International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Magnetic Resonance Imaging Evaluation of Cruciate Ligament Injuries in Traumatic Knee Internal Derangements

Dr. Jangam Lakshanica[1], Dr. M S Raghu Nadhavarma[2], Dr. S Swetha Reddy[3], Dr. Varsha Vivek Shetty[4]

[1,2,3]Post Graduate Resident, Department of Radio Diagnosis, The Oxford Medical College Hospital and Research Centre, Bangalore, India.
[4]Assistant Professor, Department of Radio Diagnosis, The Oxford Medical College Hospital and Research Centre, Bangalore, India

Abstract

Introduction: The knee joint is highly prone to trauma due to its complex anatomy and weight-bearing role. Cruciate ligament injuries (ACL & PCL) are particularly critical, compromising knee stability. MRI offers superior soft tissue visualization, facilitating accurate diagnosis and grading.

Aim and Objectives: To evaluate the diagnostic performance of MRI in detecting and grading ACL and PCL injuries in traumatic knee cases.

Materials and Methods: A descriptive cross-sectional study was conducted over 18 months, including 50 patients with traumatic knee injuries assessed using 1.5 Tesla MRI.

Results: ACL tears were present in 21.05% and PCL tears in 14.04% of patients. MRI effectively graded these injuries, aiding clinical decisions.

Discussion: These findings are consistent with published studies on cruciate ligament imaging, reaffirming MRI's pivotal role.

Conclusion: MRI is a reliable, non-invasive modality for assessing ACL and PCL injuries, ensuring prompt and appropriate management.

Keywords: Knee Injuries, Cruciate Ligament Tears, ACL, PCL, Magnetic Resonance Imaging, Trauma Assessment, Ligament Grading.

1. Introduction

The knee joint is among the most complex and heavily loaded joints in the human body, frequently subjected to injuries from sports, road traffic accidents, and occupational activities. Injuries to the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) are especially significant, as they disrupt joint stability and can lead to chronic functional impairment if undiagnosed or untreated [1,2].

Magnetic Resonance Imaging (MRI) has revolutionized musculoskeletal imaging by providing exceptional soft tissue contrast and multiplanar capabilities. It allows direct visualization of cruciate ligaments, accurate detection of partial or complete tears, and identification of indirect signs such as bone contusions or joint effusion [3,4].

Studies by Bencardino et al. and Vahey et al. have demonstrated MRI's high sensitivity and specificity for cruciate ligament injuries, solidifying its role as the imaging modality of choice [4,5].
This study was undertaken to evaluate the prevalence and grading of ACL and PCL injuries on MRI in patients with traumatic knee derangements.

2. Aim and Objectives

2.1 Aim

To evaluate traumatic cruciate ligament (anterior cruciate ligament & posterior cruciate ligament) injuries of the knee using Magnetic Resonance Imaging.

2.2 Objectives

1. To identify and grade anterior cruciate ligament & posterior cruciate ligament injuries on MRI in patients with traumatic knee injuries.
2. To establish the diagnostic utility of MRI in cruciate ligament assessment following trauma.

3. Materials and Methods

This descriptive, cross-sectional study was conducted in the Department of Radio-Diagnosis at a tertiary care center in Bengaluru over a duration of 18 months (May 2023 to November 2024).

3.1 Study Design: Descriptive cross-sectional study.

3.2 Study Duration: 18 months.

3.3 Study Setting: Department of Radio-Diagnosis, The Oxford Medical College Hospital and Research Centre, Bengaluru.

3.4 Sample Size Calculation:

The sample size was calculated based on a previous study by Indrajeet Kaur et al., which reported an anterior cruciate ligament (ACL) injury prevalence of 91% among knee trauma patients [6].
The formula used for the calculation is:

$$n = z^2 \frac{[p(1 - p/q)}{d^2}$$

Where:

z = 1.96 at α = 0.05, p = 0.91 %, Q = q = 9 = 1-p, d = 8 %

$$n = \frac{4\ x\ 91\ x\ 9}{8\ x\ 8}$$

n = 50.

Thus, the minimum sample size required was 50 patients.

3.5 Sampling Method: Consecutive sampling of patients meeting the inclusion criteria.

3.6 Sample Collection and Equipment:

Patients referred with traumatic knee injuries underwent clinical history-taking and MRI examination using a 1.5 Tesla Siemens Magnetom Sempra (XA-12 Platform). Imaging included T1, T2, proton density, and fat-saturated sequences in axial, sagittal, and coronal planes.

