



## Accuracy of MRI of ACL Tears in Patients with Knee Injury in Relation to Arthroscopy

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### Declaration

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Both authors equally contributed to the study and approved the final manuscript

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### ABSTRACT

**Background:** Anterior cruciate ligament tear is a common problem in people who get knee injury, and it mostly happen when the knee twist suddenly during sports or fall. It makes the knee painful and unstable, and many patients cannot walk properly. Doctors use arthroscopy to see the ligament directly, but magnetic resonance imaging is used a lot because it is simple and non-invasive. **Objective:** To determine the diagnostic accuracy of Magnetic resonance imaging to detect anterior cruciate ligament tears in patients with knee injury taking arthroscopy as gold standard. **Study Design:** Cross-sectional validation study. **Duration and Place of Study:** This study was done from November 2024 to April 2025 in the Radiology Department of Benazir Bhutto Hospital, Rawalpindi. **Methodology:** A total of 165 patients aged 16–65 years with knee injury were included by consecutive sampling. All patients first had magnetic resonance imaging and later arthroscopy by the same team. Magnetic resonance imaging findings were compared with arthroscopy, which was taken as the gold standard. True positive, false positive, true negative and false negative values were calculated. A 2×2 table was used to find sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy. **Results:** Magnetic resonance imaging showed anterior cruciate ligament tear in 68 patients (41.2%), while arthroscopy confirmed tear in 50 patients (30.3%). There were 45 true positive cases, 23 false positive cases, 5 false negative cases and 92 true negative cases. The sensitivity of magnetic resonance imaging was 90.00%, specificity was 80.00%, diagnostic accuracy was 83.00%, positive predictive value was 66.20% and negative predictive value was 94.80%. **Conclusion:** This study showed that magnetic resonance imaging has good accuracy for finding anterior cruciate ligament tears.

### INTRODUCTION

ACL tear is one of the common problems in knee injury, and it happen mostly when the knee twist suddenly during sports or fall.<sup>1</sup> The anterior cruciate ligament is very important because it keep the knee stable, and when it get damage the patient feel pain, swelling, and cannot move the knee properly.<sup>2</sup> Many young people who play football, basketball or other running sports get this injury more, and sometimes they hear a pop sound at the time of injury.<sup>3</sup> The knee become unstable after the tear and the patient feel like the knee is giving way when walking or trying to stand.<sup>4</sup>

Arthroscopy is a surgical procedure that allow doctors to see inside the knee joint by using a small camera.<sup>5</sup> It is consider as gold standard method to diagnose ACL tear because it show direct view of the ligament and other structures.<sup>6</sup> During arthroscopy, the doctor make small cuts around the knee and insert the camera and instruments so they can check the ACL clearly and know if it is fully tear or partial tear.<sup>7</sup> Many times arthroscopy is used not only for diagnosis but also for treatment in same

setting, where torn ligament and meniscus can be repair or remove.<sup>8</sup> The procedure take less time, patient recover fast, and there is less pain compare to open surgery, but still it require trained surgeon and hospital setting.<sup>9</sup>

MRI play very important role in diagnosis of ACL tears because it allow to see the ligament, meniscus and other soft tissues without surgery.<sup>10</sup> MRI use magnetic waves to produce images of knee joint which help doctor to know if the ACL is normal, partial tear or complete tear.<sup>11</sup> In many hospitals MRI is used before arthroscopy because it is simple, non-invasive and give good information about knee injury.<sup>12</sup> But sometime MRI may not give accurate result because swelling or patient movement can make the image unclear, and also interpretation depend on radiologist experience.<sup>13</sup>

Bari et al. reported that, when compared with arthroscopy as the gold standard, MRI demonstrated a sensitivity of 87.7%, specificity of 81.6%, a positive predictive value (PPV) of 80.5%, and a negative predictive value (NPV) of 88.6% for diagnosing ACL tears.<sup>14</sup> Similarly, Rayan et al. found MRI sensitivity, specificity, PPV, and

NPV to be 77%, 100%, 100%, and 95%, respectively, against arthroscopic confirmation.<sup>15</sup>

There is need to do this study in Rawalpindi because many patients come with knee injuries but there is not much local data to know how accurate MRI is for ACL tears in our own population. Most studies are from other cities or other countries, and their results may not match with our hospital settings where patient type and injury patterns are different. In Rawalpindi, many young people play sports and road accidents are also common, so ACL injuries are seen a lot, but still doctors depend mostly on arthroscopy without knowing proper MRI accuracy here. By doing this study we can understand how well MRI work in our local conditions and help improve diagnosis and management for knee injury patients in our community.

