

# Role of Magnetic Resonance Imaging (MRI) in Evaluation of Knee Joint Lesions

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## ABSTRACT

**Introduction:** Disease processes and injuries that disrupt ligaments, menisci, articular cartilage and other structures of the knee cause painful knee resulting in significant morbidity and disability. MRI provides excellent soft tissue contrast and multiplanar images when compared to other musculoskeletal imaging modalities. Aim: To identify common lesions seen in the knee joint and describe the MRI features in various types of traumatic and non-traumatic lesions causing knee pain.

**Material and methods:** This study was undertaken from December 2020 to December 2021 in the Department of Radiodiagnosis, AMCMET Medical college, L.G hospital, maninagar, ahmedabad. The study population consisted of 121 patients who underwent MRI of knee.

**Result:** The study population consisted of 121 outpatients presented with knee joint pain, swelling or trauma comprising of 73(60.3%) males and 48 (39.7%) females. Their ages ranged between 6 to 70 years; the peak age was 21 to 30 years. Joint pain without swelling was the commonest presenting clinical complaint. Anterior cruciate ligament tear was in 37 patients (30%), posterior cruciate ligament tear in 6(4.8%), collaterals ligament injury in 6(5%), medial meniscal lesions in 55 patients (45%), lateral meniscal lesions in 16 (13%), joint effusion in 99 (82%), bone marrow edema 34(30%), osteoarthritis 14(11.5%), Baker cyst were diagnosed in 4 (3%).

**Conclusion:** MRI in Evaluation of Knee joint is of vital importance, as MRI can demonstrate the exact nature and extent of soft tissue as well as bony abnormality.

**Keywords:** MRI of Knee, Meniscal Tears, Cruciate and Collaterals Ligament's Injury.

## INTRODUCTION

Knee pain accounts for more than one million emergency department and 1.9 million primary care outpatient visits annually.<sup>1</sup> High prevalence of knee joint pain was reported by various authors.<sup>2,3</sup>

In 2003, patients made about 19.4 million visits to the doctor because of knee problems.<sup>4</sup> Menisci are commonly injured in knee trauma especially in road traffic accidents and amongst young males in the sports field.<sup>5</sup>

Knee injuries can be acute or chronic in nature. A direct blow or twisting of the knee accounts for most acute injuries. Chronic problems arise from overuse of the joint and often involve the surrounding ligaments or tendons. These problems are likely when pain develops gradually or discomfort is recurrent over a period of time. Chronic problems are often triggered by prior injuries, especially if original injury was not allowed to heal completely.

Osteoarthritis is the most prevalent medically treated arthritic condition worldwide (for example, 3532 per 100 000 people in the United States).<sup>6,7</sup>

Diagnosis of osteoarthritis is made on the basis of clinical examination or radiography. Population based longitudinal studies in the US<sup>8</sup> and the United Kingdom<sup>9</sup> showed the lifetime risk of knee osteoarthritis increases with age and with the risk highest in obese people.<sup>8,9</sup> Radiography can show osteophytes, bony outgrowths at the joint margin, and narrowing of the joint space, but it cannot visualize soft tissue pathology.<sup>10</sup>

In contrast, MRI can visualize various tissues that are clinically relevant and have an important role in regard to structural progression not seen on radiography. MRI can also show incidental findings in otherwise asymptomatic people.<sup>11</sup>

In the knee, MRI visualizes most components of the joint, including articular cartilage, menisci, intra-articular ligaments, intraarticular bony structure abnormalities, which are not detectable by radiography.<sup>12</sup> We used MRI to evaluate the presence of soft tissue and bony abnormality in painful knee joints so as to improve the clinical outcome.

## Aims and Objectives

1. To identify the various ligament and meniscal injuries.
2. To describe the MRI features of the ligament and meniscal injuries.
3. To identify common lesions seen in the knee joint and describe the MRI features in various types of traumatic and non-traumatic lesions causing knee joint.

