ORIGINAL RESEARCH

MRI evaluation of Internal Derangement Of Knee Joint And Comparison with Diagnostic arthroscopy– A Prospective Study

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Received: 23 June, 2023 Accepted: 28 July, 2023

ABSTRACT

Objective: To evaluate the role of MRI in patients clinically suspected to have internal derangement of knee joint and to compare the MRI results with Arthroscopy. **Methods**: This prospective study was conducted in Department of Radiodiagnosis, Geetanjali Medical college and hospital, Udaipur, Rajasthan. Patients referred from orthopedic and other OPD with suspected internal derangement (IDK) of the knee were investigated with MRI. Total 100 patients were included in the study. After completion of MRI examination, arthroscopy was performed in cases wherever it was indicated. Arthroscopy was used as a gold standard and findings of these 100 cases were compared with MRI **Results:** It was found that MRI has a diagnostic accuracy of 90%, 90%, 93.5%, 100% and 74.4% for detecting medial meniscus, lateral meniscus, and anterior cruciate, posterior cruciate and osteochondral injuries respectively. **Conclusion**: MRI has a high diagnostic value in the diagnosis of meniscal and cruciate injuries. MRI is highly accurate in diagnosis of complete ACL tear and PCL tear. MRI is less sensitive than arthroscopy in detecting early chondral injuries.

Keywords: MRI knee, internal derangement of knee(IDK), knee arthroscopy.

INTRODUCTION

Internal Derangement of Knee (IDK) is the term used for a group of disorders involving disruption of the normal functioning of the ligaments or cartilages (menisci) of the knee joint. In the settingof injuryto knee, it is not alwayspossible to diagnose themeniscal or ligamentous injury clinically as the clinical tests have their limitations.Arthroscopy, considered as the gold standard, is invasive, expensive and requires day surgery admission. In today's era it has become a therapeutic surgical procedure, rather than a diagnostic tool.

MRI is currently gold standard non-invasive diagnostic imaging modality of choice for nearly all clinical indications concerning the knee. MRI provides excellent visualization of the internal structures of the knee along with soft tissue structures and bone marrow abnormalities.

MATERIALS AND METHODS

This prospective study designed to evaluate 100 patients, who were referred to our department with strong clinical suspicion of internal derangements of knee joint, –underwent MRI evaluation of knee followed by arthroscopy in selected cases, wherever indicated. Patients with neoplasm, inflammatory or infectious disorders and patients who had previously undergone arthroscopy with repair of ligaments & menisci were excluded from study. After completion of MRI examination, arthroscopy was performed in cases wherever it indicated. Arthroscopy was used as a gold standard and MRI findings of these cases were compared with MRI.

OBSERVATIONS AND RESULTS

Present study is a prospective clinical hospital based study comprising 100 patients of suspected internal derangements of knee joint (IDK). Arthroscopy evaluation was performed in 31 patients.

Most common age group of patients presenting with IDK was from 21-30 years, constituting 31% with mean age 24.3 years. Males were majority (76 %).

Pain was most common presenting complaint followed by swelling, constituting 79% and54% respectively. Patients presented with overlapping symptoms in most of the cases. On clinical examination, most common positive clinical test was McMurray's test seen positive in 48% of cases followed by Lachman's Test constituting 26% of patients**.**

Our study reveal that the meniscal tear was the most common cause of IDK followed by cruciate ligament injuries (tTable-1)

S.NO.	LESION	NO.OF CASES	%OF CASES
1.	MEDIALMENISCALTEAR	**49**	**49%**
2.	LATERALMENISCALTEAR	**18**	**18%**
3.	ANTERIORCRUCIATELIGAMENTTEAR	**32**	**32%**
4.	POSTERIORCRUCIATELIGAMENTTEAR	**7**	**7%**
5.	MEDIALCOLLETERALLIGAMENTTEAR	**11**	**11%**
6.	LATERALCOLLETERALLIGAMENTTEAR	**5**	**5%**
7.	CARTILAGEDEFECT	**19**	**19%**
Table1:Lesions comprising internal derangement of knee joint			

