

# Diagnostic Accuracy of Magnetic Resonance Imaging for Anterior Cruciate Ligament Injury in Comparison With Arthroscopy: A Retrospective Cohort Study

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## ABSTRACT

### Background

Anterior cruciate ligament (ACL) injuries are among the most common ligamentous injuries of the knee and frequently affect young and active individuals. Accurate diagnosis is essential for timely management and prevention of long-term complications. Magnetic resonance imaging (MRI) is widely used as a non-invasive diagnostic modality, whereas arthroscopy remains the reference standard for definitive diagnosis.

### Aim

To evaluate the diagnostic accuracy of MRI in detecting ACL injuries using arthroscopy as the reference standard.

### Methods

This retrospective cohort study was conducted in the Department of Orthopaedics at Krishna Hospital and Medical Centre over a period of two years following institutional ethical approval. Thirty-two patients aged 18–60 years with suspected ACL injury who underwent both MRI and arthroscopy were included. Clinical examination findings, MRI reports, and arthroscopic findings were recorded and analyzed. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of MRI were calculated using arthroscopy as the gold standard. Agreement between MRI and arthroscopy was assessed using Cohen's kappa statistic.

### Results

The mean age of the study population was  $35.09 \pm 7.84$  years, with the majority of patients belonging to the 30–39 years age group. Male patients constituted 59.4% of cases. Sports-related trauma was the most common mechanism of injury (34.4%). MRI detected ACL tears in 62.5% of patients, whereas arthroscopy confirmed ACL tears in 59.4%. MRI demonstrated a sensitivity of 89.47%, specificity of 84.62%, PPV of 89.47%, NPV of 84.62%, and overall diagnostic accuracy of 87.50%. Cohen's kappa analysis showed moderate agreement between MRI and arthroscopy ( $\kappa = 0.541$ ,  $p = 0.002$ ).

### Conclusion

MRI is a reliable, non-invasive diagnostic tool for evaluating ACL injuries and demonstrates good agreement with arthroscopy. It can effectively guide clinical decision-making and reduce the need for purely diagnostic arthroscopy in selected patients.

**Keywords:** Anterior cruciate ligament; Arthroscopy; Diagnostic accuracy; Knee injury; Magnetic resonance imaging

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## INTRODUCTION

Anterior cruciate ligament (ACL) injury is one of the most frequently encountered ligamentous injuries of the knee joint and is commonly associated with sports-related trauma, road traffic accidents, and sudden twisting injuries. The ACL functions as the primary stabilizer against anterior translation of the tibia relative to the femur and also contributes to rotational stability of the knee joint. Injury to the ACL can lead to pain, instability, reduced functional performance, and long-term degenerative changes if not diagnosed and managed appropriately.[1-3]

Clinical evaluation remains the initial step in diagnosing ACL injuries. Special tests such as the Lachman test, anterior drawer test, and pivot shift test are commonly employed; however, their accuracy may be limited in acute settings due to pain, swelling, and muscle guarding. Consequently, imaging modalities play a significant role in confirming the diagnosis.[4, 5]

Magnetic resonance imaging (MRI) has become the preferred non-invasive imaging modality for evaluating ACL injuries because of its excellent soft tissue contrast and ability to identify associated intra-articular lesions such as meniscal tears, cartilage injuries, and bone contusions. Previous studies have reported MRI sensitivity ranging from 85% to 98% and specificity ranging from 75% to 95% for diagnosing ACL tears.[6,7]

Arthroscopy remains the gold standard for diagnosing ACL injuries because it allows direct visualization of intra-articular structures and simultaneous therapeutic intervention. Despite its high diagnostic accuracy, arthroscopy is invasive, expensive, and associated with procedural risks.[6]

Given the increasing reliance on MRI for diagnosing ACL injuries, it is important to evaluate its diagnostic performance in comparison with arthroscopy. Therefore, the present study was conducted to assess the diagnostic accuracy of MRI in detecting ACL injuries using arthroscopy as the reference standard.

## MATERIALS AND METHODS

This retrospective cohort study was conducted in the Department of Orthopaedics at Krishna Hospital and Medical Centre over a period of two years after obtaining approval from the Institutional Ethics Committee. The study population included patients presenting with suspected anterior cruciate ligament (ACL) injury who underwent both magnetic resonance imaging (MRI) and

arthroscopy. Patients aged between 18 and 60 years with suspected or confirmed ACL injury who had undergone both MRI and arthroscopic evaluation and were willing to participate in the study were included. Patients younger than 18 years or older than 60 years, those with a history of previous knee surgery, history of trauma exceeding 18 months, ACL injury associated with avulsion fracture of the tibial spine, pre-existing medical conditions affecting knee function, and patients unwilling to undergo arthroscopy were excluded from the study.

Detailed demographic and clinical data were collected retrospectively from medical records. Clinical examination findings included assessment of knee stability along with performance of the Lachman test and anterior drawer test. All patients underwent MRI evaluation of the affected knee, and the findings were interpreted by experienced radiologists to determine the presence or absence of ACL tears. Subsequently, arthroscopic examination was performed, during which ACL integrity and associated intra-articular abnormalities were directly assessed by orthopedic surgeons. Arthroscopic findings were considered the reference standard for comparison with MRI findings.

Data were entered into Microsoft Excel and analyzed using SPSS version 21.0. Categorical variables were expressed as frequencies and percentages, whereas continuous variables were expressed as mean  $\pm$  standard deviation.

