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PATTERNS OF MENISCAL INJURIES ON KNEE MRI: A SINGLE-CENTRE EXPERIENCE FROM IBADAN, NIGERIA – A RETROSPECTIVE CROSS-SECTIONAL STUDY

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ABSTRACT

Background: **Meniscus injury is one of the most common causes of consultations for knee disorders and requires timely diagnosis to guide appropriate treatment. MRI has become a practical tool for the evaluation of ACL injuries, with its high levels of accuracy and sensitivity. This study aims to determine the pattern of meniscal injuries in people presenting for knee MRI.**

Materials and Methods: **This retrospective cross-sectional study was conducted among patients who underwent MRI over a 3-year period (January 2023 to December 2025). Patients' demographic data, alongside the mechanisms of trauma, types, and location of meniscal injury, and presence of degeneration, were assessed. A descriptive statistical analysis was performed. Frequency and percentages were used for categorical and ordinal variables.**

Results: **The male distribution was 70.3%. The mean age was 35.6±14.6 years. The single most common cause of injury was found to be sport-related injuries seen in 11 (14.9%). The proportion of meniscus injury (medial meniscus and lateral meniscus) was found to be 48 (64.9%). Medial meniscus tears were present in 35 (43.5%) patients, found mostly in the posterior horn. Degenerative trauma was found in 28 (37.8%).**

Conclusion: **The present study observed that 43.5% of the patients who underwent MRI had medial meniscal tear, whereas lateral meniscal tears were seen in 28.4% of the patients. Hence, it is imperative to screen patients with knee complaints clinically and radiologically.**

Keywords: Meniscal injury, Knee MRI, Anterior cruciate ligament, Degenerative tears, Medial meniscus, Cartilage.

INTRODUCTION

The medial meniscus (MM) and lateral meniscus (LM) are crescent-shaped fibrocartilaginous structures that function primarily in shock absorption and load transmission through the tibiofemoral joint; therefore, a traumatic twist in the knee or further damage to an already degenerative knee may result in a tear to the meniscus.[1] Meniscal injury is a common traumatic injury in the knee and meniscal injury may lead to long-term degenerative joint changes, such as articular cartilage degeneration, joint space narrowing, osteophyte formation, and symptomatic osteoarthritis.[2,29] This study explores the prevalence of meniscal injury and the pattern of meniscal injuries in people presenting for knee Magnetic Resonance Imaging (MRI).

Meniscal tears are a common knee injury, and it has been estimated to affect 60–70 per 100,000 of the population.[2,7] Meniscus injury is one of the most common causes of consultations for knee disorders and requires timely diagnosis to guide appropriate treatment.[5,29] Meniscal tears can cause a range of symptoms, including pain localising to the joint line, swelling, clicking, catching, locking, and the classic feeling of "giving away" of the knee.[7]

The rate of meniscal injuries in men is 2 to 4 times higher than that in women.[8,12] It is not uncommon to see meniscal injuries in conjunction with damage to structures such as anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), or other bony injuries.[9,25] Meniscal tears are often classified according to their orientation. They can be vertical longitudinal, vertical radial, horizontal, oblique or complex. Longitudinal tears are more common medially, whereas radial tears are more frequently seen laterally. The acute injuries frequently result from sport injuries where there is a twisting motion on the partially flexed, weight-bearing knee. Acute meniscal injuries may also occur as part of more major, combined injuries to the knee. Older patients who have pre-existing degeneration in the knees have meniscal diseases while

traumatic tears have been observed in younger patients with higher functional demand.[4,10]

MRI has become a practical tool for the evaluation of ACL injuries, with its high levels of accuracy and sensitivity reported in the literature, with the sensitivity and specificity for meniscal tears ranging from 90 to 95% in most reports.[14,15,16] MRI has an enormous impact on musculoskeletal imaging (the knee being the most frequently visualised) having gained popularity since its introduction in the 1980's as a diagnostic tool of musculoskeletal disorders.[6,21]

Meniscal lesions are regular findings on MRI, especially in the osteoarthritic knee.[3,20] They can be in the form of: horizontal, flap, and (or) complex tears; maceration; extrusion; or destruction.[5] However, asymptomatic lesions are frequent incidental findings on the knee MRI of the middle-aged or older patient.[19] Magnetic resonance imaging (MRI) of the knee is widely used to diagnose damage to the menisci, and clinicians often use the findings as a factor in determining whether a person should undergo an arthroscopic procedure.[21,30] However, there is a paucity of epidemiological data on the prevalence of meniscal tears in the general population[13], making it difficult to interpret the diagnostic information provided by MRI among persons who have symptoms that are possibly attributable to tears or other forms of meniscus pathology. This study aims to determine the pattern of meniscal injuries in people presenting for knee MRI.