MEDIAL MENISCAL INJURES

Out of 100 patients of IDK, 67(67%) patients had meniscal tear. Of these, 49(73%) patients had medial meniscal tear and 18 (27%) patients had lateral meniscal tear. Out of 49 medial meniscal tears, 32(66%) involved posterior horn, 3(5%) involved anterior horn, 6 (12%) involved body and 8(16%) involved entire meniscus. Out of 49 medial meniscal tears,8(22.2%) were classified as grade 1, 8(10.2%), as grade 2 and 30(73.4%) as grade 3 (Fig.1).Out of 36 grade-3medialmeniscal tears, 9 (25%)tears were classified as horizontal tears, 4(11.1%)as vertical, and15(41.6%) complex tears, 3(8.3%) bucket handle, 3(8.3%)radial tearand2(5.5%)as flaptear (Fig.2) (tTable-2).

Arthroscopy was performed in 31patients. Preoperative MRI of these patients showed grade-3 medial meniscal tears in 17 patients. On arthroscopy medial meniscal tears found in 16 patients. 2 cases diagnosed as tear on MRI found to be normal on arthroscopy (false positive) and 1 case which was normal on MRI found to be torn on arthroscopy (false negative). In our study the positive predictive value , negative predictive value, sensitivity, specificity and accuracy for detecting medial meniscal tears were 88%, 92%, 88%, 86% and 90% respectively.

SLNO	TYPEOF TEAR	NO.OF CASES	%OF CASES
1.	HORIZONTAL	**9**	**25%**
2.	VERTICAL	**4**	**11.1%**
3.	COMPLEX	**15**	**41.6%**
4.	RADIAL	**3**	**8.3%**
5.	BUCKETHANDLE	**3**	**8.3%**
6.	FLAP	**2**	**5.5%**
	TOTAL	**36**	
Table 2: Distribution of morphological types of medial meniscal tears			

LATERAL MENISCAL INJURIES

Lateral meniscal tears were reported in 18(18%) out of these, 12 (66.6%) were involved posterior horn, 1(5.5%) anterior horn, 3(16.6%) body and 2 (11.1%) involving entire meniscus. Of the 18 lateral meniscal tears, grade-3 was most common (15 tears, 83.3%)following2(11.1%)asgrade1tearand1(5.5%)asg rade2.Ofthe15grade-3lateral

meniscal tears, 2 (13.3%) were classified as horizontal, 6(40%) vertical, 3(20%) complex, 2(13.3%) bucket handle tear, 1(6.6%) radial tear and 1(6.6%) as flap tear (Table-3). Arthroscopy was performed in 31 patients. Preoperative MRI of these patients reported grade -3 tears in 6. On arthroscopy, lateral meniscal tears found in 5 patients. 2 cases diagnosed as tear on MRI found converted to normal on arthroscopy(false positive) and 1case which was normal on MRI found to be torn on arthroscopy (false negative). In our study the positive predictive value , negative predictive value, sensitivity, specificity and accuracyfor detecting lateralmeniscal tearswere 66.6%, 96%, 92%, 88% and 90% respectively.

SLNO	TYPEOF TEAR	NO.OF CASES	%OF CASES
1.	HORIZONTAL	**2**	**13.3%**
2.	VERTICAL	**6**	**40%**
3.	COMPLEX	**3**	**20%**
4.	RADIAL	**1**	**6.6%**

5.	BUCKETHANDLE	**2**	**13.3%**
6.	FLAP	**1**	**6.6%**
	TOTAL	**15**	
Table 3: Distribution of morphological types of lateral meniscal tears			

