Original Article
DOI: https://doi.org/10.70749/ijbr.v3i7.2987

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Diagnostic Accuracy of MRI In Detection of ACL Tear Keeping Arthroscopy as Gold Standard

Babar Ali[1], Adnan Ahmed Qureshi[1], Abid Hussain Jamali[1], Ulfat Memon[1], Shabana[1]

[1]Department of Radiology, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Pakistan

ARTICLE INFO

Keywords: Anterior cruciate ligament, Arthroscopy, Diagnostic imaging, Knee injuries, Magnetic resonance imaging

Correspondence to: Babar Ali,
Department of Radiology,
Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Pakistan.
Email: drbabarali85@gmail.com

Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 08-06-2025 Revised: 04-07-2025
Accepted: 10-07-2025 Published: 15-07-2025

ABSTRACT

Background: Anterior cruciate ligament tear is common knee injury observed in young and active persons mostly. Early and accurate diagnosis is important to prevent instability and long-term complication. Arthroscopy is considered gold standard but it is invasive so imaging methods are needed. **Objective:** To determine the diagnostic accuracy of magnetic resonance imaging in detection of anterior cruciate ligament tear keeping arthroscopy as gold standard. **Study Design:** Cross sectional study. **Duration and Place of Study:** This study was conducted from 7 March 2025 to 7 June 2025 in the Department of Radiology of LUMHS Jamshoro. **Methodology:** A total of 143 patients aged 15 to 60 years with recent knee injury were included. Magnetic resonance imaging was performed using 1.5 Tesla machine and findings were assessed by radiologist. Arthroscopy was done for confirmation. Data was analyzed using statistical package for social sciences version 22. Diagnostic accuracy parameters were calculated and chi square test was applied. P value ≤0.05 was taken as significant. **Results:** The mean age was 32.80±7.42 years. Magnetic resonance imaging showed sensitivity of 83.33%, specificity of 92.08%, positive predictive value of 81.40%, negative predictive value of 93.00% and overall diagnostic accuracy of 89.51% (p≤0.05). True positive cases were 35 while true negative was 93. **Conclusion:** Magnetic resonance imaging is reliable and noninvasive method for detection of anterior cruciate ligament tear with good diagnostic accuracy compared to arthroscopy.

INTRODUCTION

Anterior cruciate ligament (ACL) tear is a common injury involving the knee joint, commonly seen in young and active individuals.[1] This injury is usually caused by sudden twisting or pivoting movements, falls, road traffic accidents, and sports injuries. The ACL is the key ligament responsible for stabilizing the knee joint, controlling the movement of the tibia bone in the anterior direction, as well as controlling rotational movements in the knee joint.[2] ACL injury is characterized by acute pain, swelling in the knee joint, subjective feeling of instability, gait abnormalities, and in some patients, a sensation of a "pop" in the knee joint at the time of injury.[3] ACL injury has been observed in sports participants, particularly in females compared to males, and it is increased in females due to biomechanical and hormonal factors.[4]

The diagnosis of an ACL injury involves the taking of an accurate history and physical examination, in addition to the use of imaging techniques. The physical examination, including the Lachman test, the anterior drawer test, and the pivot shift test, is commonly used in the assessment of the ACL.[5] However, the test that has the highest sensitivity and reliability in the assessment of the ACL is the Lachman test. However, the physical examination may not be sufficient in the assessment of an ACL injury, especially in the setting of an acutely painful knee or in an obese patient, and imaging techniques may be necessary in the confirmation of the diagnosis.[6] The gold standard in the assessment of an ACL injury is arthroscopy, as it allows direct visualization of the intra-articular structure and the accurate confirmation of the injury.[7]