MATERIALS AND METHODS

This retrospective cross-sectional study was conducted at University College Hospital, (UCH), Ibadan, Nigeria, over a two-year period from April 2023 to May 2025. The study protocol received institutional ethical clearance prior to commencement, and informed consent was obtained from all participants after detailed explanation of the study objectives and procedures.

We employed nonprobability sequential convenient sampling to identify participants by systematically reviewing all knee MRI examinations performed during the study period. The inclusion criteria comprised all patients presenting for knee MRI who were willing to participate and provide informed consent. Exclusion criteria included skeletally immature patients and those who declined participation. Of the 74 patients who underwent knee MRI during the study period, 56 demonstrated meniscal injuries while 18 showed no meniscal pathology; however, all participants were included in the analysis to provide comprehensive data on the spectrum of knee pathology.

Patient records were meticulously reviewed, and relevant clinical history along with MRI findings pertaining to the menisci, ligaments, bone defects, and articular cartilage were systematically documented as interpreted by a senior surgeon at the time of imaging. Meniscal lesions involving either the medial or lateral meniscus were classified according to standard morphological patterns including bucket handle tears, vertical tears, horizontal tears, complex tears, degenerative tears, longitudinal tears, and cystic defects. The location, extent, and specific characteristics of each tear pattern were recorded. Associated ligamentous injuries involving the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), lateral collateral ligament (LCL), and medial patellofemoral ligament (MPFL) were similarly documented. Degenerative changes within the knee joint were graded on a three-point scale (Grade 1: mild, Grade 2: moderate, Grade 3: severe) based on established radiological criteria.

All data were entered into SPSS software for comprehensive statistical analysis. Prior to analysis, rigorous data cleaning was performed including cross-checking for missing values, identification and management of outliers, and resolution of inconsistencies to ensure data integrity. Descriptive statistical analysis was employed as the primary analytical approach. Categorical and ordinal variables were summarised using frequencies and percentages, while continuous variables were described using means, medians, and ranges (minimum and maximum values). The association between demographic variables (age group and gender) and injury patterns was evaluated using the Chi-square test for categorical variables. Statistical significance was set at $p \leq 0.05$ for all analyses.

RESULTS

Study population and demographics

The study comprised 74 participants who underwent knee MRI imaging during the study period. Of these, 56 participants (75.7%) demonstrated meniscal injuries on imaging, while 18 participants (24.3%) showed no meniscal pathology (Figure 1). Among the 56 patients with meniscal injuries, 37 patients had medial meniscal injuries, 20 had lateral meniscal injuries, and 1 patient presented with both medial and lateral meniscal pathology.

Table 1: Gender distribution of meniscal injuries

Gender	Medial Meniscus	Lateral Meniscus	Total
Male	28	16	44
Female	9	4	13
Total	37	20	57

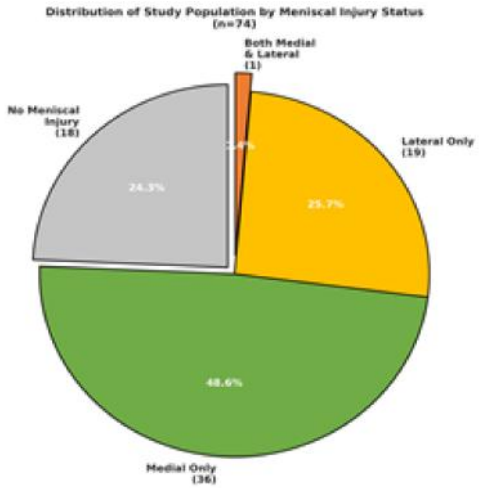


Figure 1: Distribution of study population by meniscal injury status (n=74)

Meniscal injury patterns

Gender and age distributions of meniscal injuries demonstrated distinct patterns (Tables 2). Male patients showed significantly higher prevalence of meniscal pathology compared to female patients, particularly for medial meniscal injuries. The cohort with meniscal injuries comprised predominantly males (28 with medial injuries, 16 with lateral injuries) compared to females (9 with medial injuries, 4 with lateral injuries).

