

Role of magnetic resonance imaging in the evaluation of knee joint injuries with arthroscopic correlation

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Abstract

Background: Trauma to the knee joint is a significant cause of morbidity in young active individuals especially in road traffic accidents and in athletes. An accurate diagnosis regarding the type and extent of injury is essential for early operative as well as non-operative treatment. The most widely used diagnostic modalities to assess knee joint injury are arthroscopy and MRI. Arthroscopy, though accurate, is invasive and can cause complications like infection and haemarthrosis. Magnetic resonance imaging has now been accepted as the best modality for non-invasive evaluation of knee injuries. MRI has excellent soft tissue delineation with additional advantages of multiplanar imaging and thin section capabilities to evaluate subchondral bone and bone marrow. **Aims and Objectives:** To detect various types of traumatic lesions of the knee using MRI and to determine the diagnostic accuracy of MRI in comparison with arthroscopy in the assessment of meniscal and ligamentous injuries of the knee joint. **Materials and Methods:** A Prospective study was conducted from September 2016 to May 2017 on 60 patients with knee injury were referred to the Department of Radio-Diagnosis for MRI evaluation and later underwent knee arthroscopy examination by an orthopedic surgeon. MR images were obtained using Siemens Magnetom Essenza 1.5 Tesla with proper patient positioning using a dedicated knee coil. The findings of MRI and arthroscopy were correlated. Statistical analysis was done to calculate the sensitivity, specificity, PPV, NPV and diagnostic accuracy of MRI in comparison with arthroscopy. **Results:** In our study the most common abnormal MRI finding was complete tear of ACL seen in 42 cases (73%), followed by joint effusion which was seen in 28 cases (46%). Most common type of meniscal injury was a Grade III tear involving posterior horn of medial meniscus (60%). The statistical analysis was as follows: for medial meniscus resulted in 94.3% sensitivity, 98 % specificity, 93% PPV, 94% NPV and accuracy of 95%, for lateral meniscus resulted in 83.33% sensitivity, 98.4% specificity, 86.65% PPV, 96% NPV and 96% accuracy, for anterior cruciate ligament resulted in 97.42%, 85.72%, 84% PPV, 97.56% NPV and 93 % accuracy, for posterior cruciate ligament resulted in 88 % sensitivity, 98% specificity, 83.3 % PPV, 97.13% NPV and 98.4% accuracy. **Conclusion:** MRI is an excellent non-invasive modality with high level of accuracy in diagnosis of meniscal and ligamentous injuries of knee. It is an appropriate screening tool and helps to avoid unnecessary diagnostic arthroscopy in most cases of traumatic knee injuries.

Key Words: Arthroscopy, Diagnostic accuracy, Magnetic resonance imaging, Traumatic knee joint injuries.

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INTRODUCTION

The knee joint is a common site for injury, mainly due to trauma and sports related injuries.¹ Diagnostic arthroscopy is a vital tool, providing diagnostic precision to 87-96%. However, it is an invasive procedure with the possibility of infection, hemarthrosis, as well as complications related to anesthesia. MRI is a completely non-invasive diagnostic modality and there is no ionizing radiation. Furthermore the ligaments of knee are

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categorized into intra and extra-articular, consequently. MRI plays the most important role in their overall evaluation. The extra-articular ligaments are not visible on routine arthroscopic procedures.^[2] The overall assessment of the entire joint using MRI gives a composite diagnosis³, is more relevant thus reducing the number of diagnostic arthroscopy.

MATERIALS AND METHODS

A prospective hospital based study was conducted on 60 patients with history of traumatic injury to knee who were referred to the department of Radio-Diagnosis, in our institute. Patients above the age of 10 years and all patients with history of recent and old trauma to the knee were included. Infective, neoplastic lesions, post-operative knee joint, patients with metallic implants and in all patients where MRI is contraindicated are excluded from the study. All 60 patients underwent MRI evaluation of knee joint and then later had arthroscopic examination. Institutional ethical committee clearance was obtained before the start of the study. All MRI images were obtained using Siemens Magnetom Essenza 1.5 Tesla and a dedicated extremity knee coil. For sagittal images the patients were placed in supine position with an external rotation of knee 15-20 degree and flexion of 5-10 degree resting on a pad for better visualization of anterior cruciate ligament.^[4] Knee is placed in neutral position for coronal images. The coil is applied as close as possible to the injured knee. Routine knee protocol was done using PD Fat sat axial, coronal and sagittal images, T1 TSE Sagittal, STIR Sagittal and axial, T2 FSE sagittal, T2 fat sat sagittal, GRE Sagittal sequences were obtained. T2 Weighted Proton density images with fat suppression routinely used to assess for fluid, bone marrow hyperemia, and articular cartilage.^[5] STIR images used for identifying bone contusion.

Image Analysis: A meniscal tear on MRI was defined by loysch *et al*⁶ as being grade 3 signal intensity i.e., intrameniscal signal intensity unequivocally extending upto an articular surface and **two -slice –touch** rule was applied in which a tear corresponds to increased signal

touching the articular surface on at least two slices. A partial tear of ACL was considered if there was abnormal signal intensity within the ligament or otherwise intact fibers appear wavy on sagittal and coronal images. A complete tear of ACL was considered if there was disruption of all the fibers or if it was not visible at all on MRI.⁷ Standard criteria of signal inhomogeneity were used to establish a diagnosis of other abnormalities such as ligament tears and bone contusions.

RESULTS

Table 1: Age and sex distribution of study population.

