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RESEARCH ARTICLE

MRI EVALUATION OF LIGAMENTOUS INJURIES OF KNEE JOINT AND ITS CORRELATION WITH JOINT EFFUSION

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ABSTRACT

Aim and Objectives: The purpose of this study is to define role of MRI in evaluating and grading various ligaments tears. Another objective of this study was to correlate joint effusion with ligamentous injuries.

Materials and Methods: This study was conducted using Siemens Essenza 1.5 T MRI machine. Ninety cases were studied and descriptive analysis performed. Joint effusion was measured by documented methods in lateral suprapatellar pouch in antero-posterior measurement at its widest point. Statistical analysis was performed using these values.

Results: In present study, the most common ligamentous injury was ACL tears (53%) followed by MCL tears (32%). Complete tear (42%) was common grade among ACL tears and partial tears (81%) were more common among PCL tears. MCL tears were more common than LCL tears and grade I was commonest grade among them. Joint effusion more than 10 mm in lateral suprapatellar pouch was associated with 25 out of 27 patients (i.e. 92.59%) with higher grades of ligamentous injuries.

Conclusion: MRI is excellent non-invasive modality for evaluation and grading of ligamentous injuries of knee joint. Joint effusion of more than 10 mm in lateral supra-patellar pouch was associated with higher grades of ligamentous injuries.

Abbreviations: MRI = Magnetic Resonance Imaging, T = Tesla, ACL=Anterior Cruciate Ligament, PCL= Posterior Cruciate Ligament, MCL=Medial Collateral Ligament, LCL=Lateral Collateral Ligament.

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INTRODUCTION

Knee joint is one of the most active joint of our body and commonly evaluated with MRI (Tan *et al*., 2014). Knee joint is very important in day-to-day activities and in various sport activities. In past few years there is increase in injuries from recreational and competitive sports activities (Clasby and Young, 1997). Knee is the one of the most commonly injured joints and therefore, large number of these patients are referred for x-ray, CT and MRI scan of knee joints by evaluating physicians. X-ray (radiograph) of knee is usually first investigation in patients with knee pain. But, information obtained from normal x-ray of knee is very limited in diagnosing knee pathology, as it cannot visualize various internal structures like menisci, ligaments and bone marrow (Kim *et al*., 2011). So despite it being first investigation done in painful knee its role is curtailed due to more accurate and more superior MRI scan especially in the evaluation of ligamentous & meniscal injuries. CT scan also does not provide superior soft tissue details; it involves radiation and hence is not preferred except for evaluation of bony lesions (bony avulsion fractures, cortical stress changes related to chronic injury). USG also has limited role in evaluation of internal structures of knee joint and is considered as complimentary technique for knee evaluation (Geiger *et al*., 2013). MRI of knee is invaluable in understanding and diagnosing different knee pathologies causing painful knee. MRI is non-invasive, radiation free & non-operator dependent diagnostic modality, unlike x-ray & CT scan, which involves radiation, and USG, which is operator dependent. MRI is widely accepted by the evaluating physicians, usually well tolerated by the patients and helps in differentiating various knee pathologies, which are similar clinically. The MRI provides minute and superior soft tissue details with the help of multiplanar imaging. This allows better visualization of different components of the knee joint, which includes menisci, intra-articular ligaments, articular cartilage, synovium and bone marrow. Pathologies like various peri-articular, intra-articular lesions like ligament and meniscus injuries and few bony lesions which are not demonstrated by other imaging techniques, are very well evaluated with MRI

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(Shapiro *et al*., 2010; Tehranzadeh *et al*., 1989). MRI has a high specificity and negative predictive value, suggesting that screening MRI studies can effectively rule out the presence of ACL tears and reduce the number of unnecessary diagnostic arthroscopies performed. So, in the last few years MRI has become better alternative technology for arthroscopy in diagnosing knee pathologies. Hence, MRI is currently the modality of choice for clinical conditions concerning the knee joint.

Aims and objectives

The purpose of this study is to define role of MRI in evaluating and grading various ligaments & meniscal tears. Another objective of this study was to correlates joint effusion with ligamentous & meniscal injuries.