## MATERIAL AND METHODS

**Source of Data:** Patients who undergo MR imaging of the knee on the advice of the referring doctor on his suspicion of Internal derangement of the knee at the department of Radio Diagnosis, AMC MET Medical college, L.G hospital, maninagar, ahmedabad.

## Method of data collection

**Duration of study:** From December 2020 to December

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2021.

Sample size: 121 patients.

**Study type:** prospective Study

#### Inclusion Criteria

- Patients who undergo MR imaging of the knee on the advice of the referring clinician/doctor.

#### Exclusion Criteria

- Patients with cardiac pacemakers and metallic implants were not subjected to MRI.
- Post operative cases.
- Motion disorder and claustrophobia, if severe may make the examination difficult.

#### Methods

- All patients will be subjected to MR imaging

#### Imaging protocols

- Patients will be subjected to MRI Equipment: Siemens Magnetom Avanto 1.5 Tesla 18 Channel Whole body MR scanner
- Protocol:
  - i. T1 & PDFS weighted sequences in sagittal and coronal planes.
  - ii. T2 weighted in axial, coronal and sagittal planes.
  - iii. STIR images.

#### Interpretation of MRI Data:

- The anterior and posterior cruciate ligaments were considered normal, if they were visualised as a continuous low signal intensity band on both coronal and sagittal images (Figure 2 & 3).
- Cruciate ligament injuries were classified into sprain, partial surface tear, interstitial or intrasubstance tear, complete tear and avulsion injuries. Complete tears were subclassified based on the location of the tear into proximal, middle or distal third or as near the femoral or tibial attachment sites.
- Cruciate ligament sprain was diagnosed when the ligament appeared hyperintense without distortion of individual fibres or ligament laxity.
- Complete cruciate ligament tear was diagnosed when there was discontinuity in the ligament with abnormal ligament course, fluid signal intensity traversing its fibers and intermediate or high signal intensity its fibre.
- Focal or globular intrameniscal high signal intensity was considered MR grade 1 signal intensity (Normal meniscus in Figure 1).
- Horizontal, linear intrameniscal high signal was considered MR grade 2 signal intensity. Both grade 1 and 2 signal changes do not show extension to the articular surface and represent mucinous degeneration.
- Intrameniscal high signal intensity extending up to the articular surface was considered as grade 3 signal change. Meniscal tear was diagnosed when grade 3 signal change was present.
- Meniscal tears were classified into flap, horizontal, radial, vertical, bucket handle and complex tears based on cross-sectional and surface patterns.

- Injuries of the collateral ligaments were classified into sprains, partial tears and complete tears.

## RESULTS

The sample population comprised of 121 outpatients' complaining of knee joint pain and or swelling were recruited in the study. Their ages ranged between 6 to 70 years, the peak age was in 21 to 30 years which accounted 73(60.3%) Males (Table 1) of the study population, while 48 (39.7%) were females.

A joint pain without swelling was the commonest presenting clinical complaint by (69%), while painful swollen knee was the second symptom in incidence (31%). Common knee in our study was left knee 65(54%) followed by right knee 56(46%).

**Meniscal Tear:** Of the 121 patients evaluated with MRI of the knee, 66 patients (54%) had meniscal tears. Of the 66 patients, 50 (41%) involved the medial meniscus tear alone, 11 (9%) had the lateral meniscus tear alone and 5 (4%) had the medial as well as lateral meniscus tears. Of the 66 patients had meniscal tears detected on evaluation with MRI of the knee, 40 tears (33.5%) involved the posterior horn, 21 tears (17%) involved the anterior horn while 10 (7.5%) involved the body of the meniscus. Of the 55 medial meniscal tears, 15 (12%) was Grade I tear, 7 (6%) were Grade II tears and 33 (27%) were Grade III tears. Of the 16 lateral meniscal tears, 3 (2.5%) were Grade II tears, 8 (6.5%) were Grade III, and 5(4%) were Grade I tear. (Distribution of various types of meniscal tears shown in Table 3/Figure-4)

**Pathologies of PCL:** In our study of 121 patients, 6 patients (4.8%) had PCL pathologies. Out of 6 patients having PCL tear, 1 (0.8%) of them had partial tear and 5 (4%) had complete PCL tear. MR image of a study patient showing partial PCL tear [Table 4 & 5/Figure 5-8].

