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A PROSPECTIVE CROSS-SECTIONAL STUDY ON MRI EVALUATION OF INTERNAL DERANGEMENTS OF THE KNEE JOINT

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Abstract

Introduction: Internal derangements of knee joint constitute a major source of morbidity in patients attending orthopaedic outpatients department of our hospital. It includes a group of disorders due to disruption of normal functioning of ligaments and menisci of knee joint leading to persistent or intermittent signs and symptoms such as pain, instability, or abnormal mobility of the knee. MRI would be a noninvasive, nonoperator dependent effective modality for early detection of these pathologies and has very high negative predictive value.

Material and Methods: The study was carried out over a period of one year from April 2018 to April 2019. Fifty patients with clinically suspected internal derangement of knee were included in this prospective study. They were evaluated with detailed clinical history and clinical examinations and were subsequently subjected to imaging of knee using 1.5 T HDxt 8 Channel GE MRI machine.

Results: ACL was the commonest ligament to be injured with partial tear being more common than complete tear. MCL was the commonest ligament to be torn in association with ACL. Indirect signs of ACL injury were evaluated and helped to corroborate the tears. Meniscal injury was common in medial meniscus and predominantly involved the posterior horn. In lateral meniscus anterior horn was involved more than posterior horn. In both the meniscus horizontal tear was the most common. Certain pattern of associations of injuries was found such as ACL tear with posterolateral corner injury.

Interpretation and Conclusion: MR is an excellent tool for evaluation of ligaments, menisci and osseous structures of knee joint. Various clinical tests and appropriate clinical history complements MR examination. Similarly MR imaging of knee complements therapeutic arthroscopies and would greatly reduce the need of diagnostic arthroscopies. Thus MR is a non-invasive, painless and morbidity-free modality for accurate preoperative assessment that is well accepted by patients.

Introduction

The knee joint is a bicondylar (saddle) type of synovial and weight bearing joint. Internal derangements of the knee is a blanket term used to cover a group of disorders involving tear of the normal functioning of the ligaments or cartilages.

Trauma to knee joint is a significant cause of morbidity in young active individuals associated with sports, especially in contact sports like football. MRI has emerged as an excellent modality for imaging of ligaments, cartilage, menisci and other structures around the knee joint.[1] Multiplanar MR images provide significant improvement in assessing these structures and is being used for pre and postoperative evaluation. A MRI also has limitations. The MRI is sensitive for the diagnosis of medial meniscal tears and anterior cruciate ligament tears but has lower sensitivity for injuries to the lateral meniscus, medial collateral ligament, patellar retinaculum, and articular cartilage.[2-5]

This modality has superseded already available modalities like plain radiograph and CT, over last two decades. This study was designed to explore the role of MRI in the clinical diagnostic routine for internal derangement of the knee at a teaching hospital in the state of Gujarat in Western India.

Aims and Objectives

1. To identify the various MRI imaging findings in clinically suspected cases of internal derangement of knee.
2. To correlate imaging findings with clinical examination findings.
3. To identify and assess indirect signs of ACL and lateral meniscal tears.

Material and Methods:

The study was conducted at Government Medical College and Sir Takhatsinhji Hospital, Bhavnagar, which is a teaching institute in the government sector of Gujarat State in western India, after taking permission from

Institutional Review Board (IRB) Human ethical committee (HEC), Government Medical College, Bhavnagar. The study was carried out over a period of one year from April 2018 to April 2019. The study utilized an observational type & cross sectional study design. The study group included a sample size of 50 patients selected by a purposive sampling. The data were analyzed by a descriptive analysis. A complete clinical history of the patients were taken with particular reference to the clinically suspected or diagnosed cases of the internal derangements of the knee joint after taking the informed consent of the patients. Patients with ferromagnetic implants, pacemakers and aneurysm clips were excluded from the study. 1.5 T HDxt 8 Channel GE MRI machine was used for knee joint.

Sequences used were axial, sagittal and coronal PD Fat sat; sagittal and axial T2 FSE, coronal T1 FSE and 2D MERGE. Data were initially entered into a MS Excel spreadsheet and then exported into statistical software for analysis. The frequency distribution of categorical variables was expressed as proportions and proportions for continuous variables were determined.