Table 2: Age distribution of meniscal injuries

Age Group	Medial Meniscus	Lateral Meniscus	Total	Percentage (%)
≤20 years	3	2	5	8.8
21-30 years	12	8	20	35.1
31-40 years	9	5	14	24.6
41-50 years	7	3	10	17.5
>50 years	6	2	8	14.0
Total	37	20	57	100.0

Medial meniscus injuries

Medial meniscal injuries were identified in 37 patients (66.1% of those with meniscal pathology, 50.0% of the total study population). The distribution of tear types is illustrated in figure 2. Horizontal tears were the most prevalent pattern, affecting 23 patients (62.2% of medial meniscal injuries), with 14 occurring in men (37.8%) and 9 in women (24.3%, p=0.071). Complex tears represented the second most common pattern, occurring in 7 patients (18.9%), all of whom were male. Degenerative changes were observed in 4 patients (10.8%), vertical tears in 2 patients (5.4%), and bucket handle tears in 1 patient (2.7%).

Lateral meniscus injuries

Lateral meniscal pathology was present in 20 patients (35.7% of those with meniscal injuries, 27.0% of the total cohort). The injury patterns demonstrated considerable heterogeneity (Figure 3). Horizontal tears and degenerative changes were the most common patterns, affecting 7 and 5 patients respectively. Less common patterns included complex tears (2 patients), vertical tears (2 patients), cystic defects (2 patients, exclusively female), bucket handle tears (1 patient), and longitudinal tears (1 patient). Gender analysis revealed marked male predominance, with 16 males (80.0%) and 4 females (20.0%, p=0.326).

Associated ligamentous injuries

Concomitant ligamentous injuries were documented in 38 of the 74 participants (51.4% of the total cohort), representing 67.9% prevalence among patients with meniscal injuries. The distribution of ligament injuries is shown in Table 3. The anterior cruciate ligament (ACL) was the most frequently injured structure, with tears identified in 20 patients (27.0% of total cohort), followed by posterior cruciate ligament (PCL) and medial collateral ligament (MCL) with 6 patients each (8.1%), lateral collateral ligament (LCL) with 5 patients (6.8%), and medial patellofemoral ligament (MPFL)

Table 3: Distribution of associated ligamentous injuries

Ligament	Number (n)	% of Total Cohort (n=74)	% of Meniscal Injuries (n=56)
Anterior Cruciate Ligament (ACL)	20	27.0	35.7
Posterior Cruciate Ligament (PCL)	6	8.1	10.7
Medial Collateral Ligament (MCL)	6	8.1	10.7
Lateral Collateral Ligament (LCL)	5	6.8	8.9
Medial Patellofemoral Ligament (MPFL)	1	1.4	1.8
Total patients with ligament injuries	38	51.4	67.9

