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Original Article

Magnetic Resonance Imaging Assessment of Internal Derangements of the Knee Joint

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ABSTRACT

Background: Internal derangements of the knee joint are a leading cause of pain and disability, requiring precise diagnostic evaluation. Magnetic Resonance Imaging (MRI) is the non-invasive gold standard for assessing soft tissue injuries. This study aimed to evaluate the spectrum and prevalence of such derangements using MRI in a tertiary care setting in Bangladesh. **Objective:** To assess the patterns and frequency of internal derangements of the knee joint as detected by Magnetic Resonance Imaging. **Methods & Materials:** A prospective cohort study was conducted at the Department of Radiology & Imaging, Shaheed Tajuddin Ahmad Medical College & Hospital, Gazipur, Bangladesh, from January 2024 to June 2025. A purposive sample of 53 patients with clinical suspicion of knee derangement underwent 1.5 Tesla MRI. Images were evaluated by experienced radiologists. Data on demographics, clinical presentation, and MRI findings were collected and analyzed using descriptive statistics and chi-square tests in SPSS version 23.0. **Results:** Analysis of 53 patients revealed meniscal tears as the most common injury (79.2%), predominantly affecting the medial meniscus (52.8%). Anterior cruciate ligament (ACL) tears were present in 39.6% of cases, with a significant association to lateral meniscal tears (p=0.042). Sports trauma (41.5%) and degenerative causes (37.7%) were primary etiologies, each demonstrating distinct injury patterns (p=0.003). **Conclusion:** MRI is essential for characterizing knee derangements, with medial meniscal and ACL tears being most prevalent. The high frequency of combined injuries necessitates comprehensive imaging to inform appropriate management. Further multicenter studies are recommended to validate these findings.

Keywords: *Anterior cruciate ligament, Knee injuries, Magnetic Resonance Imaging, Meniscal tear, Trauma*

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Introduction

The knee joint, a complex hinge synovial joint, is integral to human locomotion, bearing significant static and dynamic loads during daily activities [1]. Its stability and function are maintained by a sophisticated interplay of osseous structures, articular cartilage, menisci, ligaments, and tendons. Disruption of any of these components, collectively termed internal derangements of the knee, is a pervasive source of pain, functional impairment, and long-term morbidity worldwide [2,3]. These injuries stem from a wide array of etiologies, including acute trauma-common in sports and vehicular accidents — and degenerative processes associated with aging and obesity, leading to conditions like meniscal tears and ligamentous insufficiency [4]. The clinical diagnosis of knee pathologies is often challenging due to nonspecific symptoms like pain, swelling, locking, and instability, which overlap across different injury types [5]. Accurate diagnosis is paramount, as mismanagement can accelerate joint degeneration, culminating in premature osteoarthritis [6]. Historically, diagnostic arthroscopy was considered the gold standard but is invasive, costly, and carries surgical risks. Consequently, a reliable, non-invasive diagnostic modality is essential for precise pre-therapeutic evaluation. Magnetic Resonance Imaging (MRI) has revolutionized musculoskeletal radiology by providing unparalleled soft-tissue contrast, multi-planar capabilities, and non-ionizing radiation, making it the cornerstone for imaging internal derangements [7,8]. It allows for detailed visualization of menisci, cruciate and collateral ligaments, articular cartilage, and bone marrow, facilitating the detection of occult injuries not apparent on clinical examination or radiographs. Global studies have consistently affirmed the high diagnostic accuracy of MRI for knee injuries. Its sensitivity and specificity for detecting meniscal and anterior cruciate ligament (ACL) tears often exceed 90% and 85%, respectively, when compared to arthroscopy [9,10]. The epidemiology of these injuries exhibits geographical and population-specific variations influenced by activity patterns, demographics, and prevalence of degenerative disease. While numerous studies from Western and other Asian populations have documented the prevalence and patterns of knee MRI findings, there remains a relative paucity of recent, prospective data from the Bangladeshi context [11,12]. The local burden of disease, influenced by unique occupational, athletic, and lifestyle factors, may present a distinct epidemiological profile. This gap in contemporary local evidence necessitates focused research. A precise understanding of the spectrum and frequency of knee internal derangements in the Bangladeshi population is crucial for several reasons: it guides resource allocation for advanced imaging, informs the development of context-specific clinical guidelines, aids in public health planning for injury prevention, and ultimately improves patient outcomes through targeted management. Therefore, this study was conceived to prospectively evaluate the role of MRI in assessing internal derangements of the knee joint at Shaheed Tajuddin Ahmad Medical College & Hospital, Gazipur, Bangladesh. The findings aim to delineate the common patterns, distribution, and demographic associations of these injuries, thereby contributing valuable data to the national

and regional orthopedic and radiological literature [13].