Results

Data of 50 patients were analyzed in this study in patients who were presenting with complaints of knee pain, swelling, limitation of movements and instability.

There were 37 males (74%) and 13 females (26%) in this study. Male patients exceeded the number of female patients in all the age groups. The age group ranged from 15 to 70 years with mean age of 30.4 years. Maximum patients (58%) were in the age group of 15-30 years and only 42% were more than 45 years.

Definite history of acute trauma (within six weeks) preceded the symptomatology in 43 cases (86%).73% of males and 61.5% of females belonged to acute traumatic group. Other 14% of patients had a history of remote trauma or belonged to non-traumatic group.

ACL tear was seen in 35(63.63%), PCL tear in 08(14.56%), MCL tear in 7 (12.81%) and LCL tear in 5 (9%) of cases. ACL tears were imaged in total of 35 cases. Complete tear of ACL was detected in 15 cases (42.85%) and partial tear in 20 cases (57.14%).

Avulsion injury of ACL seen in 5 cases.

Associated LCL tears were identified in 4 cases and MCL tears in 6 cases. ACL tears were associated with tear of posterior cruciate ligament in 4 cases.

Almost all of cases with Positive Lachman's test had complete ACL tears on MR. In 18% of cases, ACL tear were not suspected clinically on Lachman's test but was detected on MR. The mean Sagittal ACL – Tibial angle was 45º in case of partial ACL tear, while the mean was only 34.4º in complete ACL tears. PCL tear was found in 8 cases. Complete tear was found in 2 cases and partial tear in 6 cases. Associated ACL tear was found in 5 cases. MCL injury was found in 2 cases and LCL injury in 1 case. Posterior drawer test was positive in two cases of complete PCL tear and was not demonstrated in 6 cases of partial tears. Of the total cases with meniscal tears 29 (59.18%) were isolated medial meniscal, 13(26.53%) were isolated lateral meniscal and 7 (14.29%) involved both menisci. In Medial Meniscus, Posterior horn was involved in 28 (96.55%), one case of body of medial meniscus affection and the predominant type of tear in posterior horn was horizontal tear that occurred in 25 (86.2%).

The commonest type of tear to involve the whole of meniscus was horizontal tear. Grade II tear were the commonest seen in 21 cases (72.41%) followed by Grade III in 5 cases (17.24%), Grade I in 3 cases (10.34%).Total 13 cases of lateral meniscus tears seen. Predominant type of tear was horizontal and was seen in 11 cases (84.64%).Grade II tears were common in both medial and lateral menisci followed by Grade III tears. 63.63% of total meniscal tear were of Grade II and 19.04% were Grade III. Lachman's test was conclusive for ACL tear in 81.08% of cases, posterior drawer test in 75%, Mcmurray's test in 72.41% of medial meniscal tear, 63.63% of lateral meniscal tear, Valgus stress test in 79.31% of MCL tear and Varus stress test in 92.30% of LCL tears.

Other associated findings were chondromalacia patellae in 3 cases. Osgood-Schlatter disease in one case was seen. One case of Osteochondritis dissecans (OCD) at the posterior aspect of lateral femoral condyle was noted. One case of osteochondral defect(stage IV) at the inferomedial patellar body associated with grade III injury of medial patella-femoral ligament vastus medialis obliquus(MPFL-VMO complex)associated with recent patellar dislocation was found. One case of trochlear dysplasia type A was seen. One case of bone infarcts in tibia, infective bursitis in suprapatellar and infrapatellar bursa associated with ganglion cyst of PCL with interstitial tear of ACL, Fibrous cortical defect (FCD), patellar osteomyelitis, patella alta was found. Associated Osteoarthritic (OA) changes were found more in old aged patients. One case of low grade partial tear in medial patellar retinaculum associated with moderate suprapatellar and minimal knee joint effusion was noted. Lipohemarthrosis associated with comminuted fracture of upper tibial condyle, both plateau, intercondylar eminence was found.