MATERIALS AND METHODS

This Descriptive study was conducted in MRI section of Department of Radio-diagnosis of Medical College and tertiary health care Centre. The period of study was from August 2012 to August 2013. Ninety (90) patients were included in this study after satisfying the eligibility criteria. Written informed consent was taken from all study participants.

Inclusion criteria

Patients who were having pain in the knee due to traumatic and non-traumatic causes with or without swelling, who were above 18 years irrespective of the sex, who were referred to the MRI section of Department Radio-diagnosis of Medical College and Research Centre.

Exclusion criteria

1. Patients not giving consent for the study.
2. Patients with previous operative history of knee joint.
3. Any absolute contraindication for MRI like patients with metallic implant, foreign body, pacemaker, vascular clips, etc. (19)(20).

SIEMENS MAGNETOM ESSENZA 1.5 TESLA machine was used for the study. A flexible surface coil for knee joint was used for the study to obtain high resolution and detailed images. Multiple sequences were used in various planes (coronal, sagittal and axial planes). The images were obtained and stored in the department computer database. The bio data, detailed clinical history and MRI findings were noted in pre-designed proforma. The collected data was tabulated in Master Chart using Microsoft excel and descriptive statistical analysis was carried out. Joint effusion was measured by documented methods in lateral suprapatellar pouch in antero-posterior measurement at its widest point (Kolman *et al*., 2004). Statistical analysis was performed using these values.

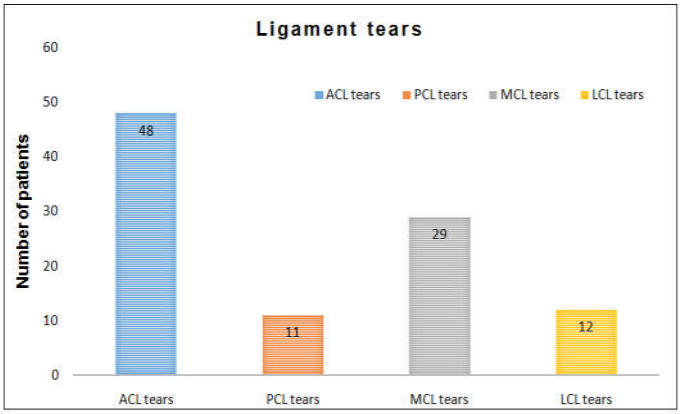
RESULTS

In this study out of total 90 patients evaluated, ligamentous tears were seen in 58 (64.44%) patients. These patients had tears involving either single ligament or combination of ligaments. ACL tear was seen in 48 (53.33%) patients, PCL tear in 11 (12.11%) patients, MCL tear in 29 (32.22%) patients and LCL tear in 12 (13.33%) patients.

Table 1. Ligament Tears

Ligament tears	Number of patients	Percentage* (out of total 90 patients)
ACL tear	48	53.33%
PCL tear	11	12.22%
MCL tear	29	32.22%
LCL tear	12	13.33%

Chart 1: Bar diagram showing ligament tears and affected number of patients



Anterior Cruciate Ligament (ACL) tears

Out of 90 patients included in this study, ACL tear was seen in 48 (53.33%) patients. Partial tear was seen in 28 (58.33%) patients and complete tear was seen in 20 (41.66%) patients. Low-grade partial tear was seen in 18 (37.50%) patients and high-grade partial tear in 10 (20.83%) patients.

Table 2. ACL tear Grades

Grade ACL tear	Number of patients	Percentage
Complete tear	20	41.66%
High grade partial tear	10	20.83%
Low grade partial tear	18	37.50%
TOTAL	48	100.00%

Fig. 1. Complete tear of ACL in its mid part showing flattened ACL with disruption of fibres on PD FS SPC 3D SAG sequence

Posterior Cruciate Ligament (PCL) tears

In this study of 90 patients, posterior cruciate ligament tear was seen in 11 (12.22%) patients. Out of these tear 2 were complete tears and 9 were partial tears

Table 3. PCL tear Grades

Grade PCL tear	Number of patients	Percentage
Complete tear	2	18.19%
Partial tear	9	81.81%
TOTAL	11	100.00%

Medial collateral ligament (MCL) tears

Medial collateral ligament tears were seen in 29 (32.22%) patients out of total 90 patients included in the study. Out of these 17 were grade I, 8 were grade II and 4 were grade III tears.