3.7 Inclusion Criteria:

1. Patients with clinical suspicion of cruciate ligament injuries following acute knee trauma.
2. History of acute knee pain, swelling, or restricted mobility.

3.8 Exclusion Criteria:

1. Degenerative knee arthritis.
2. Metallic implants or MRI contraindications (e.g., pacemakers, clips).
3. Vitally unstable or critically injured patients.
4. Claustrophobia.
5. Previous knee surgery.

All MRIs were performed using a 1.5 Tesla Siemens Magnetom Sempra (XA-12 Platform). Imaging protocols included T1-weighted, T2-weighted, proton density (PD), and fat-saturated sequences in sagittal, axial, and coronal planes. Cruciate ligaments were evaluated for fiber discontinuity, altered signal intensity, and associated findings such as joint effusion.

Ethical clearance was obtained from the institutional ethics committee. Informed consent was obtained from all patients prior to participation.

3.9 Statistical Analysis: Data were summarized using frequencies and percentages.

4. Results

4.1 Age Distribution

The majority of cruciate ligament injuries (ACL & PCL) were observed in the 30 to 39 year age group (38.89%), followed by 20 to 29 years (27.78%) and 40 to 49 years (22.22%). Lower incidences were noted in the 10 to 19 year (5.56%) and 50 to 59 year (5.56%) age groups, with no cases recorded above 60 years.

Table 1: Age Distribution

Age Group	Count	Percentage (%)
10-19	1	5.56%
20-29	5	27.78%
30-39	7	38.89%
40-49	4	22.22%
50-59	1	5.56%
60+	0	0.00%

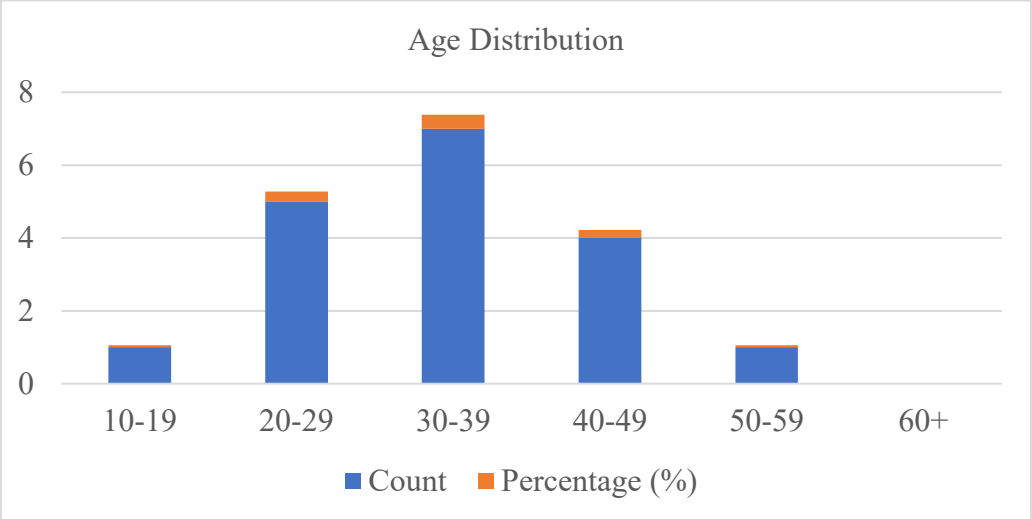

Figure 1: Age Distribution

4.2 Gender Distribution

Cruciate ligament injuries demonstrated a male predominance, with 77.78% of cases occurring in males and 22.22% in females.