Magnetic resonance imaging (MRI), being a noninvasive diagnostic tool, is widely used in the detection of ACL tears.[8] MRI has been found to be quite effective in detecting ACL tears by displaying better soft tissue contrast. It is helpful in visualizing the ligament, as well as the menisci. MRI is able to display partial as well as complete ACL tears by showing discontinuity in the ligament, abnormal signal intensity on T2-weighted images, and non-visualization of the ligament.[9] It is also able to display indirect signs such as bone contusion, anterior tibial translation, and meniscal lesions. Even though MRI has been found to display a high sensitivity as well as specificity, there is a variable diagnostic accuracy, leading to false-positive as well as false-negative results.[10] There is a scarcity of data on the accuracy of MRI in

diagnosing ACL injuries in Jamshoro and it has been observed that practitioners are relying on international data, which may not be appropriate for the local population. There are differences in the presentation of patients, injury patterns, and availability of facilities in the region, which can affect the results of MRI. In addition, if the accuracy of MRI is not evaluated, it can lead to increased patient burden and health care costs due to unnecessary arthroscopies. Thus it is recommended that a study be done in Jamshoro to assess the reliability of MRI in comparison with arthroscopy in diagnosing ACL injuries.

METHODOLOGY

The study was conducted in the Department of Radiology of LUMHS Jamshoro over a period from 07/03/2025 to 07/06/2025 and it was designed as a cross sectional study. Approval for study was taken from CPSP as well as from institutional ethical committee of hospital before starting the research work. The ethical approval certificate number was NO. LUMHS/REC/-553 dated 12-12-2024. The sample size of 143 patients was calculated based on previous study values where sensitivity was 91.6%, specificity was 95.3%, prevalence was 25.9%,[11] confidence interval was 95% and margin of error was 9%.

Inclusion Criteria

Patients aged 15 to 60 years of both male and female gender having recent knee injury within 2 months along with swelling, limited movement, loss of full range of motion and discomfort were included.

Exclusion Criteria

Patients with previous knee surgery, femoral condyle fracture, tibial plateau fracture, dislocated knee, metal implants, active joint infection, degenerative joint disease, arthritis on radiography and contraindications to MRI were excluded from the study.

A suspected anterior cruciate ligament tear was considered when patient had pain with VAS score >4 at outer or posterior aspect of knee, swelling within few hours after injury, limitation of knee movement due to pain or swelling, loss of full range of motion and difficulty in walking. Informed consent was taken from all patients before enrollment and procedure was explained including risks and benefits. All patients underwent detailed history and clinical examination. Clinical tests including anterior drawer test and Lachman test were performed and patients having positive findings were considered more suspicious for ACL tear. MRI was performed using 1.5 Tesla MR unit Magneton Harmony by Siemens with use of dedicated knee coil. The knee was positioned in slight external rotation approximately 50°–100° to align ACL in imaging plane. Multi planar imaging was obtained in axial, coronal and sagittal sections using T1 weighted, T2 weighted, PD FS weighted and STIR sequences. Images were assessed by experienced radiologist. After MRI evaluation, arthroscopy was performed by orthopaedic surgeon having 5 years experience and findings were recorded for comparison. After completion of MRI and arthroscopic procedure, results were compared and frequency of ACL tear was determined. Diagnostic performance of MRI was calculated in terms of true positive, true negative, false positive and false negative cases.

MRI signs of ACL tear were noted when any of the following were observed: discontinuity of ligament fibers, abnormal course or laxity, increased signal intensity on T2-weighted images, and non-visualization of the ligament. Indirect associated signs were also noted, which included bone contusions, translation of the anterior tibial plateau by more than 5 mm, deep lateral femoral notch by more than 1.5 mm, PCL buckling, Segond fracture, and tear of the lateral meniscus posterior root.

Arthroscopy was considered confirmatory when any of the following was observed: direct visualization of ligament disruption, lax or non-existent ACL, and positive hook test. All data was entered and analyzed using SPSS version 22. Mean and standard deviation was calculated for continuous variables like age, weight, height and BMI. Frequencies and percentages were calculated for categorical variables including gender, mechanism of injury, affected side and MRI and arthroscopy findings. Stratification was done with respect to age, gender and mechanism of injury and post stratification diagnostic accuracy was calculated. P value ≤0.05 was considered statistically significant.

