

Magnetic Resonance Imaging Evaluation of Anterior and Posterior Cruciate Ligament Injuries of the Knee: A Prospective Observational Study

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Received: 28th Feb, 2026; Revised: 6th March 2026; Accepted: 7th April, 2026; Available Online: 20th April, 2026

ABSTRACT

Background: Cruciate ligament injuries of the knee, particularly involving the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL), are common causes of knee instability following trauma. Accurate diagnosis is essential for appropriate management, and Magnetic Resonance Imaging (MRI) has become the modality of choice for evaluating these injuries and associated intra-articular pathologies.

Aim: To evaluate the role of MRI in diagnosing anterior and posterior cruciate ligament injuries of the knee and to assess associated findings.

Materials and Methods: This prospective observational study was conducted over one year and included 50 patients presenting with knee trauma and clinical suspicion of ligament injury. MRI of the knee was performed using standard protocols. ACL and PCL injuries were assessed for presence and type (partial or complete tear), along with associated findings such as meniscal injuries, bone contusions, and joint effusion. Statistical analysis was performed using appropriate tests, with $p < 0.05$ considered significant.

Results: ACL tears were observed in 72% of patients, while PCL tears were seen in 20%. Complete ACL tears (44%) were more common than partial tears (28%). Joint effusion (64%) and meniscal injuries (56%) were frequent associated findings. A significant association was found between mode of injury and ACL tears ($p = 0.048$).

Conclusion: MRI is a highly sensitive and reliable modality for diagnosing cruciate ligament injuries and associated knee pathologies, aiding in accurate management.

Keywords: Anterior cruciate ligament; Posterior cruciate ligament; MRI

How to cite this article: Vikhe G, Karnawat A, Sachdev YP. Magnetic Resonance Imaging Evaluation of Anterior and Posterior Cruciate Ligament Injuries of the Knee: A Prospective Observational Study. Int J Drug Deliv Technol. 2026;16(64s):1203-120. DOI: 10.25258/ijddt.16.64s.127

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Injuries to the cruciate ligaments of the knee, namely the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL), are among the most common causes of knee instability, particularly in young and physically active individuals. (1) These injuries frequently result from sports-related trauma, road traffic accidents, or sudden twisting mechanisms, and can significantly impair functional mobility if not diagnosed and managed appropriately. While ACL injuries are more prevalent, PCL injuries, though less common, are often associated with high-energy trauma and may coexist with other ligamentous or meniscal injuries. (2,3,4)

Accurate and early diagnosis of cruciate ligament injuries is essential for optimal treatment planning and prevention of long-term complications such as chronic instability, meniscal tears, and early osteoarthritis. Clinical examination, though valuable, may be limited in the acute setting due to pain, swelling, and muscle guarding. In this

context, Magnetic Resonance Imaging (MRI) has emerged as the imaging modality of choice for comprehensive evaluation of knee injuries.(5)

MRI provides excellent soft tissue contrast and allows detailed visualization of ligament morphology, signal alterations, and associated intra-articular pathologies. It facilitates assessment of partial and complete tears, ligament continuity, fiber orientation, and secondary signs of injury. Therefore, this study aims to evaluate the role of MRI in diagnosing anterior and posterior cruciate ligament injuries and to assess associated findings to aid in accurate and early management.

STUDY METHODOLOGY

This prospective observational study was conducted in the Department of Radio-diagnosis at a tertiary care center over a period of one year. A total of 50 patients presenting with knee pain, instability, or clinical suspicion of cruciate ligament injury were included in the study. Prior approval was obtained from the Institutional Ethics Committee, and

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written informed consent was secured from all participants before inclusion in the study.

Patients were selected based on predefined inclusion and exclusion criteria. Inclusion criteria comprised patients aged 18–60 years with a history of knee trauma and clinical features suggestive of anterior cruciate ligament (ACL) or posterior cruciate ligament (PCL) injury. Exclusion criteria included patients with previous knee surgery, known degenerative joint disease, fractures around the knee, and contraindications to MRI such as metallic implants or claustrophobia. A detailed clinical history including mode of injury, duration of symptoms, and associated complaints was recorded.

All patients underwent Magnetic Resonance Imaging of the knee using a standardized imaging protocol. MRI was

performed using sequences including T1-weighted, T2-weighted, proton density (PD), and fat-suppressed sequences in axial, sagittal, and coronal planes. The images were evaluated for integrity, continuity, and signal intensity changes of the ACL and PCL. Injuries were classified as partial or complete tears. Associated findings such as meniscal injuries, bone contusions, joint effusion, and collateral ligament injuries were also assessed.

