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MRI EVALUATION OF PAINFUL KNEE: A STUDY AT KATURI TERTIARY REFERRAL CENTER

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ABSTRACT: INTRODUCTION: Normal knee joint functional activity is essential for day to day life. 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 in understanding and to diagnose the varied pathologies causing painful knee joint. The information obtained from conventional radiographs of the knee is limited, and by CT scans is limited to bone pathogly with limited information about ligaments and synovium. **AIMS AND OBJECTIVES:** a) To describe the MRI features in various types of traumatic and non-traumatic knee pain. b) To identify the common lesions seen in the knee joint. **METHODOLOGY:** The study population included 100 patients who underwent MR imaging of the knee who presented with knee pain to the DEPARTMENT OF RADIOLOGY, KATURI MEDICALCOLLEGE referred by the clinician. **STUDY PERIOD:** Nov 2010 to Oct 2012. **STUDY DESIGN:** Descriptive study. All the MRI scans of the knee in this study were performed using GE Signa Profile EXCITE MR machine with a 0.2 tesla field strength magnet in a closely coupled extremity coil. **RESULTS AND DISCUSSION:** The pathology of knee joint is broadly classified as traumatic and non-traumatic. Traumatic pathology mainly included the ligament injuries and non-traumatic included arthritis, cysts and neoplastic lesions.
KEYWORDS: MRI, knee, joint, meniscus, ACL, PCL, MCLLCL.

INTRODUCTION: Normal knee joint functional activity is essential for day to day life. 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 in understanding and to diagnose the varied pathologies causing painful knee joint. The information obtained from conventional radiographs of the knee is limited, and by CT scans is limited to bone pathogly with limited information about ligaments and synovium.[1,2]

MRI allows superior soft tissue detail with multiplanar imaging capability that provides accurate evaluation of the intra- and extra-articular structures of the knee not demonstrated with any other imaging modalities currently available. 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.[1,2]

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 gold reference standard. MRI is currently the imaging modality of choice for nearly all

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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.[3]

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b) To identify the common lesions seen in the knee joint.

METHODOLOGY: The study population included 100 patients who underwent MR imaging of the knee who presented with knee pain to the DEPARTMENT OF RADIOLOGY, KATURI MEDICALCOLLEGE referred by the clinician.

STUDY PERIOD: Nov 2010 to Oct 2012.

STUDY DESIGN: Descriptive, incidence study.

INCLUSION AND EXCLUSION CRITERIA: The inclusion and exclusion criteria for this study are as mentioned below:

INCLUSION CRITERIA: All cases of knee pain where MRI was used as a modality in diagnosing the cause.

EXCLUSION CRITERIA:
- 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 the patients were 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 GE Signa Profile EXCITE MR machine with a 0.2 tesla field strength magnet in a closely coupled extremity coil.

The MRI protocol consisted of the following sequences:

Image Plane	Slice Acquisitions Thickness	Fov	Matrix	Acquisitions	Image
Sagittal T2WI FSE	4mm/Skip 1.0mm	18	288x160	1	5min 17s
Sagittal PD FSE	4mm/Skip 1.0mm	18	256x192	1	6min 20s
Fat suppressed FSE T2WI (axial, coronal sagittal)	4mm/Skip 1.0mm	20	192x160	1	5min 12s

STIR FSE coronal	4mm/Skip 1.0mm	14	192x160	1	5min 12s
STIR coronal	4mm/Skip 0.5mm	20	192x160	1	5min 12s
Axial PD	6mm/Skip 1.0mm	18	256x224	1	3min 40s
Table 1: PULSE SEQUENCES AND IMAGING PLANES					

Grades of tears meniscal which were classified as below[4,5]:
  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 surfacearea.
     a) Grade 3a is a linear intrameniscal signal that abuts the aticular margin.
     b) 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.

SIGNS OF ACL TEARS[6,7]:
PRIMARY SIGNS:
  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.

Secondary signs of associated bone bruises, fractures and segond fractures were assessed.

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

Segond fracture was defined as avulsion fracture involving the proximal lateral tibia, immediately distal to the lateral plateau

MCL TEARS WERE GRADED AS BY KAPLAN[8,9]:
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.[10]

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

Grade 2A: 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 cauley. [11]
- **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.

PCL TEARS WERE EVALUATED AND GRADED AS BELOW[10]:
- 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 fibres.
- Partial tear or intra substance 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.

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.

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SYNOVIAL LESIONS: were assessed for: 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.