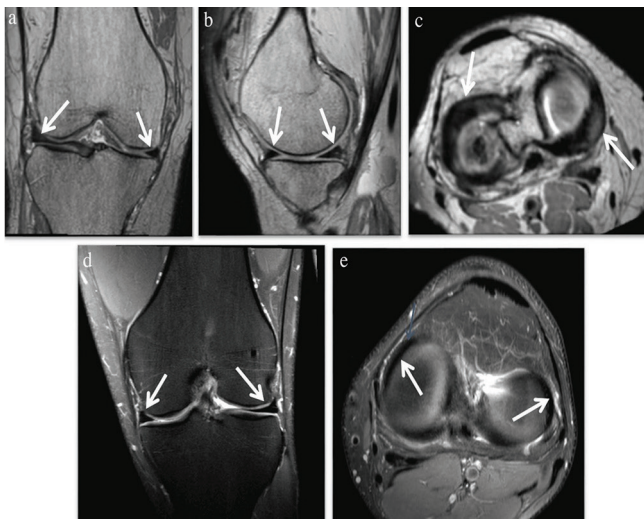
**Collateral Ligament Injuries:** Of the 6 patients with ligament tears, 4 patients (3%) had medial collateral ligament (MCL) tears. Of these 4 patients, 3 patients (2.5%) had Grade I tear (sprain), 1 patients (0.8%) had Grade II tear (Partial tear) and none of the patient had Grade III tear. Only 2 (1.5%) patients were found to have LCL tears, all 2 patients had Grade I tear (sprain). (Table 6/Figure 9)

**Bone Contusions:** Bone contusions were more common in tibia (24) than femur (10). Contusions in the lateral femoral condyle (16) being more common than in the medial femoral condyle (8).

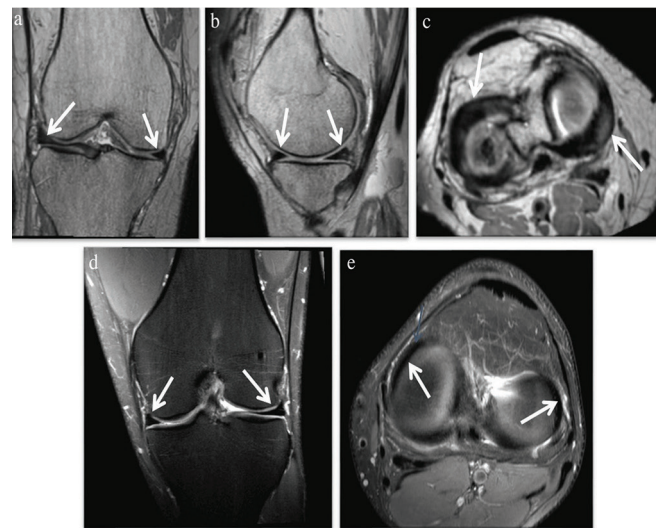
**Bone Fractures:** Bone fractures were seen in 27 patients out of which 18 (14.8%) fractures involved the tibia, 6 (5%) fracture involved the femur, and 3 (2.5%) fracture involved the fibula.

**Cystic Lesions:** In the current study 7 patients had a total of 7 cysts. Baker cyst (Figure 11) was seen in 4 (3%) patients and parameniscal cyst was seen in 3 (2.5%) (Figure 12) patients involving the medial meniscus and was associated with horizontal tear of the medial meniscus.

