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Patterns of meniscal tears in patients with anterior cruciate ligament injury

Jerin Jose*, Ibin Varghese, Nadir Shajan Abdin, Abhijith Gopinathan

Department of Orthopaedics, Government Medical College, Kottayam, Kerala, India

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***Correspondence:**
Dr. Jerin Jose,
E-mail: jerinjos33@gmail.com

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ABSTRACT

Background: Anterior cruciate ligament (ACL) injuries are among the most common intra-articular knee injuries and are frequently associated with meniscal tears. The menisci play a crucial role in load transmission, stability, and joint congruency, and their injury in ACL-deficient knees accelerates degenerative changes and worsens functional outcomes. Understanding the pattern and distribution of meniscal tears in ACL injuries is essential for early diagnosis, appropriate surgical planning, and prevention of long-term osteoarthritis. Objectives were to evaluate the pattern of meniscal tears in patients with ACL injury.

Methods: This observational study was conducted in the Department of Orthopaedics, Government Medical College, Kottayam, over a period of 1.5 years from June 2024 to December 2025. A total of 272 patients aged ≥18 years with clinically and radiologically confirmed ACL injury were included. Patients with associated posterior cruciate ligament (PCL), medial collateral ligament (MCL), or lateral collateral ligament (LCL) injuries without ACL involvement, previous knee surgeries, or advanced osteoarthritis (Kellgren-Lawrence grade >3) were excluded. All patients underwent detailed clinical evaluation, magnetic resonance imaging (MRI) of the knee, and diagnostic arthroscopy where indicated. Data regarding the presence, type, and anatomical location of meniscal tears were recorded and analysed using SPSS version 26.

Results: Meniscal injury was present in 202 patients (74.3%). Isolated medial meniscus tears were the most common (58.4%), followed by combined medial and lateral meniscus tears (26.7%), while isolated lateral meniscus tears were least frequent (14.9%). The posterior horn of the medial meniscus was the most commonly involved site (65.3%), followed by the posterior horn of the lateral meniscus (24.3%). The body of the lateral meniscus was the least affected region (6.9%).

Conclusions: The study demonstrates a high prevalence of meniscal tears in ACL-injured knees, with predominant involvement of the medial meniscus, especially its posterior horn. Early detection and timely management of ACL injuries are essential to prevent secondary meniscal damage and long-term degenerative changes of the knee joint.

Keywords: Anterior cruciate ligament injury, Meniscal tear, Medial meniscus, Posterior horn

INTRODUCTION

The anterior cruciate ligament (ACL) is the primary stabiliser of the knee joint, and the meniscus is the secondary stabiliser in the anterior-posterior direction. When there is a persistent ACL tear or loss of ACL function, the meniscus takes over as the primary stabiliser of the knee joint.[1] ACL is a key ligamentous structure guiding rotation in the normal knee joint. Its disruption changes the ability of the knee joint to maintain stability during rotational, accelerative, and decelerative activities. It is the primary restraint to anterior tibial translation, providing 85% of the total restraining force to the anterior drawer.[2,3]

The menisci are important structures within the knee, along with ligaments, with complex biomechanical functions. Lateral and medial menisci are crescent-shaped structures made of fibrocartilage that collectively cover approximately 70% of the articular surface of the tibial plateau.[3] They have a wedge shape and thicker areas along the edge of the joint, increasing the tibial plateau's articular surface and enhancing joint congruency while serving as a supplementary stabilising mechanism inside the joint. They are thought to carry 40-70% of the load across the knee, and they have a role in shock absorption, proprioception, and enhancement of stability.[4] Damage to both of these structures might compromise joint stability and affect joint mobility. ACL injuries have become one of the common intra-articular injuries of the knee seen in orthopaedic clinics. ACL injury can be caused by contact or non-contact activities. Most of the patients with ACL injuries are found to have associated injury to other intra-articular structures, such as the meniscus, ligaments, and cartilage.[5,6]

