

## ROLE OF MRI IN KNEE JOINT INJURIES IN CORRELATION WITH ARTHROSCOPY

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### Abstract

**Background:** In traumatic knee injuries, MRI is one of the principle investigations attributable to its accuracy, better spatial and contrast resolution, and as an alternative to invasive arthroscopy. The aim of the study was to demonstrate MRI findings in various types of traumatic knee injuries, their patterns, to correlate them with the arthroscopic findings, and to establish the accuracy of MRI. **Materials and Methods:** This is a non-interventional, cross-sectional type of observational study conducted on 65 patients with knee injury in a tertiary care hospital. An MRI of knee followed by arthroscopy was performed in 36 patients; the remaining 29 patients were managed conservatively. Arthroscopy was done within two months of MRI. **Result:** The various types of lesions seen on MRI were as follows: anterior cruciate ligament(ACL) tears-36 (55.38%), medial meniscus(MM) tears-29 (44.61%) followed by lateral meniscus(LM) tears and posterior cruciate ligament(PCL) tears, each six(9.23%). Medial collateral ligament(MCL) tear- three (4.61%) and lateral collateral ligament(LCL) tear- one (1.53%). In detecting the cruciate and meniscal injuries on MRI, the sensitivity, specificity and accuracy were calculated and were as follows: for ACL: 100, 94.1, 97.2; for PCL: 100, 97. 97.2; for MM: 90.4, 86.7, 88.9 and for LM: 100, 96.9, 97.2 respectively. **Conclusion:** MRI is an accurate, non-invasive and cost-effective means to evaluate knee injuries. It is noted that ACL, MM and MCL tears are more common than PCL, LM and LCL tears.

## INTRODUCTION

The knee joint is a large compound type of synovial and weight bearing joint.<sup>[1]</sup> This complex articulation is characterized by the presence of ligamentous and meniscal structures, which play an important role in the stability and mobility.<sup>[2,3]</sup> Due to extensive range of functions, the bone and soft tissue of knee are at risk of injuries.<sup>[4]</sup>

In patients with trauma to the knee joint, clinical examination combined with radiological investigations like radiographs and even CT scan may fall short in diagnosing many of the internal derangements of this joint, especially the soft tissue

lesions. MRI due to its enhanced soft tissue contrast resolution and multiplanar imaging capacity provides significant supremacy over the other imaging techniques in the rating of traumatic injuries of knee joint.<sup>[5]</sup>

Arthroscopy has diagnostic precision of 64-94%, but is an invasive procedure and has its own set of complications. The accuracy of MRI is very high in diagnosing the lesions and has a sensitivity of 80-100%.<sup>[6,7]</sup> Fast spin echo(FSE) and fat suppression MRI techniques have extended the sensitivity and specificity of MRI in detection of meniscal and cruciate ligament injuries.<sup>[7]</sup>

## MATERIALS AND METHODS

The study was prospective, diagnostic descriptive study conducted in the Department of Radiodiagnosis in a tertiary care hospital over a period of 24 months.

65 patients in the age group of 11 to 60 years, who presented with knee injury referred from OPD (outpatient department) and IPD (inpatient department) for MRI imaging were included in the study. Arthroscopy was done in 36 patients and the findings of arthroscopy were correlated with MRI findings. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of MRI were calculated.

Patients willing to co-operate during examination and undergo MRI scanning with clinically suspected injuries of the knee and consenting for the same were included in the study.

Patients with cardiac pacemaker, metallic implants in the body and those with claustrophobia were excluded.

Proper informed consent and approval from the institutional ethics committee was obtained.

MRI was performed with a Sonata Maestro Class Magnetom 1.5 T MR SCANNER from SIEMENS (Erlanger, Germany) with gradient field strength of 40 m T/m<sup>2</sup>. A dedicated knee coil was used.

The patients were briefed about the procedure and made to restrict body movements during the scan time. The knee was imaged in three standard planes (axial, coronal and sagittal planes) using pulse sequences SE (spin echo), T1W (T1 weighted), FSET2W (fast spin echo T2 weighted), STIR (short tau inversion recovery), PDFS (proton density fat saturated).