Age in years	Male	Female	Total
11-20	6	3	9
21-30	17	5	22
31-40	10	7	17
41-50	6	1	7
ABOVE 50	3	2	5
Total	40	20	60

Table 2: Spectrum of abnormal MRI findings

Abnormal MRI Findings	Number	Percentage
Acl Tear	42	70%
Pcl Tear	9	15%
Medial Meniscal Injury	24	40%
Lateral Meniscal Tear	7	11.6%
Medial Collateral Ligament	15	25%
Lateral Collateral Ligament	5	8.3%
Joint Effusion	28	46.6%
Bone Contusion	10	16.6%
Articular Cartilage	4	6.6%

Table 3: Comparison of MRI findings with Arthroscopy

RESULTS	ACL	PCL	MM	LM
True Positive	38	8	16	5
True Negatives	18	51	41	53
False Positive	3	1	3	1
False Negative	1	1	1	1
Sensitivity	97.42%	88.88%	94.12%	83.33%
Specificity	85.72%	98.08%	93.71%	98.41%
Ppv	84.3%	83.3%	92.68%	86.68%
Npv	97.56%	97.12%	94.30%	96.25%
Accuracy	93.30%	98.4%	95.00%	96.6%

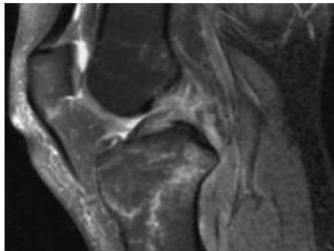


Figure 1

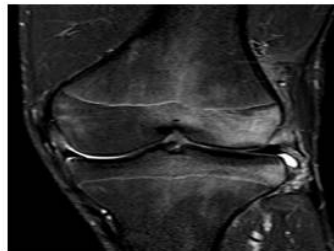


Figure 2

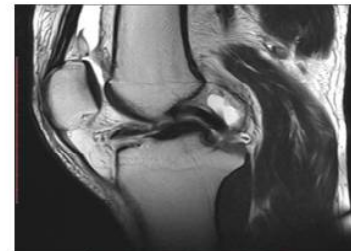


Figure 3

Figure 1: PD Fat suppressed MR image showing loss of continuity and abnormal signal of ACL fibers – Complete ACL Tear

Figure 2: Coronal STIR images showing bone marrow contusion of lateral femoral and tibial condyles with joint effusion

Figure 3: Sagittal PD image showing Double PCL sign – bucket handle tear of medial meniscus

The study group consisted of 60 patients with history of traumatic injuries to the knee joint. All the patients underwent arthroscopy. The findings on MRI were correlated with arthroscopic findings and sensitivity, specificity, negative predictive value, positive predictive value and diagnostic accuracy were calculated. Of the 60 patients in this study 40 were males and 20 were females. The study showed male preponderance of about 80% as seen in Table 1. In our study, the most common abnormal MRI finding was ACL tear seen in about 42 patients (73%), followed by joint effusion which accounted for 46.6% as seen in Table 2. The most common meniscal injury was involving the medial meniscus in 24 patients (40%). In our study, ACL tear was most commonly associated with medial meniscal injury in upto 16 cases. Among cruciate ligament injuries complete tear of ACL was more common seen in upto 35 cases. Of the total 30 patients with meniscal injuries, grade 3 tear involving the posterior horn of medial meniscus was frequently observed in upto 16 patients. For ACL injury MR showed a sensitivity of 97.42%, specificity of 85.72%, NPV of 84%, PPV of 96% and diagnostic accuracy of 93.3%. for PCL injury sensitivity 88.88%, specificity of 98%, PPV of 84 %, NPV of 98 % and diagnostic accuracy of 98.4% accuracy. for medial meniscal injuries sensitivity of 94.4%, specificity of 93.71%, PPV of 92 %, NPV of 94 % and diagnostic accuracy of 95%. For lateral meniscal injuries the sensitivity of 83.3%, specificity of 98.41%, PPV of 86.6%, NPV of 94.3% and diagnostic accuracy of 96% were noted as seen in Table 3.

DISCUSSION

A study by R. Mackenzie *et al* revealed overall sensitivity for menisci and cruciate to be 92% and specificity of 94%. Meta -analysis done by Oei and colleagues showed pooled sensitivity of medial and lateral meniscus were 93% and 88%, while specificity were 88 and 95 % respectively. For ACL and PCL tears, the pooled sensitivity and specificity were 94%, 91% and 94% and 99% respectively⁸. Medial meniscus (60%) was more commonly injured than lateral meniscus, our results matched with studies done by Singh *et al.*, and Bari., *et al.*, Barronian *et al.*, found 100% sensitivity for medial meniscus tear and 79 % for lateral meniscal tears therefore finding MRI to be a reliable pre arthroscopy tool. Dowdy *et al* documented that a positive MRI for an ACL tear combined with negative arthroscopy did not necessarily represent false positive MRI as an intra-substance tear may be present, which is difficult to detect with arthroscopy.⁹ Robertson *et al.*, reported that the overall diagnostic accuracy of MRI in assessment of ligamentous and meniscal injuries was upto 95%. Our study showed an excellent correlation between MRI and Arthroscopy,

the results of our study matched the above mentioned studies.

CONCLUSION

MRI is a useful non invasive modality with high diagnostic accuracy, high sensitivity and negative predictive value making it a reliable screening test for diagnosing traumatic lesions of knee. It has high sensitivity for ACL tears, in patients with positive clinical examination and a positive MRI report an arthroscopist can go for a therapeutic arthroscopy directly. Despite the fact that arthroscopy is the gold standard in evaluating knee pathologies, there are many limitations of the procedure like difficulties in diagnosing extra-articular pathologies, posterior and inferior meniscal tears. Hence performing an MRI prior to arthroscopy is essential in evaluation of traumatic internal derangement of knee.

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