

# Magnetic Resonance Imaging Evaluation of Menisci and Cruciate Ligamentous Injuries of the Knee with Arthroscopic Correlation

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## Abstract

**Introduction:** Now a days Magnetic Resonance Imaging (MRI) has become the primary investigation for the assessment of knee injuries. Non-invasive MRI has the ability of high resolution and accuracy to diagnose the knee injuries and it can be the alternative to diagnostic arthroscopy.

**Objective:** To validate MRI evaluation in the assessment of cruciate ligamentous and meniscal injuries of the knee joint and compare with arthroscopic findings.

**Materials and Methods:** This cross sectional study was conducted at Combined Military Hospital, Dhaka from 01 January 2013 to 30 June 2013 where sixty patients who had the history of twisting injuries to the knee were selected in this study. Along with injury history they were strongly suspected to have meniscal and/or cruciate ligamentous tears. Then they were examined by open MRI machine 0.4 tesla, Hitachi, made in Japan. A Quadrature (QD) extremity coil was used in this study. Spin echo T<sub>1</sub>, fast spin echo T<sub>2</sub> and Short Tau Inversion Recovery (STIR) sequences were taken in direct coronal, sagittal and axial planes with 4mm slice thickness. Data were recorded and statistical analysis was done by SPSS version 20.

**Results:** Total 60 patients underwent MRI and Arthroscopic examination. The final diagnosis was established by direct findings at Arthroscopic examination. The Sensitivity, Specificity and Accuracy of Magnetic Resonance Imaging in the diagnosis of cruciate ligamentous and meniscal injuries as compared to arthroscopy were Anterior Cruciate Ligament (ACL): 96.88% sensitivity, 96.43% specificity, 96.66% accuracy, 96.87% Positive predictive value (PPV) and 96.42% Negative predictive value (NPV); Medial Meniscus (MM): 96.43% sensitivity, 98.87% specificity, 96.66% accuracy, 96.42% PPV and 98.88% NPV; for Lateral Meniscus (LM): 80.00% sensitivity, 97.77% specificity, 93.33% accuracy, 92.30% PPV and 93.62% NPV.

**Conclusion:** As a non-invasive diagnostic modality Magnetic Resonance Imaging is very useful and having high sensitivity, specificity and accuracy in the detection of meniscal and cruciate ligament injuries. To prevent unwanted arthroscopies MRI should be done in every patient of suspected cruciate ligamentous and meniscal injury before doing arthroscopy.

**Key-words:** Anterior Cruciate Ligament (ACL), Posterior Cruciate Ligament (PCL), Medial Meniscus (MM), Lateral Meniscus (LM), Magnetic Resonance Imaging (MRI).

## Introduction

MRI plays an important role in the diagnosis of knee lesions since 1984. It has become a primary tool to guide the management of injured knee. MRI is a noninvasive diagnostic modality having high sensitivity, specificity and accuracy in the diagnosis of meniscal and cruciate ligament injuries. Every suspected patient of ligamentous injury of the knee should be evaluated by MRI before doing arthroscopy thus preventing the maximum unwanted arthroscopies<sup>1</sup>. Arthroscopy is invasive though it is highly sensitive and specific in both diagnostic and therapeutic aspect<sup>2</sup>.

Arthroscopy to diagnose the cruciate ligaments and menisci injury is regarded as the gold standard, but it is invasive and expensive. MRI has replaced conventional arthrography in the evaluation of injury of cruciate ligaments and menisci as a non-invasive procedure and reduced both morbidity and cost associated with the arthroscopic examination. MRI is a good, accurate and noninvasive technique for the assessment of menisci and ligamentous injuries. MRI can be used as a first line diagnostic mode in patients with soft tissue trauma to knee<sup>3</sup>. Thus as a non-invasive diagnostic modality MRI can prevent unwanted arthroscopy as it has high sensitivity, specificity and accuracy in the diagnosis of cruciate ligament and meniscal injuries.

