

Role of MRI in Evaluation of Knee Lesions

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Abstract

Background and Aim: MRI is currently the imaging modality of choice for nearly all clinical indications concerning the knee. The acutely injured knee is readily imaged for the detection of meniscal and ligamentous injury. In the evaluation of chronic knee pain, MRI can obviate the need for multiple imaging procedures simultaneously evaluating the structures of the knee, marrow space, synovium and periarticular soft tissues concerning the knee. Present study was done with an aim to describe the MRI feature in various types of traumatic and non traumatic lesions of knee joint.

Material and Methods: The study population included 70 patients who underwent MR imaging of the knee when they presented with knee joint complaints (pain or swelling) in Tertiary Hospital from December 2014 to December 2016. MR imaging was performed with a MRI Scanner 1.5 TESLA (SIEMENS –MAGNETOM AVANTO TIM + DOT MRI SYSTEM) Once a patient satisfied the inclusion criteria for this study, he or she was administered the study proforma. MR findings were correlated with clinical and arthroscopic findings wherever possible.

Results: Of the 70 patients evaluated with MRI of the knee, 26 patients (37%) had 32 meniscal tears. Of the 32 meniscal tears, 21 (66 %) involved the medial meniscus alone, 4 (12%) involved the lateral meniscus and 7 (22%) involved the medial as well as lateral meniscus. Ligament tears were seen in 38 patients on evaluation of MR images of knee out of 70 patients included in the study. Of the 38 patients with ligament tears, 31 patients (81.57%) had ACL tears, 2 patients (5.2%) had PCL tears, 14 patients (36.84%) had medial collateral ligament tears and 9 patients (22.68%) had lateral collateral ligament tears.

Conclusion: MRI is the examination of choice in the evaluation of internal joint structures of the knee like menisci, cruciate ligaments and articular cartilage. The diagnostic accuracy of MRI, although variable for different individual structures, is good enough, especially when using the concept of composite knee injury, to appropriately identify patients who require arthroscopic therapy.

Key Words: Arthroscopy, Articular cartilage, MRI, knee injury.

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Introduction

Normal knee joint function is essential for day to day life and in many popular sports. The number of patients with knee joint complaints is quite significant. The information obtained from conventional imaging techniques like x-rays, sonography and CT scan of the knee is limited.

MRI has revolutionized diagnostic imaging of the knee. This innovative technology allows superior soft tissue details with multiplanar imaging capability that provides accurate evaluation of the intra- and extra-articular structures of the knee not demonstrated with other imaging modalities. [1,2]

The developments and advancements in MRI and the introduction of high resolution coils have provided a non-invasive, non-operator dependent, cost effective means to diagnose knee pathology. MRI is well tolerated by patients, widely accepted by evaluating physicians and assists in distinguishing pathologic knee conditions that may have similar clinical signs and symptoms.

MRI of the Knee Evaluates [3]

Bones: A knee MRI will include parts of the lower femur, upper tibia, upper fibula and the patella. The knee MRI can detect bone bruises, fractures, cysts, tumors, infection and dislocations.

Cartilage: Knee MRIs are very good at looking at the cartilage of knee. MRI can detect cartilage fraying, fissuring, and defects.

Tendons and Ligaments: Knee has a complex set of tendons and ligaments that an MRI can evaluate. In addition to the ACL, it can look for injury to the PCL (posterior cruciate ligament), medial and lateral collateral ligaments, the quadriceps and patellar tendons, popliteus tendon, among others. Any of these tendons and ligaments can be injured and the injury may only be seen on MRI.

Meniscus: Each knee has two menisci (medial and lateral). MRI is quite good at looking for injury to these structures. Meniscus injuries include partial or complete tears and meniscal degeneration.

