## ORIGINAL ARTICLE
# Diagnostic Accuracy of Magnetic Resonance Imaging in Diagnosing ACL Injuries Taking Arthroscopy as Gold Standard

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## ABSTRACT
**Introduction:** Low velocity, non - intrusive, acceleration-deceleration, and contact traumas with a rotating component are the most common causes of anterior cruciate ligament (ACL) injuries. The objective of the study was: To determine the diagnostic accuracy of magnetic resonance imaging in detecting anterior cruciate ligament tear using arthroscopy as a gold standard."
**Materials and methods:** MRI scans of all the cases performed in the hospital radiology department and reported by a radiologist for ACL tear. Arthroscopy reports which were performed under general anesthesia by a senior orthopedic surgeon were also reviewed. ACL tear was assessed as an operational definition. Whole data was collected and recorded on an already structured Performa
**Results:** Arthroscopy confirmed anterior cruciate ligament tear in 78 (62.40%) cases whereas 47 (37.60%) patients revealed no anterior cruciate ligament tear. In MRI-positive patients, 72 (True Positive) had an anterior cruciate ligament tear and 06 (False Positive) had no anterior cruciate ligament tear on arthroscopy. Among, 47 MRI negative patients, 06 (False Negative) had anterior cruciate ligament tear on arthroscopy whereas 41 (True Negative) had no anterior cruciate ligament tear on arthroscopy
**Conclusion:** This study concluded that magnetic resonance imaging has high sensitivity and accurate modality, which has not only dramatically enhanced our tendency to diagnose anterior cruciate ligament injury but also helpful in reducing the number of pure diagnostic arthroscopies. So, we recommend that preoperative MRI should be done in every patient with ACL injury for selecting proper therapy for these particular patients.
**Keywords:** Trauma, Anterior cruciate ligament (ACL) injuries, MRI, Arthroscopy, Diagnostic Accuracy

## INTRODUCTION
Low velocity, non - intrusive, acceleration-deceleration, and contact traumas with a rotating component are the most common causes of anterior cruciate ligament (ACL) injuries (1). Impact sports may potentially result in ACL tear as a result of rotating , valgus pressure, or extreme stretching, all of which are in direct relation to contact or clash (2). Previously, ACL damage was more common in sports contact injuries, whereas surrounding structures were commonly implicated. At the moment, an ACL injury is most likely to be an indirect injury, for example alighting due to a layup in basketball.

Either of the two types are more common among sportsmen than those in the general public and are common in alpine skiing, international football, American football, Australian rules football, basketball, rugby, pro wrestling, martial arts, and rhythmic gymnastics. It's also acknowledged that women are roughly three times more likely than males to have it.

Arthroscopy offers direct visibility of all intra-articular tissues, resulting in a increased level of precision in both management and therapy, making arthroscopy the investigation of choice for evaluating interior diseases and other knee abnormalities. (3, 4). However, arthroscopy is a rather costly and intrusive procedure. Furthermore, it's much less useful for assessing extracapsular connective tissue (5).

As per a meta-analysis, Thomas et al discovered that MRI had a 63.6 percent sensitivity and a 94.5 percent specificity for detecting ACL tears (6). In another study, Grubor et al found that MRI had an 84 percent sensitivity and a 68.4 percent specificity for detecting ACL tears (7). . From another study, De Maio et al deduced that MRI had a 100 percent sensitivity and a 97 percent specificity for detecting ACL injuries (8). Yaqoob et al. found that the sensitivity and specificity of MRI for detecting ACL tears were 91.6 percent and 95.25 percent, respectively, and that the prevalence of ACL rupture was 25.9 percent. (9).

ACL tears are a prevalent concern in tertiary care institutions regularly. Given this, there is no particular screening method for identifying ACL tears. In the studies, there is some variation in the reliability of MRI (10). As a result of doing this study, the correct diagnostic accuracy of ACL may be evaluated to improve patient adherence. The objective of the study was: To determine the diagnostic accuracy of magnetic resonance imaging in detecting anterior cruciate ligament tear using arthroscopy as a gold standard."

## MATERIALS & METHODS
This was a retrospective study, done in the Department of Radiology, Sir Ganga Ram Hospital. Data was collected during January 2020 to July 2021 and the cases from the last 5 years were included. We collected the data of all the patients according to our inclusion criteria and we were able to find a total of 125 patients. Non-probability, consecutive sampling technique was used.