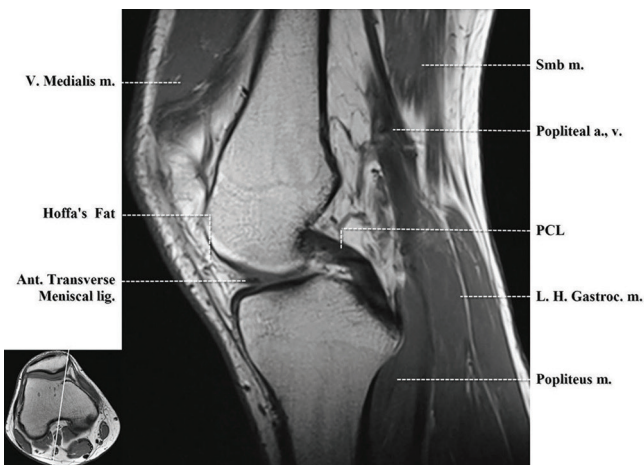
**Osteoarthritis:** MRI changes suggestive of osteoarthritis were found in 14 (11.5%) patients, out of which 8 (6.6%) had involvement of medial compartment, 4 (3.4%) of the lateral



**Figure-1:** (a-e) Normal medial and lateral menisci (arrows)—MRI appearance of normal menisci on Proton Density (a-c) and fat suppress proton density (d, e) images.



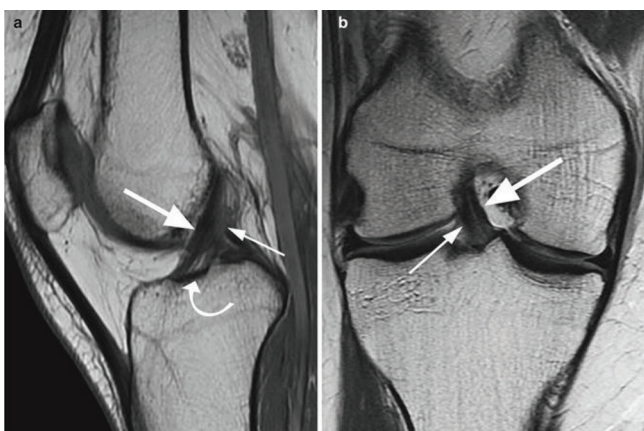
**Figure-4:** Figure B Proton density fat saturated sagittal image & Figure A STIR Coronal MRI image shows Grade III tear of posterior horn of medial meniscus.



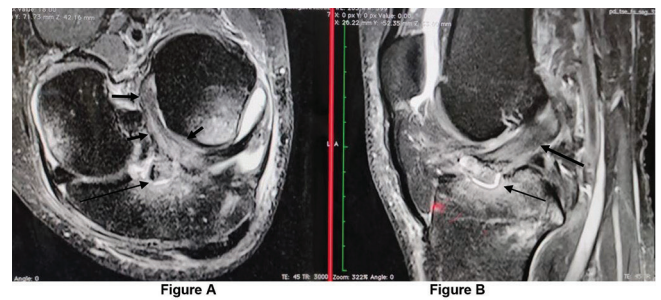
**Figure-2:** Sagittal T1-weighted image. Intercondylar notch. a., artery; Ant., anterior; m., muscle; L.H. Gastroc., lateral head gastrocnemius; lig., ligament; PCL, posterior cruciate ligament; Smb, semimembranosus; V., vastus; v., vein.



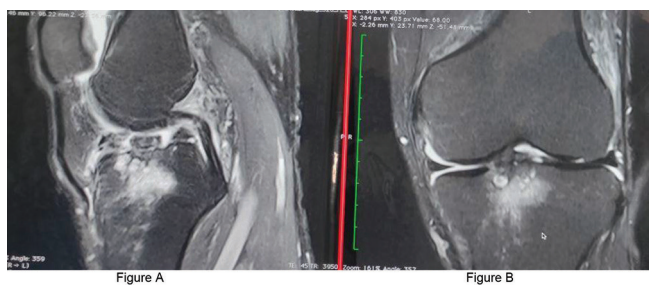
**Figure-5:** ACL avulsion fracture. Anteroposterior (a) and lateral (b) radiographs of the left knee show intercondylar fracture (arrow).