Table 2: Gender Distribution

Gender	Count	Percentage (%)
Male	14	77.78%
Female	4	22.22%

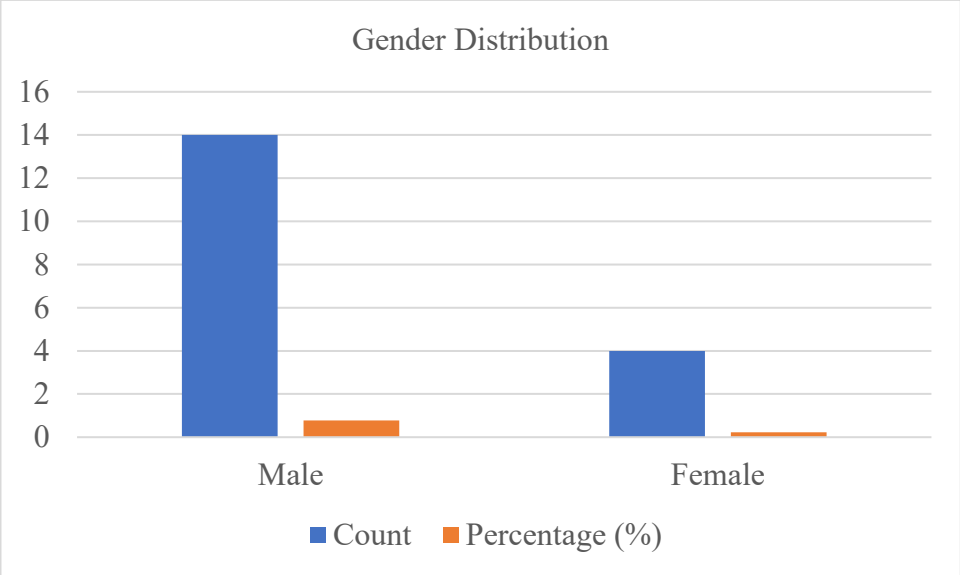

Figure 2: Sex Distribution

4.3 Right versus Left Knee Distribution

A slight right knee predominance was noted, with 55.56% of cruciate ligament injuries affecting the right knee and 44.44% involving the left knee.

Table 3: Right versus Left Knee Distribution

Knee	Count	Percentage (%)
Right	10	55.56%
Left	8	44.44%

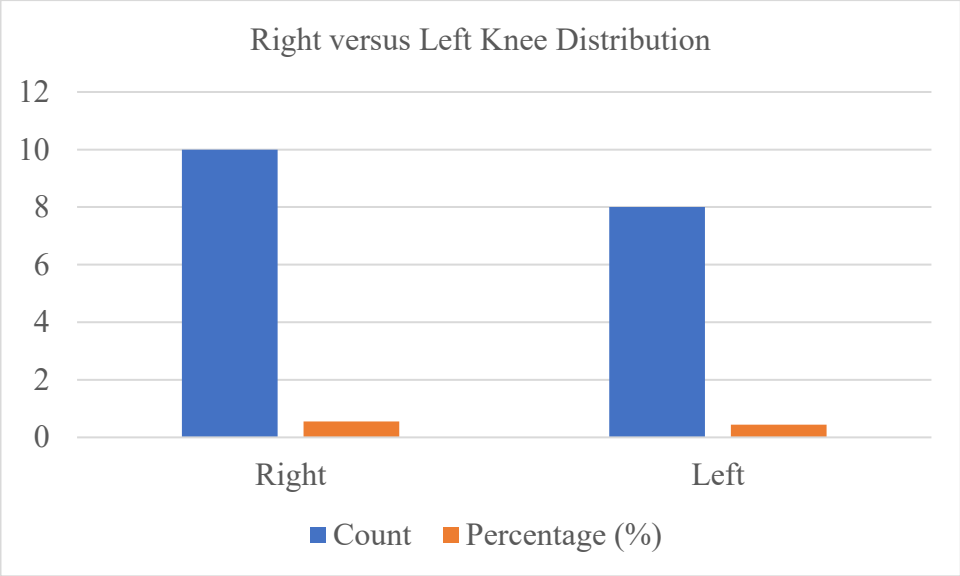

Figure 3: Right versus Left Knee Distribution

5.4 ACL Tear Distribution

ACL tears were present in 24% of patients, with Grade 1 injuries seen in 10%, Grade 2 in 6%, and Grade 3 (complete tears) in 8%. The majority (76%) showed no evidence of ACL tear.