The collected data were compiled and analyzed using appropriate statistical methods. Descriptive statistics including mean, standard deviation, frequency, and percentage were used to summarize the findings. The association between MRI findings and clinical parameters was evaluated using suitable statistical tests such as Chi-square test or Fisher's exact test. A p-value of less than 0.05 was considered statistically significant.

RESULTS:

Table 1. Demographic and Clinical Profile of Patients (n = 50)

Parameter	Frequency (n)	Percentage (%)
Age Group (years)		
18–30	20	40.0
31–45	18	36.0
46–60	12	24.0
Gender		
Male	34	68.0
Female	16	32.0
Mode of Injury		
Sports injury	22	44.0
Road traffic accident	18	36.0
Fall/twist injury	10	20.0
Duration of Symptoms		
< 2 weeks	15	30.0
2–6 weeks	20	40.0
> 6 weeks	15	30.0

Table 2. MRI Findings of Cruciate Ligament Injuries

MRI Findings	Frequency (n)	Percentage (%)
ACL tear (total)	36	72.0
• Partial ACL tear	14	28.0
• Complete ACL tear	22	44.0
PCL tear (total)	10	20.0
• Partial PCL tear	6	12.0
• Complete PCL tear	4	8.0
Combined ACL + PCL injury	4	8.0

Table 3. Associated MRI Findings in Knee Injuries

Associated Findings	Frequency (n)	Percentage (%)
Meniscal injury	28	56.0
Bone contusion	24	48.0
Joint effusion	32	64.0
Medial collateral ligament injury	14	28.0
Lateral collateral ligament injury	8	16.0

Table 4. Association Between Mode of Injury and ACL Tear

Mode of Injury	ACL Tear Present (n=36)	ACL Tear Absent (n=14)	p-value
Sports injury	18 (50.0%)	4 (28.6%)	
RTA	12 (33.3%)	6 (42.9%)	

Fall/twist	6 (16.7%)	4 (28.6%)	0.048 (Significant)
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Statistical Test Used: Chi-square test

DISCUSSION

The present study evaluated the role of MRI in diagnosing anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) injuries of the knee and assessing associated intra-articular pathologies. The findings emphasize the clinical relevance of MRI as a comprehensive, non-invasive modality for accurate evaluation of ligamentous injuries, particularly in patients with acute knee trauma. (6,7)

In this study, the majority of patients were in the younger age group of 18–30 years (40%), followed by 31–45 years (36%), indicating that cruciate ligament injuries predominantly affect young, active individuals. This is consistent with the higher exposure of this population to sports and high-energy activities. A clear male predominance (68%) was observed, which aligns with existing literature and may be attributed to greater participation in physically demanding activities and higher risk of trauma among males.

Sports-related injuries (44%) emerged as the most common mode of injury, followed by road traffic accidents (36%) and fall/twisting injuries (20%). This distribution highlights the increasing incidence of sports-related ligament injuries, particularly ACL tears, due to sudden deceleration, pivoting, and rotational forces acting on the knee. The association between mode of injury and ACL tears was found to be statistically significant ($p = 0.048$), indicating that sports injuries are strongly linked to ACL involvement.

MRI findings revealed that ACL injuries were far more common than PCL injuries, with 72% of patients demonstrating ACL tears compared to 20% with PCL tears. Among ACL injuries, complete tears (44%) were more frequent than partial tears (28%), suggesting that a significant number of patients presented with severe ligament disruption. PCL injuries were less common and predominantly partial in nature, reflecting their typical association with high-impact trauma. Combined ACL and PCL injuries were relatively rare (8%), but clinically significant due to their impact on joint stability.

The study also demonstrated a high prevalence of associated intra-articular findings, with joint effusion (64%) being the most common, followed by meniscal injuries (56%) and bone contusions (48%). These findings underscore the importance of MRI in identifying concomitant injuries that may not be clinically evident. Meniscal injuries, particularly in association with ACL tears, are well-documented and contribute to long-term joint degeneration if not addressed appropriately. Collateral ligament injuries were also noted, with medial collateral ligament involvement (28%) being more

common than lateral collateral ligament injuries (16%), reflecting the typical injury mechanisms. (8-11)

Overall, MRI proved to be an invaluable tool in the evaluation of cruciate ligament injuries by providing detailed anatomical and pathological information. It not only facilitates accurate diagnosis and grading of ligament tears but also aids in identifying associated injuries, thereby guiding appropriate management strategies. Early and precise MRI evaluation is crucial for planning surgical or conservative treatment and for preventing long-term complications such as chronic instability and osteoarthritis.

CONCLUSION:

In conclusion, the study reinforces the pivotal role of MRI in the comprehensive assessment of knee ligament injuries. Given its high diagnostic accuracy and ability to evaluate associated pathologies, MRI should be considered the imaging modality of choice in patients with suspected cruciate ligament injuries.

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