Patient was placed in supine position with the knee in a closely coupled extremity coil. The knee was externally rotated 15°-20° (for visualization of anterior cruciate ligament (ACL) completely on sagittal images) and flexed 5°-10° (to increase the accuracy of assessing the patello-femoral compartment).

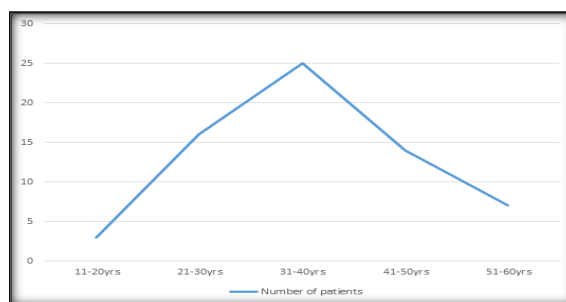
An orthopaedic surgeon performed all arthroscopic examination within two months of MRI examination.

After thorough verification, data was entered and analyzed by using the SPSS 21.0 software package (statistical package for social sciences). The categorical variables were expressed in terms of numbers and percentages. Results were expressed by means of either tables or figures.

## RESULTS

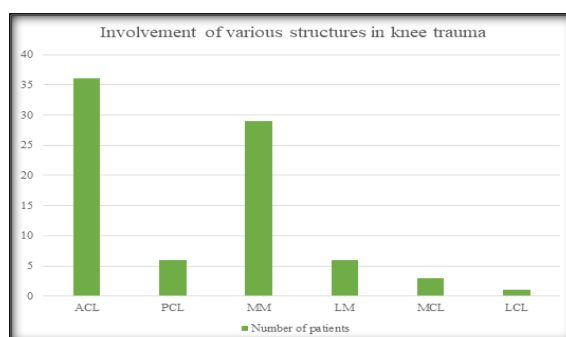
MRI examination was performed on 65 patients with the complaints of knee injury. Among these 47 were men (72.3%) and 18 were women (27.7%). The distribution of patients according to their age is given in [Graph 1]. The maximum number of patients were in the age group of 31 to 40

years (38.4%). Among all these subjects 33 (50.7%) had derangement of right knee while 32 (49.3%) had left sided derangement.



Graph 1: Distribution of patients according to age

The involvement of various structures in knee trauma are demonstrated in (Graph 2). ACL tear (complete or partial) was the most encountered pathology, followed by PCL, MCL and LCL tears.



Graph 2: ACL was most commonly injured-55.3%, followed by MM-44.6%, PCL and LM-9.2% each, MCL-4.6% and LCL-1.5%

ACL-Anterior cruciate ligament; MM-Medial meniscus; PCL- posterior cruciate ligament; LM- Lateral meniscus; MCL- Medial collateral ligament; LCL- Lateral collateral ligament

Out of 36 patients of ACL tears [Graph 3], 21 patients had complete tear and 15 patients had partial tear. In complete ACL tears 6 patients showed acute [Figure 1] while 15 patients showed chronic tear [Figure 2]. 22 patients (61.11%) had mid-substance tears [Figure 1], 13 patients (36.11%) had tears at femoral attachment [Figure 2B] and only one patient (12.77%) at the tibial attachment were noticed.

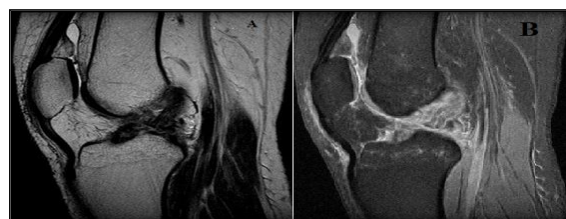
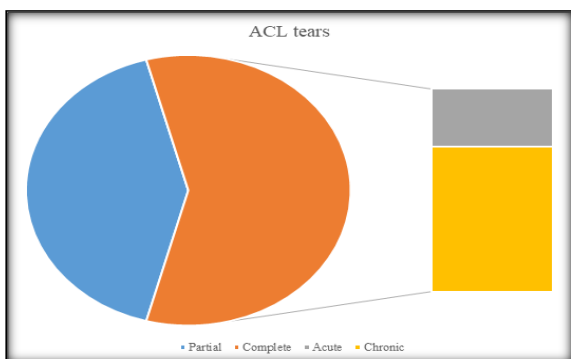


