

# Magnetic Resonance Imaging of the Knee Injuries and Its Correlation with Arthroscopy: A Prospective Study.

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## ABSTRACT

**Background:** Knee trauma may cause injury to menisci, cartilages, cruciate ligaments or bones. Immediately after injury joint effusion may also develop and it is very difficult to clinically judge the extent of damage caused to the knee. Plain radiography though can diagnose fractures it is not sensitive or reliable in detecting meniscal tears and ligament injuries. Magnetic resonance imaging of the knee joint has revolutionized the way we treat the knee injuries. MRI allows excellent soft-tissue details with multiplanar imaging capability that gives accurate evaluation of extra- and intra-articular structures of the knee not demonstrated with other imaging modalities. Advantages of MRI over other imaging modalities include lack of radiation, lack of beam hardening artefacts, excellent soft tissue contrast and multi planar imaging capabilities. MRI moreover is non invasive and do not require manipulation of knee as in arthrogram. Aims: (1) To study the occurrence of ligament and meniscal injuries following knee trauma. (2) To analyze type and grade of the ligament injuries with the help of appearances on MRI study. (3) To correlate the MRI findings with the arthroscopic findings in selected patients. (4) To study the limitations and pitfalls of MRI in detecting the ligament injuries of knee. **Methods:** This study was a prospective clinico-radiological study of 97 patients with knee injuries conducted at radiology department of a tertiary care medical college located in an urban area. The duration of the study was 18 months. Patients presenting with suspected internal derangement of knee following trauma were included in this study. MRI of knee was done in all cases. T1 & PD weighted sequences in sagittal and coronal planes, T2- weighted in axial, coronal and sagittal planes were done in all patients. Fat suppressed T2 or STIR sequences were done wherever indicated. Arthroscopy was done in selected cases. The findings of MRI and arthroscopy were correlated. **Results:** The study comprised of 97 patients with knee injury in whom ligament or meniscal injuries leading to internal derangement of knee were suspected. Out of 97 patients 60 (61.85%) were males and 37 (38.14) were females with a M: F ratio of 1: 0.61. In males most common affected age group was found to be 21-30 years (38.33%) while in females it was more than 40 years (35.13%) of age. Joint effusion was present in 57 (58.76%) patients. ACL tear was present 36 (37.11%) patients, in 10 patients the tear was partial while in remaining 26 patients the tear was complete. Complete and Partial PCL tear was present in 1 and 2 patients respectively. MCL tear was present in 25 cases (25.77%). MCL tear was grade I, II and III in 16, 4 and 5 patients. LCL tear was seen in 10 patients out of which 6 were Grade I followed by Grade II and Grade III in 2 patients each. Medial meniscus was injured in 58 patients (59.79%) and lateral meniscus was injured in 10 patients. Osseous and other injuries were present in 48 patients (49.48%). Arthroscopy was done in 23 (23.71) patients who had high grade injuries or in doubtful cases. Out of the cases in whom arthroscopy and MRI both were done MRI correlated with arthroscopic findings in 19 (82.60) and there was discrepancy between MRI and arthroscopic findings in 4 cases (17.40%). **Conclusions:** MRI is an excellent, noninvasive, radiation free imaging modality with multiplanar capabilities and excellent soft tissue delineation. It can accurately detect, localize and characterize various internal derangements of the knee joint and help in arriving at a correct anatomical diagnosis thereby guiding further management of the patient.

**Keywords:** Internal derangement of knee, arthroscopy, Magnetic resonance imaging, advantages and pitfalls.

## INTRODUCTION

Within a decade of its clinical introduction,

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Magnetic Resonance Imaging became the imaging test of choice for ligament pathologies in knee.<sup>[1]</sup> Early diagnosis and success of surgical inventions in ligament injuries helped promote MRI as the modality of choice for detection of ligament injuries and marrow abnormalities. Today use of MR Imaging of knee to accurately diagnose the site, extent and severity of ligament and meniscal injuries