**Figure-3:** Normal anterior cruciate ligament (ACL). Sagittal proton-density (PD) FSE image (a) and coronal proton-density (PD) FSE MR image (b).



**Figure-6:** Figure A & B Proton density fat saturated axial & sagittal images show a bone fragment avulsed from the tibia (arrow) with an intermediate signal intensity in ACL and adjacent marrow edema.



**Figure-7:** Figure A Proton density fat saturated sagittal image & Figure B STIR Coronal MRI image shows complete tear of ACL with adjacent marrow oedema and Synovial effusion.



Figure A Figure B

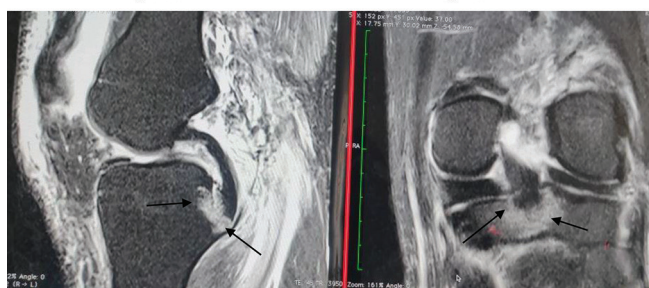


Figure C Figure D

**Figure-8:** Anteroposterior (A) and lateral (B) radiographs of the knee joint appears normal. In same Patient MRI Knee joint Show Figure C Proton density fat saturated sagittal image & Figure D STIR Coronal MRI image shows a avulsed bony fracture from the tibia (arrow) with an intact PCL and adjacent marrow edema

compartment, 2 (1.5%) patient had involvement of bilateral compartments.

Osteomyelitis: MRI changes suggestive of osteomyelitis seen in 3 (2.5%) patients (Figure 11).

Synovial joint effusion seen in 99 (81.8%) patients where mild in 66 (54.5%) patients and severe in 33 (27.3%) patients (Table 7/Figure 10).

In this study bone infarct seen in 4 (3%) patients, chondromalacia of patella seen in 8 (6.5%) patients and synovial chondromatosis seen in 1 (0.5%) patient.

**DISCUSSION**

Present study was an observational analysis of the various causes of a painful knee detected by MR imaging. In the present study, we found that the mean age of the group was 25.6 years with a male dominance. Our results are in concordance with those of Yadav R et al., who described a



**Figure-9:** STIR Coronal Image Demonstrating Complete Tear of the Medial Collateral Ligament at its Proximal Third with Joint Effusion

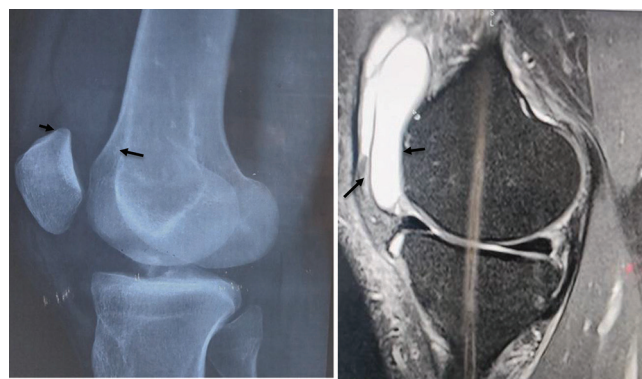
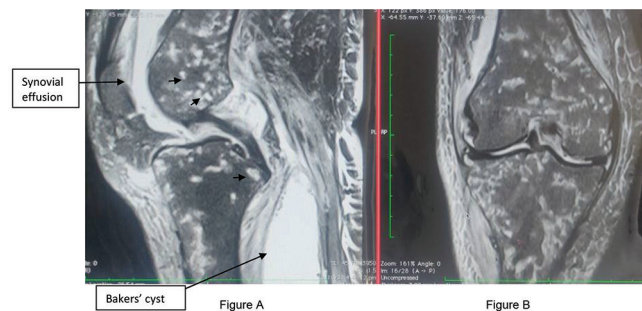