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## Materials and Methods

This cross-sectional study was conducted in Combined Military Hospital, Dhaka from 01 January 2013 to 30 June 2013. The total number of patients was sixty. They had the history of twisted knee injuries. Patients above twenty years of age irrespective of sex who attended in Combined Military Hospital, Dhaka, referred from the Orthopaedics Department for MRI of the knee suspected to have meniscal and/or cruciate ligamentous injury were included in this study. After proper examination by the orthopaedic surgeons, sixty patients came for MRI. Either the meniscus or ligaments or both injuries were showed in MRI, then knee arthroscopies were done. Patients who had the history of neoplasms, inflammatory or infective disorders, contraindicated for MRI and patients had the history of significant injury to the knee between the time of MRI and arthroscopy were excluded from this study.

Open MRI machine Hitachi, made in Japan 0.4 tesla was used to perform MRI. The protocols were sagittal T<sub>1</sub>, T<sub>2</sub> and T<sub>2</sub>\*; coronal and axial T<sub>2</sub> weighted images. A dedicated extremity knee coil was used. Two trained and qualified Radiologists studied and reported MRI images. Qualified orthopaedic surgeons by using KARL STORZ arthroscopy machine performed arthroscopic examinations.

MRI was done between 7 days to 45 days from the date of injury. Six days to 35 days was the duration between MRI and arthroscopic examination. Data were recorded and statistical analysis was done by SPSS 20. By keeping arthroscopic examination as gold standard, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were calculated for MRI.

## Results

A total of 60 patients underwent MRI and Arthroscopic examination where final diagnosis was established by direct findings with Arthroscopy. Out of 60 cases, 43 showed ACL tears and 28 showed medial meniscal tears, 15 cases with lateral meniscal tears. Among them, 20 cases had ACL tears with menisci injury. Isolated ACL tears were seen in 23 cases. Distribution of ACL tear are as follows:

**Table-I:** Distribution of ACL tear of patients by site (n=43)

Location	MRI		Arthroscopy	
	Count	Percentage	Count	Percentage
Mid-substance	26	60.47%	25	58.14%
Femoral attachment	10	23.25%	10	23.26%
Tibial attachment	07	16.26%	8	18.16%

**Table-II:** Distribution of ACL tear of patients by MRI and Arthroscopic (n=43)

MRI diagnosis	Arthroscopic diagnosis		Total
	Positive for tear	Negative for tear	
Positive for tear	42 True positive	1 False positive	43
Negative for tear	1 False negative	16 True negative	17
Total	43	17	60

**Table-III:** Validity test for MRI in the detection of ACL tear

Validity test	Percentage
Sensitivity	97.67
Specificity	94.11
Accuracy	96.66
Positive predictive value	97.68
Negative predictive value	94.12

Twenty eight patients were with of medial meniscus tears, the most common location of the tear was the posterior horn. In this study, posterior horn tears in 18(64.28%) cases, 8(28.57%) cases had anterior horn and mid third tear in 2(7.14%) cases were seen by MRI. Patients with posterior horn tears in 17 (60.71%) cases, anterior horn tears in 8(28.57%) cases and middle third tear in 3(10.71%) cases were seen by arthroscopic examination (Table-IV).

**Table-IV:** Distribution of MM tear patients by site (n=28)

Location	MRI		Arthroscopy	
	Count	Percentage	Count	Percentage
Anterior horn	8	28.57%	8	28.57%
Posterior horn	18	64.28%	17	60.71%
Middle third	2	7.14%	3	10.71%

**Table-V:** Distribution MM tear patients by MRI and Arthroscopic diagnosis (n=28)

MRI diagnosis	Arthroscopic diagnosis		Total
	Positive for tear	Negative for tear	
Positive for tear	27 True positive	1 False positive	28
Negative for tear	1 False negative	31 True negative	32
Total	28	32	60

**Table-VI:** Validity test for MRI in the detection of MM tear

Validity test	Percentage
Sensitivity	96.43
Specificity	98.87
Accuracy	96.66
Positive predictive value	96.42
Negative predictive value	98.88

Thirteen LM tears were detected on MRI. Posterior horn tears were seen most commonly. Ten (76.92%) patients had posterior horn tears, anterior horn tears in 3(23.07%) patients and middle third tear was not found on MRI. Fifteen LM tears detected on arthroscopy, 9 patients (60%) had posterior horn tears, 4 patients (26.66%) had anterior horn tears and 2 patients (13.33%) had middle one-third tears.

