



## Radio Diagnosis

## SPECTRUM OF MRI FINDINGS IN KNEE INJURIES WITH ARTHROSCOPIC CORRELATION IN ACTIVE SERVICE POPULATION.

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**ABSTRACT** **Context:** Traumatic knee injuries are conventionally assessed by clinical means leading to higher false diagnosis. MRI being a noninvasive radiological investigation helps to screen patients who will benefit from invasive diagnostic/therapeutic arthroscopy for planning subsequent management. In view of the above, a study was planned to correlate the findings of MRI Knee joint with subsequent arthroscopy findings in cases of internal derangement of knee.

**Aim:**

1. To compare the MRI findings of meniscal and ligament injuries of knee with arthroscopic findings.
2. To assess the advantages and limitations of each modality

**Materials and Methods:** In this prospective study, 66 patients (age group 16-52 years) with history of acute knee trauma with clinically suspected internal knee derangement underwent MRI followed by arthroscopy. MRI findings were compared with arthroscopic findings to assess the accuracy of each procedure.

**Results:** Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI in diagnosing ACL tear was 96%, 83 %, 96 %, 83 % and 94 % respectively, for PCL tears was 100%, for medial meniscus tear was 89%, 100%, 100%, 88% and 94 % respectively, for lateral meniscus tear was 100%, 96 %, 86 %, 100 % and 97 % respectively and for osteochondral changes. was 29%, 100 %, 100 %, 81 % and 70 % respectively.

**Conclusions:** MRI has high sensitivity and specificity in detecting ligament and meniscal injuries. MRI should be done for any patients suspected of having internal derangement of knee to complement and at times avoid invasive arthroscopy.

**KEYWORDS :** Arthroscopy, Internal derangement knee, MR imaging of knee

**INTRODUCTION:**

The Knee joint is the largest joint of human body with complex intra-articular structures in the form of menisci and ligaments providing it stability during the range of motion<sup>1</sup>. It is also one of the joints commonly involved in trauma related to sports, RTA, or injuries and also the most common cause of surgical intervention in sports related injuries. Injury to these intra-articular structures is generally termed as "internal derangement of knee" which was first coined by William Hey in year 1784<sup>2</sup>. The severity and frequency of these injuries is more common in young and associated with significant morbidity. In armed forces soldiers are prone to these injuries as they are actively involved in training and sports activities. If not managed properly with early diagnosis and management, it can cause significant disability. Meniscal damage predisposes the adjacent articular cartilage to increased axial and shear stress, resulting in early degenerative osteoarthritis and further aggravate the disability.<sup>3</sup>

Clinical examination of knee injuries has 70% accuracy in diagnosing the pathology but high rate of false diagnosis especially in acute stage following injury due to associated pain and swelling<sup>4,6</sup>. MRI and Arthroscopy remain the choice of investigation for comprehensive assessment of the bony and soft tissue injury.

This study was done to correlate the findings of MRI and knee arthroscopy to define the advantages and shortcomings of each procedure in assessing knee trauma.

**Subjects and Methods:** This study was designed as a prospective study. It was carried out at Department of Radio diagnosis of a tertiary care hospital over a period of 18 months from Apr 2018 to Sep 2019. The study was approved by the institutional ethics committee.

**Inclusion criteria:** A total of 66 patients in the age group of 15-50 yrs. were included in the study. Patients' internal derangement of knee following trauma underwent MRI with prior consent.

**Exclusion criteria:** Patients with infective etiology of knee, fractures and suspected masses around knee joint were excluded from the study. Patients with prior history of arthroscopic procedure and contraindication to MRI such as pacemakers, metallic implants etc. were not included in the study.

MR imaging was done with 1.5 tesla superconducting magnet (Signa GE Healthcare) using dedicated quadrature extremity coils. Knee was kept in 15–20-degree external rotation and in 5-10 degrees flexion for better visualization of anterior cruciate ligament. Protocols of sequences included T1SE and T2 FSE in sagittal and coronal plane, GRE in axial plane, PD FS sequence in all three orthogonal planes.

MRI findings were defined in terms of meniscal, ligament and cartilage related findings. The "two-slice-touch" rule, previously described by De Smet and Tuite, served as the primary guide for diagnosing a meniscal tear<sup>7,8</sup>. Meniscal tears were further described according to location (Anterior horn/ body/ posterior horn), type (horizontal, longitudinal, radial, root, complex, displaced, and bucket-handle tears.). ACL and PCL injuries were classified as partial or complete. Other findings such as injury to the ligaments (medial and lateral collateral, patellar), joint effusion/hemarthrosis, osteochondral injuries, tendinopathy, intraarticular loose bodies, soft tissue injuries etc. were also recorded.

Patients with positive findings underwent arthroscopy. The time interval from MRI to arthroscopy was up to 6 weeks. The findings of both the MRI and Arthroscopy were then correlated, and results were analyzed.

