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Role of MRI in Evaluating Traumatic Knee Injuries

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ABSTRACT
The knee joint is a biggest joint of the human body with complex articulation characterized by the presence of ligamentous and meniscal structures that play an important role in the stability and mobility. MRI due to its excellent soft tissue contrast resolution and multi planar imaging capabilities provides significant advantages over other imaging techniques in the evaluation of traumatic injuries of knee joint. Study aimed to study the role of MRI in the evaluation of traumatic injuries of knee joint. A total number of 100 patients referred with history of knee injury were imaged with 1.5 Tesla Gesigna HdxII MRI machine in the department of radiology over a period of 18 months. Commonest injuries detected in the study are anterior cruciate ligament tear, tear of posterior horn of medial meniscus, bone contusions and joint effusions. Clinical presentation and radiographs of the patient did not help in diagnosis in most of the cases of acute knee injury, especially in multiple ligament and bone injuries. MRI detected soft tissue injuries very well in addition to the bony injuries. Magnetic resonance imaging is the excellent non invasive investigation tool for knee injury due to excellent soft tissue contrast resolution and multi planar imaging capabilities which provides the most detailed evaluation in cases of various soft tissue injuries of knee joint.

INTRODUCTION

A common reason for referring a patient to an orthopaedic surgeon is ligamentous injury of the knee. An accurate method for assessing the collateral and cruciate ligament integrity is magnetic resonance imaging (MRI). The identification of a ligamentous injury can be aided by a number of direct and indirect MRI findings. This article will focus mainly on indirect indicators, like bone bruising and osteochondral fractures. The ability of MRI to differentiate between partial and complete ruptures and also assess the knee for related injuries is what makes MRI valuable[1]. The most frequent reason to do MRI of the knee is to discover meniscal tears[2], which has been demonstrated in certain studies to be more accurate than a physical examination[3,4]. Because of its high negative predictive value[5], magnetic resonance imaging (MRI) can help rule out conditions that could clinically resemble meniscal tears and prevent needless diagnostic arthroscopy[6]. Most notably, MRI provides significant information on the location, size and structure of meniscal tears, all of which will impact the course of treatment[3]. Its major advantages over other imaging techniques include its ability to evaluate soft tissue features and bone features in several imaging planes. It also provides good soft tissue contrast for better assessment. The procedure is non-invasive and radiation-free, offering a true "lesional mapping" experience. Additionally, MRI has shown to be a cost-effective method by lowering needless arthrosporic and surgical procedures[1].The purpose of the study was to examine the function of MRI in the assessment of severe knee injuries.

MATERIALS AND METHODS

A total of 50 patients referred with history of knee injury were imaged with 1.5 Tesla GE-signa HdxII MRI machine in the department of radiology over a period of 8 months. It was a cross sectional study and total of 50 patients fulfilling the inclusion criteria were studied. Patients were referred from Outpatient department of tertiary care centre with history of knee injury.

Inclusion Criteria:
• Patients referred with history of knee injury.

Exclusion Criteria:
• All patients who were not willing to participate in the study.
• Patients with ferromagnetic implants, pacemakers, cochlear implants and aneurismal clips.
• Degenerative arthritis, infection, neoplasm and any previous surgery to knee.

The ethical clearance was obtained from Ethics committee of Sree Mookambika Institute of Medical Sciences. Patients fulfilling the selection criteria were informed about the purpose and type of study and were enrolled after obtaining a written informed consent. The sample size was calculated using the formula $N=Z^2 PQ/d^2$ and using prevalence as 15%(posterior cruciate ligament) in a study done by Rajesh Umap[7].

The Statistical Analysis: Data collected was coded and entered into Microsoft Excel Worksheet. The categorical data was expressed as rate, ratio, proportion and percentages.

RESULTS AND DISCUSSIONS

This observational study was done at Department of Radiology, Sree Mookambika Institute of Medical Sciences with duration of 8 months, aiming at evaluating the role of MRI in all type of knee injuries. A total of 50 patients with history of injury to knee joint were studied. Majority of the patients were males(60%) and females were 40% with male to female ratio of 1.5: 1. The commonest age group was 30 to 45years for male and 45-65 years for females. The mean age group of the patients was 40.52±16.02 years, the mean age of male was 36.7±14.4 years and female was 46.25±17.3 years.