Figure 1: Sagittal T2 weighted image(A) and PDFS image(B) showing bulky ACL with hyperintense signal and loss of continuity. There is inflammation with irregularity of Hoffa's fat pad suggestive of acute ACL tear. PDFS- proton density fat saturated; ACL- Anterior cruciate ligament

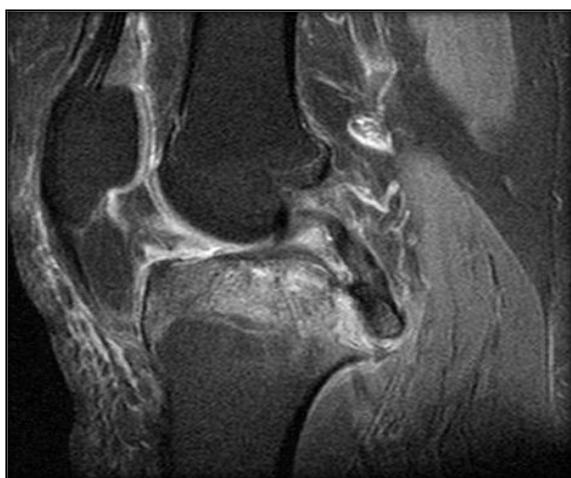


**Figure 2: Sagittal T2 weighted image showing chronic tear of femoral attachment of ACL. ACL-Anterior cruciate ligament**



**Graph 3: Among ACL tears, complete tear(58%) was more common than partial tear(42%), and among complete tears, chronic tear(71%) was more common than acute tear(29). ACL- Anterior cruciate ligament**

In ACL tears, most common MRI finding was non-visualization, then hyper intensity and least common was discontinuity of the fibres [Table 1]. While in PCL tears, hyper intensity [Figure 3] was more common than discontinuity [Figure 4].

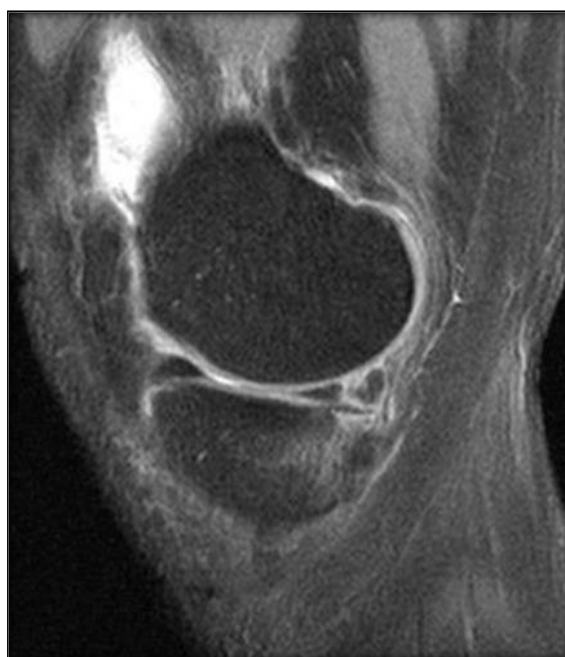


**Figure 3: Sagittal PDFS image of knee showing hyperintensity along PCL associated with avulsion fracture of tibial plateau. PDFS- proton density fat saturated; PCL- Posterior cruciate ligament**



**Figure 4: Sagittal T2 weighted image show focal discontinuity within the PCL substance with fluid cleft suggestive of PCL tear in its mid-portion. PCL- Posterior cruciate ligament**