Table 1: Ligament injury

LIGAMENT INJURY	NUMBER	PERCENTAGE
ACL	35	63.63%
PCL	8	14.56%
MCL	7	12.81%
LCL	5	9%

Table 2: Frequency of ACL tears

ACL TEAR	NUMBER	PERCENTAGE
COMPLETE	15	42.85%
PARTIAL	20	57.14%

Table 3: Frequency of PCL Tears

ACL TEAR	NUMBER	PERCENTAGE
COMPLETE	02	25%
PARTIAL	06	75%

Table 4: Site and type of tear-medial meniscus

TYPES OF TEAR	ANTERIOR HORN	ROOT	BODY	POSTERIOR HORN
OBLIQUE	0	0	0	3
HORIZONTAL	0	0	2	20
BUCKETHANDLE	0	0	0	0
RADIAL	0	0	0	1
COMPLEX	0	2	2	0
FLAP	0	0	0	1

Table 5: Site and type of tear-lateral meniscus

TYPES OF TEAR	ANTERIOR HORN	ROOT	BODY	POSTEOR HORN
OBLIQUE	0	0	0	0
HORIZONTAL	6	0	3	5
BUCKET HANDLE	0	0	0	0
RADIAL	0	0	0	0
COMPLEX	0	1	0	0
FLAP	1	0	1	0

Table 6: Grades of meniscal tears

GRADE	MEDIAL MENISCUS	LATERAL MENISCUS	PERCENTAGE
Grade I	3	1	9.52%
Grade II	21	7	66.7%
Grade III	5	3	19.04%
Grade IV	0	0	0%

Figure 1: Sagittal PD fat image showing complete midgrade ACL Tear

Figure 2: Sagittal PD fat image showing complete PCL tear

Figure 3: Coronal PD fat image showing Medial Meniscus grade II tear of posterior horn of medial meniscus

Figure 4: Coronal PD fat image showing posterior horn and body of lateral meniscus tear

Discussion

Disruption of various ligaments and cartilage around the knee joint leads to significant morbidity, especially in

young adults involved with sporting activities.73% of males and 61.5% of females belonged to acute traumatic group. In a study done by Majewski et al.[6] acute traumatic injuries of knee were common in age group of 20-29 and 70% of them were male. In our study acute traumatic injury to knee was found in 73% of males as well. In this study ligamentous injury was seen in 96%. Of them 63.63% had ACL injury, 14.56% had PCL injury, 12.81% had MCL injury and 9% had LCL injuries.

Of the 35 cases of ACL tears, 42.85% was complete tear and partial tear in 57.15% cases. 88% of the complete ACL tears involved the midsubstance. In a study done by Mink et al.[7] midsubstance tear was demonstrated in 90% of ACL tears. Amilcare Gentili et al.[8] performed an retrospective study to establish the sensitivity and specificity of indirect signs of ACL tears on MR. They reported 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 translation of tibia > 7 mm. Presence of these indirect signs corroborated the presence of ACL tear in our study.

Associated posterolateral corner injury was seen in 60% of ACL tears. LCL injuries and bony contusions involving lateral femoral and tibial structures. 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.[9]

Complete ACL tears were suspected clinically by positive Lachman test and confirmed on MR examination. Study done by Malanga et al.[10] on physical examination of knee demonstrated that the Lachman test is sensitive and specific for the detection of anterior cruciate ligament tears. Similar results were found in our study also. Injury to PCL was noted in 8 cases. All eight cases had increased intrasubstance signal intensity of ligament. In six cases continuity of the ligament was maintained but showed increased thickness in anteroposterior diameter. The mean PCL thickness was 9 mm in these cases. Two patients had definite disruption of continuity of PCL. These results are comparable to the study done by William Rodriguez et al.[11] 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. Bone bruise was found in 37.5% of PCL tears. Sonin et al[12] reported high incidence of bone bruise in association with PCL tear ranging from 32 to 83%. Bone contusions were seen in 37.5% of PCL tears and predominantly involved the lateral and anterior tibial surface in all the cases. Mair et al[13] found bone bruise in 83% of PCL tear and commonest pattern was tibial contusion, similar to results of our study. Associated bony bruise was noted in 83.33% of cases. Lateral femoral bruise was found in 50% and medial femoral bruise was found in 0% of cases in association with MCL injury. Tibial bruise was found in 83.33% of cases.