Methods & Materials

This prospective cohort study was conducted at the Department of Radiology & Imaging, Shaheed Tajuddin Ahmad Medical College & Hospital, Gazipur, Bangladesh, from January 2024 to June 2025. A purposive sample of 53 consecutive patients with clinical suspicion of internal knee derangement was enrolled.

Inclusion criteria

Patients of all ages and genders were included if they were referred for a knee MRI by an orthopedic specialist. Key indications included persistent knee pain for over four weeks, clinical signs of locking, instability, or effusion, and failure of conservative management.

Exclusion criteria

Individuals were excluded if they had a history of prior knee surgery, contraindications to MRI (e.g., incompatible pacemakers or severe claustrophobia), or had sustained acute trauma requiring immediate surgical intervention before imaging.

Study procedure

All participants underwent MRI on a 1.5 Tesla scanner (Siemens Healthineers) using a dedicated knee coil. A standard imaging protocol was followed, obtaining T1-weighted, T2-weighted, and Proton Density (PD) sequences with fat suppression in sagittal, coronal, and axial planes. Images were independently evaluated by two consultant musculoskeletal radiologists.

Data analysis

The MRI findings were recorded on a structured proforma. Data analysis was performed using SPSS software version 23.0. Descriptive statistics (frequencies, percentages, mean ± SD) were used to summarize demographic and radiological findings. Inter-observer agreement was assessed using Cohen's kappa coefficient.

Result

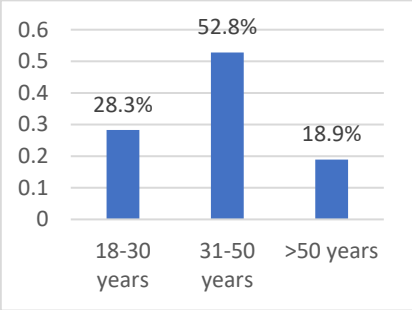

Figure 1 Age distribution of participants.

The study comprised 53 patients, with a mean age of 38.7 ± 12.4 years (range: 18-67 years) *Figure 1*.

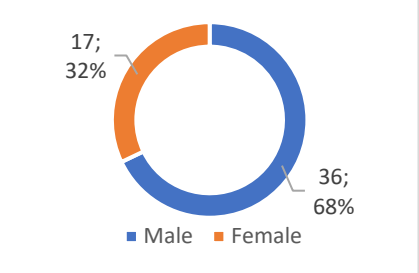

Figure 2 Gender distribution of participants.

The majority of participants were male (n=36, 67.9%), and the male-to-female ratio was 2.1:1 (*Figure 2*).

The most common presenting complaint was pain, reported by all patients (100%), followed by swelling (73.6%) and a sensation of instability (45.3%) *Table I*.

Table I
Symptoms distribution.

Symptoms	n (%)
Pain	53 (100.0)
Swelling	39 (73.6)
Instability	24 (45.3)
Locking	17 (32.1)

Analysis of the mechanisms of injury revealed that sports-related trauma was the most prevalent cause (41.5%), closely followed by degenerative changes (37.7%). Road traffic accidents (RTAs) accounted for 15.1% of cases, while other or unspecified mechanisms constituted 5.7%. The right knee (56.6%) was involved more frequently than the left knee (43.4%) (*Table II*).

Table II
Etiology of knee injuries and laterality.