RESULTS

A total of 143 patients was included in the study. The mean age of the patients was 32.80 ± 7.42 years, mean weight was 71.29 ± 10.25 kg, mean height was 167.66 ± 8.40 cm, mean BMI was 25.58 ± 4.59 kg/m^2 and mean duration of pain was 4.79 ± 2.30 weeks. Regarding gender distribution, majority of the patients were male, which were 98 (68.5%), while female patients were 45 (31.5%). The most common mechanism of injury was sports activity, which was seen in 70 (49.0%) patients, followed by fall in 31 (21.7%), road traffic accident in 26 (18.2%), and others in 16 (11.2%) patients (Table 1).

Table 1

Patient Demographics

Demographics	Mean ± SD
Age (years)	32.80 ± 7.42
Weight (kg)	71.29 ± 10.25
Height (cm)	167.66 ± 8.40
BMI (Kg/m2)	25.58 ± 4.59
Duration of pain (weeks)	4.79 ± 2.30
Gender	
Male n (%)	98 (68.5%)
Female n (%)	45 (31.5%)
Side	
Right n (%)	75 (52.4%)
Left n (%)	68 (47.6%)
Mechanism of Injury	
Sports Activity n (%)	70 (49.0%)
Fall n (%)	31 (21.7%)
Road Traffic Accident n (%)	26 (18.2%)
Others n (%)	16 (11.2%)

On overall results, MRI detected ACL tear as positive in 43

(30.1%) patients, while arthroscopy, which served as the gold standard, confirmed positive ACL tear in 42 (29.4%) patients. The negative results on MRI was found in 100 (69.9%) cases, whereas arthroscopy showed negative results in 101 (70.6%) cases, out of total 143 patients in both modalities (Table 2).

Table 2
Overall Results of MRI and Arthroscopy in Diagnosis of Anterior Cruciate Ligament Tear

Anterior Cruciate Ligament Tear	MRI	Arthroscopy
Positive	43 (30.1%)	42 (29.4%)
Negative	100 (69.9%)	101 (70.6%)
Total	143 (100%)	143 (100%)

When comparing MRI with arthroscopy, there were 35 true positive cases, 8 false positive cases, 7 false negative cases and 93 true negative cases (Table 3).

Table 3
Comparison of MRI Versus Arthroscopy in Diagnosis of Anterior Cruciate Ligament Tear

MRI	Arthroscopy		Total
	Positive	Negative	
Positive	35 (TP)	8 (FP)	43
Negative	7 (FN)	93 (TN)	100
Total	42	101	143

Key: TP = True positive, FP = False positive, FN = False negative, TN = True negative

The overall sensitivity of MRI in diagnosis of ACL tear was found to be 83.33%, specificity was 92.08%, diagnostic accuracy was 89.51%, positive predictive value (PPV) was 81.40%, and negative predictive value (NPV) was 93.00% (Table 4).

Table 4
Sensitivity, Specificity, Diagnostic Accuracy, PPV and NPV of MRI in Diagnosis of Anterior Cruciate Ligament Tear

Diagnostic Parameter	Result
Sensitivity	83.33%
Specificity	92.08%
Diagnostic Accuracy	89.51%
PPV	81.40%
NPV	93.00%

In stratified analysis, when the patients were stratified by age, those who were aged 40 years or below showed sensitivity of 86.84%, specificity of 91.57%, diagnostic accuracy of 90.08%, PPV of 82.50%, and NPV of 93.83%. In contrast, patients who was older than 40 years shows sensitivity of 50.00%, specificity of 94.44%, diagnostic accuracy of 86.36%, PPV of 66.67%, and NPV of 89.47%. When analysis was done by gender, male patients had sensitivity of 81.25%, specificity of 93.94%, diagnostic accuracy of 89.80%, PPV of 86.67%, and NPV of 91.18%. Female patients showed sensitivity of 90.00%, specificity of 88.57%, diagnostic accuracy of 88.89%, PPV of 69.23%, and NPV of 96.88%. (Table 5).