Table 4: ACL Tear Distribution

ACL Tear	Count	Percentage (%)
No Tear	38	76.00%
Grade 1	5	10.00%
Grade 2	3	6.00%
Grade 3	4	8.00%

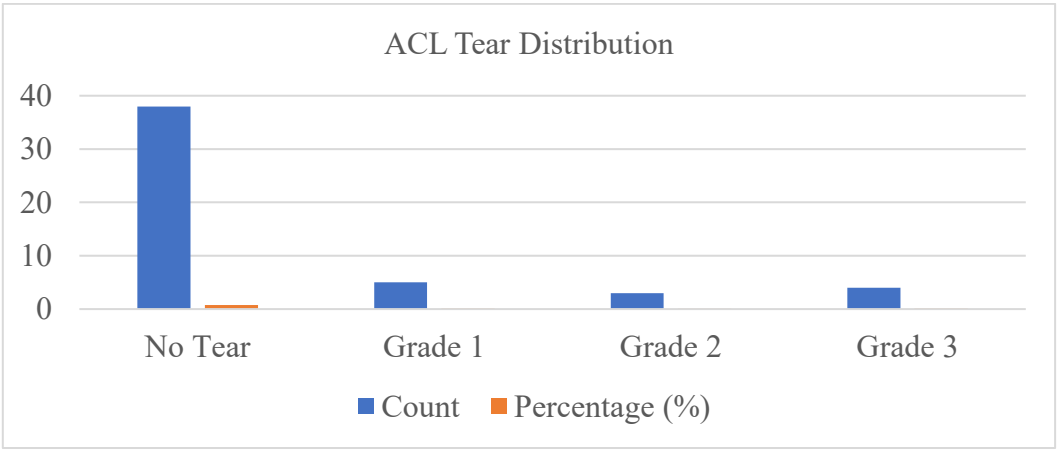

Figure 4: ACL Tear Distribution

5.5 PCL Tear Distribution

PCL tears were identified in 16% of patients, distributed as 6% Grade 1, 4% Grade 2, and 6% Grade 3 injuries. Most patients (84%) did not exhibit PCL involvement.

Table 5: PCL Tear Distribution

PCL Tear	Count	Percentage (%)
No Tear	42	84.00%
Grade 1	3	6.00%
Grade 2	2	4.00%
Grade 3	3	6.00%

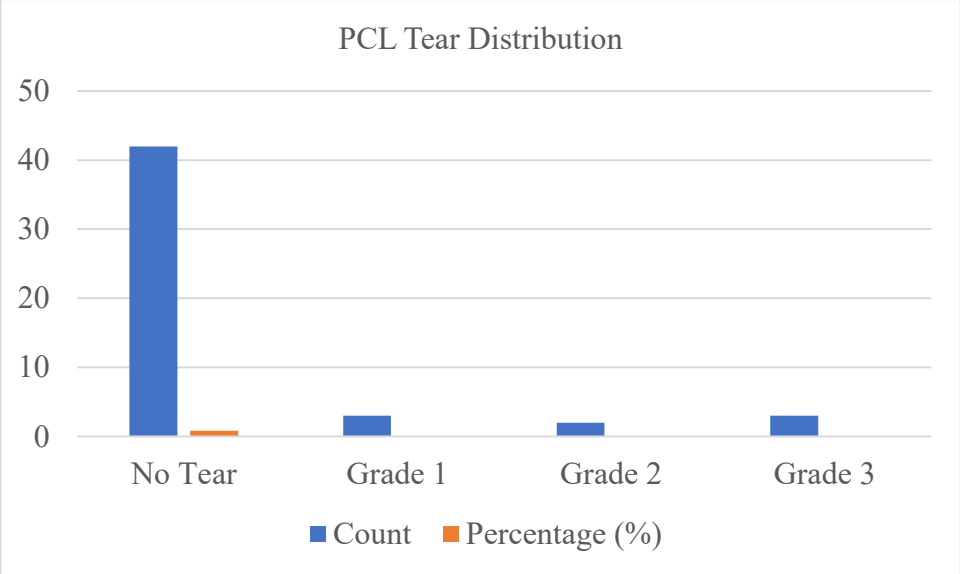

Figure 5: PCL Tear Distribution

5.6 Other Associated Findings

Among patients with cruciate ligament injuries, joint effusion was the most frequent associated finding (50%), followed by bone contusions (22.22%), subchondral cysts (16.67%), suprapatellar bursal fluid (16.67%), and Baker's cyst (5.56%).