Characteristics	n (%)
Etiology	
Sports-related trauma	22 (41.5)
Degenerative	20 (37.7)
Road traffic accident	8 (15.1)
Other/Unknown	3 (5.7)
Laterality	
Right knee	30 (56.6)
Left knee	23 (43.4)

The distribution of injuries across anatomical structures showed a high prevalence of multiple pathologies. Meniscal tears were the most common finding, present in 79.2% of patients (n=42). The medial meniscus was more frequently injured (52.8% of all patients) than the lateral meniscus (26.4%). Anterior cruciate ligament (ACL) tears were identified in 39.6% of patients (n=21), with complete tears (Grade III) being predominant (71.4% of ACL injuries). Posterior cruciate ligament (PCL) injuries were far less common (7.5%). Medial collateral ligament (MCL) sprains were observed in 30.2% of cases. A significant association was found between ACL tears and concomitant lateral meniscal tears (p=0.042). Osteochondral injuries, including bone contusions and full-thickness cartilage defects, were detected in 49.1% of the cohort (*Table III*).

Table III
Frequency and distribution of MRI-detected knee injuries.

Injury type	n (%)	Subtypes (if applicable)	n (%)
Any meniscal tear	42 (79.2)	Medial meniscus	28 (52.8)
		Lateral meniscus	14 (26.4)
Cruciate ligament injury	24 (45.3)	ACL tear	21 (39.6)
		PCL tear	4 (7.5)
Collateral ligament injury	16 (30.2)	MCL sprain (Grade I/II)	16 (30.2)
		LCL sprain	3 (5.7)
Osteochondral injury	26 (49.1)	Bone contusion	20 (37.7)
		Full-thickness cartilage defect	12 (22.6)

Note: Percentages are based on total N=53. Patients often had multiple injuries.

The spectrum of meniscal tear types demonstrated that vertical longitudinal tears were the most common pattern overall (35.7% of all tears). In the medial meniscus, posterior horn tears were overwhelmingly predominant (85.7%), whereas lateral meniscus tears were more evenly distributed between the anterior and posterior horns (Table IV).

Table IV
Patterns and locations of meniscal tears (n=42 patients with tears).

Meniscus	Tear location, n (%)	Tear pattern, n (%)
Medial (n=28)	Posterior Horn: 24 (85.7)	Vertical longitudinal: 12 (42.9)
	Body: 6 (21.4)	Horizontal cleavage: 8 (28.6)
	Anterior Horn: 2 (7.1)	Degenerative/Complex: 8 (28.6)
Lateral (n=14)	Posterior Horn: 7 (50.0)	Vertical longitudinal: 9 (64.3)
	Body: 5 (35.7)	Bucket-handle: 3 (21.4)
	Anterior Horn: 6 (42.9)	Radial: 2 (14.3)

Data analysis test for tear location vs. meniscus: Chi-square test, p=0.027.

Degenerative complex tears were most frequently observed in patients over 50 years of age (p=0.018). A comparative analysis of injury patterns based on etiology showed distinct profiles. Sports-related injuries had a significantly higher proportion of ACL tears (59.1%) and lateral meniscal involvement (45.5%) compared to the degenerative group (*Table V*).

Table V
Association between ACL tears and concomitant meniscal injuries.

Meniscal injury	ACL intact (n=32), n (%)	ACL torn (n=21), n (%)	p-value
Any meniscal tear	23 (71.9)	19 (90.5)	0.095
Medial meniscal tear	16 (50.0)	12 (57.1)	0.602
Lateral meniscal tear	6 (18.8)	8 (38.1)	0.042
Both menisci torn	1 (3.1)	1 (4.8)	0.752

Data analysis test: Chi-square test (or Fisher's Exact test where applicable).

In contrast, the degenerative etiology group was characterized by a higher incidence of isolated medial meniscal tears (65.0%) and a notable prevalence of cartilage loss (75.0%). These differences in injury patterns across etiological groups were statistically significant (p=0.003) (*Table VI*).

Table VI
Comparative injury patterns by primary etiology.

MRI finding	Sports trauma (n=22), n (%)	Degenerative (n=20), n (%)	p-value
ACL tear	13 (59.1)	3 (15.0)	0.003
Medial meniscus tear	11 (50.0)	13 (65.0)	0.331
Lateral meniscus tear	10 (45.5)	2 (10.0)	0.010
Cartilage loss (≥Grade III)	5 (22.7)	15 (75.0)	<0.001
Isolated meniscal tear	4 (18.2)	10 (50.0)	0.030

Data analysis test: Chi-square test. P-value for overall difference in patterns across groups = 0.003.