RESULTS:

SEX	NUMBER OF PATIENTS
MALE	79
FEMALE	21
TOTAL	**100**
TABLE 1: SEX DISTRIBUTION OF THE PATIENTS STUDIED:	

AGE GROUP (YEARS)	NUMBER	PERCENTAGE
0-10	0	0%
11-20	12	12%
21-30	19	19%
31-40	21	21%
41-50	20	20%
51-60	14	14%
61-70	12	12%
71-80	02	02%
Table 2: AGE DISTRIBUTION: The age wise distribution of cases were as follows		

MENISCAL TEARS:

MENISCUS INVOLVED	NUMBER	PERCENTAGE
MEDIAL ONLY	32	54%
LATERAL MENISCUS ONLY	12	20%
BOTH MEDIAL AND LATERAL	16	26%
TABLE 3: MENISCUS INVOLVED		

HORN INVOLVED	NUMBER	PERCENTAGE
POSTERIOR HORN ONLY	45	75%
ANTERIOR HORN ONLY	11	18%
BOTH	04	07%
TABLE 4: MENISCUS HORN INVOLVED		

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Of the 48 medial meniscal tears, 30 tears could be graded. 8 were grade 1 tears, 9 were grade 11 tears, 11 grade 3 and 2 were grade 4 tears. All of the tears in the medial meniscus involved the posterior horn.

GRADE	NUMBER
GRADE 1	08
GRADE2	09
GRADE3	11
GRADE4	02
TABLE 5: GRADING OF MEDIAL MENISCAL TEARS	

LATERAL MENISCUS	GRADE 1	GRADE 2	GRADE 3A	GRADE 3B	GRADE 4
ANTERIOR HORN	1	1	1	1	0
POSTERIOR HORN	1	5	2	2	1
TABLE 6: GRADING OF LATERAL MENISCAL TEARS					

TYPES OF MENISCAL TEARS	NUMBER
VERTICAL TEAR	06
HORIZONTAL TEAR	17
BUCKET HANDLE TEAR	03
TABLE 7: TYPES OF MENISCAL TEARS	

LIGAMENT TEARS: Ligament tears were seen in 45 patients on evaluation of MR images of knee out of 100 patients included in the study. Of the 45 patients with ligament tears, 32 patients (80.1 %) had ACL tears, 10 patients (5.7 %) had PCL tears, 18 patients (35.5 %) had medial collateral ligament tears and 10 patients (22.8 %) had lateral collateral ligament tears.

LIGAMEN INVOLVED	NUMBER
ANTERIOR CRUCIATE LIGAMENT	32
POSTERIOR CRUCIATE LIGAMENT	10
MEDIAL COLLATERAL LIGAMENT	18
LATERAL COLLATERAL LIGAMENT	10
TABLE 8: LIGAMENTS INVOLVED	

TYPE OF ACL TEAR	NUMBER
ACUTE COMPLETE TEAR	20
ACUTE PARTIAL TEAR	08
CHRONIC TEARS	04
TABLE 9: ACL TEARS:	

GRADE OF MCL TEAR	NUMBER	PERCENTAGE
GRADE 1	10	56%
GRADE 2	06	33%
GRADE 3	02	11%
TABLE 10: MCL TEARS:		

DISCUSSION: Disease processes and injuries that disrupt ligaments, menisci, articular cartilage and other structures of the knee cause painful knee that cause significant morbidity and disability. Imaging of knee therefore present a special challenge because of its complex structure. A variety of imaging modalities are currently used to evaluate knee abnormalities. These modalities include standard radiography, scintigraphy, computed tomography (CT), planar tomography and arthrography.[1,2]

MR imaging has revolutionized knee imaging. There are many reports in literature comparing magnetic resonance imaging with arthroscopic findings. These studies have helped validate the role of MR imaging in the clinical arena; especially for the evaluation of meniscal and ligamentous injuries. Also MR imaging plays a valuable role in the evaluation of a variety of acute and chronic knee disorders causing painful knee joint.[3] There are many advantages of MR imaging over other modalities.

The wide spectrum of indications for MR imaging of the knee include: traumatic causes of knee pain(meniscal tears, ligament tears,); chronic causes[3] of knee pain (osteochondritis dissecans, osteonecrosis, chondromalacia patellae, synovial/meniscal/popliteal cysts, intraarticular soft tissue tumours); degenerative changes(arthritis, synovial hypertrophy) and others(infections, synovial chondromatosis, pigmented villonodular synovitis, loose bodies).

The study population consisted patients in the age group of 12-87 years with a mean of 37.2 years. Maximum number of patients who underwent MRI of the knee for painful knee belonged to the age group of 31-40 years. This study also showed a male preponderance for knee pain, accounting for 79% of the case load.

