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MRI - A Diagnostic Tool in the Evaluation of Internal Derangements of Knee Joint

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Abstract: ***Internal derangement of knee joint is the major source of morbidity in patients attending orthopaedic outpatients department of our hospital. It constitutes a group of disorders due to disruption of normal functioning of ligaments and menisci of knee joint leading to both persistent or intermittent signs and symptoms such as pain, instability, or abnormal mobility of the knee. MRI would be an noninvasive nonoperator dependent effective modality for early detection of these pathologies and has very high negative predictive value. MRI of knee would save us many unnecessary diagnostic arthroscopy, which is an invasive procedure with associated risks. With pivotal role played by MRI, Arthroscopy could be used mainly for therapeutic purposes. The purpose of this study was to evaluate the usefulness of MRI in early and precise diagnosis of internal derangement of knee. Identification of indirect signs of tear of ligaments and menisci would increase the sensitivity of detection.***

Keywords: Internal Derangement, Arthroscopy, ligaments, menisci.

1. Introduction

Knee being one of the major joints involved in kinesis, also bears the consequences of increased mobility. The price of its mobility is a tendency to instability. With increasing involvement in sports related activities especially in young people, trauma related knee pathologies have increased.

MRI has emerged as an excellent modality for imaging of ligaments, cartilage, menisci and other structures around the knee joint.[1] This is due to the combination of multiplanar capability and superior soft tissue characterization. This modality has superseded already available modalities like radiograph and CT, over last two decades.

It is a non invasive diagnostic modality that lacks the radiation issues associated with radiograph and CT and is non-operator dependent unlike ultrasound.

2. Methodology

Source of Data

A prospective observational study was performed in the department of radiodiagnosis, GEMS & HOSPITAL, Ragolu, on patients referred from orthopaedic department over a period of six months.
Sample size: Fifty cases

Inclusion Criteria

1. Patients presenting with painful or unstable knee joint with or without other associated symptomatology.
2. Any age group.
3. Both male and female patients.

Exclusion Criteria

1. Patients who has been operated previously on the same knee.
2. Any absolute contraindication for MRI.

They were evaluated with clinical examinations and were subsequently subjected to imaging of knee using 1.5 T GE MRI machine.

Imaging Protocol Used

Sequences used were axial, sagittal and coronal PD Fat Sat; sagittal, axial and coronal T2 FSE and sagittal T1 FSE.

3. Results

Data of 50 patients were analyzed in this study.

Ligamentous Tears

Tears of various ligaments around the knee were identified involving either a single ligament or combination of ligaments. ACL tear was seen in 29 (45.3%), PCL tear in 5 (7.8%), MCL tear in 16 (25%) and LCL tear in 14 (21.8%) of cases.

ACL Tears

ACL tears were imaged in total of 29 cases. Complete tear of ACL was detected in 19 cases and partial tear in 10. Associated LCL tears were identified in 13 cases (45%) and MCL tears in 10 cases (35%).

ACL tears were associated with tear of posterior cruciate ligament in 4 cases.

All of these had history of significant trauma.

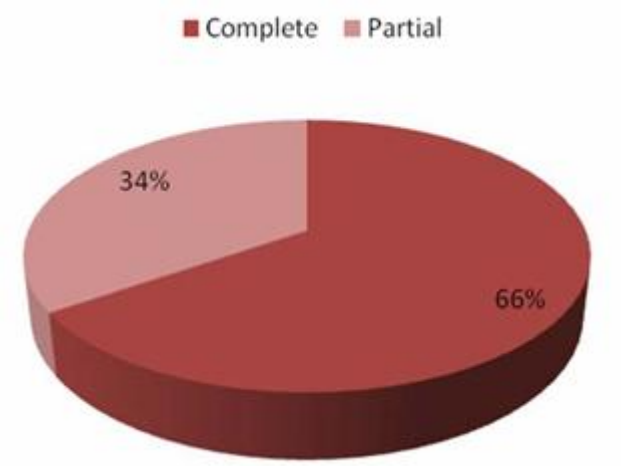

Figure A: Pie chart depicting types of ACL tear

Association with joint effusion was noticed in 67%. Bone contusion was associated in 72% of ACL tears. Bony contusions of lateral compartment structures were noted in 20 cases (69%).

86% of cases with Positive Lachman's test had complete ACL tears on MR. In 14% of cases, ACL tear were not suspected clinically on Lachman's test but was detected on MR these were all cases of partial ACL tears.

Indirect signs of ACL tear in the form of Objective criteria such as Sagittal ACL – Tibial angle, Blumensaat line – ACL angle, PCL angle and anterior tibial displacement were used.

The mean Sagittal ACL – Tibial angle was 41º in case of partial ACL tear while the mean was only 23º in complete ACL tears.