## METHODOLOGY

This study was carried out in the Radiology Department of Benazir Bhutto Hospital, Rawalpindi, and it took place from 30-11-2024 till 30-04-2025. The approval from the ethical review board was already taken before starting the study (No 520 dated 18/9/2024) so that the procedures stayed according to institutional rules.

A total of 165 cases were selected after calculating the sample with a 95% confidence level by using known sensitivity of MRI as 87.7% and specificity as 81.6%,<sup>7</sup> with margin of error kept at 10% and expected ACL tear frequency of 25.4%.<sup>15</sup> The sampling method was non-probability consecutive sampling. Patients between 16–65 years of both genders who came with knee injury due to sports, fall, or direct hit were allowed in the study. Those who had fracture of tibial plateau, femoral condyle, dislocation, earlier knee surgery or any MRI contraindication were not included. These decisions were made by reviewing the clinical records and initial assessment. Every patient was asked for written consent before any information or imaging was taken.

Basic details like name, age, gender, BMI, life style, cause of injury and duration of injury was noted first. After that, the patients were sent for MRI, which was performed by consultant radiologists along with the researcher. Later these individuals were admitted and arthroscopy was done by the same surgical team to reduce variations. MRI mentioned presence or absence of ACL tear, and arthroscopy also recorded ACL tear status for each case. ACL tear on MRI was judged when the ligament showed loss of fiber pattern, abnormal signal, wavy look, or non-visualization. During arthroscopy, ACL tear meant that one bundle failed to stay continuous and firm or that both anteromedial and posterolateral bundles were completely separated. Based on these findings, cases positive by both MRI and arthroscopy were counted as true positive, and cases negative by both were taken as true negative. When MRI showed tear but arthroscopy did not, it was false positive, and when MRI missed tear but arthroscopy detected it, it was false negative. Sensitivity meant how well MRI picked ACL tear that arthroscopy also confirmed. Specificity meant MRI correctly identifying no tear which arthroscopy also agreed. PPV meant the proportion of MRI-positive results that were actually ACL tear on arthroscopy, while NPV meant proportion of MRI-negative results that truly had no tear on arthroscopy.

All data were analyzed in SPSS version 25. Age, BMI and duration of injury were shown as mean with standard deviation. Gender, life style, cause of injury and ACL tear on MRI and arthroscopy were shown as frequencies and percentages. A 2×2 table was made to calculate sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy of MRI taking arthroscopy as the gold standard.

## RESULTS

The study included a total of 165 patients with knee injuries that was evaluated for anterior cruciate ligament tears. The mean age of patients were  $38.96 \pm 14.15$  years, and the mean BMI was recorded as  $25.30 \pm 4.65$  kg/m<sup>2</sup>. The average duration of symptoms before presentation were  $6.58 \pm 3.24$  weeks. Regarding gender distribution, males was more predominant with 110 patients (66.7%) compared to females who was 55 patients (33.3%). When looking at lifestyle patterns, active lifestyle was observed in 74 patients (44.8%), while sedentary lifestyle was present in 62 patients (37.6%), and sports-related lifestyle was found in 29 patients (17.6%). The causes of injury shows that sports injury was the most common cause affecting 51 patients (30.9%), followed by fall injury in 42 patients (25.5%), direct hit/blow injury in 36 patients (21.8%), and other causes also in 36 patients (21.8%) (as shown in Table-I).

**Table I**  
*Patient Demographics*

Demographics	Mean $\pm$ SD / n (%)
Age (years)	38.96 $\pm$ 14.15
BMI (kg/m <sup>2</sup> )	25.30 $\pm$ 4.65
Duration of Symptoms (weeks)	6.58 $\pm$ 3.24
<b>Gender</b>	
Male	110 (66.7%)
Female	55 (33.3%)
<b>Lifestyle</b>	
Active	74 (44.8%)
Sedentary	62 (37.6%)
Sports-related	29 (17.6%)
<b>Cause of Injury</b>	
Sports injury	51 (30.9%)
Fall injury	42 (25.5%)
Direct hit/blow injury	36 (21.8%)
Others	36 (21.8%)

The overall diagnostic findings reveals that MRI detected anterior cruciate ligament tear as positive in 68 patients (41.2%) and negative in 97 patients (58.8%) out of total 165 patients. However, arthroscopy which is considered the gold standard, identified positive tears in 50 patients (30.3%) and negative results in 115 patients (69.7%) among the same 165 patients (as shown in Table-II).