**Table-VII:** Distribution of LM tears patients by site (n=15)

Location	MRI		Arthroscopy	
	Count	Percentage	Count	Percentage
Anterior horn	3	23.07%	4	26.66%
Posterior horn	10	76.92%	9	60.00%
Middle third	-	-	2	13.33%

**Table-VIII:** Distribution of LM tear patients by MRI and Arthroscopic diagnosis (n=15)

MRI diagnosis	Arthroscopic diagnosis		Total
	Positive for tear	Negative for tear	
Positive for tear	13 True positive	No False positive	13
Negative for tear	2 False negative	45 True negative	47
Total	15	45	60

**Table-IX:** Validity test of MRI in the diagnosis of LM tear

Validity test	Percentage
Sensitivity	80.00
Specificity	97.77
Accuracy	93.33
Positive predictive value	92.30
Negative predictive value	93.62

## Discussion

This study included 60 patients where 43 patients showed ACL tears, 28 patients showed MM tears, 15 patients showed LM tears. No case of PCL tear was found in this study.

Cruciate ligament tears: MRI showed ACL tears in 43 patients. 26(60.47%) patients had mid-substance tears, at the femoral attachment 10(23.26%) patients and 7(16.28%) patients at the tibial attachment were detected. The most common tear location was at mid-substance in this study. Mid substance tears in 25(58.14%) patients, femoral attachment tears in 10 (23.26%) patients and tibial attachment tears in 8(18.60%) patients were detected on arthroscopy. The most common type of tears occur in mid substance<sup>4,11</sup>. One false positive case was found. That was found normal in arthroscopy. One false negative case misinterpreted as normal on MRI found the partial tear on arthroscopy. Relatively low sensitivity (40%-75 %) but has moderate to high specificity (62%-94%) in diagnosis of partial tears by MR imaging had been shown in two large study results<sup>5,6</sup>. The sensitivity, specificity and accuracy of MRI in detecting ACL tear were 97.67%, 94.11%, 96.66% respectively found in this study which were corresponding to the previous study<sup>1</sup>, but not consistent with other recent study<sup>14</sup>.

Meniscal tears: Twenty eight cases had medial meniscal and 15 cases had lateral meniscal tears on MRI among the 60 patients corresponds with the study<sup>7,10,12,13</sup>. Medial meniscal tear is more common than the lateral meniscal tear reported by them. Common tear site in this study was at posterior horn of medial meniscus consistent with the study<sup>15</sup>. In this study, 13 patients had lateral meniscus tears seen on MRI. Posterior horn tears of lateral meniscus were commonly seen, not consistent with the study<sup>15</sup>, they showed anterior horn more commonly injured.

The sensitivity, specificity and accuracy for the diagnosis of medial meniscal tears in this study were 96.43%, 98.87% and

96.66% respectively. For the diagnosis of Lateral Meniscal tears the sensitivity, specificity and accuracy were 80%, 97.77% and 93.33% respectively, both correspond with old study<sup>8</sup>.

Out of the 28 Medial Meniscal tears, there were one false positive and one false negative case. In this study, the one false positive was in the posterior horn of the medial meniscus on MRI. The exact cause of the false positives in the diagnosis of a tear in the posterior horn of the medial meniscus was not clear. It may be due to intra-meniscal tear not reaching to the articular surface of the meniscus not seen by arthroscopic examination or misinterpretation of normal anatomy.

Fifteen patients had lateral meniscal tear detected by arthroscopic examination, one was false positive on MRI may be due to pseudo tear appearance caused by meniscofemoral ligament.

There were 3 bucket handle tears in medial meniscus seen in this study had been confirmed by arthroscopic examination. So medial meniscus bucket handle tears are more common than lateral meniscus<sup>9,10</sup>.

## Conclusion

It has been evident from this study that MRI is a noninvasive very useful modality for the assessment of menisci and cruciate ligament injuries of the knee having high sensitivity, specificity and accuracy. It has been found that MRI is highly accurate for the assessment of tears of the menisci and cruciate ligaments. So by using MRI as a screening tool for therapeutic arthroscopy, unnecessary diagnostic arthroscopy in most patients can be avoided. As a noninvasive modality, MRI is not related to the morbidity associated with arthroscopy, should be done for all patients of suspected ligamentous and meniscal injury of knee before arthroscopy thus preventing unwanted arthroscopies.

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