The mean Blumensaat line – ACL angle was + 3º in partial ACL tear and was

+ 27º in complete ACL tears.

The mean PCL angle was 123º in partial ACL tear and more acute angled with a mean angle of 106º in complete ACL tears.

Mean anterior tibial displacement measured 6mm in partial ACL tear and 9mm in complete ACL tears.

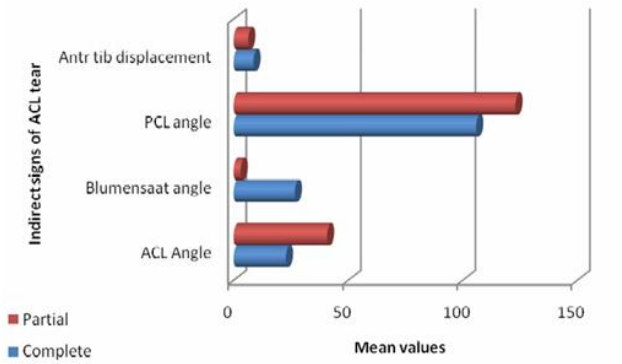

Figure B: Indirect signs of ACL tear

PCL Tear

PCL tear was found in 5 cases. Complete tear was found in 3 and partial tear in 2 cases.

Associated ACL tear was found in 4 cases (80%). MCL injury was found in 3 and LCL injuries in 3.

Bone contusions were seen in 4 cases (80%) and involved lateral aspect of tibia in all cases.

Joint effusion was present in all the case of PCL tear.

Meniscal Tears

Meniscal tears were found in 50 cases with medial meniscus involved in 31 and lateral meniscus in 19. Of the total cases with meniscal tears, 17 (47%) were isolated medial meniscal, 5 (14%) were isolated lateral meniscal and 14 (39%) involved both menisci.

In **Medial Meniscus**, Posterior horn was involved in 20 (65%) and the predominant type of tear in posterior horn was oblique tear that occurred in 10 (50%). Also the commonest type of tear involving anterior horn was also oblique tear. The commonest type of tear to involve the whole of meniscus was bucket handle tear.

Grade III tear were the commonest seen in 13 cases (42%) followed by Grade II in 29%.

In **lateral meniscus**, also posterior horn was commonest site of involvement, occurring in 10 (53%). Predominant type of tear was radial and was seen in 4 (21%). Oblique tears predominantly involved the posterior horn of lateral meniscus. In contrast to medial meniscus, bucket handle tears of lateral meniscus spared the anterior horn. Two cases of meniscocapsular separation was seen and involved posterior horn of lateral meniscus. Horizontal tears involved the anterior horn more than posterior horn.

Grade III tears were common in both medial and lateral menisci followed by Grade II tears. 44% of meniscal tear were of Grade III and 30% were Grade II. Least common grades of tear were Grade IV tear in medial meniscus and Grade I tear in lateral meniscus.

Table 8: Grades of meniscal tears

GRADES OF TEAR	MEDIAL MENISCUS	LATERAL MENISCUS	TOTAL PERCENTAGE
GRADE I	5	1	12%
GRADE II	9	6	30%
GRADE III	13	9	44%
GRADE IV	4	3	14%

Superior Meniscopopliteal fascicle was disrupted in 82% of lateral meniscal tear. But in two cases of disruption of Meniscopopliteal fascicle, lateral meniscal tear was not found.

4. Discussion

Disruption of various ligaments and cartilage around the knee joint leads to significant morbidity, especially in young adults involved with sporting activities.

Invent of MR imaging and it's increasing use in musculoskeletal imaging has revolutionized the understanding of pathologies around knee joint. It has replaced radiographs and CT in evaluation of ligamentous and meniscal pathologies. It is an non-invasive technique that do not require contrast administration and is not operator dependant.

Many studies have been published on sensitivity and specificity of MRI in identifying ligamentous and meniscal pathologies and imaging features compared with arthroscopy or surgical findings. These have suggested MR to be an effective tool for evaluation of knee joint.

This study included 50 patients who were clinically suspected as having some form of internal derangement of knee. In study done by Mink et al.[2] midsubstance tear was demonstrated in 90% of ACL tears. The indirect signs of ACL tears were analyzed.

Amilcare Gentili et al.[3] performed an retrospective study to establish the sensitivity and specificity of indirect signs of ACL tears on MR. They reported a sensitivity and specificity were as follows; 90%, 97% for ACL angle < 45º; 89%, 100% for Blumensaat – ACL angle > 15º; 52%, 94% for PCL angle <107º and 41%, 91% for anterior displacement of tibia > 7 mm. Presence of these indirect signs corroborated the presence of ACL tear in our study.