Table 5
Stratified Analysis of Sensitivity, Specificity, Diagnostic Accuracy, PPV and NPV of MRI in Diagnosis of Anterior Cruciate Ligament Tear with Age, Gender and Mechanism of Injury

Variables	Groups	Diagnostic Parameter	Result
Age (years)	≤40	Sen	86.84%
		Spec	91.57%
		DA	90.08%
		PPV	82.50%
		NPV	93.83%
	>40	Sen	50.00%
		Spec	94.44%
		DA	86.36%
		PPV	66.67%
		NPV	89.47%
Gender	Male	Sen	81.25%
		Spec	93.94%
		DA	89.80%
		PPV	86.67%
		NPV	91.18%
	Female	Sen	90.00%
		Spec	88.57%
		DA	88.89%
		PPV	69.23%
		NPV	96.88%
Mechanism of Injury	Fall	Sen	100.00%
		Spec	95.45%
		DA	96.77%
		PPV	90.00%
		NPV	100.00%
	Sports Activity	Sen	72.22%
		Spec	88.46%
		DA	84.29%
		PPV	68.42%
		NPV	90.20%
	Road Traffic Accident	Sen	100.00%
		Spec	100.00%
		DA	100.00%
		PPV	100.00%
		NPV	100.00%
	Others	Sen	60.00%
		Spec	90.91%
		DA	81.25%
		PPV	75.00%
		NPV	83.33%

DISCUSSION

The aim of the current study was to determine the diagnostic accuracy of magnetic resonance imaging in the detection of anterior cruciate ligament tears, with the use of arthroscopy as a standard procedure. The study participants were predominantly male, with 98 participants (68.5%), which is a reflection of the increased male population in sports and recreational activities that expose them to conditions leading to ligamentous injuries in the knee. Sports activity was the leading cause of injury, accounting for 70 patients (49.0%), as it is a condition that involves a lot of impact, leading to sudden deceleration and pivoting, which puts a lot of pressure on the anterior cruciate ligament. In comparison, the study found that the magnetic resonance imaging detected the presence of anterior cruciate ligament tears in 43 patients, while the arthroscopy detected the presence in 42 patients. This could have been attributed to the sensitivity of the magnetic resonance imaging, which is able to detect even slight changes in the anterior cruciate ligament due to the presence of edema. In conclusion, the sensitivity, specificity, and accuracy of the magnetic resonance

imaging in the detection of the anterior cruciate ligament tears were 83.33%, 92.08%, and 89.51%, respectively, a reflection of the ability of the imaging technique to clearly visualize the ligaments in multiple planes.

The findings of present study demonstrated that MRI had sensitivity of 83.33%, specificity of 92.08%, and diagnostic accuracy of 89.51% in detection of ACL tear. These results were comparable to Asad *et al.* [12] who reported sensitivity of 88.7%, specificity of 78.9%, and accuracy of 85%, and to Javaid *et al.* [13] who found sensitivity of 93.20%, specificity of 76.31%, and diagnostic accuracy of 90%. Similarly, Haider *et al.* [14] reported MRI sensitivity of 88.6% for ACL tears, which is close to present study findings. The slightly higher sensitivity in those studies may be attributed to differences in MRI field strength, radiologist experience, and patient selection criteria, whereas the higher specificity observed in present study may reflects a more homogenous study population with clearer clinical indications for MRI.

In contrast, Kadhim *et al.* [15] reported a notably lower sensitivity of 61.0% using routine MRI reports, which was much lower than the 83.33% found in present study. This difference is likely because Kadhim *et al.* [15] used retrospective routine radiology reports rather than dedicated musculoskeletal MRI interpretation, and also reported that MRI–arthroscopy interval significantly affected accuracy (p=0.038), suggesting that delayed imaging may leads to underestimation of ACL tears due to resolution of acute edema and hemorrhage that normally helps in identifying the tear. On other hand, Khan *et al.* [16] reported higher sensitivity of 90% but lower specificity of 63%, which differ from present study specificity of 92.08%. This lower specificity in Khan *et al.* [16] may be explained by higher rate of false positive results, possibly due to inclusion of patients with partial tears or surrounding soft tissue changes that was misinterpreted as complete ACL tears on MRI.