Table 6: Other Associated Findings

Other Findings	Count	Percentage (%)
Joint Effusion (any)	9	50.00%
Bone Contusion	4	22.22%
Subchondral Cyst	3	16.67%
Suprapatellar Bursal Fluid	3	16.67%

Baker's Cyst	1	5.56%

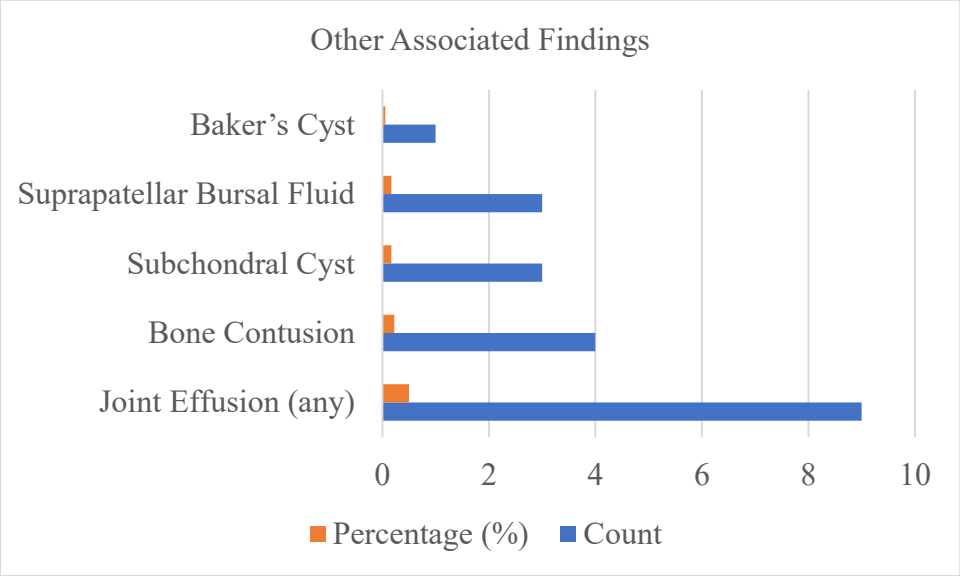

Figure 6: Other Associated Findings

Overlap of ACL and PCL injuries was observed in 2 patients (4% of total cohort), leading to an adjusted unique cruciate ligament injury group of 18 patients (36% of the study population).

Discussion

My study corroborates previous findings emphasizing MRI as the modality of choice for evaluating cruciate ligament injuries in knee trauma [3,4].

The observed predominance of ACL tears over PCL tears aligns with anatomical and biomechanical considerations described in the literature, where the ACL is more frequently subjected to rotational and hyperextension forces [1,2].

The grading distribution seen in this study is consistent with Bencardino et al. and Vahey et al., who detailed MRI's ability to differentiate partial from complete tears and to identify secondary signs such as bone marrow edema [4,5].

This strengthens the utility of MRI not only in diagnosing cruciate ligament disruptions but also in planning patient management and rehabilitation.

Limitations of our study include the absence of arthroscopic correlation, which is often considered the gold standard. Larger multi-center studies with surgical validation could further substantiate these findings.

Conclusion

Magnetic Resonance Imaging has proven to be a reliable, non-invasive modality for assessing ACL and PCL injuries in traumatic knees. By enabling early and accurate diagnosis, MRI facilitates timely decisions regarding conservative management or surgical reconstruction, ultimately improving patient outcomes.

References

1. Rajan D.A., Sudheer V.A. MRI Evaluation of Internal Derangement in the Traumatic Knee. *Int J Radiol Diagn Imaging*. 2021;4(1):1-4.
2. Ohri P., Goya S., Niveditha, Kohli M. Imaging Findings of Knee Trauma on MRI. *Ann Int Med Dent Res.* 2022;8(1):12-23.
3. Oei E.H.G., Nikken J.J., Verstijnen A.C.M., Ginai A.Z., Hunink M.G. MR Imaging of the Menisci and Cruciate Ligaments: A Systematic Review. *Radiology*. 2003;226(3):837-848.
4. Bencardino J.T., Beltran J. MRI of ACL and PCL injuries. *Semin Musculoskelet Radiol.* 2001;5(4):293-304.
5. Vahey T.N., Broome D.R., Kayes K.J., Shelbourne K.D. MR Imaging of the Knee: Direct and Indirect Signs of ACL Injury. *Radiographics*. 1991;11(5):927-939.
6. Kaur I., et al. Prevalence of ACL Injuries in Knee Trauma: A Descriptive MRI-Based Study. *J Clin Orthop*. 2020;10(2):88-94.