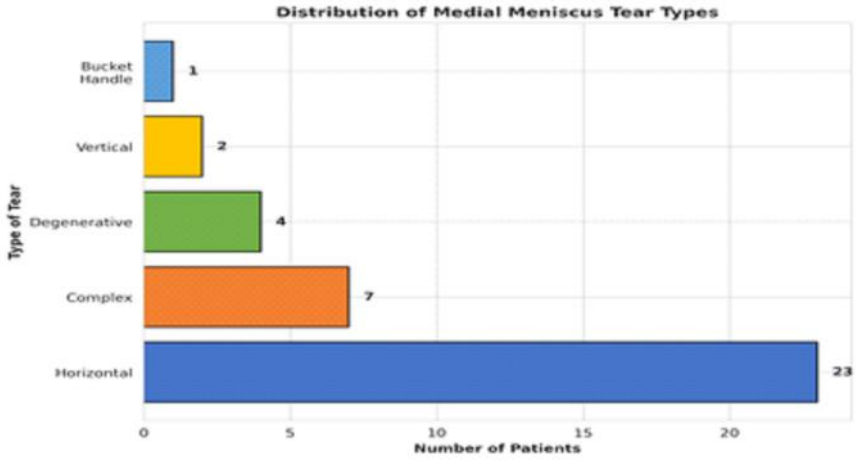


Figure 2: Distribution of medial meniscus tear types

with 1 patient (1.4%). Multiple ligament injuries were observed in some patients, accounting for the sum of individual ligament injuries exceeding the total number of patients with ligamentous pathology.

Degenerative changes

Degenerative changes were identified in 29 participants, representing 37.84% of the total study population (Table 4). This included both participants with and without meniscal injuries. The remaining 46 participants (62.16%) demonstrated no degenerative changes on imaging.

Table 4: Presence of degeneration in the study population

Category	Number (n)	Percentage (%)
With degenerative changes	29	37.84
Without degenerative changes	46	62.16
Total	75	100.00

Among the 29 participants with degenerative changes, grading distribution was as follows (Figure 4): Grade 1 degeneration (mild) was most prevalent, affecting 15 patients (51.7% of those with degeneration), Grade 2 degeneration (moderate) was present in 5 patients (17.2%), and Grade 3 degeneration (severe) was identified in 9 patients (31.0%).

Comparative statistical analyses were performed to evaluate gender and age-related differences in injury patterns. While several clinically relevant trends emerged, including higher prevalence of complex and degenerative tears in males and age-related variations in injury distribution, most comparisons did not achieve statistical significance ($p>0.05$). This likely reflects the relatively modest sample size, particularly in certain demographic subgroups. The p-values across different injury types and demographic comparisons ranged from 0.071 to 0.718, with comparisons approaching but not reaching conventional significance thresholds for medial horizontal tears by gender ($p=0.071$) and overall medial meniscal injury distribution ($p=0.086$).

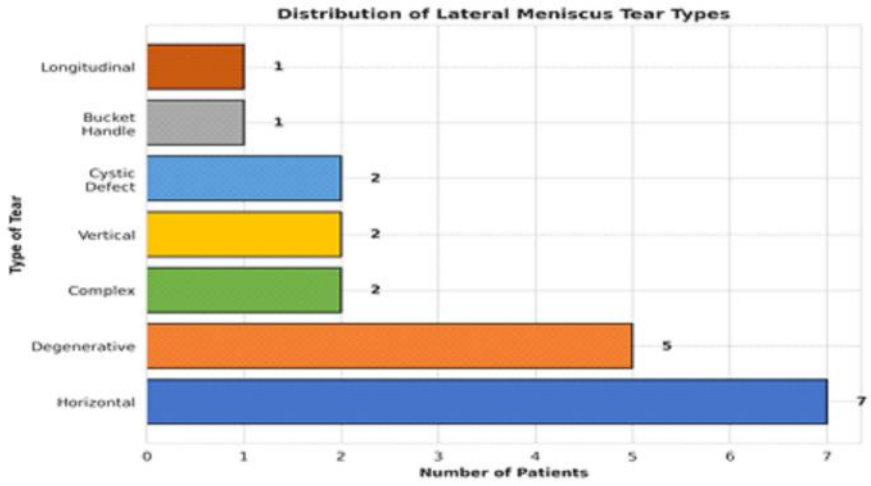


Figure 3: Distribution of lateral meniscus tear types

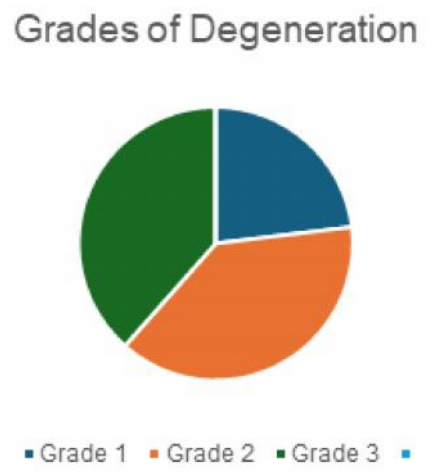


Figure 4: Distribution of degeneration grades among affected participants

DISCUSSION

This study provides important insights into the pattern and characteristics of meniscal injuries as detected by MRI examination. Our findings demonstrate that meniscal pathology is highly prevalent among patients undergoing knee MRI, affecting 75.7% of the study population. This high detection rate underscores the value of MRI as a diagnostic tool for knee pathology and suggests that clinical suspicion prompting MRI referral is generally well-founded.

