

A Prospective Study of Role of Magnetic Resonance Imaging in Evaluation of Painful Knee Joint

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Abstract : The objective of this study is to describe the MRI features in various traumatic and non traumatic lesions causing painful knee joint.

Materials and methods: 140 consecutive patients with painful knee joint were selected for the study from October 2012 to April 2014.

Clinical examinations, MRI knee (within 4 days of referral) & in selected cases arthroscopy was performed and the findings were compared.

Results: Out of 140 patients MR images were normal in 4 patients. It was positive for meniscal tears in patients with maximal involvement of the medial meniscus and the posterior horn. These tears were classified into grades with maximum number of tears belonging to grade 3. In ligament tears more number of tears were seen in ACL. Secondary signs associated with ligament tears were also assessed. Other chronic causes of painful knee joint were minimal.

Conclusion: MRI is an accurate, non-invasive technique for examination of the soft tissues and osseous structures of the knee. It has great capability in diagnosing meniscal tears and classifying them into grades and types which would avoid unnecessary arthroscopic examination. It is a very good modality to diagnose complete tears of the ACL and in diagnosing meniscal tears which are difficult to be seen on arthroscopy.

Keywords - knee joint, ligaments, menisci

I. Introduction

Normal knee joint function is essential for day to day life and in many popular sports. The number of patients with complaints of painful knee joint is quite significant and therefore magnetic resonance imaging (MRI) of the knee is of great value to understand and diagnose the varied pathologies causing painful knee joint. 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.

Arthroscopy of the knee is an invasive procedure with associated risks and leading to discomfort for the patient. Injuries to the intra-articular structures like menisci and cruciate ligaments are diagnosed with high sensitivity and specificity by MRI as compared with arthroscopy, which is still regarded as the reference standard.

In the past 15 years, MRI of the knee has become available as an alternative to diagnostic arthroscopy. MRI has proven to be accurate for the diagnosis of intra- and periarticular pathology, especially for meniscal pathology and ligamentous injuries. It is good enough, especially when using the concept of composite injury, to appropriately identify patients, who require arthroscopic therapy. In playing this role MRI has diagnostic and therapeutic impact. MRI when used in all patients with high clinical suspicion of intra-articular knee pathology, instead of direct arthroscopy can avoid 35% of arthroscopies.

II. Aims And Objectives

1. To describe the MRI features in various types of traumatic and non traumatic lesions causing painful 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 a proper diagnosis.

III. Materials And Methods

140 cases with history of painful knee joint, who were referred to radiology department from orthopaedic department of NMCH & RC, Raichur, suspecting internal derangement of knee, served as the subjects for this study.

This prospective study design evaluates various causes of painful knee joint as diagnosed with the MRI scan of the knee done on these patients from a period of October 2012 to April 2014

Inclusion criteria: All cases of knee pain where MRI was used as a modality in diagnosing the cause

Exclusion criteria:

- Patients referred from other hospitals for the sole purpose of getting an MRI scan done due to its non availability there.
- Patients who had no history of knee pain but underwent MRI of the knee
- Post operative cases

Data Acquisition

Once a patient satisfied the inclusion criteria for this study, he or she was briefed about the procedure. The noise due to gradient coils (heard once the patient was inside the bore of the magnet) and the need to restrict body movements during the scan time was explained to the patient.

All the MRI scans of the knee in this study were performed using Hitachi Airis 0.3 Tesla whole body MRI scanner

The MRI protocol consisted of the following sequences:

1. T1 & PD weighted sequences in sagittal and coronal planes.
2. T2- weighted in axial, coronal and sagittal planes.

Fat suppressed T2 or STIR sequences wherever indicated.

