmail.com

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ABSTRACT

Background: Post-traumatic knee injuries are frequent among young, active individuals, particularly following road traffic accidents and sports activities. The knee joint is highly susceptible to trauma due to its complex anatomy and reliance on ligamentous and meniscal support for stability. **Objective:** To evaluate the spectrum, prevalence, and patterns of post-traumatic knee lesions using Magnetic Resonance Imaging (MRI), and to establish its role as a stand-alone diagnostic tool independent of arthroscopic correlation. **Materials and Methods:** This prospective observational study included 217 patients with clinically suspected internal derangements of the knee following trauma. MRI was performed using a 1.5 Tesla system with a dedicated knee coil. Sequences assessed included T1, T2, PD-FS, STIR, and GRE in multiple planes. Findings were analyzed for ligamentous, meniscal, osseous, and peri-articular soft-tissue injuries. **Result:** MRI revealed joint effusion in 85.3% of cases, anterior cruciate ligament (ACL) tears in 69.6%, medial meniscus tears in 32.7%, lateral meniscus tears in 24.4%, and osseous lesions in 45.2%. Posterior cruciate ligament (PCL) and collateral ligament injuries were less frequent. **Conclusion:** MRI is a highly sensitive, non-invasive modality for the evaluation of post-traumatic knee injuries. It reliably demonstrates soft-tissue and osseous derangements and provides comprehensive information for patient management, eliminating the need for routine diagnostic arthroscopy.

INTRODUCTION

The knee joint is the largest and one of the most complex synovial joints in the human body. It is formed by the articulation of the femur, tibia, and patella, and its stability depends largely on soft-tissue structures such as the cruciate ligaments, collateral ligaments, and menisci. While this anatomical design allows for a wide range of motion and load-bearing capacity, it also renders the joint particularly vulnerable to traumatic injury. Such injuries are frequent in young, active individuals, including athletes, military personnel, and those involved in high-energy trauma such as road traffic accidents.[1,2] Post-traumatic knee injuries may range from isolated sprains to complex multi-structural derangements involving ligaments, menisci, cartilage, and osseous components. Early and accurate diagnosis is critical for guiding appropriate treatment—whether conservative or surgical—and for minimizing long-term morbidity, particularly the development of chronic instability and early osteoarthritis.[3,4]

Conventional imaging modalities such as radiography and computed tomography (CT) are effective for evaluating fractures and gross osseous pathology but are limited in their ability to detect soft-tissue injuries. Arthroscopy, though considered the gold standard for intra-articular assessment, is invasive, expensive, and associated with procedural risks, including infection, hemarthrosis, and postoperative morbidity.[5,6]

Magnetic Resonance Imaging (MRI), introduced for clinical musculoskeletal use in the mid-1980s, has since revolutionized knee imaging.[7] It provides excellent soft-tissue contrast, multiplanar imaging capability, and non-invasive assessment of intra- and peri-articular structures, including cruciate and collateral ligaments, menisci, articular cartilage, and bone marrow lesions.[8-10] MRI has therefore largely supplanted diagnostic arthroscopy in the initial evaluation of suspected knee injuries.

This study aims to evaluate post-traumatic knee injuries exclusively by MRI, without correlation to arthroscopy, thereby emphasizing the role of MRI as a primary and independent diagnostic modality in the

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comprehensive assessment of traumatic knee joint derangements.

MATERIALS AND METHODS

This was a prospective observational study carried out in the Department of Radiodiagnosis from November 2015 to October 2017. A total of 579 patients presenting with knee trauma were screened, of which 217 satisfied inclusion and exclusion criteria and were included in the study.

Inclusion criteria were: adults (≥18 years) with a history of knee trauma within the preceding year and clinical suspicion of internal derangement (ligament, meniscus, or osseous injury). Exclusion criteria were: patients <18 years, contraindications to MRI (cardiac pacemakers, ferromagnetic implants, aneurysm clips, severe claustrophobia), prior knee surgery, neoplastic/infectious/inflammatory joint disease, hemodynamically unstable trauma, knee dislocations, or radiographic evidence of advanced degenerative arthritis. These criteria are consistent with established radiological research protocols.[11,12]

MRI Protocol: All scans were performed on a 1.5 Tesla Siemens Magnetom Avanto scanner using a dedicated knee coil. Patients were positioned supine with the knee in 5–10° flexion and 10–15° external rotation, a positioning known to optimize ACL visualization.[13] Sequences acquired included: sagittal and coronal T2-weighted and proton density fat-suppressed (PD-FS), axial T2-weighted, coronal T1-weighted, coronal STIR, and sagittal GRE. Thin slices (3–4 mm) with interslice gaps of 0.5–1 mm were obtained with a field of view (FOV) of 160–200 mm. These protocols align with prior musculoskeletal MRI methodology.[14,15]

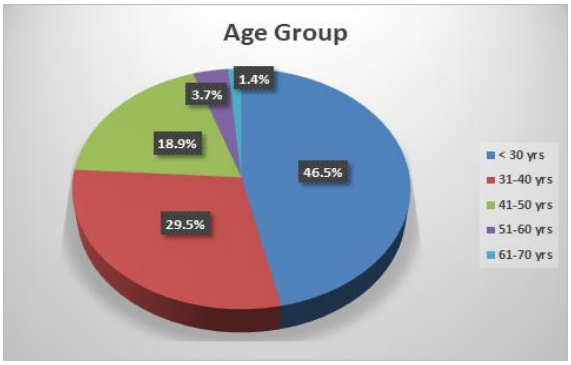
Image Analysis: All images were interpreted on PACS (DICOM format) by radiologists experienced in musculoskeletal imaging. Structures assessed included cruciate and collateral ligaments, menisci, articular cartilage, bone marrow, and peri-articular soft tissues. Ligament and meniscal lesions were classified as normal, partial tear, or complete tear, while osseous lesions were categorized as marrow contusion, fracture, or osteochondral defect. This systematic approach follows established musculoskeletal MRI evaluation guidelines.[16]

Statistical Analysis: Data were entered into SPSS v21.0. Quantitative variables were expressed as mean ± SD, while categorical variables were expressed as frequencies and percentages. The chi-square test was used to assess associations between MRI findings and demographic/trauma variables, with $p < 0.05$ considered statistically significant.