Soft Tissues: This refers to the muscles and tissues around knee. A knee MRI scan will show parts of the thigh muscles and muscles of the upper calf area

Today, Magnetic Resonance Imaging (MRI) is available to save knees from unnecessary arthroscopy; internal derangements can then be treated by arthroscopic surgery. [4]

MRI should be done before arthroscopy of knee in all cases in which the clinical diagnosis is Internal Derangement of Knee (IDK). The overall accuracy of this study is better than the other similar study.

Magnetic resonance imaging (MRI) is a well -accepted imaging modality in the diagnostic workup of patients with knee complaints and has largely replaced diagnostic arthroscopy for this purpose.² MRI is currently the imaging modality of choice for nearly all clinical indications concerning the knee. The acutely injured knee is readily imaged for the detection of meniscal and ligamentous injury. In the evaluation of chronic knee pain, MRI can obviate the need for multiple imaging procedures simultaneously evaluating the structures of the knee, marrow space, synovium and periarticular soft tissues concerning the knee. [5-8]

Aims and Objectives

1. To describe the MRI feature in various types of traumatic and non traumatic lesions of knee joint
2. To identify the common lesions seen in the knee joint.
3. To analyze the types of knee joint abnormalities detected by MRI which will aid in making proper diagnosis

4. Evaluate the age and sex wise distribution of various knee lesions.

Material and Methods

The study population included 70 patients who underwent MR imaging of the knee when they presented with knee joint complaints (pain or swelling) in Tertiary Hospital from December 2014 to December 2016.

The MRI was done on advice of the referring doctor and no patient was made to undergo MRI KNEE for the sole purpose of this study.

Inclusion criteria:

- Patients presenting with knee joint complaints and giving consent for the study.
- Patients able to cooperate for the examination e.g. ability to lie immobile for the period of the examination.

Exclusion criteria

- 1) Patients with cardiac pacemakers.
- 2) Patients with metallic implants in the body, foreign body in the eye.
- 3) Patients with claustrophobia.

MR imaging was performed with a MRI Scanner 1.5 TESLA (SIEMENS – MAGNETOM AVANTO TIM + DOT MRI SYSTEM) Once a patient satisfied the inclusion criteria for this study, he or she was administered the study proforma. The patients were briefed about the procedure. The noise due to gradient coils and the need to restrict body movements during the scan time was explained to the patient.

Patient was placed in supine position and feet first in MR imager, with knee to be imaged in approximately 15-20-degree external rotation to aid the imaging of anterior cruciate ligament in the sagittal plane. Knee was also flexed 5-10 degrees for assessing patellofemoral compartment. Knee to be imaged was centred with the 160 mm field of view, including in the image both the suprapatellar bursa and insertion of patellar ligament on the tibial tubercle. Localizer was taken in axial, sagittal and coronal planes after making proper positioning of the patient.

The MRI protocol consisted of the following sequences: PULSE SEQUENCES AND IMAGING PLANES

Table 1: MRI sequences

| Image Plane | Slice Thickness | Fov (Cm) | Matrix | Acquisitions | Image Time |
|---|-----------------|----------|-----------|--------------|------------|
| Coronal PD | 4mm/skip 0.5mm | 14 | 512 x 256 | 1 | 4 min |
| Sagittal T2WI FSE | 3mm/skip 0.5mm | 16 | 256x244 | 1 | 2min 40s |
| Sagittal PD FSE | 4mm/skip 0.5mm | 14 | 512 x 256 | 1 | 2min 46s |
| Fat suppressed FSE T2WI (axial, coronal sagittal) | 3mm/skip 0.5mm | 14 | 512 x 256 | 1 | 3min 58s |
| STIR FSE coronal | 3mm/skip 0.5mm | 14 | 256 x 192 | 1 | 4min 58s |
| STIR coronal | 3mm/skip 0.5mm | 16 | 266x192 | 1 | 2min 40s |
| Axial PD | 6mm/skip 1.0mm | 18 | 256x224 | 1 | 3min 40s |