Findings of meniscal tears were classified into:

- 1) **Area of involvement** (anterior horn or posterior horn) as by Stoller, Crues et al¹

Grades of tears which were classified as below

- a) **Grade 1:** Meniscal tear is globular and does not communicate with the articular surface.
- b) **Grade 2:** Meniscal tear is linear in nature and remains within the substance of the meniscus not communicating with the articular surface.
- c) **Grade 3:** Tear has increased signal intensity within the meniscus that extends to the articular surface
Grade 3a is a linear intrameniscal signal that abuts the articular margin
Grade 3b is a more irregular area of signal intensity that abuts the articular margin
- d) **Grade 4** tears are menisci which are distorted in addition to the changes in grade 3

- 2) **Types of tear**²

- a) **Vertical tears** are usually traumatic compared with **horizontal** cleavage tears that are more often degenerative
- b) **Radial tears/ parrot beak tears** are seen as areas of increased signal intensity in the margin of menisci
- c) **Bucket handle tear** is a complete vertical tear oriented in the axial plane with displacement of one or two
Meniscal tear is linear in nature and remains within the substance of the meniscus not communicating with the articular surface

The incidences of MRI features of bucket handle tears were assessed as below:³

Double posterior cruciate ligament sign was defined as a band of low signal intensity seen anterior to the PCL on a sagittal image and paralleling its course.

Flipped meniscus sign was considered to be present if a well defined meniscus shape was seen immediately posterior to the anterior horn with a shortened posterior horn.

Fragment in notch was defined as a band like area of low signal intensity within the notch but not appearing on the same slice as PCL.

The involvement of medial meniscus and lateral meniscus with bucket handle tears were also assessed.

Ligaments were assessed in the following manner:

ACL was considered to be intact⁴ if it was visualized as a continuous linear band with low signal intensity that demonstrated normal orientation on proton density or T2- weighted images .ACLs with slight undulations, focal or diffuse thickening or amorphous appearance were also considered intact.

ACL tear was classified⁴ as acute if the MR examination was performed within 6 weeks of injury. Acute ACL tear was suggested if the ligament was diffusely disrupted and if soft tissue edema was present. Edema was defined as a region of low to medium signal intensity on proton density images that showed mild hyperintensity on T2 weighted images and fat suppressed images. The primary features of complete acute tears are:-

1. Discontinuity with increased signal intensity between segments or at the femoral or tibial attachments.
2. Flat or horizontal distal tibial segment with high signal intensity near the femoral attachment.
3. Complete absence of the ligament with effusion and high signal intensity in the mid-joint space.
4. Wavy ligament

Acute incomplete tears of ACL⁴ showed increased signal intensity (T2WI) with thickening and a normal course.

Chronic ACL tear⁴ was considered if MR examination was performed more than 6 months after injury. A chronic ACL tear was suggested if the ligament was focally or diffusely disrupted without evidence of significant edema. 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.

Secondary signs of associated bone bruises, fractures and second fractures were assessed⁵.

Association of bone contusion, bone injury and second fracture with ACL tears was assessed.

Second fracture was defined as avulsion fracture involving the proximal lateral tibia, immediately distal to the lateral plateau.⁶

PCL tears were evaluated and graded as below:

Complete tears of PCL was considered when there was failure to identify the PCL, inability to define ligamentous fibres with amorphous areas of high signal intensity on T1- and T2- weighted MR images in the region of PCL, or depiction of PCL fibres with a focal discrete disruption of all visible fibres⁷.

Partial tear or intrasubstance injury refers to PCLs that do not meet these criteria but demonstrated abnormal signal intensity within their substance or that have some intact and some discontinuous fibres.⁷

MCL tears were graded as by Kaplan⁸:

Grade 1: A sprain shows increased signal intensity in the soft tissues medial to the medial collateral ligament

Grade 2: A severe sprain or partial tear, shows high signal in the soft tissues medial to the medial collateral ligament, but also shows a high signal or partial disruption of the medial collateral ligament itself.

Grade 3 - or complete tear, shows disruption of the medial collateral ligament.

LCL tears were classified as:

Grade 1: A sprain shows increased signal intensity in the soft tissues medial to the medial collateral ligament

Grade 2: Severe sprain or partial tear, shows high signal in the soft tissues medial to the medial collateral ligament, but also shows a high signal or partial disruption of the medial collateral ligament itself.

Grade 3 or complete tear: Shows disruption of the lateral collateral ligament.

Chondromalacia patellae: Classified according to the work done by Mc cauley⁹.

Stage 1: Normal contour ± signal intensity changes

Stage 2: focal areas of swelling with signal intensity changes on T1 and T2 weighted sequences

Stage 3: irregularity and focal thinning with fluid extending into cartilage

Stage 4: focal bone exposure

Neoplasms: MR images of the knee joint were evaluated and findings suggestive of neoplasms were recorded.