The observed male predominance (70.3%) in our cohort aligns with established epidemiological data showing that men experience meniscal injuries at rates 2 to 4 times higher than women, likely reflecting differences in activity levels, participation in high-risk sports, and occupational exposures. The peak incidence in the 21-30 year age group corresponds to the period of maximum physical activity and sports participation, consistent with findings from previous studies documenting higher injury rates in young, athletically active populations.

Our finding that medial meniscal injuries (43.5%) predominated over lateral meniscal injuries (28.4%) is consistent with established anatomical and biomechanical principles. The medial meniscus is less mobile than the lateral meniscus due to its firm capsular attachments, making it more susceptible to injury during rotational stress. Furthermore, studies have consistently demonstrated that medial meniscal tears occur more frequently than lateral tears in the general population.

Among medial meniscal tears, horizontal tears were the most prevalent pattern (23 patients, 62.2% of medial injuries), followed by complex tears (7 patients, 18.9%). This distribution pattern suggests a predominance of degenerative pathology, as horizontal tears are characteristically associated with degenerative processes and are more common in older age groups. The high proportion of horizontal tears in our cohort may reflect the age demographics of our patient population, with the majority falling into the 30-49 years age bracket where early degenerative changes begin to manifest. Complex tears, representing the second most common pattern, typically result from a combination of traumatic and degenerative mechanisms and are associated with more severe pathology requiring more extensive surgical intervention.

The lateral meniscus injury patterns showed greater heterogeneity, with horizontal tears (7 patients) and degenerative changes (5 patients) being most common. This diversity in injury patterns reflects the different loading mechanisms and functional demands placed on the lateral compartment. The presence of cystic defects exclusively in female patients (2 cases) represents an interesting finding, though the small sample size precludes definitive conclusions. Cystic meniscal lesions typically result from the extrusion of synovial fluid through meniscal tears and may be associated with horizontal cleavage tears.

A significant finding of our study was the high prevalence of concomitant ligamentous injuries, present in 38 patients (51.4% of the total cohort). The anterior cruciate ligament (ACL) was the most frequently injured ligament (20 patients, 27.0%), which is consistent with the well-established association between ACL rupture and meniscal tears. The literature suggests that meniscal tears occur in 50-70% of ACL-injured knees, with the lateral meniscus being more commonly affected in acute ACL injuries and the medial meniscus in chronic ACL-deficient knees. The mechanism underlying this association involves the altered knee kinematics following ACL disruption, which increases abnormal translational and rotational forces on the menisci.

The age distribution of injuries revealed that ligamentous pathology predominantly affected younger age groups, with 55.2% of ligament injuries occurring in patients under 50 years of age. This pattern likely reflects the higher activity levels and exposure to traumatic events in younger populations. In contrast, meniscal injuries showed a more even distribution across age groups, supporting the dual aetiology of meniscal tears encompassing both acute traumatic events in younger patients and degenerative processes in older individuals.

Degenerative changes were identified in 37.84% of the study population, affecting both patients with and without meniscal tears. Among those with degenerative

changes, Grade 1 (mild) degeneration was most prevalent (51.7%), followed by Grade 3 (severe) degeneration (31.0%), and Grade 2 (moderate) degeneration (17.2%). This distribution pattern, with a relative paucity of Grade 2 changes, may suggest a biphasic disease process where early degenerative changes either stabilise or rapidly progress to more advanced stages. The presence of degenerative changes in patients without meniscal tears highlights the importance of considering the entire spectrum of intra-articular pathology rather than focusing solely on discrete structural tears.