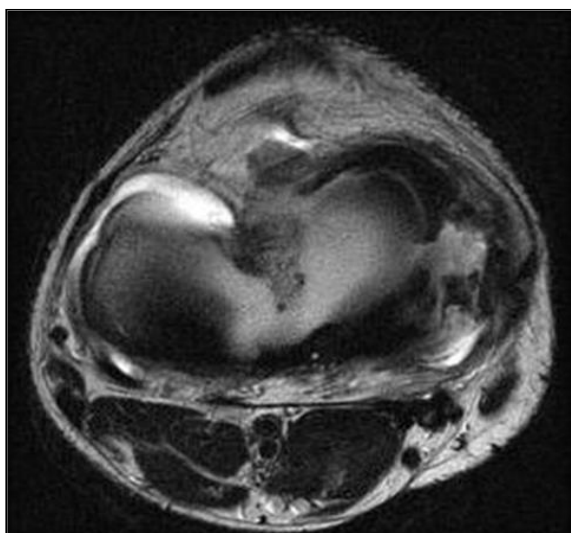
In MM injuries, Grade-III tears [Figure 5] were most common followed by grade I and grade II. One (2.12%) patient showed Bucket-handle tear [Figure 6] of MM. Radial tear of MM [Figure 7] was seen in one (2.12%) patient. In LM injuries, Grade-III tears [Figure 8] were most common followed by grade I and grade II [Table 2]. Grade III meniscal tears in MM were maximum at posterior horn 26 (89.65%), and in LM it was observed in anterior horn 3 (50%), and only in one (16.66%) patient it was present in both the horns.



**Fig. 5: Sagittal PDFS image showing MM Grade III longitudinal tear. PDFS- proton density fat saturated; MM- Medial meniscus**



**Figure. 6:** Sagittal T2 weighted image showing MM Bucket Handle Tear -Double PCL sign. MM-Medial meniscus; PCL- Posterior cruciate ligament



**Figure. 7:** Axial T2 weighted imageshowingMM Radial Tear. MM- Medial meniscus



**Figure. 8:** Sagittal PDFS image showing Grade III lateral meniscal tear. PDFS- proton density fat saturated; PDFS- proton density fat saturated

Collateral ligament tears [Figure 9 and 10] were associated with ACL and PCL tears.



**Figure. 9:** Coronal STIR image showing complete MCLtear with soft tissue contusion. STIR- short tau inverse recovery; MCL- Medial collateral ligament



**Figure. 10:** Coronal STIR image showing complete LCL tear. STIR- Short tau inverse recovery; LCL- Lateral collateral ligament

Out of 65 patients, arthroscopy was performed in 36 (28 males and 8 females) patients. Rest of the patients were managed conservatively. There was excellent correlation between locations of signal abnormality in MRI with the location of tears on arthroscopy.

The MRI findings of ACL, PCL, MM and LM injuries were compared with the arthroscopic results [Table 3] and following parameters were calculated: sensitivity, specificity, accuracy, positive predictive value(PPV), negative predictive values(NPV)[Table

4]. In all the cases, structures reported as normal on MRI were found to be normal on arthroscopy.

**Table 1: MRI signs of ACL and PCL tear. ACL- Anterior cruciateligament; PCL- Posterior cruciateligament**

MRI signs of cruciate ligament tear	Non visualisation	Hyperintensity	Discontinuity
MRI signs of ACL tear	11 (44.44%)	9 (38.88%)	6 (16.66%)
MRI signs of PCL tear	0	5 (83.33%)	1 (16.66%)

**Table 2: Types of meniscal injuries on MRI**

Name of meniscus and type of tear	Grade-I	Grade-II	Grade-III	Bucket handle	Radial
Medial meniscus	10 (21.27%)	8 (17.02%)	27 (57.44%)	1(2.12%)	1 (2.12%)
Lateral meniscus	4 (36.36%)	1 (9.09%)	6 (54.54%)	0	0

**Table 3: Correlation of MRI and arthroscopic findings. ACL-Anterior cruciateligament;PCL- posterior cruciateligament; MM-Medialmeniscus; LM- Lateral meniscus**

	Tear on MRI	Tear on arthroscopy	Normal on MRI	Normal on arthroscopy
ACL	28	25	8	8
PCL	3	2	34	34
MM	21	21	15	15
LM	4	3	32	32

[Table 3] Correlation of MRI and arthroscopic findings. ACL-Anterior cruciateligament;PCL- posterior cruciateligament; MM-Medialmeniscus; LM- Lateral meniscos.