Table 4. MCL tear Grades

Grades of MCL tear	Number of patients	Percentage
I	17	58.62%
II	8	27.58%
III	4	13.79%
TOTAL	29	100.00%

Lateral collateral ligament (LCL) tears

In this study of 90 patients, lateral collateral ligament tears were seen in 12 (13.33%) patients. Out of these, 8 were grade I LCL tears, 3 were grade II and 1 was grade III.

Table 5. LCL Tear Grades

Grades of LCL tear	Number of patients	Percentage
I	8	66.66%
II	3	25.00%
III	1	8.33%
TOTAL	12	100.00%

Joint effusion

In this study joint effusion was measured by documented methods in lateral suprapatellar pouch in antero-posterior measurement at its widest point. We have taken 10 mm as cut off value for significant joint effusion as per previous documented studies. Then patients with ligamentous injuries were classified in three categories i.e. absent joint effusion, less than 10 mm and more than 10 mm. these patients were sub classified according to different grades of injury as given in Table 6. All grade III tears of MCL and LCL as well as all complete tears of PCL were associated with joint effusion of more than 10 mm. Similarly, 18 out of 20 patients with complete ACL tear were associated with joint effusion of more than 10 mm. Out of total 27 patients with higher grades of ligamentous injuries, 25 patients (92.59%) shown associated joint effusion of more than 10 mm in lateral suprapatellar pouch.

Table 6. Joint Effusion

		Number of Patients with Joint effusion	
	Grades of tears	< 10 mm	> 10 mm
ACL	Low-Partial	16	2
Tear Grades	High-Partial	2	8
	Complete	2	18
PCL	Partial	8	1
Tear Grades	Complete	0	2
MCL Tear	I	19	1
Grades	II	4	1
	III	0	4
LCL	I	6	1
Tear Grades	II	4	0
	III	0	1

DISCUSSION

There are various modalities available for evaluation of knee joint, but nowadays MRI has become imaging modality of choice for ligamentous injuries of knee joint. Role of MRI for evaluation of knee joint has increased in past few years. Internal structures like ligaments of knee joint are better evaluated with MRI as compared to USG, conventional X-rays,