Arthropathies – were classified as those due to osteoarthritis or degenerative changes. A possible diagnosis of rheumatoid arthritis changes of the knee was given after correlating it with clinical history and laboratory parameters

Cystic lesions of the knee were classified as :

Popliteal cysts were seen as low signal intensity on T1 and high signal intensity collection on T2- weighted images in the gastrocnemiosemimembranosus bursa through a weak portion of the poster medial capsule of the knee between the medial head of gastrocnemius muscle and the semimembranosus muscle. Its association with arthritis was also assessed.

Ganglion cysts were seen on MR images as septated fluid collection adjacent to a cruciate ligament. These are not associated with connection to a meniscal tear

Meniscal cysts were seen on MR images as well defined rounded cysts seen as low signal intensity on T1- and high signal intensity on T2-weighted images and are located adjacent to a meniscal tear.

Synovial lesions

Synovial thickening which was considered when seen as an area of intermediate signal intensity on T1- weighted images whereas effusion is lower in signal intensity.

IV. Results

In this study group which comprised of a total number of 140 patients, the age at presentation with knee pain ranged from 14 to 65 years with males and females comprising 63% and 37%, respectively.

Meniscal Tears:

Types of meniscal tears: Of the 84(60%) meniscal tears, could be classified into types with 42(50%) having vertical tears, 26(31%) having horizontal tears and 8(9.52%) having bucket - handle tears.

Injury	Total
Meniscal injury	84(60%)
Cruciate ligament injury	38(27%)
Collateral ligament injury	34(24%)

	Grade 1	Grade 2	Grade 3	Total
Medial meniscal injury	6(10%)	24(40%)	30(50%)	60(71%)
Lateral meniscal injury	2(9%)	8(33%)	14(58%)	24(28%)
Anterior cruciate ligament injury	4(12%)	4(12%)	26(76%)	34(89%)
Posterior cruciate ligament injury	0	2(50%)	2(50%)	4(10%)
Medial collateral ligament	4(15%)	10(35%)	14(50%)	28(82%)
Lateral collateral ligament	1(16%)	2(33%)	3(50%)	6(17%)
Chondromalacia patella	2(33%)	4(66%)	0	6

Percentage for grading is given from total no. of specific entity e.g(6/60×100=10%)

		Total
Bone Fracture		
1. Tibia	10	16
2. Femur	04	
3. Fibula head and Patella	02	
Cysts of knee		
1. Bakers cyst	06	18
2. Parameniscal	04	
3. Ganglion Cyst	08	
Arthritis		
1. Medial compartment	12	22
2. Lateral compartment	04	
3. Both compartment	06	
Synovium	10	10
Neoplastic lesion		
1. Giant cell Tumor	03	06
2. Synovial Sarcoma	02	
3. ?chondrosarcoma	01	

Arthroscopic Correlation

Out of 140 patients, follow up with arthroscopy could be done in only 54 patients. In 54 patients total number of tears on MRI were 80 out of which 34 were ACL tears, 26 were medial meniscus tears and 20 were lateral meniscus tears. From the 34 ACL tears on MRI, only 28 tears were confirmed on arthroscopy. Most of the tears correlating on arthroscopy were complete ACL tears.

On MRI medial meniscal tear was seen in 26 patients out of whom only 20 patients correlated on arthroscopy. Most of the patients showing a tear on arthroscopy had grade III tear. Similarly in lateral meniscal tears out of 20 patients only 16 patients correlated on arthroscopy. Out of 80 tears only 64 correlated on arthroscopy.

V. Discussion

The current study included **140 patients** who had history of knee pain and underwent MRI of the knee joint. The study included MRI of the knee joint of which 30 were left knee and 40 were right knee.

In this study 51% patients evaluated with MRI of the knee for evaluating painful knee joint had meniscal tears. Of these, maximum number of patients had medial meniscal tears only. Crues et al¹⁰ 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. In our study, majority of the meniscal tears involved the posterior horn, followed by anterior horn and the body of menisci. Crues et al¹⁰ in their study also reported meniscal tears involving the posterior horns which accounted for 57% compared to the 16% involving the anterior horn.