Meniscal injuries are concomitantly associated with ACL injuries. Diagnostic arthroscopy or MRI can be used to diagnose meniscal injuries or internal derangements of the knee.[7] MRI knee is non-invasive and can be used as a screening tool before therapeutic intervention; MRI is more accurate in diagnosing meniscus and Ligament injuries. A combination of clinical examination, including Anterior drawer test, Lachman test and imaging studies, including MRI, provides a provisional diagnosis, though no definitive diagnosis can be reached without the help of diagnostic arthroscopy. Meniscal injuries are linked to the early onset of joint osteoarthritis.[8,9] Patients with meniscal injuries who underwent ACL reconstruction had poor results and early osteoarthritis. The complexity of meniscal tears increases in chronic ACL injuries; it becomes very difficult to repair the meniscus in chronic cases.[10-12] Hence, meniscal tears should be identified and repaired early to prevent degenerative changes in the knee joint. The present study aims to evaluate the pattern of meniscal tears in patients with ACL injury.

METHODS

This observational study was carried out in the Department of Orthopaedics, Government Medical College, Kottayam, over a period of 1.5 years, from June 1st 2024, to December 31st 2025. The study included patients presenting with knee pain and/or instability who were diagnosed with ACL injury during the study period. The sample size was calculated based on a previous study by Venkataraman et al which reported a prevalence of meniscal injury of 77% in ACL-injured patients.[1] Using a 95% confidence level (Z=1.96), absolute precision of 5%, and the formula $n=Z^2pq/d^2$, the minimum required sample size was estimated to be 272 patients, all of whom were included in the study.

Patients aged 18 years and above with a confirmed diagnosis of ACL injury and who were medically fit for radiological and/or arthroscopic evaluation were included after obtaining informed consent. Patients with PCL, MCL or LCL injuries without ACL involvement, those with a history of previous knee surgery, and patients with advanced knee osteoarthritis (Kellgren-Lawrence grade >3) were excluded. All eligible participants underwent a detailed clinical evaluation, including history and physical examination with special tests such as the anterior drawer test and Lachman test, followed by radiological assessment using MRI of the knee. Diagnostic arthroscopy was performed wherever clinically indicated, and findings related to the presence, type, and location of meniscal tears were documented using a structured proforma.

Data was entered into Microsoft excel and subsequently analysed using SPSS version 26. Categorical variables were summarised as frequencies and percentages, while continuous variables were expressed as mean and standard deviation. The results were presented using appropriate tables and graphical representations to describe the pattern and distribution of meniscal tears associated with anterior cruciate ligament injuries.

RESULTS

A total of 272 patients with anterior cruciate ligament injury were included in the study. The majority of patients were in the 18-30-year age group, comprising 170 patients (62.5%), followed by 53 patients (19.5%) in the 31-40-year group and 41 patients (15.1%) in the 41-50-year group; only 8 patients (2.9%) were above 50 years of age. The study population was predominantly male, with 235 patients (86.4%), while females accounted for 37 patients (13.6%). Most patients had a normal body mass index, seen in 193 patients (71.0%), whereas 76 patients (27.9%) were overweight and 3 patients (1.1%) were obese (Table 1).

With regard to the mechanism of injury, falls were the most common cause, reported in 176 patients (64.7%), while road traffic accidents were responsible for injury in 96 patients (35.3%). The left knee was more commonly involved, affecting 145 patients (53.3%), compared to the right knee, which was involved in 127 patients (46.7%) (Table 2).

Meniscal injury was identified in 202 patients, accounting for 74.3% of the study population, while 70 patients (25.7%) had isolated ACL injury without meniscal involvement. Among those with meniscal tears, isolated medial meniscus injury was the most frequent pattern, observed in 118 patients (58.4%), followed by combined medial and lateral meniscal injuries in 54 patients (26.7%). Isolated lateral meniscus tears were noted in 30 patients (14.9%) (Table 3).

Analysis of the anatomical distribution of meniscal tears showed that the posterior horn of the medial meniscus was the most commonly affected site, involving 132 patients (65.3%). This was followed by tears of the posterior horn

of the lateral meniscus in 49 patients (24.3%). Injuries to the anterior horn and body of both menisci were less frequent, with the body of the lateral meniscus being the least commonly involved region, seen in 14 patients (6.9%) (Table 4).

Table 1: Sociodemographic profile of the study population, (n=272).