Various Knee injuries studied were: meniscal tears, Vertical tears, Radial tears/parrot beak tears. Ligaments were assessed in the following manner: ACL was considered to be intact if it was visualized as a continuous linear band with low signal intensity that demonstrated normal orientation on proton density or T2-weighted images. ACL tear was classified as acute if the MR examination was performed within 6 weeks of injury. Chronic ACL tear was considered if MR

examination was performed more than 6 months after injury. The ligament was also considered chronically torn if it appeared as a continuous band with low signal intensity that bridged the expected origin and insertion of the ACL but demonstrated significant focal angulations. PCL tears were evaluated and graded. MCL tears were graded as by Kaplan [9] LCL tears were also measured. Chondromalacia patellae: Classified according to the work done by Mc cauley [10]

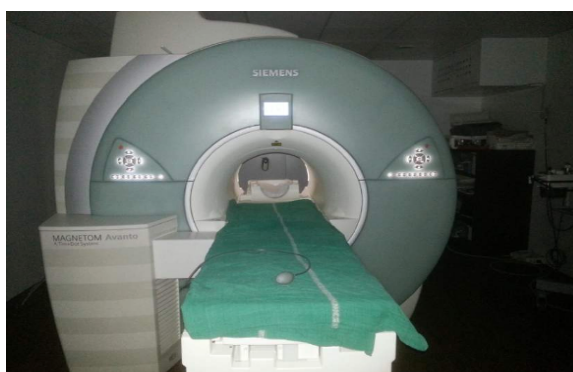


Figure 1: MRI Scanner

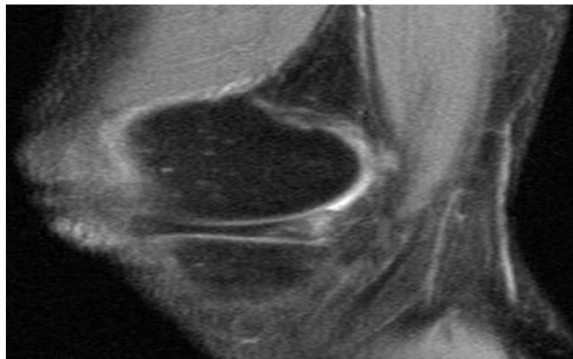


Figure 2: PDFS sagittal Image of Grade I Meniscal Degeneration



Figure 4A

**Figure 4B**

Fig. 4: Sagittal T2 WI(A) and PDFS(B) images showing bulky ACL with hyperintense signal and loss of Continuity. There is inflammation with irregularity of Hoffa's fat pad suggestive of acute ACL tear.

Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2007) and then exported to data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). For all tests, confidence level and level of significance were set at 95% and 5% respectively.

Results

The mean age was 34 years and the maximum number of patients affected belongs to the age group of 21 to 40 year. There were 55 males and 15 females in the patients included in the study. Males comprised 79% of the group while the females comprised 21%.

Table 1: Sex distribution

| Sex | No. of Patients | Percentage (%) |
|--------|-----------------|----------------|
| Male | 51 | 73% |
| Female | 19 | 27% |
| Total | 70 | 100% |

Of the 70 patients evaluated with MRI of the knee, 26 patients (37%) had 32 meniscal tears. Of the 32 meniscal tears, 21 (66 %) involved the medial meniscus alone, 4 (12%) involved the lateral meniscus and 7 (22%) involved the medial as well as lateral meniscus. Of the 32 meniscal tears detected on evaluation with MRI of the knee, 29 tears (91%) of the involved the posterior horns, 2 tears (6%)

involved the anterior horns while 1(3%) involved both the anterior and posterior horns.