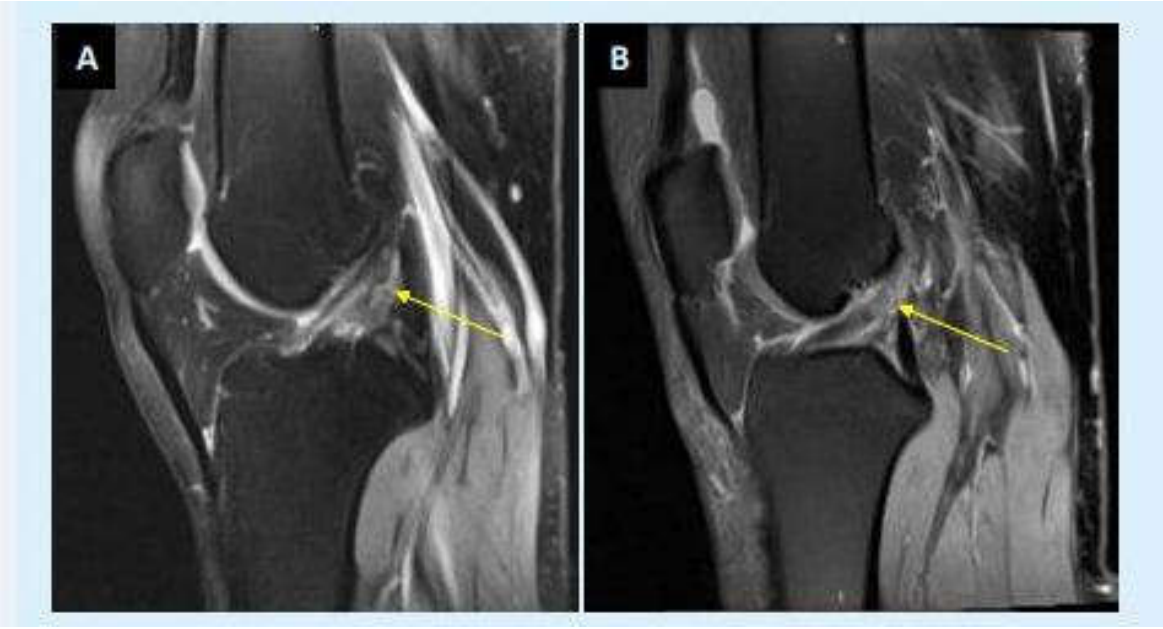


Fig. 2. A -Low grade partial tear of ACL seen as disruption of few Fibres with Hyperintense signal within on PD FS sag image. B -High grade partial tear of ACL seen as disruption of more than half of Fibres with only few intact Fibres maintaining the continuity as seen on PD FS sag image

Fig. 3. A-PD FS sag image. B –PD spc 3D sequence showing complete disruption of PCL with disruption of Fibres with loss of continuity

Fig. 4. Partial tear of PCL seen as increased signal intensity (arrow) within the PCL on PD FS sag images

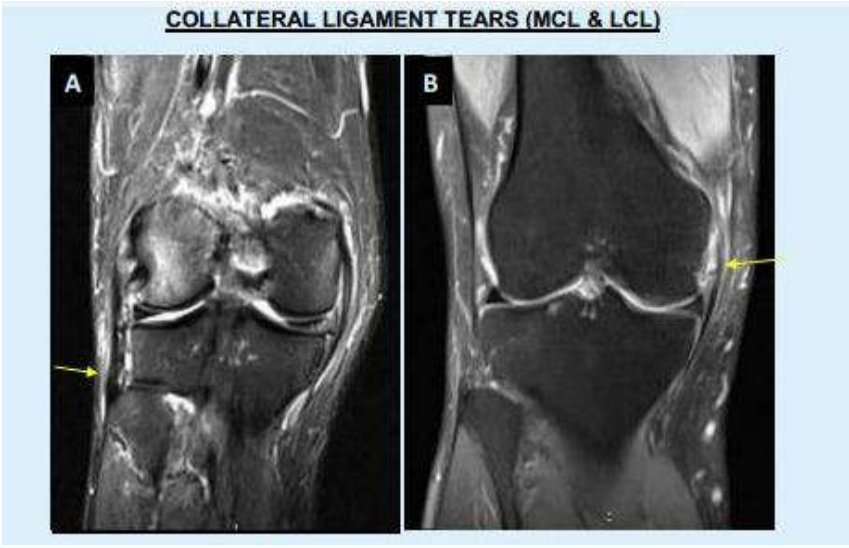


Fig. 5. A–Grade I LCL tear as soft tissue edema(arrow) superficial to LCLon STIR COR image, B –Grade II MCL tear as hyperintense signal within the ligament (arrow) on PD FS cor image