RESULTS

A total of 217 patients with post-traumatic knee injuries were included. The mean age was 28.3 ± 4.2 years (range: 18–66 years). The majority belonged to the 18–30 year age group (46.5%), followed by 31–40 years (29.5%). This finding reflects the high vulnerability of young, active adults to knee trauma, consistent with previous epidemiological studies.[15,16]

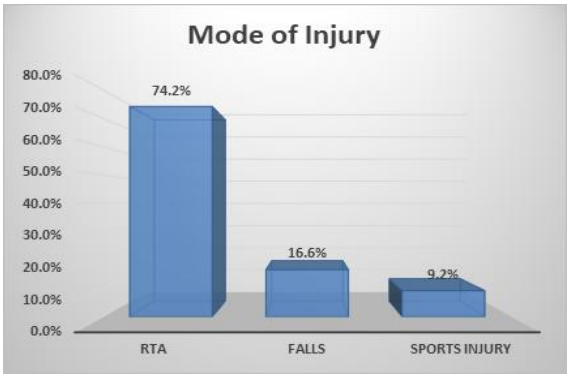
Of the 217 patients, 147 were male (67.7%) and 70 were female (32.3%), giving a male-to-female ratio of approximately 2:1. The predominance of male patients corresponds with global data on musculoskeletal trauma, particularly in road traffic accidents and sports-related injuries.[17]



Graph 1: Distribution of patients according to age

The right knee was more commonly injured (121 cases, 55.8%) than the left (96 cases, 44.2%).

Most patients presented within 1 month of injury (77.4%), with 30.9% undergoing MRI within the first week. Delayed presentations (>6 months) were rare (4.6%). Acute presentations allowed better correlation of MRI findings with fresh injuries, particularly bone contusions and effusions, as noted in prior studies.[18,19]



Graph 2: Distribution of the patients according to mode of injury

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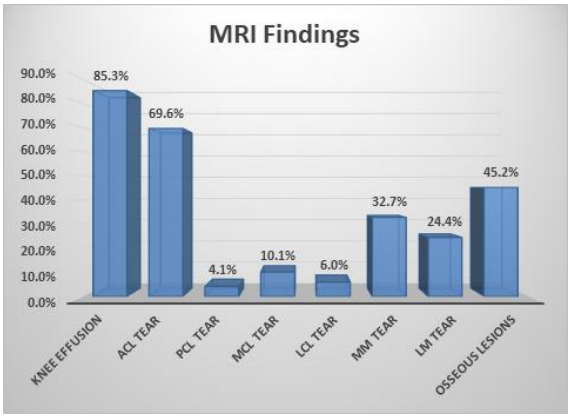

Graph 3: Spectrum of MRI findings in knee injuries

The most common finding (85.3%), present either in isolation (10.8%) or associated with other injuries (89.2%). This supports its role as a non-specific but important marker of intra-articular pathology.[20]

Table 1: Distribution of knee joint effusion isolated and associated with other injuries

Knee Effusion	Number of patients	Percentage
Isolated	20	10.8%
Associated with other Injuries	165	89.1%
Total	185	100.0%

DISCUSSION

The demographic pattern of predominantly young male patients corresponds with global trauma studies.[15,16] Road traffic accidents accounted for most cases, similar to prior Indian and international series.[17] The high incidence of joint effusion (85.3%) underlines its importance as an indirect marker of intra-articular pathology, though non-specific.[18]

ACL was the most commonly injured structure (69.6%), with mid-substance tears predominating. These findings are consistent with biomechanical studies showing the mid-portion of the ACL to be most vulnerable.[19,20] PCL injuries were rare (4.1%), reflecting global data that isolated PCL injuries constitute <5% of knee trauma.[21]

Meniscal tears were frequent, with medial meniscus (32.7%) more commonly affected than lateral (24.4%). The posterior horn was the predominant site, aligning with the meniscus' anatomical vulnerability and prior imaging studies.[22-24]

Collateral ligament injuries were less frequent, with MCL more commonly involved (10.1%) than LCL (6.0%), supporting the "unhappy triad" association of ACL, MCL, and medial meniscus injury.[25]

Nearly half of patients (45.2%) demonstrated osseous lesions, predominantly bone contusions, which are typically occult on radiographs but well visualized on MRI.[26,27] Recognition of these lesions is clinically important, as they can indicate mechanism of trauma and predict associated injuries.

Collectively, these findings reinforce MRI's value as a comprehensive, non-invasive tool for evaluating traumatic knee injuries. Unlike arthroscopy, MRI permits assessment of both intra-articular and peri-articular structures without procedural risks. Our data support using MRI as the primary diagnostic modality, reserving arthroscopy for therapeutic intervention.

CONCLUSION

MRI is a highly sensitive and reliable tool in evaluating post-traumatic knee injuries. It enables detailed visualization of cruciate and collateral ligaments, menisci, cartilage, osseous lesions, and joint effusions in a single examination. Given its non-invasive nature and diagnostic yield, MRI should be considered the first-line modality in suspected knee trauma, reducing the need for diagnostic arthroscopy.

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Conflicts of Interest

The authors declare that they have no conflicts of interest related to this study.

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