Variables	Category	N (%)
Age group (in years)	18-30	170 (62.5)
	31-40	53 (19.5)
	41-50	41 (15.1)
	>50	8 (2.9)
Gender	Male	235 (86.4)
	Female	37 (13.6)
BMI	Normal	193 (71.0)
	Overweight	76 (27.9)
	Obese	3 (1.1)

Table 2: Injury-related characteristics of the study population, (n=272).

Variables	Category	N (%)
Mode of injury	Fall	176 (64.7)
	Road traffic accident	96 (35.3)
Side of injury	Left knee	145 (53.3)
	Right knee	127 (46.7)

Table 3: Distribution according to presence and type of meniscal injury.

Variables	Category	N (%)
Meniscal injury (n=272)	Present	202 (74.3)
	Absent	70 (25.7)
Type of meniscal injury (n=202)	Isolated medial meniscus	118 (58.4)
	Isolated lateral meniscus	30 (14.9)
	Combined medial and lateral	54 (26.7)

Table 4: Distribution of meniscal tears according to anatomical location.

Meniscus	Part involved	N (%)
Medial meniscus	Anterior horn	33 (16.3)
	Body	24 (11.9)
	Posterior horn	132 (65.3)
Lateral meniscus	Anterior horn	21 (10.4)
	Body	14 (6.9)
	Posterior horn	49 (24.3)

DISCUSSION

The present study evaluated the pattern of meniscal tears in patients with ACL injury. The study population was predominantly male (86.4%) with a mean age of 29.98±9.84 years, and the majority (62.5%) belonged to the 18-30-year age group. Most participants had normal body mass index (71%), sustained injury due to a fall (64.7%), and had left-sided knee involvement (53.3%). Meniscal injury was present in 74.3% of patients, with isolated medial meniscus tears being the most common (58.4%), followed by combined medial and lateral meniscus tears (26.7%). The posterior horn of the medial meniscus was the most frequently involved site, followed by the posterior horn of the lateral meniscus, while the body of the lateral meniscus was the least commonly affected.

In this study, meniscal injury was present in 74.3% of patients, with isolated medial meniscus tears being the most common, particularly involving the posterior horn. Similar observations were reported by Mansori et al and Smith et al who found a higher incidence of medial meniscal tears with predominant involvement of the posterior horn, especially in chronic ACL-deficient knees.[3,13]

The predominance of medial meniscus injury in the present study is also in agreement with findings by Millett et al and Kilcoyne et al who demonstrated an increased frequency of medial meniscal tears with longer duration between injury and surgical intervention.[12,14] In contrast, studies by Duncan et al and Feucht et al reported a higher incidence of lateral meniscal tears, particularly in acute ACL injuries and younger patients, highlighting the influence of injury mechanism and chronicity on tear patterns.[15,16] Overall, the present study supports existing evidence that meniscal tears are commonly associated with ACL injuries, with the medial meniscus-especially the posterior horn-being most frequently affected. Variations across studies may be attributed to differences in patient demographics, mechanism of injury, and timing of intervention, emphasising the importance of early diagnosis and management of ACL injuries to prevent secondary meniscal damage.

This study has certain limitations that should be considered while interpreting the findings. The study did not assess the duration between injury and presentation, which could influence the pattern and severity of meniscal tears. Additionally, not all patients underwent arthroscopy, and reliance on MRI in some cases may have led to under- or overestimation of meniscal injuries. The study also did not evaluate functional outcomes or long-term follow-up, limiting the ability to correlate tear patterns with clinical prognosis. Furthermore, potential confounding factors such as activity level, occupation, and rehabilitation status were not analysed.

CONCLUSION

The current study concludes that meniscal injuries are frequently associated with ACL injuries, with 74.3% of patients demonstrating concomitant meniscal tears. The most important finding of this study is the predominance of isolated medial meniscus tears (58.4%), followed by

combined medial and lateral meniscus tears (26.7%), while isolated lateral meniscus tears (14.9%) were less common. Anatomically, the posterior horn of the medial meniscus was the most frequently involved site (132 cases), followed by the posterior horn of the lateral meniscus (49 cases), whereas the body of the lateral meniscus (14 cases) was least commonly affected. These results emphasize the vulnerability of the medial meniscus-particularly its posterior horn-in ACL-deficient knees and highlight the importance of early diagnosis and timely intervention to prevent secondary meniscal damage and long-term degenerative changes of the knee joint.

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