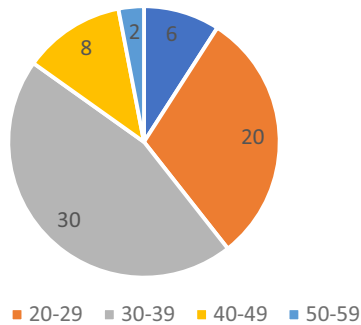
**Statistical Analysis:** The results were analysed keeping arthroscopy as the gold standard. Statistical analysis was done to find out sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the MRI findings.

MRI and arthroscopic findings were recorded in tabulated form and grouped in 4 categories:

1. True positive- MRI findings confirmed on arthroscopy
2. True negative: MRI was negative for the lesion and arthroscopy confirmed it.
3. False positive: Lesion seen on MRI but absent on arthroscopy
4. False negative: Lesion absent on MRI but seen on arthroscopy.

**RESULTS:**

In the present study of 66 patients with knee trauma, there were 64 (96%) males and 2 (4%) females. Age distribution of patients was in 16-52 years age bracket [Figure-1]. Maximum patients were in 20-29 (20%) and 30-39 (30%) years of age.

**Fig 1: AGE DISTRIBUTION PATIENTS****TOTAL: 66****FIGURE 1**

**ACL TEAR:** Of the 66 patients, 52 (84%) patients had complete/partial ACL tears, as detected on MRI, and confirmed on arthroscopy (true positives). In 02 cases tear was reported as partial on MRI and was found to be complete on Arthroscopy. Whereas in 2 cases tears were reported as complete on MRI and detected to be partial on Arthroscopy. 10 patients had normal ACL on both MRI and arthroscopy (true negatives). Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI was 96%, 83%, 96%, 83% and 94 % respectively.

**PCL TEAR:** 04(6%) patients had PCL tears of which 2 had partial tears and 2 had complete tears on both MRI and arthroscopy (true positives). There were no false negative or positive cases. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 100%.

**MEDIAL MENISCUS TEAR:** 32(48%) patients had medial meniscus tear on both MRI and arthroscopy (true positives). 4(6%) patients had tears detected on arthroscopy but were negative on MRI (false negative). No false positive cases were detected. 30 patients had normal meniscus on both MRI and arthroscopy (true negatives). Sensitivity, specificity, positive predictive value, negative predictive value and accuracy was 89%, 100 %,100 %,88 % and 94 % respectively. Most tears were involving the posterior horn and body. 04 cases had bucket handle tears, 02 involving posterior horn and body and 02 anterior horn and body respectively. 06 cases had radial tears, 10 had complex tears, 2 had vertical tears and 2 were involving the meniscal root. False negative cases showed fraying on arthroscopy and radial tears involving anterior horn.

**LATERAL MENISCUS TEAR:**12 (18%) patients had lateral meniscus tear on both MRI and arthroscopy (true positives). 2 (3%) patients were found positive on MRI but negative on arthroscopy (false negatives). Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy was 100%, 96 %,86 %,100 % and 97 % respectively [Table 4]. 4 cases had radial tears, 4 had complex tears, 2 had vertical and 2 had meniscal root tear, respectively.

14 (21%) patients were found to have osteochondral changes on arthroscopy whereas only 4 of these were positive on MRI. Two had chondromalacia patella on MRI. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy was 29%,100%,100%, 81% and 70% respectively.

Three patients had MCL tears detected on MRI. Two patients had loose bodies as detected on arthroscopy and negative on MRI. 52 patients had synovial effusion of various degrees as seen on MRI.

#### **DISCUSSION:**

Knee joint is one of the largest and complex synovial joints of the body. It is a type of hinge joint with three distinct compartments<sup>1</sup>. It is one of the commonly injured joints in sports related trauma and road traffic accidents. MRI is the investigation of choice in such cases. It has the advantage of being non-invasive and helps to decide whether invasive diagnostic/ therapeutic arthroscopy is required or not.

Arthroscopy remains the gold standard for evaluation of knee joint. Several studies have been carried out in the past to correlate the accuracy and sensitivity of MRI with arthroscopy. To mention a few, Crues et al carried out their study on 277 patients in the year 1987 correlating the meniscal injuries on MRI with the surgical findings<sup>9</sup>. In this study 89% of grade I and grade II tears were negative at surgery whereas 91.3% of grade III tears were positive. Mandelbaum et al in a study of 83 knees reported that MRI was 90% accurate for detection of medial meniscal tears. Accuracy was 80% for lateral meniscal tears and 100% for anterior cruciate ligament (ACL) tears<sup>10</sup>. Study by J P Singh et al showed marked increase in the accuracy as well as sensitivity of MRI in picking up various types of injuries. Sensitivity, Specificity and Accuracy of MRI in detecting medial meniscus tears was 96.5 percent, 98.28 percent, 97.69 percent respectively; for lateral meniscus 87 percent, 99.29 percent, 97.11 percent respectively, for anterior cruciate ligament 98.72 percent, 98.94 percent, 98.84 percent and for posterior cruciate ligament 98.72 percent, 98.94 percent, 98.84 percent respectively. Injuries were mostly involving the posterior horn of medial meniscus (45 patients:79 percent), and mid-substance of anterior cruciate ligament (53 patients:68 percent)<sup>11</sup>.