is one of the most efficient uses of MRI technology.<sup>[2]</sup>

Advantages of MRI over other imaging modalities include lack of radiation, lack of beam hardening artifacts, excellent soft tissue contrast and multi planar imaging capabilities (thereby not requiring manipulation of knee as in arthrogram).<sup>[3]</sup> This boon in knee imaging has challenged radiologist to rapidly master the interpretation of MR examinations of the knee. Several excellent studies detail the normal anatomy as well as pathologies of knee. Despite the optimistic outlook, the rapid growth also threatens the credibility of MR imaging of knee, when diagnostic standards are not maintained at a high level. A more detailed knowledge of anatomy and pathology is required as more anatomic areas are now visible and more diseases accessible to diagnosis.<sup>[4]</sup> Many new pulsing sequences have significant advantages in terms of speed and spatial resolution but also new ambiguities in the understanding of tissue-contrast relationship and signal intensities. Because of these shortcomings, the accuracy of MRI in imaging of ligament tears has been challenged a number of times.<sup>[5]</sup>

Lack of quality control sometimes create an undesirable situation where an excellent technological tool like MRI is substituted for other less accurate (physical examination), largely operator-dependant and invasive (arthroscopy) procedures.<sup>[6]</sup>

One of the contentious issue facing arthroscopists is the discrepancy of MRI and arthroscopy findings. The important causes of this discrepancy include radiologists' experience and selection bias in studies.<sup>[7]</sup> In many studies comparing the sensitivity and specificity of MRI with arthroscopic findings it is presumed that arthroscopy is 100% accurate method of diagnosis though it's not case in all cases.<sup>[8]</sup> Arthroscopy itself is an operator dependant procedure and results definitely depends upon the arthroscopists skills.<sup>[9]</sup> Moreover the studies taking into account the findings of MRI and arthroscopy has a potential factor of selection bias as Selection criteria for arthroscopy have a major role in most retrospective studies and this may be responsible for interpretation of MRI results.<sup>[10]</sup> We conducted this study to know the incidence, types and grades of ligament and meniscal injuries following knee trauma and to analyze type and grade of the ligament injuries with the help of appearances on MRI study. One of the important aspects of our study was to correlate the MRI findings with the arthroscopic findings in selected patients.

#### Aims and objectives

1. To study the occurrence of ligament and meniscal injuries following knee trauma.
2. To analyze type and grade of the ligament injuries with the help of appearances on MRI study.

3. To correlate the MRI findings with the arthroscopic findings in selected patients.
4. To study the limitations and pitfalls of MRI in detecting the ligament injuries of knee.

### MATERIALS & METHODS

Study was conducted after obtaining permission from institutional ethical committee. This was a prospective clinic-radiological study of 97 patients with injuries to knee. 97 patients with history of trauma to the knee from an urban and nearby semi-urban areas who were referred to radiology department from private practitioners were studied.

#### Inclusion Criteria

All patients referred with clinically suspected internal derangement of knee following trauma to knee

#### Exclusion Criteria

- i) Patients with claustrophobia, ferromagnetic implants, pacemakers, and aneurysm clips in whom MRI was contraindicated.
- ii) Patients with major injuries like liver/splenic rupture and flail chest and patients with unstable vital parameters especially in the setting of trauma.
- iii) Patients who refused consent.

All patients were subjected to MR imaging which was done using Siemens Magnetom symphony Maestroclass 1.5 Tesla. Whole- body MR scanner. Arthroscopy was done in selected cases.

#### Imaging protocols

Patients were subjected to MRI after clinical evaluation by the referring orthopaedician to the following protocols:

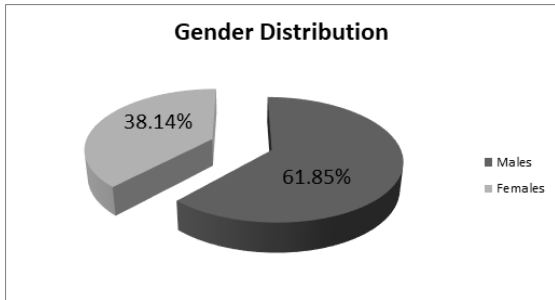
- a) T1 & PD weighted sequences in sagittal and coronal planes.
- b) T2- weighted in axial, coronal and sagittal planes.
- c) Fat suppressed T2 or STIR sequences wherever indicated.