Discussion

This prospective study provides a detailed overview of the spectrum of internal derangements of the knee joint as assessed by MRI in a Bangladeshi cohort. The findings highlight a high prevalence of soft tissue injuries, with meniscal tears and ACL injuries being predominant, consistent with the global epidemiological profile of knee disorders [3,14]. The demographic profile, with a mean age of 38.7 years and a male preponderance (67.9%), aligns with studies from other regions where active, young to middle-aged males are more susceptible to traumatic knee injuries, often due to occupational and sports-related activities [11,15]. The predominance of sports-related trauma (41.5%) as the leading etiology, followed closely by degenerative causes (37.7%), underscores a dual burden. This pattern mirrors trends observed in both developed and developing nations, where increased sports participation coexists with an aging population prone to degenerative joint disease [4,16]. The high frequency of medial meniscus tears (52.8%) is a consistent finding across numerous studies, attributable to its firm attachment to the joint capsule and greater susceptibility to shear and rotational forces [17]. The marked propensity for posterior horn tears (85.7% of medial tears) is anatomically explained by its relative immobility and weight-bearing role, making it vulnerable to degenerative changes and traumatic impingement [18]. The significant association found between ACL tears and concomitant lateral meniscal injuries (p=0.042) is a well-documented biomechanical relationship. The mechanism of ACL rupture, often involving a valgus stress with internal rotation, directly loads the lateral meniscus and the posterolateral tibial plateau, explaining this frequent "unhappy triad" component [19,20]. Our finding that 38.1% of ACL-deficient knees had a lateral meniscal tear reinforces the imperative for meticulous MRI evaluation of all compartments when an ACL tear is identified, as missed concomitant injuries can compromise surgical planning and long-term outcomes [6]. The comparative

analysis by etiology revealed statistically distinct injury patterns. The sports injury group showed a significantly higher incidence of ACL tears (59.1%) and lateral meniscal injuries, characteristic of high-energy, rotational trauma [9]. In contrast, the degenerative group presented with a higher burden of isolated medial meniscal tears and significant cartilage loss (75.0%), a hallmark of the osteoarthritic process [21]. These divergent profiles validate the role of MRI not only in diagnosis but also in elucidating the underlying pathophysiology, which is crucial for tailoring management, whether geared towards ligament reconstruction or degenerative joint preservation [22]. The findings of this study have important clinical and public health implications for our setting. The high diagnostic yield of MRI confirms its indispensable role in the pre-surgical evaluation of knee injuries, potentially reducing diagnostic arthroscopies. The prevalence of sports-related ACL injuries calls for enhanced programs focused on neuromuscular training and injury prevention in athletes [23]. Conversely, the substantial degenerative pathology indicates a need for better management strategies for early osteoarthritis. This study is not without limitations. The purposive sampling from a single tertiary center may limit the generalizability of the findings to the broader population or primary care settings. The sample size, while adequate for descriptive analysis, constrained more complex multivariate analyses. Furthermore, the lack of arthroscopic correlation in all cases means the diagnostic accuracy of MRI in this cohort could not be definitively calculated, though it is well-established in the literature [10]. Future multicenter studies with larger samples and arthroscopic correlation are recommended.

Limitations

The study limitations include a single-center design and purposive sampling, which may affect generalizability. The modest sample size and lack of universal arthroscopic correlation are additional constraints. Future multi-center studies with larger cohorts are recommended.

Conclusion

This study delineates the common patterns of internal derangements of the knee joint in a representative Bangladeshi cohort using MRI. It confirms meniscal and ACL injuries as the most prevalent pathologies, with distinct patterns observed based on traumatic versus degenerative etiology. The findings underscore the critical value of MRI as the primary non-invasive imaging modality for accurate diagnosis and comprehensive assessment, thereby guiding appropriate clinical and surgical management to mitigate long-term sequelae like post-traumatic osteoarthritis.

Recommendation

We recommend routine use of MRI for detailed knee assessment and the development of local injury prevention programs. Future studies should employ larger, multicenter cohorts with arthroscopic correlation to validate these findings and explore longitudinal outcomes.

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