Of 100 patients MRI of the knee was normal in 6 patients. Of the 100 patients evaluated with MRI of the knee for evaluating painful knee joint, 40patients (40%) had 60 meniscal tears. Of the 60 meniscal tears, 32 (54 %) involved the medial meniscus alone, 12 (20%) involved the lateral meniscus and 16 (26 %)involved the medial as well as lateral meniscus.

Of the 60 meniscal tears, 30 tears could be classified into types with 6 vertical tears, 17 were horizontal tears and 7 were of the bucket handle type of tear. All the 6 vertical tears had history of associated trauma. Berquist[12] states that most of the vertical tears have a traumatic cause.

Of the 32 patients of 100 who had anterior cruciate ligament tears, 20 patients (63%) had acute tear (complete), 8 (25%)had acute tear(partial) and 4 (12%)had chronic tears. An ACL tear was considered acute if the MR examination was performed within 6 weeks of injury and chronic if MR examination was performed more than 6 weeks after injury as by Vahey et al.[6] Vahey et al in his study of 81 patients with ACL tear correlated with arthroscopy findings had a sensitivity of 100 % specificity of 93% and an accuracy 96% for the diagnosis of acute complete tear and a

sensitivity of 87%, specificity of 93% and an accuracy of 90% with a diagnosis of chronic ACL tear.

Medial collateral ligament tear was seen in 18 of 100 patients. Of the 18 patients, 10(55%) had grade 1 tear, 6 (34%)had grade 2 tear and 2 (11%) had grade 3 tears.

Posterior cruciate ligament tear was seen in 10 patients with 4 patient having complete tear and 6 patient having partial tear. The incidence of PCL tear in the study group of 100 patients was 10%. The PCL being a stronger ligament therefore has low incidence of tears.

Lateral collateral ligament tears were seen in 16 patients with 8 tears belonging to grade 1, 6 tears belonging to grade 2 and 2 tears belonging to grade 3.

Of 100 patients included in this study, chondromalacia patellae was found to be the cause of knee pain in 6 patients which included 2 females and 4 males. Of these 6 patients with chondromalacia patellae, grade 1 was seen in 3 patients, grade 2 in 1 patients, grade 3 in 1 patients and grade 4 in 1 patients. Berquist[11] states that chondromalacia affects men more than females. Chondromalacia patellae was diagnosed based on the criteria of focal signal or focal contour abnormality on either T2- weighted or proton density- weighted images as per McCauley et al.[11]

Cysts of the knee - Of 100 patients, 20 patients had cystic lesions of the knee on evaluation of their knee MR images which was causing them knee pain. Of these 20 patients, 7 patients had popliteal cyst of which 1 was a ruptured popliteal cyst. The prevalence of popliteal cyst in this study is 7%. Fielding et al[7] in his study of Baker's cyst on MR imaging of knee and its prevalence found it to be 5%.

Meniscal cyst was seen in 13 patients and all them involved the lateral meniscus. Of these 7 was associated with horizontal tears of the meniscus and 6 had no associated meniscal tears. Burk et al[13] in their study of meniscal cysts also found that these cysts are associated with horizontal tears of the meniscus.

Neoplastic lesion - On evaluation of 100 knee MR images features of neoplastic lesion was found in 3 patients. Sessile osteochondroma was seen in 1 patient. Giant cell tumour was seen in 1 patient and a chondromatous lesion(chondroblastoma) was seen in 1 patient.
Features of osteomyelitis was seen in 3 patients with evidence of synovial thickening, articular destruction.

Arthritis - Features of arthritis was seen in 13 patients of the total 100 patients included in the study. Osteoarthritis was seen in 10 patients and degenerative arthritis was seen in 3 patients. Most common cause of hyaline cartilage damage is osteoarthritis either primary or secondary. It occurs mostly in patients over 35 years. In this study, all patients with osteoarthritis were over 35 years.

Of the 100 knee MR images evaluated for knee pain, 3 patients had synovial lesions with 2 patients with synovial hypertrophy and 1 patient with synovial osteochondromatosis. 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.[14]

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CONCLUSION: Magnetic resonance imaging is an accurate, non-invasive technique for examination of the soft tissue and osseous structures of the knee. Studies have shown that it is cost effective when used to evaluate patients with knee pain. In the setting of traumatic knee injuries, MR imaging is the best non-invasive modality for the diagnosis of meniscal and ligament tears.

This study also demonstrates a valuable role of MR imaging in the examination of a wide spectrum of chronic knee abnormalities unassociated with acute trauma. MR imaging depicts the anatomy of the knee joint without need for intravenous contrast agents or joint manipulation.

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