Statistical analysis revealed that while several clinically relevant trends emerged, including higher rates of complex tears in males and age-related variations in injury patterns, most comparisons did not achieve statistical significance ($p>0.05$). This finding likely reflects the modest sample size of our study, particularly within certain demographic subgroups. The comparison approaching significance for medial horizontal tears by gender ($p=0.071$) and overall medial meniscal injury distribution ($p=0.086$) suggests that with a larger sample size, these differences may reach statistical significance.

The MRI accuracy for meniscal tear detection has been reported to range from 70-98% depending on various factors including field strength, reader experience, and tear characteristics. In our institution, knee MRI examinations were performed using standard protocols optimised for meniscal evaluation, contributing to reliable identification of meniscal pathology. The high sensitivity and specificity of MRI for meniscal tears have established it as the gold standard imaging modality for non-invasive evaluation of suspected meniscal injuries, reducing the need for diagnostic arthroscopy in many cases.

Despite these limitations, our study provides valuable data on the spectrum of meniscal injuries encountered in clinical practice and confirms several important patterns including the male predominance, the higher frequency of medial versus lateral injuries, the association between meniscal tears and ligamentous injuries particularly involving the ACL, and the significant burden of degenerative meniscal pathology in our population. These findings have important clinical implications for patient counselling, treatment planning, and prognostication.

Future prospective studies with larger sample sizes, long-term follow-up, correlation with arthroscopic findings, and inclusion of clinical outcome measures would provide more robust evidence regarding the natural history of meniscal injuries, optimal treatment strategies for different tear patterns, and predictors of clinical outcomes. Additionally, investigation of the genetic, biomechanical, and biochemical factors that contribute to meniscal injury susceptibility may open new avenues for preventive strategies and targeted therapeutic interventions.

The substantial burden of degenerative meniscal pathology, present in over one-third of patients, underscores the need for careful distinction between symptomatic tears requiring intervention and incidental degenerative findings that may not be the primary source of symptoms. The heterogeneity of injury patterns across different demographic groups and anatomical locations emphasises the importance of individualised treatment approaches based on patient age, activity level, tear characteristics, and associated pathology.

MRI remains an invaluable tool for the comprehensive assessment of meniscal injuries, providing detailed information on tear morphology, location, and associated injuries that is essential for treatment planning. Continued research into the natural history of different tear patterns, refinement of MRI techniques and interpretation, and development of evidence-based treatment algorithms will further enhance our ability to optimise outcomes for patients with meniscal injuries.

Limitation

Our study has several limitations that warrant consideration. First, the retrospective design may introduce selection bias, as we only included patients who underwent MRI examination, potentially excluding those with minor injuries managed clinically without imaging. Second, the relatively modest sample size, particularly in certain subgroups, limited our statistical power to detect significant differences in injury patterns across demographic categories. Third, we did not correlate MRI findings with arthroscopic or surgical outcomes, which would have provided validation of the imaging diagnoses and information on treatment outcomes. Fourth, information on the mechanism of injury, symptom duration, and functional outcomes was not systematically available, limiting our ability to correlate injury patterns with clinical presentation and prognosis.

CONCLUSION

This study demonstrates that meniscal injuries are highly prevalent among patients undergoing knee MRI, affecting approximately three-quarters of the study population. The predominance of medial meniscal injuries, particularly horizontal tears, reflects the characteristic loading patterns and anatomical

constraints of the medial compartment. The strong male predominance and the high frequency of concomitant ACL injuries highlight the multifactorial nature of knee pathology and the importance of comprehensive evaluation of all intra-articular structures.

The substantial burden of degenerative meniscal pathology, present in over one-third of patients, underscores the need for careful distinction between symptomatic tears requiring intervention and incidental degenerative findings that may not be the primary source of symptoms. The heterogeneity of injury patterns across different demographic groups and anatomical locations emphasises the importance of individualised treatment approaches based on patient age, activity level, tear characteristics, and associated pathology.

MRI remains an invaluable tool for the comprehensive assessment of meniscal injuries, providing detailed information on tear morphology, location, and associated injuries that is essential for treatment planning. Continued research into the natural history of different tear patterns, refinement of MRI techniques and interpretation, and development of evidence-based treatment algorithms will further enhance our ability to optimise outcomes for patients with meniscal injuries.

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