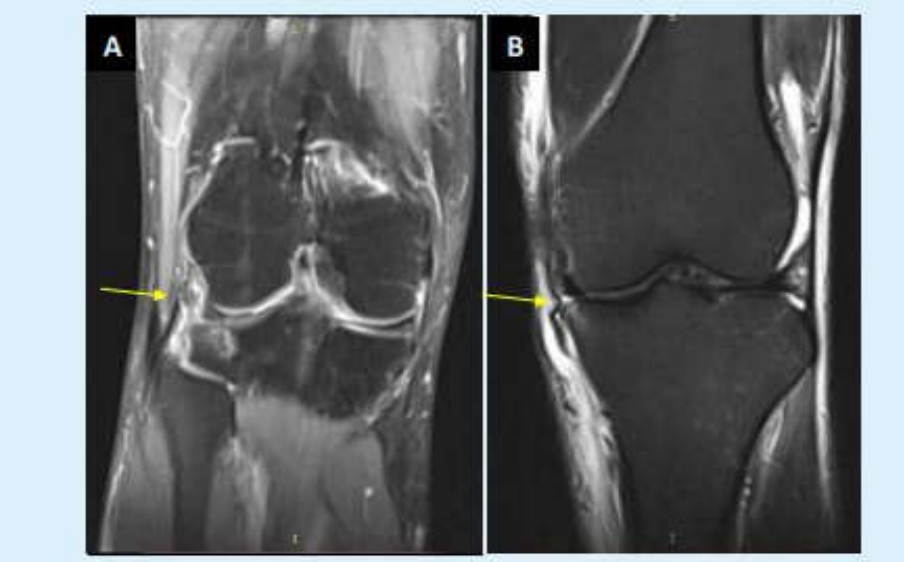


Fig. 6. A - Grade II LCL tear (arrow) on PD fs cor image, B – Grade III tear of MCL seen as complete disruption of fibres (arrow) on STIR COR images

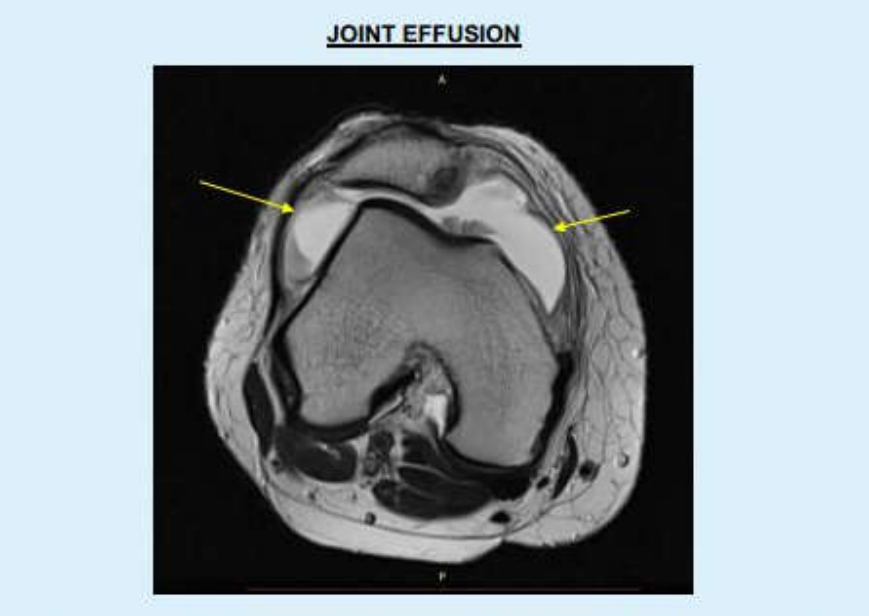


Fig. 7. Joint effusion

CT scan and arthrography. As per literature even arthroscopy cannot detect grade I and II injuries, which are evaluated on MRI (Crues *et al*., 1987). Anterior cruciate ligament (ACL) tears were observed in 48 patients (53.33%). In this study, these were second most common ligamentous tears. Anterior cruciate ligament tears were graded as partial tears and complete tears. Partial tears were graded as low-grade partial tears and high-grade partial tears. Similar grading was done by Hong *et al*. (2003) who in their study graded the severity of the ACL injury using a 4-point system from MRI, viz. intact, low-grade partial tear, high-grade partial tear, and complete tear and they compared the results with arthroscopic findings. In thus study, Partial tear was seen in 28 (58.33%) patients and complete tear was seen in 20 (41.66%) patients. Low-grade partial tear was seen in 18 (37.50%) patients and high-grade partial tear in 10 (20.83%) patients. Singh *et al*. (2004) in their series of 173 patients, 78 patients (45.08%) showed ACL tears, among these 52 (66.67%) were partial and 16 (20.51%) were complete and 10 (12.82%) cases showed non visualization of ACL. The authors concluded that ACL tears are more common than other ligamentous injuries with partial tears being more common. Our findings correlated with observations of this study. Segond's avulsion fracture seen involving proximal lateral tibia, was seen in two patients with ACL tears in this study. Weber *et al*. (1991) in their study observed high association of ACL tears and Segond fractures. Hence, they concluded that MRI signs suggestive of a Segond's fracture may be considered as indirect evidence for tears of ACL. Out of total 48 patients with ACL tear, 40patient were having associated joint effusion and 22 patients were having associated bone contusions. Bone fractures associated with ACL tears involved lateral tibial plateau / condyle in 5 patients, medial tibial plateau / condyle in 3 patients and lateral femoral condyle in 1 patient.