Figure A Figure B

**Figure-10:** Figure A lateral knee joint x ray shows increase gap in between patella and distal end of femur, Figure B Proton density fat saturated sagittal MRI image shows synovial effusion



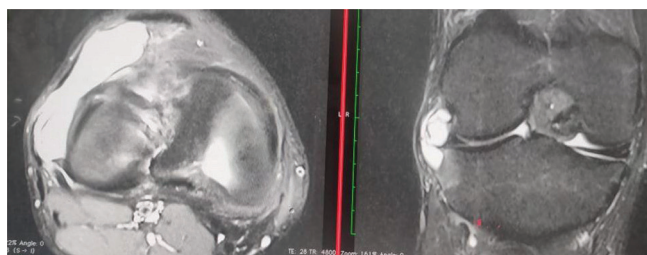
**Figure-11:** Figure A Proton density fat saturated sagittal image & Figure B STIR Coronal MRI image shows Multiple small punctuate lesions are seen involving femur and tibia – favours changes of osteomyelitis with synovial effusion and large bakers’ cyst.

mean age of 36.70±14 years and a male preponderance in their study<sup>13</sup>. Male preponderance was also seen in study done by Gimhavanekar S et al., Mansour MAM et al., and Singh JP et al.,<sup>14-16</sup>

Five percent (6 patients) of our study population had a normal MRI. This is in contrast to a previously reported (17%) rate of normal MRI in sports related knee injuries<sup>17</sup>.

Meniscal tears were the commonest soft tissue abnormality found in our study. Tears involved posterior horn of the

medial meniscus more commonly. The results are in concordance with the previously reported literature<sup>16,18- 21</sup>. Grade-III was the commonest meniscal tear in the current study which contrasts with the results by Arumugam et al., who reported grade-III as the commonest grade of meniscal tear<sup>22</sup>. Vertical tears were found to be the commonest type of meniscal tear. This contrasts with the previous finding of horizontal tear being the commonest meniscal type by Pasupuleti B et al.,<sup>18</sup>. All the vertical tears in our study were associated with a history of trauma. Reported literature also describes vertical tears as being traumatic in nature<sup>18,19</sup>. Only three patients in our study had a bucket-handle tear involving the medial meniscus. Literature also reports that most of the bucket-handle tears involve the medial meniscus<sup>14,23</sup>.



**Figure-12:** Figure A Proton density fat saturated axial image & Figure B STIR Coronal MRI image shows large para-meniscal cyst in relation to lateral meniscus.

Age in Years	Male	Female	Total	Percentage
<20	16	5	21	17%
21-30	24	15	39	32%
31-40	17	13	30	25%
41-50	10	8	18	15%
>50	6	7	13	11%
	73 (60.3%)	48 (39.7%)	121	100%

**Table-1:** Age and Sex Distribution of Patients

Pathology	No. of Patients	Percentage (%)
ACL	37	30
PCL	6	4.8
Meniscus	66	54
Collateral Ligaments	6	4.8
Bone	82	67.7
Joint effusion	99	82

**Table-2:** Distribution of patients according to knee pathology

	Medial Meniscus		lateral Meniscus	
	No. of patients	Percentage	No. of patients	Percentage
Grade I Tear	15	12	5	4
Grade II tear	7	6	3	2.5
Grade III tear	33	27	8	6.5
Tear of Anterior horn	17	14	4	3
Tear of Body	8	6	2	1.5
Tear of Posterior Horn	30	25	10	8.5
Total	55	45	16	13