CRUCIATE LIGAMENT INJURIES

Out of 100 patients ofIDK, 39(39%) patients had cruciate ligament tear. 32 (82%) had ACL tears and only 7 (18%) had PCL tear. Out of 32 ACL tear, 25 (78%) were classified as complete tear and 7(22%) as partial tear (Fig.3). 11(34.3%) of ACL tears were located in proximal segment, 17 (53.2%) in mid substance and4 (12.5%) in distal segment of ligament. Arthroscopy was performed in 31 patients. Preoperative MRI reported ACL tear in 14, and 13 patients proven as tear on arthroscopy.1 was normal on arthroscopy (false positive) and 1 case which were normal on MRI found to be torn on arthroscopy (false negative).Hence PPV, NPV, sensitivity, specificity andaccuracy for detecting anterior cruciate ligament tears were 92.8%, 94.1%, 92.8%, 94.1% and 93.5% respectively.

Of the 7 PCL tear, 3(42.8%) were classified as complete ligament tear, 1 (14.4%) as partial ligament tear and 3(42.8%) tibial avulsion (Fig. 4). Arthroscopy was performed in 31 patients. Preoperative MRI revealed posterior cruciate ligament tears in 2patients, both of them found torn on arthroscopy. The PPV, NPV, sensitivity, specificity and accuracy in our study for detecting PCL tears were 100%.

CHONDRAL INJURIES

Chondral defect were found in 19/100(19%) patients.Arthroscopy was performed in 31 patients. Preoperative MRI reported chondral defects in 7 patients. On arthroscopy chondral defects found in 9 patients. 3 cases diagnosed as defect on MRI found to be normal on arthroscopy (false positive) and 5cases which was normal on MRI found to be injured on arthroscopy (false negative). The PPV, NPV, sensitivity, specificity and accuracy for detecting chondral defects were 57%, 79%, 44.4%, 86% and 74.4% respectively.

COLLATERAL LIGAMENT INJURIES

MCL tear (11%) was more common than LCL tear (5%). Out of 11 patients of MCL tear, 4 (36%) classified as grade 1tear, 5 (45%) as grade 2 tear and2 (18%) as grade 3 tears (Fig.5). out of5LCL tear , 1 classified as grade-1 ,1 as grade-2 and 3 tears as grade 3. O' Donoghue's triad (ACL with medial meniscal and MCL tear) was seen in 1 patient.

OTHER ASSOCIATED FINDINGS

Joint effusion (73%) was the most common associated finding with bone contusion/marrowoedema seen in 17patients followed by fracture of bone seen in 9patients(Table- 4). Muscle injuries were seen in 6 patients. Popliteus muscle was most commonly injured. Patellar retinaculum tears were seen in 4 patients and patellar tendon tears were seen in 2 patients. Meniscal cystwasseenin2 patients and all they involved the posterior horn of lateral meniscus. 2 patients had popliteal cyst (Baker's cyst). Discoid meniscus was present in 2 patients (Fig.6).