Data collection was done by reviewing the charts of the patients we took those who came under the inclusion criteria and were listed for this study. Permission was obtained from all patients at the time of admission already after explaining the purpose of the study. MRI scans of all these cases performed in the hospital radiology department and reported by a radiologist for ACL tear. Arthroscopy reports which were performed under general anesthesia by a senior orthopedic surgeon were also reviewed. ACL tear was assessed as an operational definition. Whole data was collected and recorded on an already structured Performa linked hereby by one of the researchers.

## RESULTS
The age range in this study was from 18-60 years with a mean age of 35.21 ± 9.76 years. The maximum number of the patients 98 (78.40%) were falling in 18 to 40 years of age as shown in Table I.

Out of these 125 patients, 82 (65.60%) were male and 43 (34.40%) were females with a male to female ratio of 1.9:1. MRI supported the diagnosis of an anterior cruciate ligament tear in 78 (62.40%) patients. Arthroscopy confirmed anterior cruciate ligament tear in 78 (62.40%) cases whereas 47 (37.60%) patients

revealed no anterior cruciate ligament tear. In MRI-positive patients, 72 (True Positive) had an anterior cruciate ligament tear and 06 (False Positive) had no anterior cruciate ligament tear on arthroscopy. Among, 47 MRI negative patients, 06 (False Negative) had anterior cruciate ligament tear on arthroscopy whereas 41 (True Negative) had no anterior cruciate ligament tear on arthroscopy as shown in Table II. Stratification of diagnostic accuracy according to age groups is shown in Table III & IV.

Table-1: Distribution of patients according to Age.

| Age | No. of Patients | Percentage |
|---|---|---|
| 18-40 | 98 | 78.40 |
| 41-60 | 27 | 21.60 |
| Total | 125 | 100.0 |

Mean ± SD = 35.21 ± 9.76 years

Table-2: Diagnostic accuracy of magnetic resonance imaging in detecting anterior cruciate ligament tear using arthroscopy as the gold standard.

| | A positive result on Arthroscopy | A negative result on Arthroscopy |
|---|---|---|
| A positive result on MRI | 72(TP) | 06(FP) |
| A negative result on MRI | 06(FN) | 41(TN) |

*-TP=True positive **-FP=False positive ***-FN=False negative ****-TN=True Negative

Sensitivity: 92.31%
Specificity: 87.23%
Positive Predictive Value (PPV): 92.31%
Negative Predictive Value (NPV): 87.23%
Positive likelihood ratio: 7.23
Negative likelihood ratio: 0.09
Diagnostic Accuracy: 90.40%

Table 3: Stratification of diagnostic accuracy concerning age 18-40 years (n=98).

| | A positive result on Arthroscopy | A negative result on Arthroscopy |
|---|---|---|
| A positive result on MRI | 56(TP) | 04(FP) |
| A negative result on MRI | 04(FN) | 34(TN) |
| P-Value | 0.001 | |

Sensitivity: 93.33%
Specificity: 89.47%
Positive Predictive Value (PPV): 93.33%
Negative Predictive Value (NPV): 89.47%
Positive likelihood ratio: 8.87
Negative likelihood ratio: 0.07
Diagnostic Accuracy: 91.84%

Table 4: Stratification of diagnostic accuracy concerning age 41-60 years (n=27).

| | A positive result on Arthroscopy | A negative result on Arthroscopy |
|---|---|---|
| A positive result on MRI | 16(TP) | 02(FP) |
| A negative result on MRI | 02(FN) | 7(TN) |
| P-Value | 0.001 | |

Sensitivity: 88.89%
Specificity: 77.78%
Positive Predictive Value (PPV): 88.89%
Negative Predictive Value (NPV): 77.78%
Positive likelihood ratio: 4.0
Negative likelihood ratio: 0.14
Diagnostic Accuracy: 85.19%