It is crucial to identify posterolateral corner injuries as unrecognized posterolateral injuries have been suggested as a cause of chronic instability of the knee after trauma and post-surgical failure of the cruciate ligaments.[4]

The results of PCL disruption were comparable to the study done by William Rodriguez et al.[5] on 34 patients with surgically proven PCL tear, which showed mean PCL thickness of 9.6 mm in case of torn ligament. Thus the injury to PCL was less common when compared to ACL.

Sonin et al.[6] reported high incidence of bone bruise in association with PCL tear ranging from 32 to 83%. Mair et al.[7] found bone bruise in 83% of PCL tear and commonest pattern was tibial contusion, similar to results of our study.

In a study done by Mark Schweitzer et al.[8] showed that medial femoral bruises are more commonly associated with MCL tear in contradiction to our study which showed that lateral femoral bruise is more commonly associated with MCL.

Meniscal tear was diagnosed by either an area of abnormal signal within the meniscus on at least one image that extended to the meniscal articular surface, or abnormal morphology of the meniscus. If the abnormal signal extends to the articular surface on two or more images, the sensitivity for a meniscal tear increases from 56% to 94% medially and from 30% to 90% laterally JJee et al.[10] reported prevalence of torn posterior horn of medial meniscus to be about 56%. Anterior horn tear was found in 3% of cases in our study which is comparable to the study done by De Smet et al.[9] that showed involvement of anterior horn of medial meniscus in 2% of cases. Grade III tear were the commonest seen in 13 cases (42%) followed by Grade II in 29%.

Helms et al.[11] reported that 10% of tears of medial meniscus were of bucket handle type. Our study also found similar occurrence of bucket handle tears (9.5%). MR has a sensitivity of 27% to 44% and a specificity of 98% to 100% in detecting bucket-handle tears.[12]

Studies done by Wright et al.[13] emphasized the importance of MR imaging in reliable identification of meniscal displacements and fragments. Displaced meniscal fragments are often clinically significant lesions requiring surgical intervention and therefore are important to identify. Displaced meniscal injuries can occur in both the medial and lateral meniscus and include flap tears, bucket-handle tears, and free fragment displacement.

According to Lynn K Lecas et al.[14] MR imaging is a sensitive, noninvasive method of detection of meniscal tears and their displaced fragments. MR imaging may also help in preoperative planning and may facilitate the detection of inferiorly displaced fragments that might have gone unnoticed during surgery.

Study done by Blankenbaker et al.[15] on 121 patients which compared MR findings with arthroscopy, suggested that abnormal fascicle is highly associated with a lateral meniscal tear but not specific for a tear.

Fascicle abnormalities are associated with lateral meniscal tears because the biomechanic forces that tear the meniscus also cause disruption of the fascicles.

Tears of the posterior meniscal root can be easily missed because of inconsistent clinical symptoms and can be overlooked without thorough arthroscopic examination. Retrospective study conducted by So Yeon Lee et al.[16] concluded that MRI of the knee is reliable and accurate for detection of radial tears of the medial meniscal root and Coronal T2-weighted imaging was the most useful MRI sequence.

Radial tears are crucial to be identified on MR as precise description of this type of tear can alert the clinician and allow better preoperative planning. Jee WH et al.[10] emphasized that the ability to preoperatively identify such patients suitable for meniscal repair would be ideal.

In this study, 60% of Bucket handle tears involved medial meniscus and 40% the lateral meniscus. But other studies have shown 2:1 ratio of medial-to-lateral involvement in bucket-handle tears.[14] The displaced fragment could be seen as fragment in notch, double PCL or flipped meniscus sign. The double PCL sign is a highly specific indicator of a bucket- handle tear, with a specificity range of 98%–100% and a positive predictive value of 93%.[17] However the sensitivity of MR imaging for the diagnosis of bucket handle tears is lower than that for other meniscal tears.

5. Conclusion

MR imaging of knee joint complements clinical examination and arthroscopy by providing a noninvasive, painless, and morbidity-free modality for accurate preoperative anatomic assessment that is well accepted by patients. MR imaging when done in conjunction with clinical examination would thus be the best pre-arthroscopic diagnostic modality. It has replaced unnecessary diagnostic arthroscopy and complements therapeutic arthroscopy.

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Image Gallery

Figure 1: Sag PDFS showing hyperintense signal with complete disruption of fibres - complete ACL tear.

Figure 2: Sag T2 showing complete discontinuity of fibres- Complete ACL tear.

Figure 3: Sag PDFS showing linear hyperintensity in anterior horn of medial meniscus – Vertical tear.

Figure 4: Sag PDFS showing bucket handle tear of medial meniscus and effusion extending into suprapatellar space.

Figure 5: Sag PDFS showing complete disruption of fibres in posterior cruciate ligament - Complete PCL tear.

Figure 6: Coronal STIR showing bone marrow edema in lateral femoral condyle