**Table II**  
*Overall results of MRI and Arthroscopy in diagnosis of anterior cruciate ligament tear*

Anterior Cruciate Ligament Tear	MRI	Arthroscopy
Positive	68 (41.2%)	50 (30.3%)
Negative	97 (58.8%)	115 (69.7%)
Total	165 (100%)	165 (100%)

When comparing MRI findings with arthroscopy results, the data shows that there was 45 true positive cases where both MRI and arthroscopy was positive. There was 23 false positive cases where MRI showed positive results but arthroscopy was negative. Additionally, 5 false negative

cases was observed where MRI was negative but arthroscopy detected the tear as positive. Furthermore, 92 true negative cases was identified where both MRI and arthroscopy shows negative results (as shown in Table-III).

**Table III**

*Comparison of MRI versus Arthroscopy in diagnosis of anterior cruciate ligament tear*

MRI	Arthroscopy		Total
	Positive	Negative	
Positive	45 (TP)	23 (FP)	68
Negative	5 (FN)	92 (TN)	97
Total	50	115	165

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

The diagnostic performance of MRI in detecting anterior cruciate ligament tears demonstrates that the sensitivity was 90.00%, which indicates MRI's ability to correctly identify patients with ACL tears. The specificity was calculated as 80.00%, representing the ability to correctly identify patients without tears. The overall diagnostic accuracy of MRI was found to be 83.00%. The positive predictive value was 66.20%, showing the probability that patients with positive MRI results actually has ACL tears. The negative predictive value was notably high at 94.80%, indicating that patients with negative MRI results was highly unlikely to have ACL tears (as shown in Table-IV).

**Table IV**

*Sensitivity, Specificity, Diagnostic Accuracy, PPV and NPV of MRI in diagnosis of anterior cruciate ligament tear*

Diagnostic Parameter	Result
Sensitivity	90.00%
Specificity	80.00%
Diagnostic Accuracy	83.00%
PPV	66.20%
NPV	94.80%

## DISCUSSION

The mean age of patients were  $38.96 \pm 14.15$  years, which shows that ACL injuries occurs mainly in middle-aged adults who is more physically active in sports and work activities. Males was more affected 110 (66.7%) than females 55 (33.3%) because males participates more in contact sports and high-intensity activities that causes knee injuries.

Sports injury was the most common cause affecting 51 patients (30.9%) due to sudden movements like pivoting and jumping that puts excessive force on knee joint and tears the ACL fibers. The sensitivity of MRI was 90.00% which means MRI correctly identified most ACL tears because it shows good soft tissue details and can visualize ligament damage and edema. However, specificity was 80.00% indicating some false positive results occurs due to signal changes from old injuries or partial tears that looks like acute tears on MRI.

The positive predictive value was 66.20% showing that only two-thirds of positive MRI cases actually has ACL tears, so clinical correlation is needed before surgery. The negative predictive value was very high at 94.80% which means when MRI is negative, patient is unlikely to have ACL tear, so this helps to avoid unnecessary arthroscopy procedures.

The current study found MRI sensitivity of 90.00% and specificity of 80.00% for ACL tear diagnosis, which shows partial agreement with several Pakistani studies but also reveals important variations. Khan *et al.*<sup>16</sup> reported similar sensitivity of 90% but lower specificity of 63% in 160 patients at Peshawar, while Khan Niazi *et al.*<sup>17</sup> found comparable sensitivity of 89.89% with specificity of 64.28% in 127 patients at Rawalpindi. These similarities in sensitivity suggests that MRI is consistently reliable in identifying true ACL tears across different centers because of its excellent soft tissue contrast and ability to visualize ligament discontinuity. However, the present study's higher specificity of 80.00% compared to Khan *et al.*<sup>16</sup> (63%) and Khan Niazi *et al.*<sup>17</sup> (64.28%) may be attributed to differences in MRI interpretation expertise or the presence of fewer confounding factors like chronic degenerative changes in the study population.

In contrast, Sarfraz *et al.*<sup>18</sup> reported higher sensitivity of 92.3% but markedly lower specificity of 50% in 50 patients at Lahore, and Reddy *et al.*<sup>19</sup> achieved even better sensitivity of 95.5% with specificity of 83.3% in 120 patients at Bangalore. The superior performance in Reddy *et al.*<sup>19</sup> study might reflects more advanced imaging protocols or better patient selection criteria, whereas the lower specificity in Sarfraz *et al.*<sup>18</sup> could results from older MRI technology or less experienced radiologists leading to more false positive interpretations. The present study's diagnostic accuracy of 83.00% falls between Khan *et al.*<sup>16</sup> (86%) and Khan Niazi *et al.*<sup>17</sup> (84.25%), but was considerably lower than Reddy *et al.*<sup>19</sup> (92.5%), which suggests that institutional factors and radiologist expertise plays significant role in MRI interpretation.