The interpretation of MRI data was done in terms of presence or absence of joint effusion, presence or absence of any ligament (Anterior, posterior, medial or lateral or collateral ligament) injury, meniscal (medial or lateral) tear and osseous or osteochondral lesions. Arthroscopy was done by orthopedic surgeon expert in arthroscopy. It was done in selected cases where it was indicated for diagnostic or therapeutic purposes. Findings of MRI of the Knee were correlated with the arthroscopic findings in studied cases.

Data was tabulated and presented in graphical forms at appropriate places. The statistical analysis was done using computer assisted statistical software SPSS Package Version - 20. Statistical test used was Chi-square test for proportions. Probability was calculated at 0.05 level of critical significance.

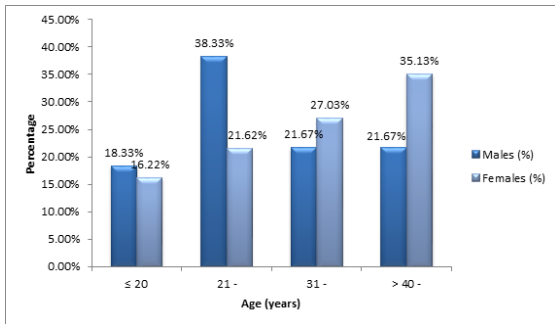
**RESULTS**

In this study total 97 patients were studied out of which 60 (61.85%) were males and 37 (38.14) were females with a M:F ratio of 1: 0.61.

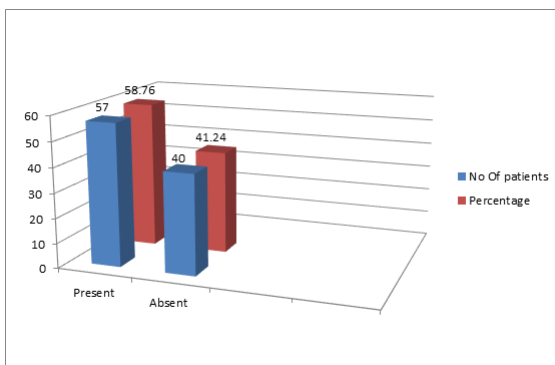


**Figure 1: Gender Distribution of the studied cases.**

Age distribution of the studied cases revealed that the most common age-group involved in knee injuries in males was 21-30 years (38.33%) while in females most common age group was more than 40 years.



**Figure 2: Age distribution of the studied cases.**



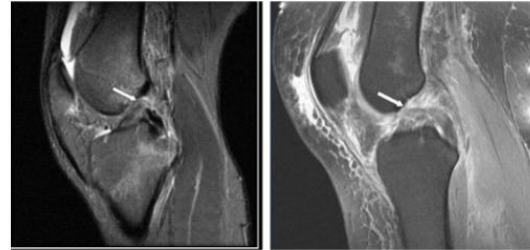
**Figure 3: Joint effusion on MRI in studied cases.**

The MRI showed ACL tear in 36 (37.11%) patients while ACL tear was absent in 61 (62.89%) patients. Out of 36 patients in whom ACL tear was present it was complete in 26 (72.22%) and incomplete in 10 (27.78%) patients.

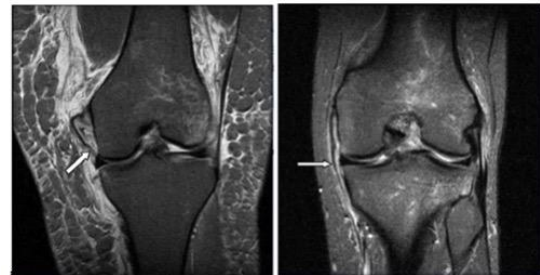
The analysis of MRI findings of the cases showed the presence of PCL tear in 3 (3.10%) patients while PCL tear was absent in 94 (96.90%) patients. Out of 3 patients in whom PCL tear was present it was complete in 1 (66.66%) and incomplete in 1 (33.33%) patients.