**Table-3:**

	No. of patients	Percentage
Partial Tear	12	10
Complete Tear	25	20.6
Total	37	30.6

**Table-4:** Anterior cruciate ligament

	No. of patients	Percentage
Sprain	5	4
Tear	1	0.8
Total	6	4.8

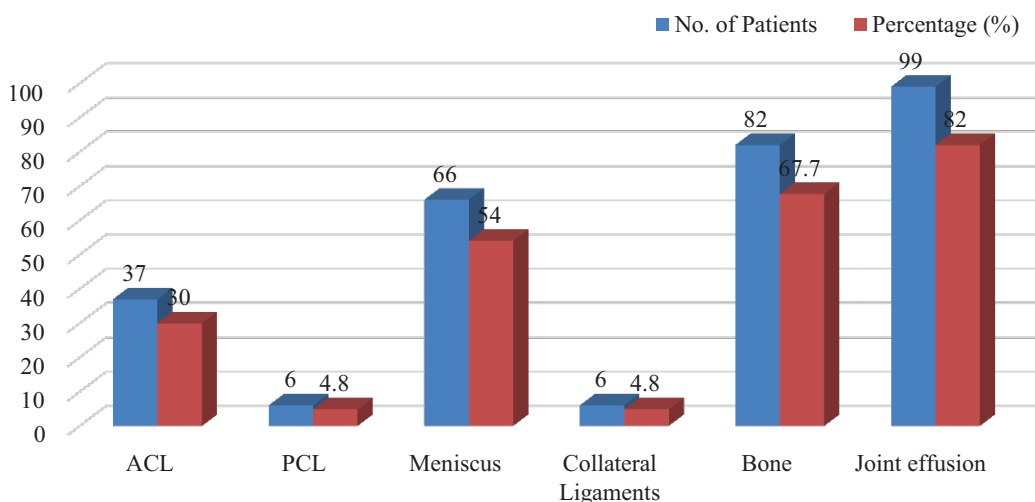
**Table-6:** Collateral ligament

	No. of patients	Percentage
Partial Tear	1	0.8
Complete Tear	5	4
Total	6	4.8

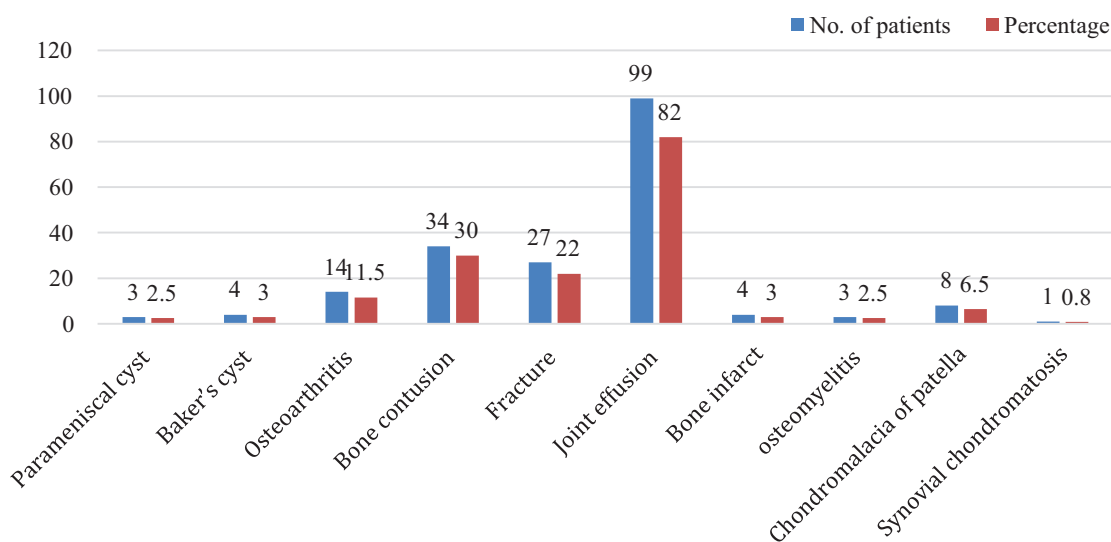
**Table-5:** posterior cruciate ligament