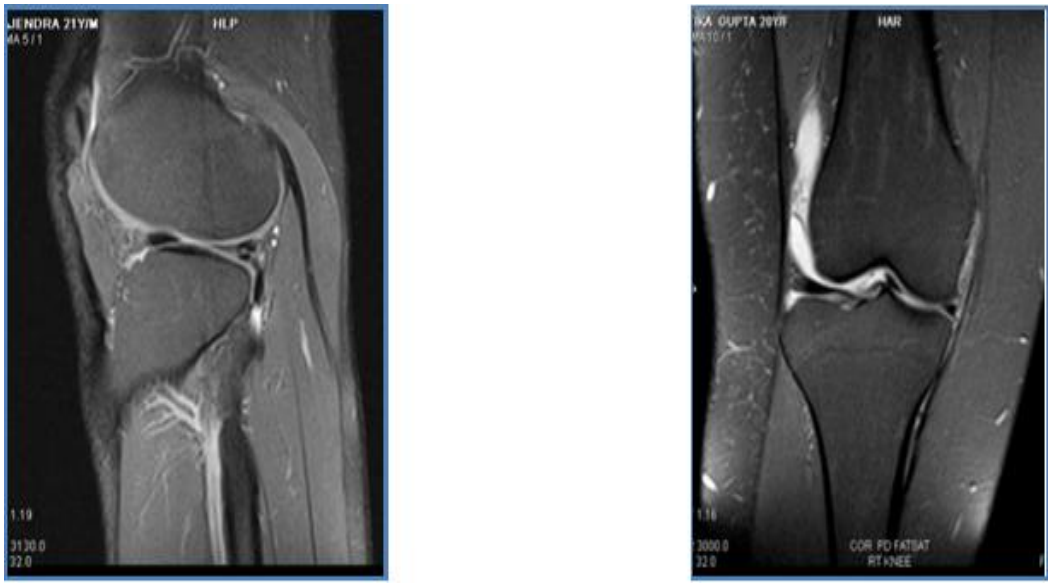
SLNO	LESION	NO.OF CASES	%OF CASES
1.	JOINTEFFUSION	73	73%
2.	FRACTURE	9	9%
3.	MARROWOEDEMA	17	17%
4.	MUSCLECONTUSION	6	6%
5.	PATELLARRETINACULUMTEAR	4	4%
6.	PATELLARTENDONTEAR	2	2%
7.	MUCOIDDEGENRATIONOFACL	3	3%
8.	DISCOID MENISCUS	2	2%
9.	CYSTIC LESIONS	4	4%
Table 4: Distribution of other associated Findings			

Fig.1: MENISCAL TEARS GRADING

GRADEI(SAGPDFAT SAT) **GRADEII(SAGPDFATSAT)** **GRADEIII(SAGPDFATSAT)**

Fig.2: MENISCAL TEARS–MORPHOLOGICAL TYPES

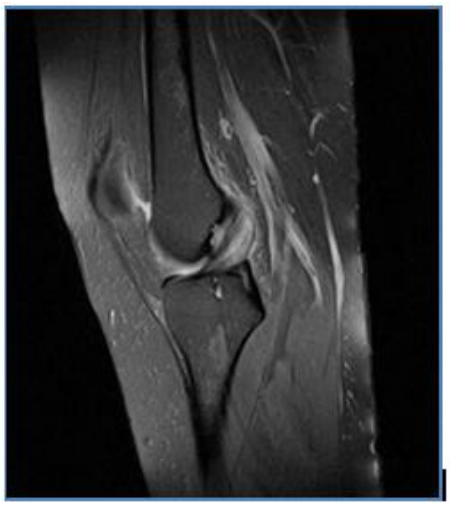
HORIZONTALTEAR(CORPDFATSAT) **RADIALTEAR(SAGPDFATSAT)**



COMPLEX TEAR(SAGPDFAT SAT) **BUCKET HANDLE TEAR(CORPDFATSAT)**

Fig.3:ACLTEAR

PARTIAL

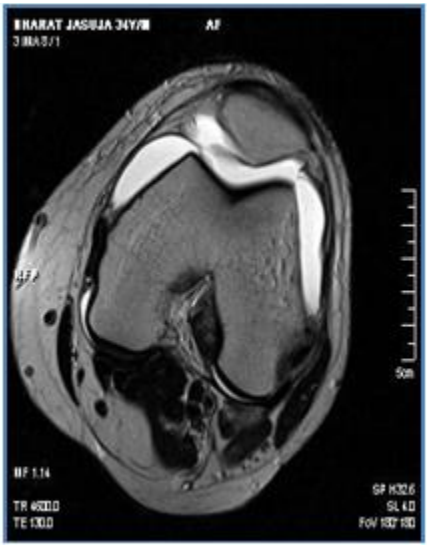


(SAGPDFAT SAT)

(OBLCORONALT2WI)

COMPLETE

(SAGPDFAT SAT)



(OBLCORONALT2WI)