Robertson *et al*. (1994) in their study of 103 patients found that discontinuity of the ACL in the sagittal and axial planes was the most accurate and reliable sign of an ACL tear.

Posterolateral tibia contusion found in association with ACL tear had sensitivity of 53%, specificity of 97% and accuracy of 79%. Lateral femoral contusion associated with ACL tear had a sensitivity of 47%, specificity of 97% and 76 % of accuracy. The presence of joint effusion with ACL tear had a sensitivity of 9%, specificity of 73% and an accuracy of 47%. In this study of 90 patients, posterior cruciate ligament tear was seen in 11 (12.22%) patients. Out of these tear 2 were complete tears and 9 were partial tears. PCL tears were much less common than ACL tears. All complete PCL tears were associated with history of trauma. PCL avulsion fracture was seen in 2 patients. Grover *et al*. (1990) studied 610 consecutive MRI examinations with suspected internal derangements of the knee, emphasizing on posterior cruciate ligament tears. They observed PCL tear in 11 patients having different grades of tears on MRI, which were confirmed on arthroscopy. They found normal PCL on arthroscopy or surgery in patients in whom MRI examination was normal. Hence, they concluded that MRI as reliable method for the detection of PCL injuries. Singh *et al*. (2004) in their study of 173 patients found 78 patients (45.08%) with ACL tears and 10 patients (50.78%) with PCL tears. These findings were similar to our study findings.

Medial collateral ligament tears were seen in 29 (32.22%) patients out of total 90 patients included in the study. Out of these 17 were grade I, 8 were grade II and 4 were grade III tears. Bone contusion was associated in 15 patients, which were more commonly located medially involving medial femoral condyle and tibial condyle / plateau. These findings were in similar to study done by Rasenberg *et al*. (1995), who in their study observed 14 patients had a Grade I MCL tear, 4 had Grade II and 2 patients had a Grade III tear on MRI. Bone contusion was associated in 3 patients. Schweitzer (1995) in their study of 76 patients found that maximum number of patients with MCL tears belonged to grade II. This was in contradiction to our study. In their study, bone contusion was associated in 24% of patients with MCL tears and located more medially involving femur. Our study findings were consistent with these observations. Lateral collateral ligament tears were seen in 12 (13.33%) patients. Out of these, 8 were grade I LCL tears, 3 were grade II and 1 was grade III. LCL tears were less common than MCL tears. All patients with ligamentous injuries were evaluated for associated joint effusion. We graded various ligamentous injuries and classified associated joint effusion in two categories as less than 10 mm and more than 10 mm in lateral suprapatellar pouch. These cut off values were taken from previously documented studies evaluating joint effusion. Kolman (2003) in their study concluded that anteroposterior measurement of 10 mm or less in the lateral aspect of the suprapatellar pouch is a reasonable threshold value for distinguishing a physiologic from a pathologic amount of joint fluid. They also found that knees in which MRI examinations demonstrate no significant effusion are most often free of internal derangement. Similarly our study found that higher grades of ligamentous injuries were associated with joint effusion of anteroposterior measurement of 10 mm or more in the lateral of the suprapatellar pouch.

Conclusion

MRI is excellent non-invasive modality for evaluation and grading of meniscal and ligamentous injuries of knee joint. Joint effusion of more than 10 mm in lateral supra-patellar pouch was associated with higher grades of ligamentous injuries. However, a study with larger sample size is needed to establish standard cut off value for joint effusion and differentiate between physiological and pathological joint effusion.

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