**Table 4: Validity of MRI findings considering arthroscopy as gold standard reference. ACL-Anterior cruciate ligament; MM-Medial meniscus; PCL- posterior cruciate ligament; LM- Lateral meniscus; PPV- positive predictive value; NPV- negative predictive value**

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Complete ACL Tear	100	94.1	95.0	100	97.2
Partial ACL Tear	66.7	93.3	66.7	93.3	88.9
PCL Tear	100	97.0	66.7	100	97.2
MM tear	90.4	86.7	90.4	86.7	88.9
LM tear	100	96.9	75.0	100	97.2

## DISCUSSION

Knee injuries were more common in men and in the fourth decade.

Arthroscopy of the knee was performed in 36 patients. Remaining patients were managed conservatively. MRI findings in patients who were managed conservatively could not be verified. ACL tears were more common than PCL tears, which correlated with the study by Hayat Ahmad Khan et al.<sup>[8]</sup> Most common ACL tear was at mid-substance with dominance at femoral attachment, which correlates with the study by Berquist et al.<sup>[9]</sup>

Among ACL tears, discontinuity of the ACL was the most common MRI sign; however, Gentili et al.<sup>[10]</sup> reported hyperintensity as the most common MRI sign for ACL tear. Meniscal tears more associated with chronic ACL tear, which correlates with study by McDaniel et al.<sup>[11]</sup>

On MRI, complete ACL tears were found in 20 patients however arthroscopically tear was found in only 19 patients. MRI was highly sensitive for complete ACL tears and LM tears, while highly specific for PCL and LM tears. The accuracy was maximum for complete ACL tears, PCL and LM tears. These findings correlates with the study done by Carlos et al and by Vasilios.<sup>[12,13]</sup>

As stated by Bin Li et al,<sup>[14]</sup> PCL is twice as strong as ACL with a larger cross-sectional area and higher

tensile power, which is responsible for a lower incidence of rupture of PCL.

MM tears and degeneration was observed in more patients as compared to LM tears. This correlates with the study reported by Hayat Ahmad Khan et al,<sup>[8]</sup> and La Prade et al.<sup>[15]</sup> The menisci degeneration demonstrated high signal intensity due to imbibed synovial fluid and our study found that T2 weighted GRE (gradient echo) images clearly depicted the meniscal tears than FSE images. Also most common tear location for MM was at posterior horn. There were three false positive interpretations of meniscal tears on MRI compared with arthroscopy. These tears were within the vascularised red zone of meniscus. It is possible that the MRI findings that had the appearance of a tear were healed tears. This area is difficult to visualize on arthroscopy, so it is also possible that meniscal tears were present in these areas but not seen during arthroscopy.

A substantial hindrance between injury and MRI may allow the meniscus to heal but the intrameniscal signal may continue, leading to false positive MRI reading. Similarly, a gap between MRI and arthroscopic evaluation could allow healing.<sup>[16]</sup> MCL tears were more common than the LCL. Collateral ligament tears were seen often associated with ACL injuries, which is reported in the study done by David W Stoller et al.<sup>[17]</sup>

## CONCLUSION

In conclusion, this study establishes the importance of MRI as an imaging modality for assessment of internal derangements of the knee joint. It is cost effective and non-invasive replacement for diagnostic arthroscopy.

MRI offers ever-increasing options for diagnostic imaging of the knee joint and proves to be the modality of choice for characterizing various pathologies related to knee injuries.

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