Table 1: Routine Mr Imaging Protocol: Knee(Volume Surface Phased Array) Coil.

Sequence	Fat Saturation	FOV (cm)	Matrix	TR (ms)	TE (ms)	Slice thickness /Gap(mm)
COR T1	No	16	256x224	1000	7.4	3/0
AX T1	No	16	256x224	1000	7.4	3/0
SAG T2 FS	No	16	256x224	5140	88	3/0
COR T2 FS	No	16	256x224	3000	72	3/0
COR STIR Intermediate	Yes	16	224x160	4480	52	3/0
PD AX Intermediate	Yes	16	224x192	4480	26	3/0
PD SAG Intermediate	Yes	16	224x192	4480	26	3/0
PD COR	Yes	16	224x192	4480	26	3/0
SAG 3D GRE	Yes	16	256x160	12	5	3/0

Fig. 1: SSAG T2W and SAG PDFS Images Depicting Complete ACL Tear(Red Arrows)

Fig. 2: SAG PDPS Images Showing Horizontal Tear of Anterior Horn of Medial Meniscus (Red Arrow) with Para Meniscal Cyst(Yellow Arrow)

Fig. 3: SAG T2W and SAG PDFS Image Showing Bucket Handle Tear of Medial Meniscus with Double PCL Sign(Red Arrows)
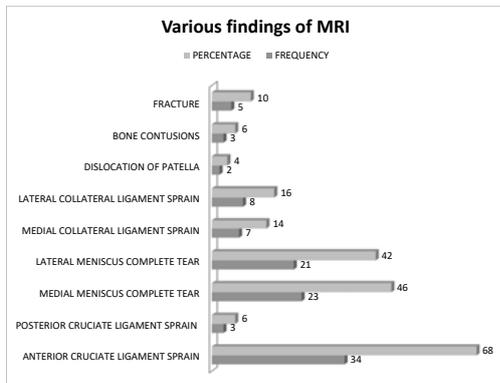

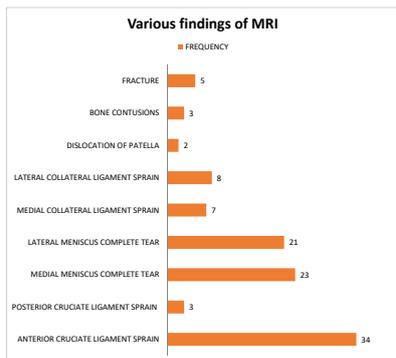Fig. 4: Various Findings in 50 Patients

Fig 5: Various Findings with MRI of 50 Patients

Clinical presentation of the patients did not help in diagnosis in majority of the cases of acute knee injury especially in multiple ligament injuries. Among the knee injuries, the most commonly affected structure were Anterior cruciate ligament (68%) followed by medial meniscus(46%), lateral meniscus(42%), lateral collateral ligament(16%), medial collateral ligament(14%), posterior cruciate ligament(6%), dislocation of patella(4%), bone contusions(6%) and fracture(10%) in (fig. 1). Out of 34 ACL injuries, sprain was the commonest(32.4%) followed by complete tear(23.5%), grade I(8.8%) and grade II(8.8%) injury, Partial ACL tear(8.8%), Intra substance tear(5.9%), complex tear(5.9%) and chronic injury(5.9%). Commonest location of tear in menisci was horizontal tear in posterior horn(52.2%) followed by bucket handle tear(34.8%), grade I injury (26.1%) and vertical tear(8.7%). Commonest type of lateral meniscus pathology was horizontal tear(26.1%), vertical tear(26.1%), grade I injury(21.7%), complex tear(17.4%) and transient lateral patellar dislocation(8.7%).