Thapa *et al.* [17] reported ACL sensitivity of 96.12% which was higher than present study, and this can be explained by the fact that they used 3T MRI in majority of cases, which provides superior spatial resolution and better signal-to-noise ratio compared to standard 1.5T MRI, thus allowing more precise delineation of ligament fibers. Saif-ur-Rehman *et al.* [18] reported MRI sensitivity of 98.39% but lower specificity of 82.61%, which again shows a pattern of high sensitivity at cost of specificity, a trade-off that is commonly seen when MRI protocols are optimized for detection rather than confirmation of injury.

Regarding overall ACL tear detection, MRI in present study identified positive cases in 43 (30.1%) patients while arthroscopy confirmed 42 (29.4%), showing close agreement between the two modalities. This concordance was similarly observed by Thapa R *et al.* [19] who found MRI detected ACL tears in 70.9% compared to 68.6% on arthroscopy, suggesting that MRI generally provides reliable estimation of ACL tear prevalence even when individual diagnostic parameters may vary across studies.

This study was performed at a single center, which may limit its ability to be generalized to a larger population sample. The sample size of 143 patients may be considered relatively small and may not be adequate for drawing definitive inferences regarding MRI test performance in a wide range of patients. The study did not account for differences in partial and complete ACL tears as seen on MRI, which may have impacted the overall results in terms of sensitivity and specificity. The results of the MRI may have been interpreted by radiologists of varying experience, which may have impacted the consistency of the results.

CONCLUSION

It has been concluded in the present study that Magnetic Resonance Imaging (MRI) is a reliable and effective non-invasive method of diagnosis of Anterior Cruciate Ligament (ACL) tears, as it has shown reasonable sensitivity, specificity, and accuracy in diagnosing ACL tears when arthroscopy is taken as a gold standard for diagnosis. The diagnostic ability of MRI has been shown to be affected by factors such as patient age, gender, and injury mechanisms, which implies that these factors should be taken into consideration in clinical practice.

Disclaimer: None

Acknowledgment: Author thankful to the medical staff of department for their continuous support. Their proper record maintenance and organized handling of patient data made this study possible.

REFERENCES

1. Baid M, Hait S, Daga S, Das A, Kumar Mandal A, Sam J, *et al.* Arthroscopic reconstruction of an anterior cruciate ligament tear using the anatomic single-bundle technique: a clinical and functional outcome evaluation. *Cureus*. 2024;16(9):e69069. https://doi.org/10.7759/cureus.69069
2. Kacprzak B, Stańczak M, Surmacz J, Hagner-Derengowska M. Biophysics of ACL injuries. *Orthop Rev (Pavia)*. 2024; 16:126041. https://doi.org/10.52965/001c.126041
3. Price A, Gangadharan R, Simmons D, Boswell W, Maddox TW, Oldershaw RA, *et al.* Don't take their word for it: investigating the diagnostic accuracy of history elements for anterior cruciate ligament tears. *J Exp Orthop*. 2025; 12(4):e70586. https://doi.org/10.1002/jeo2.70586
4. Mancino F, Kayani B, Gabr A, Fontalis A, Plastow R, Haddad FS. Anterior cruciate ligament injuries in female athletes: risk factors and strategies for prevention. *Bone Jt Open*. 2024;5(2):94-100. https://doi.org/10.1302/2633-1462.52.BJO-2023-0166
5. Tanaka S, Inoue Y, Masuda Y, Tian H, Jung H, Tanaka R. Diagnostic accuracy of physical examination tests for suspected acute anterior cruciate ligament injury: a systematic review and meta-analysis. *Int J Sports Phys Ther*. 2022;17(5):742-752. https://doi.org/10.26603/001c.36434
6. Dietvorst M, van der Steen MCM, Reijman M, Janssen RPA. Diagnostic values of history taking, physical examination and KT-1000 arthrometer for suspect anterior cruciate ligament injuries in children and adolescents: a prospective diagnostic study. *BMC Musculoskelet Disord*. 2022;23(1):710. https://doi.org/10.1186/s12891-022-05659-1