Of the 28 medial meniscal tears, 25 tears could be graded. 6 were grade 1 tears, 2 were grade 2 tears, 10 were grade 3a tears, 5 was grade 3b tears and 2 were grade 4 tears. All of the tears in the medial meniscus involved the posterior horn

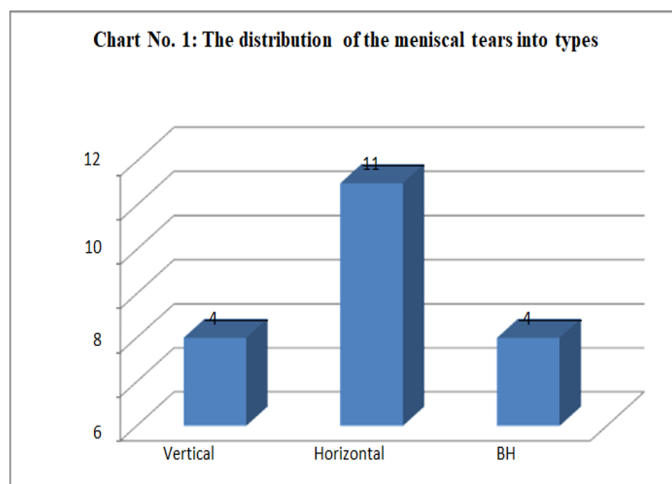
Table 2: Grades of lateral meniscal tears

| Lateral Meniscus | Grade 1 tear | Grade 2 tear | Grade 3a tear | Grade 3b tear | Grade 4 tear |
|------------------|--------------|--------------|---------------|---------------|--------------|
| Anterior horn | 1 | 1 | 1 | 0 | 0 |
| Posterior horn | 1 | 3 | 1 | 1 | 1 |

Of the 11 patients with lateral meniscal tear, 10 tears could be graded as above:

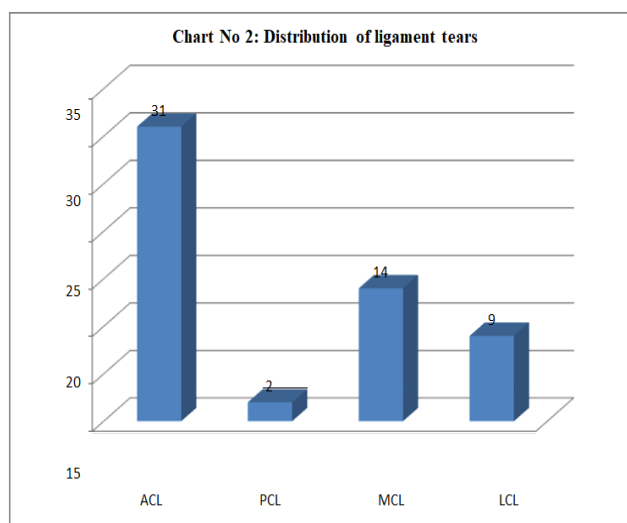
Types of meniscal tears:

Of the 32 meniscal tears, 18 tears could be classified into types with 4 having vertical tears, 11 having horizontal tears and 4 having bucket - handle tears which has been represented in the bar graph below.



Among the 4 patients with bucket handle tears, 3 (75%) had tears involving the medial meniscus and 1 (25%) had tears involving the lateral meniscus. Ligament tears were seen in 38 patients on evaluation of MR images of knee out of 70 patients included in the study. (Chart no 2) Of the 38 patients with ligament tears, 31 patients (81.57%) had ACL tears, 2 patients (5.2%)

had PCL tears, 14 patients (36.84%) had medial collateral ligament tears and 9 patients (22.68%) had lateral collateral ligament tears. Ligament tears were found in 38 patients. Ligament tears were not found in 32 patients. Statistically proportion of ligaments of tears observed is not significant ($z = 0.08$, $p > 0.05$)



Of the 31 patients with ACL tear, 23 patients had acute complete tear, 5 patients had acute partial tear, 3 patients had chronic tears of ACL. Of the 38 patients with ligament tears, 14 patients had medial

collateral ligament (MCL) tears. Of these 14 patients, 6 patients (43%) had Grade 1 tear, 7 patients (50%) had grade 1 tear and 21 patients (7%) had grade 3 tears.