Table 2: Age Distribution of Study Participants

Age distribution	Frequency(N)	Percentage(%)
15-20	10	20
21-30	5	10
31-40	4	8
41-50	19	38
51-60	5	10
61-70	7	14

Table 3: Sex Distribution

Sex	Frequency(N)	Percentage(%)
Male	30	60
Female	20	40

Table 4: Distribution of ACL, PCL Involvement Among Study Participants

Anterior Cruciate Ligament (34/50)	Frequency(N)	Percentage(%)
Sprain	11	32.4
Grade I injury	3	8.8
Grade II tear	3	8.8
Complete tear	8	23.5
Complex tear	2	5.9
Intrasubstance tear	2	5.9
Partial ACL tear	3	8.8
Chronic injury	2	5.9
Posterior Cruciate Ligament(3/50)		
Posterior cruciate ligament sprain	3	6

Table 5: Distribution of Medial and Lateral Meniscus Involvement Among Study Participants

Lateral Meniscus (23/50)	Frequency(N)	Percentage(%)
Horizontal tear	6	26.1
Vertical tear	6	26.1
Complex tear	4	17.4
Transient lateral patellar dislocation	2	8.7
Grade I injury	5	21.7
Medial Meniscus (23/50)		
Grade I	6	26.1
Horizontal tear in posterior horn	12	52.2
Vertical tear	2	8.7
Bucket handle tear	8	34.8

Table 6: Distribution of MCL and ACL Involvement Among Study Participants

Medial Collateral Ligament(7/50)	Frequency	Percentage
Grade I	5	71.4
Complex tear	2	28.6
Lateral Collateral Ligament (8/50)		
Grade I	6	75
Complex tear	2	25

Commonest type of medial collateral ligament pathology was grade I injury(71.4%) followed by complex tear(28.6%). Commonest type of injury in lateral collateral ligament was grade I(75%) followed by complex tear(25%). Patellar dislocation was noted in 2(8.7%) patients. Communited fracture at posterior aspect of medial condyle was seen in 3(40%) patients, bone infarct in 2 cases and bone marrow oedema/contusion in 3(60%). From the present study, it was noted that MRI was most comprehensive, non-invasive and safe modality in radiological evaluation of knee injury. The knee joint is intricate both anatomically and biomechanically. The diagnosis of internal abnormalities in a knee injury is the most frequent reason for a knee MRI. Out of total 100 patients, major cause of knee joint trauma was road traffic accident(32%), followed by fall (31%), sports injury (27%) and twisting injury (10%). In the present study, there was a wide variation with patients presenting complaints and MRI diagnosis. The clinical diagnosis of anterior cruciate ligament injury was noted in 42% of the study population, followed by meniscal injury (27%). The MRI findings noted were anterior cruciate ligament injury (68%), followed by medial meniscal injury (46%), lateral meniscus (42%), lateral collateral ligament (16%), medial collateral ligament (14%), posterior cruciate ligament (6%), dislocation of patella(4%), bone contusions(6%) and fracture(10%). According to a study by Li DK *et al.*, we discovered that the clinical presentation was inconclusive in cases with multiple ligament/meniscal injuries and did not aid in diagnosis in the majority of acute knee injury cases. Males outnumbered females in the current study, with 60% of patients being male and 40% being female. The male to female ratio was 1.5:1and the mean age for males was 36.7 years, while the mean age for females was 46.2 years. These findings were consistent with the sex distribution pattern reported in studies by Anil Madurwar[8]., in which the authors noted that, of the 50 patients with knee trauma examined, 42 patients (76%) were male and 8 of them were female and Singh[9], in which the authors noted that, of the 173 patients with a history of knee injuries, 113 men (65.31%) and 60 women

(34.69%). The study conducted by D S Shetty[10] found that, of the 115 patients, 70 (60.86%) were men and 45 (39.14%) were women, with a male to female ratio of 6.4:1. This pattern of sex distribution was likewise consistent with the findings of that study. According to a 2017 study by Jeevika Mu *et al,* of 43 individuals, men (84%) are more likely than females (16%) to be affected. In this study the patients with age 0-70 years with history of knee injury were included. Different age group included i.e. 10-20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years and 61-70 years. The commonest age group was 40-50 years in male, which comprised 36.75% of the male patients. Less commonly involved age group includes 21-30 years and more than 60 years. The mean age was 36.75 years. The commonest age group was 40-50 years in female which comprised 40% of the female patients. The next common age group was 60-70 years with 25% of the female patients 15% for the age of 10-20 years and 10% for the age group 21-30 years and above 60 years. The mean age was 46.25 years for female. The age distribution pattern observed in the present study was not comparable to the study of D S Shetty[10] in which commonest age group was 21-30 years for both males and females. Singh et al also found that majority of the patients with knee injury were in third decade. In this present study, the commonest age group was 40-50 years in males and females which was not comparable to the above mentioned studies. Anterior Cruciate Ligament sprain and tear (Partial and Complete) was the most common finding on MRI scanning and was present in 68% of the patients in our study. This was in line with a study by Anil Madurwar[8]. in which the authors noted 36 (76%) ACL tears in a total of 50 knees examined on MRI. The most common tear was complete tear, accounting for 23.5% of the patients, followed by grade II tear 8.8%, complex (2%) and Intrasubstance tear (2%). The study found that the most common type of knee injury was ACL injury, with complete tears being the most common location for ACL tears. Singh *et al.* found that the most common type of complete ACL tear was midsubstance tears. Low grade partial ACL tears were observed in 47.4% of patients and high grade partial ACL tears in 21% of patients with ACL injuries. Additionally, grade I sprains were observed in 6.6% of patients with ACL injuries. These findings were not comparable to the present study. Out of total 50 patients, % of PCL injuries detected was 6%. Out of 6%, only sprain was detected in 6% of cases. These findings were almost close to