**Table 1: Distribution of the cases on the basis of ACL tear.**

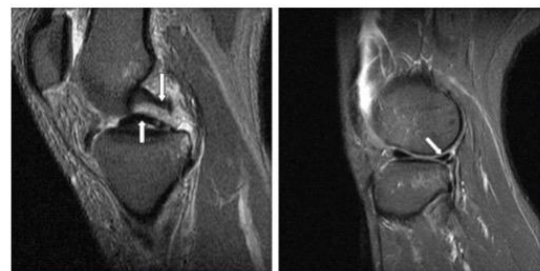
| ACL tear         | Number | Percentage |
|------------------|--------|------------|
| Yes              | 36     | 37.11      |
| No               | 61     | 62.89      |
| TOTAL            | 97     | 100.00     |
| Type of ACL tear | Number | Percentage |
| Partial          | 10     | 27.78      |
| Complete         | 26     | 72.22      |



**Figure 4: sagittal STIR image showing complete ACL tear in superior portion (Left). Sagittal proton density image showing complete ACL tear (Right)**



**Figure 5: Grade III MCL tear on coronal STIR image (Left). Grade I MCL tear on coronal STIR image (Right)**



**Figure 6: STIR SAG image showing Bucket-Handle tear of Medial Meniscus with Double PCL sign (Left). Grade III tear of lateral meniscus on sagittal STIR image (Right)**

**Table 2: Distribution of the cases on the basis of PCL tear.**

| PCL tear         | Number | Percentage |
|------------------|--------|------------|
| Yes              | 3      | 3.10       |
| No               | 94     | 96.90      |
| TOTAL            | 97     | 100.00     |
| Type of PCL tear | Number | Percentage |
| Partial          | 2      | 66.67      |
| Complete         | 1      | 33.33      |

MCL tear was present in 25 (25.77%) patients while it was absent in 72 (74.23%) patients. Out of 25 patients in whom MCL was present it was Grade I, Grade II and Grade III in 16 (64%), 4 (16%) and 5 (20%) patients respectively.

**Table 3: Distribution of the cases on the basis of MCL tear.**

| MCL tear         | Number | Percentage |
|------------------|--------|------------|
| Yes              | 25     | 25.77      |
| No               | 72     | 74.23      |
| TOTAL            | 97     | 100.00     |
| Type of MCL tear | Number | Percentage |
| Grade I          | 16     | 64.00      |
| Grade II         | 4      | 16.00      |
| Grade III        | 5      | 20.00      |

LCL tear was present in 10 (10.30%) patients while it was absent in 87 (89.70%) patients. Out of 25 patients in whom LCL was present it was Grade I in 6 (60%). While Grade II and Grade III tear were present in 2 (20%) patients each.

**Table 4: Distribution of the cases on the basis of LCL tear.**

| LCL tear         | Number | Percentage |
|------------------|--------|------------|
| Yes              | 10     | 10.30      |
| No               | 87     | 89.70      |
| Total            | 97     | 100.00     |
| Type of LCL tear | Number | Percentage |
| Grade I          | 6      | 60.00      |
| Grade II         | 2      | 20.00      |
| Grade III        | 2      | 20.00      |

Medial meniscus injury was seen in 58 (59.79%) out of 97 studied cases. Out of the cases in whom medial meniscus tear was present 10 patients (17.24%) had grade I tear while grade II and Grade III tear was found in 18(31.03%) and 30 (51.73%) patients respectively.

**Table 5: Distribution of the cases on the basis of Medial Meniscus tear.**

| MM tear         | Number | Percentage |
|-----------------|--------|------------|
| Yes             | 58     | 59.79      |
| No              | 39     | 40.21      |
| Total           | 97     | 100.00     |
| Type of MM tear | Number | Percentage |
| Grade I         | 10     | 17.24      |
| Grade II        | 18     | 31.03      |
| Grade III       | 30     | 51.73      |

Lateral meniscus injury was seen in 10 (10.30%) out of 97 studied cases. Out of the cases in whom lateral meniscus tear was present 2 patients (20.00%) had grade I tear while grade II and Grade III tear was found in 4 (40.00%) patients each.