	No. of patients	Percentage
Mild Effusion	66	54.5
Sever Effusion	33	27.3
Total	99	81.8

**Table-7:** Joint Effusion



**Chart-1:** Distribution of patients according to knee pathology



**Chart-2:** Additional MRI Findings

MRI Findings	No. of patients	Percentage
Parameniscal cyst	3	2.5
Baker's cyst	4	3
Osteoarthritis	14	11.5
Bone contusion	34	30
Fracture	27	22
Joint effusion	99	82
Bone infarct	4	3
osteomyelitis	3	2.5
Chondromalacia of patella	8	6.5
Synovial chondromatosis	1	0.8

**Table-8:** Additional MRI Findings

Tear was the commonest pathology affecting the ACL, most being acute in nature. The results are comparable to the study done by Sohali K et al.,<sup>24</sup>. The incidence of PCL pathology in our study was 4.8%, which is comparable to the 5.78% incidence reported by Singh JP et al.,<sup>16</sup>. Complete PCL tear was the commonest PCL pathology in our study which was in accordance with the reported literature<sup>18</sup>. 30%(No. 34) of our patients had bone contusion which compares well with the existing literature (28.3%)<sup>24</sup>. Tibia

was more commonly involved than femur by contusions and lateral femoral condyle was involved more frequently than its medial counterpart. Our results are in agreement with the existing literature<sup>25</sup>. Acute ACL tears were usually associated with bone contusions in our study. Similar association was reported previous studies<sup>22,26,27</sup>.

Baker's cyst was the commonest cystic lesion (3%) involving the knee joint. A similar finding has been reported previously by Sohali K et al., (10%)<sup>24</sup>. Baker's cysts were associated with joint effusion, medial meniscal tear and ACL tear. An association of Baker's cyst with joint effusion, meniscal tear and ACL tear has been previously reported<sup>28,29</sup>. The finding of parameniscal cyst involving the posterior horn of medial meniscus and its association with horizontal tear compares favorably with the reported literature<sup>30</sup>.

Medial compartment was most commonly involved by the osteoarthritic process of the knee joint which is in accordance with the existing literature<sup>31</sup>.

MR has been established as an effective non-invasive modality for identifying the knee pathology<sup>32,33</sup>. The study aimed to highlight the role of MR imaging in the evaluation

of a painful knee and strengthen its superiority over the conventional imaging (X-rays) and CT scan thereby resulting in a better clinical management

## CONCLUSION

Young adults are the most commonly population in which MRI pathology is presents.

MRI is a non-invasive, non-ionizing diagnostic modality, which gives adequate information about the surface and intrasubstance abnormality of the ligaments and menisci.

Anterior cruciate ligament and medial meniscus are the most frequently injured structures.

Its accuracy in the evaluation of meniscal tears as well as ACL pathologies is high.

MRI description of closed meniscal tears can guide the orthopaedician during arthroscopy as these tears are usually missed unless they are probed.

MRI can describe the morphology and location of meniscal tears, which can help in choosing between primary meniscal repair and partial meniscectomy.

MR imaging of the knee may help in guiding the surgical management and is especially useful in the setting of indeterminate clinical findings.

## Abbreviations

ACL - anterior cruciate ligament; PCL - posterior cruciate ligament; MM - medial meniscus; LM - lateral meniscus; MCL - medial collateral ligament; LCL - lateral collateral ligament; MRI - Magnetic Resonance Imaging

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