Fig.4: PCL TEAR

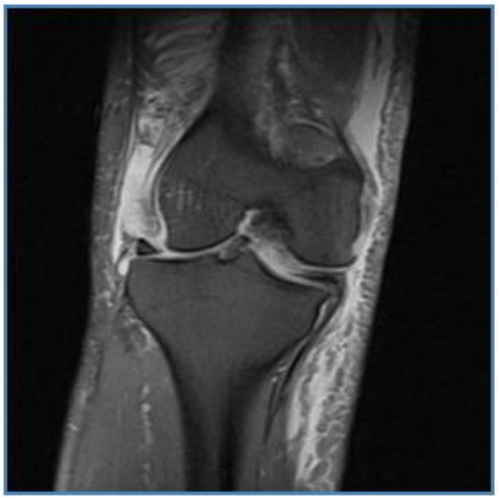
PARTIAL(SAGPD)

COMPLETE(SAGPDFATSAT)

AVULSION(SAGPDFATSAT)

Fig.5: COLLATERAL LIGAMENT TEAR

LCLTEAR(CORPDFATSAT)



MCLTEAR(CORPDFATSAT)

Fig.6: DISCOID MENISCUS(CORONAL PDF AT SAT)

DISCUSSION

Knee joint being the most complex weight bearing joint of the body is subject todamagebecauseofits inherentstructuralcomplexityandthe various typesof forces itis subjectedto. Disease processes and injuries that disrupt ligaments, menisci, articular cartilage and otherstructures of the knee cause significant morbidity and disability. MRI has emerged as the frontline investigation for evaluation of IDK. In this study, we attempt to demonstrate diagnostic value of MRI in IDK including various most common injuries of knee and were results compared with the arthroscopy findings.

This is a hospital based prospective study included 100 patients. Most of the patients were adults (20-40 yrs). Similar observations were seen by Vassilios S Nikolaou et al[1].

In our study, most common cause of IDK was meniscal tear. The medial meniscus was most commonly found torned, because MM is less mobile, and it bears more force during weight bearing than the LM. Most of the meniscal tear were located in posterior horn. Crues et al[2] in their study also found meniscal tears involving the posterior horns which accounts for 57% compared to the 16% involving the anterior horn. Weiss et al[3] also reported meniscal tears involving the posterior horn accounting for 50%-60% and tears involving the anterior horn accounting for 5%- 20% .DSmet etal also found same result in their study. Most common morphological meniscal tear was complex type followed by horizontal. This is similar to thestudybyDeSmet etal[4], intheirstudyofMM tearsin343 patients found complex type of medial meniscus tear as a most common 116 patients.

In our study, 2 false positive MRI involved the posterior horn of the medial meniscus. On retrospective analysis of MRI it was found that in one case, presence of intra-meniscal tear was not communicating with the articular surface of the meniscus and it was misinterpreted as grade-3 meniscal tear. In second case, the exact cause of the false positives diagnosis of tear was not apparent. It may be attributed to the misinterpretation of normal meniscofemoral ligament as meniscal tear or operator/procedure dependant drawback of arthroscopy. This is similar to the study by McKenzie et al[5] who described the four most common reasons for false positive diagnosis; wrong diagnosis due to variable anatomic structures, over estimation of pathology countered as meniscus tear, false negative

arthroscopic findings and tears within the meniscus without expansion to the articular surface. On retrospective analysis of MRI in one false negative case it was found that the signal intensity of the tear was misinterpreted to reflect a transverse ligament. This is similar to the observation seen by Mesgarzadeb et al[6].Another Study which was conducted by McKenzie et al[5] stated that false negative results exclusively occurred from misinterpretation of MRI.

The posterior horn was most commonly found torned in LM tears with vertical morphologically type. This is similar to the study by Naranje S et al[7] in their study; they found vertical type of lateral meniscus tear as a most common tear (53%) in all LM tears.