Sensitivity, specificity, PPV, NPV, and diagnostic accuracy of MRI were calculated using arthroscopy as the gold standard. Agreement between MRI and arthroscopy was assessed using Cohen's kappa statistic. A p-value  $<0.05$  was considered statistically significant.

## RESULTS

### Demographic Characteristics

The mean age of the study population was  $35.09 \pm 7.84$  years. Most patients belonged to the 30–39 years age group (50%), followed by the 19–29 years age group (25%). Male patients constituted 59.4% of the study population, while females accounted for 40.6%. Right-sided knee involvement was observed in 56.25% of patients, whereas left-sided involvement was observed in 43.75%.

### Mechanism of Injury

Sports-related injuries were the most common mechanism of injury (34.4%), followed by road traffic accidents and falls, each contributing 28.1%.

**Clinical Examination Findings**

A positive Lachman test was observed in 56.25% of patients. Similarly, the anterior drawer test was positive in 56.25% of cases.

**MRI Findings**

MRI detected ACL tears in 20 patients (62.5%), while 12 patients (37.5%) demonstrated normal ACL morphology.

**Arthroscopic Findings**

Arthroscopy confirmed ACL tears in 19 patients (59.4%), whereas 13 patients (40.6%) showed normal ACL morphology.

**Grading of ACL Tears**

Complete ACL tears were the predominant finding and were observed in 56.3% of patients. Partial tears were identified in 3.1% of cases.

**Correlation Between MRI and Arthroscopy**

Among the 13 patients reported as normal on MRI, 11 were confirmed normal on arthroscopy and 2 had ACL tears on arthroscopy. Among the 19 patients diagnosed with ACL tears on MRI, 17 were confirmed on arthroscopy, while 2 had normal arthroscopic findings.

**Agreement Analysis**

Cohen’s kappa analysis demonstrated moderate agreement between MRI and arthroscopy ( $\kappa = 0.541$ ), which was statistically significant ( $p = 0.002$ ).

**Table 1. Agreement analysis (Cohen’s Kappa) between MRI and arthroscopy for ACL injury**

Statistic	Value
Cohen’s Kappa ( $\kappa$ )	0.541
Standard Error	0.152
Z value	3.067
p-value	0.002
Number of cases	32

**Diagnostic Performance of MRI**

MRI showed high diagnostic performance in detecting ACL tears, with a sensitivity of 89.47% and specificity of 84.62%. The positive predictive value and negative

predictive value were 89.47% and 84.62%, respectively, indicating reliable confirmation and exclusion of ACL injuries. The overall diagnostic accuracy of MRI was 87.50%.

**Table 2. Diagnostic indices of MRI in the determination of ACL injury**

Diagnostic indices of MRI	Value
Sensitivity	89.47%
Specificity	84.62%
PPV	89.47%
NPV	84.62%
Accuracy	87.50%

**DISCUSSION**

The present study evaluated the diagnostic accuracy of MRI in identifying ACL injuries using arthroscopy as the reference standard. The findings demonstrated that MRI has high sensitivity and specificity and correlates well with arthroscopic findings.

The mean age of patients in this study was  $35.09 \pm 7.84$  years, with the majority of cases occurring in the 30–39 years age group. This finding is comparable with previous studies that reported a higher incidence of ACL injuries

among young and physically active individuals.[8-10] The predominance of male patients in the present study is also consistent with earlier reports, likely reflecting greater participation in physically demanding activities and sports.[9,10]

Sports-related trauma was identified as the most common mechanism of injury, which aligns with the established understanding that pivoting, sudden deceleration, and rotational movements are common causes of ACL injury.[1,3]

Clinical examination remains essential in the evaluation of ACL injuries; however, the sensitivity of physical tests may be limited in acute injuries because of pain and swelling. Therefore, MRI plays an important role in confirming the diagnosis and identifying associated intra-articular injuries.[5,7]

In the present study, MRI demonstrated a sensitivity of 89.47% and specificity of 84.62%, with an overall diagnostic accuracy of 87.50%. These findings are comparable with those reported in previous studies.

Li K et al. [8] reported pooled sensitivity and specificity values of 87% and 90%, respectively, for MRI in diagnosing ACL injuries, while Khandelwal K et al. [9] reported sensitivity and specificity values of 97.46% and 90.38%, respectively. Similar findings were also reported by Zhao M et al. [10], Balemane S et al. [11], Afaq M et al. [12], Sultana N et al. [13], and Javaid A et al. [14], all of whom concluded that MRI is a reliable and highly accurate modality for diagnosing ACL tears.

The moderate agreement observed between MRI and arthroscopy in the present study further supports the utility of MRI as a dependable diagnostic modality. False-positive MRI findings may occur because of mucoid degeneration, partial tears, or interpretative errors, whereas false-negative findings may result from chronic tears, fibrosis, or inadequate visualization.[7,10]

Although arthroscopy remains the gold standard, MRI offers several practical advantages. It is non-invasive, avoids anesthesia-related risks, permits evaluation of associated soft tissue injuries, and can reduce the number of unnecessary diagnostic arthroscopies.[6,12,15]

However, the study was limited by its small sample size and single-center design, which may affect the generalizability of the findings. Additionally, inter-observer variability in MRI interpretation and detailed analysis of associated meniscal and chondral injuries were not assessed.

## CONCLUSION

MRI is a reliable and accurate non-invasive imaging modality for diagnosing ACL injuries and demonstrates good correlation with arthroscopic findings. Its high sensitivity and specificity make it a valuable diagnostic tool in the evaluation of suspected ACL tears. MRI can aid in clinical decision-making, surgical planning, and reduction of unnecessary diagnostic arthroscopy.

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