Table 3: Distribution of Knee Pathologies

| Sr. No | Knee Pathologies (Lesions) | No. Of Patients (n= 70) | Percentage |
|--------|------------------------------------|-------------------------|------------|
| 1. | Anterior Cruciate Ligament Tears | 31 | 44.28% |
| 2. | Posterior Cruciate Ligament Tears | 02 | 2.8% |
| 3. | Medial Meniscal Tears | 28 | 40% |
| 4. | Lateral Meniscal Tears | 11 | 15.71% |
| 5. | Medial Collateral Ligament Tears | 14 | 20% |
| 6. | Lateral Collateral Ligament Tears | 09 | 12.85% |
| 7. | Chondromalacia Patellae | 06 | 8.57% |
| 8. | Patellar Subluxations/Dislocations | 01 | 1.42% |
| 9. | Patellar Tendon Tear | 01 | 1.42% |
| 10. | Osteoarthritis | 07 | 10% |
| 11. | Popliteal Cysts | 07 | 10% |
| 12. | Osteomyelitis | 02 | 2.85% |
| 13. | Neoplastic Lesion | 02 | 2.85% |

Discussion

The wide spectrum of indications for MR imaging of the knee include: traumatic causes of knee pain (meniscal tears, ligament tears, overuse injuries); chronic causes of knee pain (osteochondritis dissecans, osteonecrosis, chondromalacia patellae, synovial/meniscal/popliteal cysts, intraarticular soft tissue tumours); degenerative changes (arthritis, synovial hypertrophy) and others.

This study included 70 patients who had history of knee complaints (pain and swelling) and underwent MRI of the knee joint. The study included MRI of the knee joint of which 39 were left knee and 31 were right knee.

The study population consisted patients in the age group of 7-75 years with a mean of 34 years. Maximum number of patients who underwent MRI of the knee belonged to the age group of 21-40 years. Similar results have been shown by Clayton et al [7] La Prade et al [8] and Incesu et al [11] with mean age varying from 24 - 36 years.

In this study 37% patients evaluated with MRI of the knee joint had meniscal tears. Of these, 71% had medial meniscal tears

only, 10% had lateral meniscal tears only and 11% had medial as well as lateral meniscal tears. Crues et al [12] in their study of meniscal tears and correlation with arthroscopy in 142 patients found meniscal tears in 66% involving the medial meniscus and 33% involving the lateral meniscus.

Of the 32 meniscal tears noted in 70 patients, 29 tears involved (91%) the posterior horn and 2 involved (6%) the anterior horn and 1 tear (3%) involved both the anterior and posterior horns. Weiss et al [13] also reported meniscal tears involving the posterior horn accounting for 50%-60% and tears involving the anterior horn accounting for 5%-20%.

Of the 28 meniscal tears involving the medial meniscus, 6 tears were classified as grade 1, 2 tears as grade 2, 10 tears as grade 3a, 5 tear as grade 3b and 2 tears as grade 4. A study done by Ismael Silva et al¹⁴ also showed that maximum number of tears involving the medial meniscus were of grade 3.

The number of patients with bucket handle tears were 4 of which 3 (75%) involved the medial meniscus and 1 (25%) involved the lateral meniscus. Wright et al. [15] In their study of 46 patients with bucket handle tear

found that the medial meniscus (72%) is involved more than the lateral meniscus (15%).