**Table 6: Distribution of the cases on the basis of Lateral Meniscus tear.**

| LM tear | Number | Percentage |
|---------|--------|------------|
| Yes     | 10     | 10.30      |
| No      | 87     | 89.70      |
| Total   | 97     | 100.00     |

| Type of LM tear | Number | Percentage |
|-----------------|--------|------------|
| Grade I         | 2      | 20.00      |
| Grade II        | 4      | 40.00      |
| Grade III       | 4      | 40.00      |

In addition to ligament and meniscal injuries osseous and other injuries were present in 48 (49.48%) patients. In remaining patients there was no evidence of osseous or associated injuries.

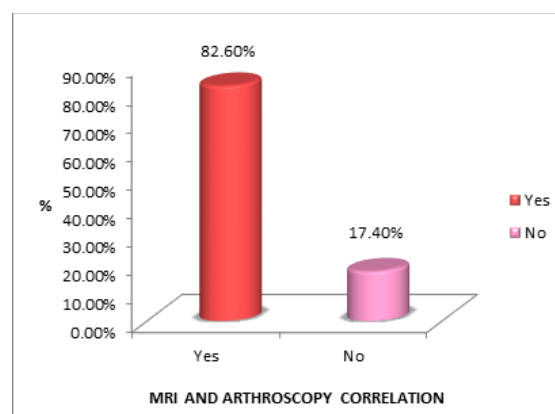
**Table 7: Osseous or other Injuries in the studied cases.**

| Osseous or other injuries | Number | Percentage |
|---------------------------|--------|------------|
| Yes                       | 48     | 49.48      |
| No                        | 49     | 50.52      |
| TOTAL                     | 97     | 100.00     |

Arthroscopy was done in 23 (23.71 %) patients. The finding of MRI and arthroscopy were correlated at the end of the study and it was found that out of 23 patients MRI and arthroscopy findings correlated well in 19 (82.60%) cases while there was discrepancy in MRI and arthroscopic findings in 4 (17.40%) cases.

**Table 8: Arthroscopy done in the studied cases.**

| Arthroscopy done | Number | Percentage |
|------------------|--------|------------|
| Yes              | 23     | 23.71      |
| No               | 74     | 76.29      |
| TOTAL            | 97     | 100.00     |



**Figure 7: MRI and arthroscopic correlation in studied cases.**

## DISCUSSION

The role of magnetic resonance imaging has steadily increased and now it has become the first line investigation for most of the lesions of knee. It is also being used for pre and post operative evaluation.<sup>[11]</sup> Complete evaluation of all the internal structures of the knee was not possible with other modalities like conventional radiography, arthrography, ultrasonography and computed tomography. Even with arthroscopy, lesions such as peripheral meniscal tears, inferior surface tears and osteochondritis dessicans without articular cartilage damage are most often not detected. Multiplanar MR

images provide significant improvement in assessing these structures.<sup>[12]</sup>

In our study joint effusions were the most common finding affecting 57 patients (58.76%). Among the ligamentous and meniscal injuries, Medial Meniscal injuries were seen in 58 patients (59.79%) followed by the ACL injuries which were seen in 36 patients (37.11%) patients.

Singh JP et al in their series of 173 patient found that 78 patients (45.08%) showed ACL tears, among these 52 (66.67%) had partial tear followed by 16(20.51%) patients who showed complete tear and 10 (12.82%) cases showed non visualization of ACL. The authors concluded that ACL tears are more common than other ligamentous injuries with partial tears being commoner.<sup>[13]</sup>

However in our study ACL tear was found in 36 patients (37.11%) among these 10 (27.78%) were partial tears and 26 (72.22%) were complete. Mucoïd degeneration of ACL was present in 7 patients. Four cases with positive findings on MRI were found negative on arthroscopy. These were partial tears of ACL. From this we could infer that subtle injuries picked up by MRI as signal change may be missed by arthroscopy.