study done by Anil Madurwar *et al.,* D J Singh[9] and Shetty[10], with PCL tear of 6%, 5% and 4.4% respectively. Out of 50 patients, horizontal tear and vertical tear were most common in both menisci. Among menisci, medial menisci(46%) was commonly injured followed by lateral menisci(42%). Posterior horn of both menisci were commonly injured among both menisci. Some of the tears located in one part were noted extending to other parts of meniscus. Horizontal tear was commonest (52.2%) followed by bucket handle tear (34.8%), vertical tear (8.7%) and grade I (26.1%) in medial meniscus. Commonest type of tear in lateral meniscus was horizontal tear (26.1%) and vertical tear(26.1%) followed by complex tear (17.4%), grade I (21.7%). Transient lateral patellar dislocation was noted in 2 patients. The meniscal injury pattern seen in this study was similar to that of D S Shetty[10], which found that the posterior horn of the medial meniscus is the most common meniscal injury. Singh *et al.* also discovered that the posterior horn of the medial meniscus is the most common meniscal injury. Jeevika[11]. also discovered that medial meniscal tears (46.5%) were more common among meniscal injuries than lateral meniscus (37.2%) and that the posterior horn of the medial meniscus (55%) is the most common site of involvement. Out of 50 patients, 8 had medial collateral ligament injuries and out of 8, 6 had grade I and 2 had complex tear. Out of 50 patients, 7 had lateral collateral ligament injuries out of which 5 had grade I and 2 had complex tear. Out of 50 patients, bone contusions were noted in 3(60%) patients which was not comparable to study done by Anil Madurwar[8], where 42% bone contusions was noted. MRI provides vital clinical information that directs patient management and treatment planning. Knee joint MRI improved the diagnosis of ligament and meniscal tears, muscles and tendons injuries, bone contusions, osteochondral injuries, traumatic chondromalacic changes, joint effusion and haemarthrosis. Overall, the results of this study demonstrated that MRI of the knee joint offers a broad diagnostic range for traumatic knee injuries. In patients who report with injuries to the knee joint, this makes it a feasible, widely recognized and accurate non-invasive imaging approach. It is also the modality of choice in clinically suspected cases of soft tissue damage where plain radiographs are normal. Moreover, the best evaluation of ligaments, meniscuses, muscles, tendons, fibrous cartilage, joint capsule, fat bursae and bone marrow is possible with superior soft tissue and multi planar plane imaging. Our study's findings are in favour of using early MRI to suggest additional surgical therapy for knee injuries. The limitation of this study was small sample size.

CONCLUSION

Due to its outstanding contrast resolution and multi planar imaging capabilities, magnetic resonance imaging of the knee is a great non-invasive investigative tool for knee injuries. It offers the most complete evaluation in situations of diverse soft tissue injuries of the knee joint. Clinical signs may point to a soft tissue injury, but an MRI is required for additional assessment. The capacity of MRI to assess bone marrow, articular cartilage, menisci, ligaments and articular capsule makes it special. Even though technological errors and anatomical variations can mimic tear, MRIs are still thought to be the best imaging method for accurately depicting internal derangement of knee injury. The most frequent injuries found in our research were bone contusions, tears in the posterior horn of the medial meniscus and anterior cruciate ligament tears.

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