## DISCUSSION

MRI is noninvasive, has proven to be safe and efficient, and has benefits over diagnostic arthroscopy, which is presently considered as the benchmark for the identification of inner knee abnormalities. (11). Arthroscopy is an intrusive surgery that might cause pain and distress in the patient. Soft tissues, ligaments, fibrocartilage, and articular cartilage are better defined anatomically and pathologically using MRI. (12). Fat reduction and fast spin-echo MRI methods have increased MRI's sensitivity and specificity in detecting articular cartilage, meniscal, and cruciate ligament abnormalities. (13). This research was carried out to assess the predictive value of magnetic resonance imaging in identifying anterior cruciate ligament tears, with arthroscopy serving as the benchmark. On arthroscopy, 72 MRI-positive patients (True Positive) had an anterior cruciate ligament rupture and 06 (False Positive) had no anterior cruciate ligament injury. Among the 47 MRI negative patients, 6 (False Negative) had an anterior cruciate ligament injury on arthroscopy, whereas 41 (True Negative) did not. The detection rate, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of magnetic resonance imaging in sensing anterior cruciate ligament tears when arthroscopy used as gold standard were 92.31 percent, 87.23 percent, 92.31 percent, 87.23 percent, and 90.40 percent. As per a meta-analysis, Thomas et al discovered that MRI had a 63.6 percent sensitivity and a 94.5 percent specificity for detecting ACL tears (6). From another research, Grubor et al deduced that MRI had an 84 percent sensitivity and a 68.4 percent specificity for detecting ACL tears (4).

According to Mackenzie R et al, the total sensitivity of MRI for detecting 71 menisci and cruciate ligament lesions is 88 percent, with a total specificity of 94 percent when compared to arthroscopic examination(14). Our analysis revealed a good connection between MRI and arthroscopy, with results that were equivalent to prior existing studies. Similarly, Oei et al. conducted a comprehensive meta-analysis of 29 papers from 1991 to 2000 that documented meniscal and cruciate ligament tears in 3683 knees. (15). Oei et colleagues discovered aggregated sensitivity and specificities for medial and lateral meniscus of 93 percent, 88 percent, and 79 percent, 95 percent, respectively, using extremely rigorous inclusion and exclusion criteria. Composite sensitivities and specificities for ACL and PCL injuries were 94 percent, 91 percent, and 94 percent, 99 percent, respectively (15). Similarly, Amr et al discovered that, when compared to knee arthroscopy, magnetic resonance imaging had a 93.9 percent sensitivity and a 66.6 percent specificity (16).

Klass et al. cited previously available sensitivities and specificities of 90-95 percent and 95-100 percent in a study of MRI for ACL injury (6). The emphasis of their study, however, was on acute Acl tears. MRI reliability in identifying a full ACL injury is often reported in studies that either contain only acute ACL tears or do not mention the sequelae of the lesions (17). . As a result, the accuracy of MRI in detecting persistent ACL damage is unknown (17). Vlychou et al used a 3.0T scanner to conduct MRI on a set of people who had suffered ACL damage at least 3 months before (18).

The researchers discovered that MRI properly diagnosed an ACL rupture in all 43 individuals. Vahey et al, on the other hand, discovered that chronic ACL injuries were harder to identify than acute Acl injuries. They examined 81 MRI imaging of ACL-injured knees retrospectively and compared the MRI appearances of the ACL with their results at arthroscopy (11). They discovered that for acute Acl injuries (MRI performed within 6 weeks of injury), the sensitivity, specificity, and accuracy were 100 percent, 93 percent, and 96 percent, respectively, and for chronic ACL tears, the sensitivity, specificity, and accuracy were 87 percent, 93 percent, and 90 percent, respectively (MRI performed more than 6 months after injury They emphasized the fact that persistent ACL lesions can have a perplexing look related to the addition of healing that might appear to be an undamaged ligament (11).

Brooks et al examined the similarity between preoperative clinical/arthroscopic and MRI/arthroscopic results (79 percent versus 77 percent agreement, respectively) in a prospective trial and concluded that MRI did not lower the frequency of unfavorable arthroscopic operations (19). Bryan et al, on the other hand, revealed conflicting findings to Brooks et al(20). They found that

MRI might reduce the rate of surgery in persistent knee issues, particularly in those who were previously scheduled for surgery.

## CONCLUSION

This study concluded that magnetic resonance imaging has high sensitivity and accurate modality, which has not only dramatically enhanced our tendency to diagnose anterior cruciate ligament injury but also helpful in reducing the number of pure diagnostic arthroscopies. So, we recommend that preoperative MRI should be done in every patient with ACL injury for selecting proper therapy for these particular patients.

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