In our study, the two false positive MRI involved the posterior horn of the LM. On retrospective analysis of MRI, it was found that in one case, presence of menisco femoral ligament was misinterpreted as meniscal tear. In second case, the hiatus of the popliteus tendon was mistaken as the tear.Similar observations were seen by Mesgarzadeb et al[6] in their study. On retrospective analysis of MRI in one false negative case, it was found that the signal intensity of the tear was communicating with the articular surface of the meniscus and it was misinterpreted as grade-2 meniscal tear. This is similar to the observation seen by McKenzie et al[5].

The ACL was more common ligament found injuredthan PCL because PCL is thick and strong. This is similar to the study by Vassilios S et al[1] in their study of 26 patients with cruciate ligament tear; they found ACL tears in 23 (88%) patients and PCLtear in 3 (12%) patients. J. P. Singh et al[8] also found same results in their study. In ACL tears complete tear were more common than partial tear.Mostofthecompletetears werelocatedinmidsubstanceofligament.This is similartothestudy by J. P. Singh et al[8] in their study of 78 patients with ACL; they found anterior cruciate ligament tears most commonly located in mid substance of the ligament (67%). In our study, the one false positive case diagnosed on MRI as partial tear of anterior cruciate ligament. On retrospective analysis of MRI abnormal signal intensity was seen within the ligament with intact fibers. Vassilios S et al[1] observed that abnormal signal in the ligament, in absence of tear may occur due to intra body mucosal or eosinophilic degeneration of the ACL.

On retrospective analysis of MRI in one false negative case it was found that abnormal signal intensity of the ligament misinterpreted as mucoid degeneration of the ACL, but on arthroscopy chronic degenerated partial tear was seen with in the ligament. Patrice W J Vincken et al[9] showed that MRI has relatively less accuracy in diagnosis of partial ACL tear.

In posterior cruciate ligament injuries, tibial avulsion was the most common injury. These results are in concordance with the observations seen by J S Grover et al[10]. In our study thediagnosticaccuracyfordetecting PCLtears was 100%. This is similartothestudyof JS Groveretal[10] and C W Heron et al[11] who found 100% sensitivity and specificity of MRI in diagnosis of PCL.

Chondral defects were seen in one fifth of the patients; however diagnostic accuracy of MRI was lower for chondral injuries in comparison to the meniscal and cruciate ligament injuries. In our study the diagnostic accuracy for detecting chondral defects was 74.4% which was corresponding to the study of Ochi M et al[12] and Vassilios S et al[1] who found accuracy of MRI significantly inferior in the diagnosis of chondral lesions. Heron et al[11] described that MRI can satisfactory reveal the advanced chondral defects as well as damages at the patellar articular cartilage, but is not accuratefor smaller injuries like fibrilization or small fissuring in articular hyaline cartilage.