The current study reported maximum no of lateral meniscal tears to be Grade III, which is similar to the study done by Silva et al¹¹ who in their study of 44 patients with meniscal tears graded them, with the maximum number of tears belonging to Grade III and minimum number of tears belonging to Grade I. Similarly in case of medial meniscus the maximum number of tears were of Grade III which is in concordance with the study done by Silva et al¹¹.

In 8 patients with bucket handle tears, half had involvement of the medial meniscus and the other half involving the lateral meniscus. Whereas Wright et al¹² in their study of 39 patients with bucket handle tear found that the medial meniscus (82%) was involved more than the lateral meniscus (18%). The current study is not in concordance with the study by Wright et al¹² probably due to lesser sample size. Amongst the MRI features of bucket handle tears, "The displaced fragment" was seen in 75% bucket handle tears. The other signs noted were - "Double posterior cruciate ligament sign" involving the medial meniscus (50%), "flipped fragment sign" 25% of tears involving the lateral meniscus, and "fragment in notch" sign was in 50% tears involving the medial meniscus and 25% involving the lateral meniscus. Wright et al¹² In their study found that the "displaced fragment sign" was seen in 84% of the menisci, the double posterior cruciate ligament sign was seen in 53% of the medial and none of the lateral bucket-handle tears; the flipped fragment sign was noted in 44% of medial and 29% of lateral menisci and a fragment was noted in the intercondylar notch in 66% of medial and 43% of lateral menisci. 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 this study was 2%. Sonin et al¹³ found the incidence of PCL tear to be 3%; in a series of study analyzing 350 case of knee injury only 10 patients had PCL tear.

Bone bruise was found in 24 patients, with predominant involvement of the femur. In this study lateral femoral condyle was more frequently involved than the medial femoral condyle. It is in concordance with the study done by Yoon KH et al¹⁴ out of 86 patients with arthroscopically proven ACL tears, prevalence of bone contusions was 68%, 73%, 24% and 26% in the lateral femoral condyle, lateral aspect of tibia, medial femoral condyle and medial aspect of the tibial plateau respectively.

Chondromalacia patellae was a cause of knee pain in 6 patients, majority of which were males and had early disease (Grade I & II). Kelly EA¹⁵ in his study also states that chondromalacia affects men more than females. The most common types of knee joint cysts reported in the study were baker's cyst and meniscal cysts. Baker's cysts were found to be associated with ACL and medial meniscal tears, which is as per the study done by Fielding et al¹⁶. The origin and pattern of meniscal cysts was similar to the study done by Burk et al¹⁷, which showed that these cysts are associated with horizontal tears of the meniscus and that most of the meniscal cysts arise from the posterior horn.

In 16% patients showing features of osteoarthritis on MRI, medial tibiofemoral compartment was predominantly involved in most of the patients. Joshi et al¹⁸ in their study of 128 patients also reported similar involvement. It is usually explained by the fact that the medial compartment bears weight and stress of the body.

Out of 140 patients arthroscopic follow up could be obtained in only 54 patients. Out of these 54 patients ACL tear was detected on MRI in 34 patients which correlated on arthroscopy in only 28 patients. Most of the patients correlating on arthroscopy had complete tear of ACL. In case of medial meniscus only 20 out of 26 meniscal tears detected on MRI correlated on arthroscopy as most of them were grade III tears. In lateral meniscal tears 16 patients out of 20 correlated on arthroscopy. It was difficult to evaluate posterior horn radial tears, grade I and II tears on arthroscopy. According to Ruth Crawford et al¹⁹ Grade 1 and 2 signals are focal or linear areas of high signal confined to the substance of the meniscus with intact outer contour lines: these are not visible at arthroscopy and MRI is highly accurate in diagnosing meniscal and anterior cruciate ligament (ACL) tears. It is the most appropriate screening tool before therapeutic arthroscopy. It is preferable to diagnostic arthroscopy in most patients because it avoids the surgical risks of arthroscopy.

VI. 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 causing painful knee. Despite its cost, MR imaging has been readily accepted by both patients and referring clinicians.

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