This was in contradistinction to the study done by Mark Schweitzer et al[14] that showed that medial femoral bruises are more commonly associated with MCL tear. Lateral compartment injuries are less common than medial compartment injuries. LCL injuries were found in 9% of cases in our study. Associated tear of capsule was not seen and popliteus myotendinous injury in 01 case. O'Donoghue's triad (combination of ACL, MCL and medial meniscus tear) was not seen. Mcmurray's test was conclusive in 72.41% of medial meniscal tear, 63.63% of lateral meniscal tear, Valgus stress test in 79.31% of MCL tear and Varus stress test in 92.30% of LCL tears. According to Malanga et al[10]although collateral ligament testing seems to be sensitive and specific, there is a lack of well-designed studies that scientifically validate the sensitivity and specificity of these tests. Meniscal tears were found in 42 cases with medial meniscus involved in 29 and lateral meniscus in 13 cases. Of the total cases with meniscal tears 29 were isolated medial Meniscal, 13 were isolated lateral meniscal and 7 involved both menisci.

Medial meniscus was commoner to get torn as it is a less mobile structure and transmits more force during weight bearing. In Medial Meniscus, Posterior horn was involved in 28 (96.55%), Jee et al[15] reported prevalence of torn posterior horn of medial meniscus to be about 56%. Anterior horn tear was found in 0 case in our study which is comparable to the study done by De Smet et al[16] 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%.

Various types of medial meniscal tears detected in this study were horizontal tear 22 cases (70.96%), oblique tear 3 cases (9.70%), bucket handle 0 case (0%), radial tear 1 case (3.22%) and complex tears 4 cases (12.90%) and flap tear in 1 case(3.22%). Helms et al[17] reported that 10% of tears of medial meniscus were of bucket handle type. Our study found no occurrence of bucket handle tears. MR has a sensitivity of 27% to 44% and a specificity of 98% to 100% in detecting bucket-handle tears.

Studies done by Wright et al[18] 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. A definite indication for MR in clinically suspected meniscal tears are the identification of the meniscal flap. It is important because arthroscopy may be necessary for its removal or

reattachment. When located inferomedial to the tibial plateau and deep in relation to the medial collateral ligament, these fragments may become an arthroscopic pitfall when the fragment is unapparent until probed with a hook. According to Lynn K Lecas et al[19].MR imaging is a sensitive, noninvasive method of detection of meniscal tears and their displaced fragments. Superior menisco-popliteal fascicle was assessed in cases of lateral meniscal injuries. Disruption of superior menisco-popliteal fascicle was not noted in lateral meniscal tear in our study. Study done by Blankenbaker et al[20] 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.

Root tear was found in 3 cases of meniscal tear. One case of medial meniscal root tear (33.3%) and two cases of lateral meniscal root tear (66.7%). 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[21] 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.

Conclusion

MR examination is a non-invasive and precise diagnostic technique to evaluate ligamentous and other soft tissue structures around the knee. Most of the injuries to ligaments and menisci can be diagnosed with increased level of confidence. Anatomical variants, artefacts and other pitfalls of imaging should be cautiously interpreted and differentiated from pathological entities. Currently, MR imaging has evolved as the most commonly performed radiologic test in the assessment of intraarticular knee abnormalities especially in traumatic settings.

Although arthroscopy has revolutionized the diagnosis and treatment of knee disorders, most orthopaedicians acknowledge the invasiveness of the procedure; limitations in evaluation of extra-articular pathology; cost and uncommon but potential complications associated with the procedure. They acknowledge the accurate diagnostic imaging complementing their clinical evaluation and providing a global intra-articular and extra-articular assessment of the knee.

Clinicians utilize MR imaging to support non-surgical management or to confirm injuries that benefit from arthroscopic or open surgical treatment.

Summary

MR imaging of knee joint complements clinical examination and arthroscopy by providing a non-invasive, 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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