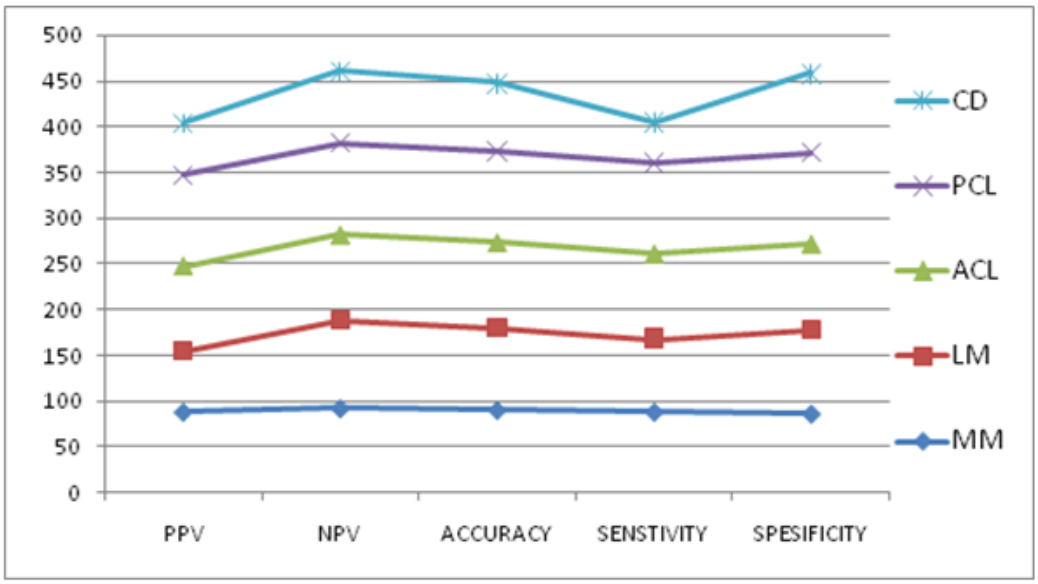
In collateral ligaments tears, in our study, MCL tears (11%) were found to be more common than the LCL tear (5%). All these cases had history of trauma and were associated with multiple injuries. This suggests presence of a single injury should prompt the examiner to look for other subtle associated injuries, which was further confirmed by Mink JH et al[13]. They observed on MRI and arthroscopy of 11 patients who had tear of ACL, 7 patients had tear of MCL, 4 patients had tear of lateral meniscus and 1 patient had tear of medial meniscus.

Joint effusion was associated with most of the positive cases. Bone marrow edema was the most common associated osseous injury. Pattern of bony injury was associated with specific type of injury in many patients. 7 patients with injury of the posterolateral tibial plateau and 4 patients with lateral femoral condoyle found to be associated with ACL tear. This is similar to the observation seen by Robertson et al[14] in their study of multiple signs of anterior cruciate ligament on MR imaging in 103 patients found that posterolateral tibia bruise associated with ACL tear had 53% sensitivity, 97% specificity and 79% accuracy. The presence of lateral femoral bruise with ACL tear had a sensitivity of 47%, specificity of 97% and an accuracy of 76%.

Overall MRI has high diagnostic value in the diagnosis of meniscal and cruciate injuries(table- 5). MRI is advantageous in conditions where arthroscopy is not useful like peripheral meniscal tears and inferior surface tears. MRI is more sensitive in detection of multiple meniscal tears that may be overlooked on arthroscopy. MRI is more sensitive than arthroscopy in detection of grade I and II intra substance degeneration, precursors to formation of meniscal tears. Many anatomic variants can mimic tears on MRI and false diagnosis can be made due to misinterpretation of these variant. MRI is highly accurate in diagnosis of complete ACL tear and PCL tear however it is less sensitive than arthroscopy in detecting partial ACL tears and early chondral injuries.

TestAccuracy	Medial Meniscus	Lateral meniscus	ACL	PCL	Chondral defect
Positive predictive value	88%	66.6%	92.8%	100%	57%
Negative predictive value	92%	96%	94.1%	100%	79.1%
Accuracy	90%	90%	93.5%	100%	74.15
Sensitivity	88%	80%	92.8%	100%	44.4%
Specificity	86%	92%	94.1%	100%	86%

Table 5: Distribution of diagnostic accuracy of MRI in various injuries



CONCLUSION

MRI is a useful non-invasive modality having high sensitivity, specificity and accuracy in the diagnosis of meniscal and cruciate ligament injuries. MRI should be done in every patient of suspected internal derangement of knee joint, to save a patient from unnecessary arthroscopy. Sonow diagnostic arthroscopyhas no roleinthe managementofinternal derangementof knee joint and arthroscopy should be performed only for therapeutic purposes.

ABBREVIATION

MRI- Magnetic resonance imaging, IDK- internal derangement of knee, MM- medial meniscus, LM- lateral meniscus , PCL- posterior longitudinal ligament, ACL- anterior cruciateligament, LCL- lateral collateral ligament, MCL- medial collateral ligament, CD- chondral defect, PPV- positive predictive value, NPV- negative predictive value.

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