Posterior cruciate ligament tear was seen in 2 patients with 1 patient having complete tear and 1 patient having partial tear. The incidence of PCL tear in the study group of 70 patients was 5%. The PCL being a stronger ligament therefore has low incidence of tears. [14]

Of the 31 patients of 70 who had anterior cruciate ligament tears, 23 patients (74%) had acute tear (complete), 5 (16%) had acute tear (partial) and 3 (10%) had chronic tears. The bone fractures associated with ACL tear were lateral femoral condyle in one patient, tibial condyles in 1 patient. Only 1 patient had associated Second fracture. Robertson et al [16] in their study of multiple signs of anterior cruciate ligament on MR imaging in 103 patients found that the most accurate and reliable sign of an ACL tear was discontinuity of the ACL in the sagittal and axial planes. Posterolateral tibia bruise associated with ACL tear had 53% sensitivity, 97% specificity and 79% accuracy.

Medial collateral ligament tear was seen in 14 of 70 patients. Of the 14 patients, 6 (43%) had grade 1 tear, 7 (50%) had grade 2 tear and 1 (7%) had grade 3 tears. The associations of bone bruise with medial collateral ligament tears were assessed to identify those bruises that were possibly unique to MCL injury. Bone bruises were quite common (64%) and, were usually seen in the tibia (8 of 9 patients with bone bruises). Typically these bruises were located laterally (6 of 9 patients with bone bruises) and 4 of 9 patients involved the medial tibial condyle. Femoral bruises were less common (5 of 9 patients). The femoral bruises in these 5 patients included involvement of the lateral condyle more than the medial condyle. Mark E. Schweitzer et al [17] evaluated multiple signs, prevalence and location of associated

bone bruises associated with MCL tears on MR imaging.

Lateral collateral ligament tears were seen in 9 patients with 5 tears belonging to grade 1, 3 tears belonging to grade 2 and 1 tear belonging to grade 3. O'Donoghue's triad (anterior cruciate ligament with medial meniscal and medial collateral ligament tear) was seen in 3 patients. Of 130 patients included in this study, chondromalacia patellae were found to be the cause of knee pain in 6 patients which included 2 females and 4 males. Of these 10 patients with chondromalacia patellae, grade 1 was seen in 2 patients, grade 2 in 2 patients, grade 3 in 1 patient and grade 4 in 1 patient. Study by Philip et al showed that maximum patients with chondromalacia patellae had early disease (stage 1 and stage 2).

Meniscal cyst was seen in 3 patients and all of them involved the lateral meniscus. Of these 2 was associated with horizontal tears of the meniscus and 2 had no associated meniscal tears. Burk et al [18] in their study of meniscal cysts also found that these cysts are associated with horizontal tears of the meniscus.

On evaluation of 70 knee MR images features of neoplastic lesion were found in 2 patients. Sessile osteochondroma was seen in 1 patient. Giant cell tumour was seen in 1 patient. Features of osteomyelitis were seen in 2 patients with evidence of synovial thickening, articular destruction with a possibility of Koch's in 1 patient.

Features of arthritis were seen in 7 patients of the total 70 patients included in the study. Osteoarthritis was seen in 10 patients and degenerative arthritis was seen in 2 patients. Most common cause of hyaline cartilage damage is osteoarthritis either primary or secondary. It occurs mostly in patients over 35 years. [19] Of the 70 knee MR images evaluated for knee pain, 2 patients had synovial lesions with 1 patient with synovial hypertrophy and 1 patient

with synovial osteochondromatosis. [20] The MR images demonstrated intraarticular signal that was typical of hyaline cartilage (isointense or slightly hyperintense to that of muscle on T1-weighted images and hyperintense on T2 weighted images. This appearance is in accordance to study by Crotty et al.[19]

Conclusion

MRI is the examination of choice in the evaluation of internal joint structures of the knee like menisci, cruciate ligaments and articular cartilage. The diagnostic accuracy of MRI, although variable for different individual structures, is good enough, especially when using the concept of composite knee injury, to appropriately identify patients who require arthroscopic therapy. MRI of the knee joint has effectively replaced arthrography and computed tomography as the imaging modality of choice in the evaluation of both acute and chronic disorders of the knee joint. Despite its cost, MR imaging has been readily accepted by both patients and referring clinicians.

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