The present study was carried out on a young active service population involved in regular physical and training activities and hence more prone to injuries. The youngest patient was 16 yrs. and the oldest was 52 yrs. old.

Grade I meniscal tear is seen as intrasubstance hyperintensity, Grade II is intrasubstance hyperintensity extending to the articular surface and Grade III tear is seen as the hyperintensity involving both the articular surfaces on T2WI and PDFS sequences. De Smet AA et al showed that if increased intrasubstance signal intensity is seen contacting the articular surface on two or more images, fulfilling the “two-slice-touch” rule, then the PPV for a tear is 94% in the MM and 96% in the LM<sup>12</sup>. In our study out of total 66 patients we found medial meniscus tears in 32 (48%) patients. 70% meniscal tears were seen in posterior horn. All 100 % of the meniscal tears were detected (specificity 100%), however the sensitivity was 89%. We also found that for complex tears involving the meniscal root, MRI has better sensitivity compared to arthroscopy. All displaced tears like bucket handle tear/flipped fragments (04 cases) were accurately diagnosed on MR imaging. Complex tears (10 cases) were also accurately diagnosed in our study.

Lateral meniscus tears were seen in 12 (18%) patients with equal distribution between anterior and posterior horn. We found high sensitivity, specificity, positive predictive value, negative predictive value, and accuracy being 100%, 96%, 86%,100% and 97% respectively. Patient with false negative findings had grade I/II tears on MRI and were not detected (false negative) on arthroscopy.

As seen in previous studies, increased intrasubstance signal intensity without extension to the articular surface (grade I and grade II tears) is often not labelled as a tear on arthroscopy. And some studies have shown that this finding does not progress to a tear<sup>12-13</sup>. Reporting grade I and 2 signal intensity changes as tear on MRI increases the rate of false positives when correlating with the arthroscopy findings. Irrespective of that MRI does have high specificity in detecting grade I and II tears as compared to arthroscopy.

For ACL tear we found sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 96%, 83%, 96%,83% and 94% respectively.

MRI was extremely sensitive in detecting tears, but specificity decreased slightly in differentiating partial vs complete tears. Partial ACL tears account for 10%–36% of surgically treated patients<sup>14</sup>. Studies have shown that MR imaging has diminished accuracy in the diagnosis of partial ACL tears in comparison with complete tears<sup>15-17</sup>. Partial tear on MR imaging is interpreted as increased intrasubstance signal, attenuation of fibres, distortion, or an abnormal orientation of the ACL<sup>17</sup>. Van Dyck et al in their study using the above criteria found up to 23% of partial tears could not be distinguished from a normal ligament and up to 23% of partial tears could not be distinguished from complete tears<sup>18</sup>. In the present study 02 cases which were labelled as partial tear on MRI, were found to be complete tear on arthroscopy and 02 cases reported as complete tear on MRI were detected to be partial tear on arthroscopy.

A cyclops lesion or a bell-hammer tear results when distal stump of a

torn ACL flips anteriorly. It has a higher incidence with partial tears with anteromedial bundle disruption<sup>19</sup>. We found one such case diagnosed as partial tear on MRI but found to be cyclops lesion on arthroscopy.

PCL tears were seen in only 04(6%) patients but were accurately detected in all the cases. PCL is well visualized due to its orientation and any abnormality is easier to detect as compared to ACL.

Osteochondral changes are better visualized on arthroscopy compared to MRI as per our results with low sensitivity and high specificity of 29 and 100% respectively. 14 (21%) patients were found to have osteochondral changes on arthroscopy whereas only 4(28%) of these were positive on MRI. Intraarticular findings like chondral fractures, loose bodies, degenerative changes, plicae etc. can mimic meniscal tears and cause false positive diagnosis on MRI<sup>20</sup>. These changes are better seen on arthroscopy.

#### Limitations of the study:

1. A larger sample size would have increased the statistical significance of the study.
2. Adoption of convenience sampling as per the available cases in a hospital set-up may be a limitation.

**Summary and conclusions:** Following conclusions can be drawn from the present study:

1. MRI being a noninvasive and safe modality is the investigation of choice in assessing acute knee trauma.
2. MRI provides high sensitivity and specificity for complete ACL and Grade III meniscus tears. PCL tears and meniscal root injuries are better visualized on MRI compared to arthroscopy.
3. Grade I and II meniscal injury/tear have a higher detection rate on MRI compared to arthroscopy.
4. Arthroscopy has higher sensitivity and specificity for detecting osteochondral changes and loose bodies and in characterizing the ACL tear as complete/partial as compared to MRI.
5. MRI has the added advantage of imaging extraarticular changes like bone contusions and MCL& LCL injuries which are inaccessible on arthroscopy.

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