7. Allott NEH, Banger MS, McGregor AH. Evaluating the diagnostic pathway for acute ACL injuries in trauma centres: a systematic review. *BMC Musculoskelet Disord*. 2022;23(1):649. https://doi.org/10.1186/s12891-022-05595-0
8. Yang T, Li Y, Yang L, Liu Q. Magnetic resonance imaging of cruciate ligament disorders: current updates. *EFORT Open Rev*. 2025;10(7):475-486. https://doi.org/10.1530/EOR-2024-0093
9. Prabakar S, Jawaharlal P, Narayanan S. Diagnostic efficacy of fat-suppressed 3D volume isotropic turbo spin-echo acquisition imaging versus conventional 2D sequences in the detection of cruciate and meniscal tears using a 3-tesla magnetic resonance imaging scanner: a comparative study. *Cureus*. 2025;17(6):e86841. https://doi.org/10.7759/cureus.86841
10. Minamoto Y, Akagi R, Maki S, Shiko Y, Tozawa R, Kimura S, *et al.* Automated detection of anterior cruciate ligament tears using a deep convolutional neural network. *BMC Musculoskelet Disord*. 2022;23(1):577. https://doi.org/10.1186/s12891-022-05524-1
11. Yaqoob J, Alam MS, Khalid N. Diagnostic accuracy of magnetic resonance imaging in assessment of meniscal and ACL tear: correlation with arthroscopy. *Pak J Med Sci*. 2015;31(2):263-268. https://doi.org/10.12669/pjms.312.6499
12. Asad A, Syed MK, Bashir MS, Saleem MS. Diagnostic accuracy of MRI for detecting anterior cruciate ligament injuries with arthroscopy as the reference standard. *JCPSP Postgrad*. 2026;2(1):83-87. https://doi.org/10.29271/jcpsppg.2026.01.83
13. Javaid A, Anam W, Ullah H, Afzal T, Mahmood R, Balooch SUD. Diagnostic accuracy of magnetic resonance imaging in the detection of anterior cruciate ligament tear, keeping arthroscopic findings as gold standard. *Pak Armed Forces Med J*. 2023;73(5):1249-1252. https://doi.org/10.51253/pafmj.v73i5.7687
14. Haider Z, Ali A, Khan S, Khan L, Ullah U, Ahmad W. Accuracy of knee MRI findings in detecting soft tissue injury, taking arthroscopy as the gold standard. *J Bahria Uni Med Dent Coll*. 2026;16(1):184-190. https://doi.org/10.51985/JBUMDC2025777
15. Kadhim AS, Alardi IM, Saadoon RA. Patterns of radiological misinterpretation of complete anterior cruciate ligament tears on routine MRI reports: an arthroscopic validation study. *Al-Rafidain J Med Sci*. 2026;10(1):193-198. https://doi.org/10.54133/ajms.v10i1.2707
16. Khan RH, Iqbal J, Ahmad A, Kamal S. Diagnostic accuracy of magnetic resonance imaging knee in diagnosis of anterior cruciate ligament tear taking arthroscopy as gold standard. *Indus J Biosci Res*. 2025;3(4). https://doi.org/10.70749/ijbr.v3i4.1108
17. Thapa S, Panta S, Adhikari A, Upadhyay HP, Shrestha SK. Accuracy of magnetic resonance imaging in diagnosis of anterior cruciate ligament and meniscus tear: an observational study. *J Nepal Med Assoc*. 2025;63(285):315-320. https://doi.org/10.31729/jnma.8982
18. Saif-ur-Rehman, Nazir F, Zulfiqar M, Saleem M, Anis Y. Accuracy of clinical examination versus MRI in the diagnosis of anterior cruciate ligament tears taking arthroscopic examination as gold standard. *J Fatima Jinnah Med Coll*. 2014;8(4):46-47.
19. Thapa R, Lamichhane S, Bhusal A, Shrestha SKD, Yadav S, Swar A, *et al.* Diagnostic accuracy of magnetic resonance imaging compared with arthroscopy in knee injuries among paramilitary personnel. *Nepal J Med Sci*. 2026;11(1):17-26. https://doi.org/10.3126/njms.v11i1.91515