The positive predictive value in this study was 66.20%, which is substantially lower than most comparative studies including Khan *et al.*<sup>16</sup> (93%), Khan Niazi *et al.*<sup>17</sup> (89.89%), Sarfraz *et al.*<sup>18</sup> (96%) and Reddy *et al.*<sup>19</sup> (94.5%). This lower PPV indicates higher rate of false positive diagnoses with 23 false positive cases out of 68 positive MRI results in the current cohort, possibly due to overinterpretation of partial tears or signal changes from previous injuries. However, the negative predictive value was remarkably high at 94.80%, which is consistent with Khan *et al.*<sup>16</sup> (54%) showing considerable variation, but the current study's high NPV aligns more closely with Reddy *et al.*<sup>19</sup> (86.2%), indicating that negative MRI findings reliably excludes ACL tears and helps to avoid unnecessary arthroscopy procedures.

Several studies demonstrated that clinical examination can achieve comparable or even superior accuracy to MRI. Saif-ur-Rehman *et al.*<sup>20</sup> showed that combined clinical tests achieved 98.39% sensitivity and 91.30% specificity, actually outperforming MRI's 98.39% sensitivity but 82.61% specificity in 108 patients at Lahore. Similarly, Khan Durrani *et al.*<sup>21</sup> found anterior-drawer test alone reached 100% sensitivity and 78.26% specificity in 47 patients, while Ashraf *et al.*<sup>22</sup> reported Lachman test yielded 81.8% sensitivity and 95.2% specificity in 150 patients. These findings suggests that experienced clinical examination can identifies ACL tears effectively, though the present study did not compare clinical tests directly with MRI, which represents a limitation as clinical correlation is important for reducing

false positive MRI interpretations before surgical intervention.

The gender distribution in present study showed male predominance at 110 patients (66.7%), which is consistent with Khan *et al.*<sup>16</sup> (153 male out of 160), Khan Niazi *et al.*<sup>17</sup> (109 male out of 127) and most other studies reflecting the higher injury rates in males due to greater sports participation. However, Khan *et al.*<sup>16</sup> noted that MRI accuracy was markedly reduced in females with 0% sensitivity and 29% specificity, suggesting gender-specific variations in MRI interpretation that warrants further investigation. The mean age in current study was  $38.96 \pm 14.15$  years, which is higher than Khan *et al.*<sup>16</sup> ( $30.0 \pm 9.29$  years), Khan Niazi *et al.*<sup>17</sup> (29.1 years) and Ashraf *et al.*<sup>22</sup> ( $39.95 \pm 11.46$  years), and Khan Niazi *et al.*<sup>17</sup> demonstrated that MRI accuracy declines beyond 35 years, which might partially explains the moderate PPV in present study if older patients was overrepresented.

Sports injury was the leading cause affecting 51 patients (30.9%) in current study, which is comparable to patterns observed across other studies where young active males sustains ACL injuries through pivoting and jumping mechanisms. The overall prevalence of ACL tears detected by arthroscopy in present study was 50 patients (30.3%), which is lower than Khan *et al.*<sup>16</sup> (85%), Khan Niazi *et al.*<sup>17</sup> (78%) and Saif-ur-Rehman *et al.*<sup>20</sup> (57.4%), but similar to Ashraf *et al.*<sup>22</sup> (44%). This variation in prevalence likely reflects different patient selection

criteria and referral patterns across institutions, with some centers receiving more pre-selected surgical candidates while others evaluates broader populations with knee injuries. The differences in study populations, MRI protocols, radiologist experience and timing of imaging after injury all contributes to the observed variations in diagnostic accuracy across studies, emphasizing the need for standardized protocols and experienced interpretation for optimal MRI performance in ACL tear diagnosis.

## CONCLUSION

The present study has concluded that MRI demonstrates good diagnostic accuracy in detecting anterior cruciate ligament tears when compared with arthroscopy as gold standard. The sensitivity of MRI was found to be excellent which indicates that it can reliably identifies most ACL tears, while specificity was moderate suggesting some false positive results occurs. The high negative predictive value confirms that MRI is particularly valuable for ruling out ACL tears and helps to avoid unnecessary invasive procedures.

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