Smith et al and Umans et al have proved that when discordant appearance of ACL was seen, they appeared normal on arthroscopy. There are several reasons for this appearance on routine MRI sequences as like mucoïd or eosinophilic degeneration with partial or volume averaging of ACL with lateral femoral condyle or periligamentous fat and sub optimal selection of sagittal imaging plane to view the ACL continuity. In these cases secondary signs were useful like PCL buckling, uncovering of posterior horn of lateral meniscus and bony contusions.<sup>[14,15]</sup>

Posterior cruciate ligament injuries were found to be relatively uncommon, in our study found in only 3 patients (3.10%) of which 2 cases (66.67 %) were partial tears and one case of complete tear was found. Sonin et al found the incidence of PCL tear to be 3 percent; in series of study analyzing 350 case of knee injury only 10 patients had PCL tear.<sup>[16]</sup>

In a study by Grover et al where they analyzed findings of 510 consecutive MRI of knee joints with an emphasis on PCL tear; 11 (2%) patients had different grades of tear on MRI which was confirmed correctly by arthroscopy. Of the other 202 patients who had undergone MRI as well as arthroscopy for internal derangement of knee none of the patients had any PCL injury as predicted correctly by MRI.<sup>[17]</sup>

In our study, MCL tears were found in 25 patients (25.77%) and injuries involving MCL were more common than the LCL tears which were found in 10 patients (10.30%). All these cases had history of trauma and were associated with multiple injuries. This suggests presence of a single injury should prompt the examiner to look for other subtle

associated injuries, which was further confirmed by Mink JH et al.<sup>[18]</sup> They observed on MRI and arthroscopy of 11 patients who had tear of ACL, 7 patients had tear of MCL, 4 patients had tear of lateral meniscus and 1 patient had tear of medial meniscus. In our study grade I tear (64 %) of MCL were more common and followed by grade III tear (20 %).

There is preponderance of MM tears over LM tears in our study which is well correlated with the study done by Singh JP et al , in a series of 173 cases of MM was seen in 57(32.95%) patients, Grade 2 in 16(9.25%) patients & Grade 1 in 20(11.56%). In LM, Grade 3 tears were seen in 28(16.18%) patients, Grade 2 in 12 (6.94%) patients & Grade I in 14(8.1%) patients. which they found 57 (38.23%) patients showed MM tear and 28 (29.41%) patients showed LM tear.<sup>[19]</sup>

In our study, MM tears were found in 58 (59.79%) with Grade I tear in 10 patients (17.24%), Grade II tear in 18 patients (31.03%) and Grade 3 in 30 patients (51.73%) and LM tear in 10 (10.30%) with Grade I tear in 2 patients (20 %) Grade 2 and 3 tears in 4 patients each (40 %). Grade III tears were the more common in Medial meniscus. Grade II and III both are common in LM. One case of coronary ligament tear was noted.

The cystic lesions encountered were meniscal cyst, parameniscal cyst and popliteal cyst (Baker's cyst). Baker's cyst was found in 6 patients, parameniscal cysts were found in 5 patients and synovial cyst was present in 1 patient. These findings were correlated with findings described by Thomas H. Berquist [20]. In our study Osseous/Osteochondral and other lesions were seen in 48 patients (49.48%). Most of these were bony contusions involving the femoral and tibial condyles. Osteochondral lesions are seen in six patients. In our study, we found one case of fracture of tibia, fibula and femur. These findings were correlated with findings described by Thomas H. Berquist.<sup>[20]</sup>

In our study, a correlation of MRI findings with arthroscopic / surgical findings was performed in 23 patients (23.71 %). Among which in 19 patients (80.41%) MRI findings are well correlated with arthroscopic findings.

The present study revealed the ability of magnetic resonance imaging in evaluation of the various internal derangements, including their detection, localization, characterization and assessment of extent of damage and the strength of correlation between MRI and arthroscopic findings confirms the value of MRI in assessing internal knee structures.

## CONCLUSION

Multiplanar MRI imaging is a valuable diagnostic tool for evaluation of knee joint following trauma. It can reliably diagnose presence and severity of ligamentous and meniscal injuries and should be done

in all patients of trauma with suspicion of ligamentous or meniscal injuries.

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