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ROLE OF MRI IN EVALUATION OF TRAUMATIC KNEE INJURIES AMONG ADULTS; SEE YOUR KNEE BY AN EYE OF A RADIOLOGIST.

Radio-Diagnosis

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ABSTRACT

Introduction: Magnetic Resonance Imaging (MRI) as a non-invasive imaging modality plays a vital role in assessment of a wide spectrum of internal knee derangements. The objective of this study is to characterise the pattern of internal derangement of knee joint using MRI, and determines the patient management.

Method: This study is a tertiary care hospital based prospective diagnostic study which was conducted in the Department of Radio diagnosis, Indira Gandhi Government Medical College and Hospital, Nagpur. This study was conducted over 90 patients who were referred from various referral centres. First Magnetic resonance imaging (MRI) knee was performed and then these patients underwent Arthroscopy. MRI images are studied for evidence of injuries to the cruciate, menisci ligaments, collateral ligaments, tendons around the knee joint, fluid collections, bony contusions and soft tissue injuries.

Results: Out of 90 cases 71 are males 19 are females. Left knee is commonly involved accounting for 55 cases. Right knee is involved in 15 cases. Young patients are maximum in number who suffered from knee injuries which predominantly comprises age group of 21 to 40 years. The most common complaint of patients is pain and instability. Anterior cruciate ligament (ACL) injury is the most common injury followed by Medial meniscus injury.

Interpretation And Conclusion: MRI is an extremely useful imaging modality for evaluation of knee injuries. It gives valuable information to the referring orthopaedician for planning the line of treatment in terms of conservative management or surgery.it is very accurate in detecting both intra and extra articular injuries.

KEYWORDS

Knee, MRI, Injuries, ACL tear, Meniscal Injury

INTRODUCTION

The knee joint is the largest, most superficial and a major weight bearing joint of our body which is primarily a hinge type of synovial joint that allows the flexion and extension movements combined with gliding, rolling and rotation about a vertical axis with mobility and stability during physical activity as well as balance while standing. It is probably one of the most frequently injured joints within the human body. These injuries are often caused by sports activities and may lead to severe pain and disability. Knee injury represents roughly 6% of all acute injuries treated at emergency department. Knee pain is a complaint in 20% of the general adult population and trauma to the knee is 2nd most common occupational accident. Magnetic resonance imaging (MRI), with its multi-planar capabilities and excellent soft tissue contrast, has established itself as the leading modality for non-invasive evaluation of the sports related knee injuries. [1].

Magnetic Resonance Imaging [MRI], a non-invasive modality, is now routinely used to assess a wide spectrum of internal knee derangement. It has gained popularity as a diagnostic tool for evaluation of musculoskeletal disorders and has largely replaced diagnostic arthroscopy for this purpose. The knee injury risk is especially high in the age group of 15 to 25 years, especially in various team sports and ball games. [2]

Potential of MRI in assessing the knee injuries were first reported in 1983 in literature. Imaging of the knee requires excellent contrast, high resolution and the ability to visualize very small structures, all of which can be provided by MR imaging. Additional advantages of MRI are multiplanar and thin section capabilities. It does not utilise ionizing radiation therefore it is entirely safe. The development of enhancement is of increased clinical importance as it has been recently shown that musculoskeletal imaging is a rapidly growing field in MR imaging applications [3].

Use of arthrography and arthroscopy improves the accuracy of diagnosis but both are invasive and cause complications and moreover these techniques require a skilled person for reporting and interpreting the results. [4]. MRI provides excellent spatial and contrast resolution of both intra and extra articular structure. It is used more commonly in the knee trauma comparing with other joints. It is an excellent diagnostic tool and plays an important role in clinical decision making [5].

MRI is an excellent test for diagnosing ligamentous and meniscal injuries and for determining whether surgery is required or if conservative management will suffice and it is also proven to be cost effective. Magnetic resonance imaging has a better soft tissue contrast, bone marrow involvement and multi planar slice capability which makes them ideal modality for imaging complex anatomy of the knee joint [6].

Meniscal injury may be associated with a history of twisting, squatting, or cutting, road traffic accident and amongst young males in the sports field. Medial Meniscus is more commonly injured than lateral meniscus and sometime associated with anterior cruciate ligament tear [7].

The aim of our work is to emphasize the role of magnetic resonance imaging in the assessment of traumatic lesions of the knee joint particularly in adult population.

Primary Objectives

The primary purpose of this study was to describe the role of MRI In the evaluation of traumatic knee injury among the adults.

MATERIALS AND METHODS

Study design: Prospective Study.

Study period: Six months (from June 11, 2021 to January 20, 2022)

Study Site: Department of Radio diagnosis, Indira Gandhi Government Medical College and Hospital, Nagpur.

Sample Collection: From the Department of Orthopaedics IGGMC, GMC and various referrals centres of Nagpur and their neighbouring regions of Vidarbha.

Sample Size: The inflated size was around 45 which is calculated with

the level of significance (α) – 5%, admissive error (d) – 9%. The scope for increasing the number of cases exists depending on the availability of patients within the study period and it is rounded up to 90.

Inclusion Criteria:
Patients of adult population (18-60 years) willing to undergo MRI scanning with traumatic injuries of the knee and consenting for the same.

Exclusion Criteria:
- Uncooperative patients.
- Patients with claustrophobia/ any other psychiatric abnormality.
- Patients not consenting for the study
- Patients on cardiac pace maker/ metal implants/Neuro stimulators.
- Children below 18 yrs.
- Age related degenerative arthrosis of knee joint

Patient Preparation:
No specific preparation unless the patient will be injected with contrast material (whenever indicated), or will receive anaesthesia (sedation in uncooperative patients), then the patient is instructed to fast for 4-6 hours. All metallic objects should be removed from the patient's body. An informed verbal consent from all participants was taken and confidentiality of information was assured. Ethical clearance was obtained from the subject committee and Institutional Review Committee.

Machine:
Siemens Magnetom Skyra (Siemens Healthcare, Erlangen, Germany).

Imaging Protocols Used:
Sequences used- axial, sagittal and coronal sections of PD Fat Sat, T2 FSE and T1 FSE.

Imaging Protocol

SEQUENCE	FOV (cm)	SLICE THICKNESS (mm)	MATRIX	NEX
Axial PD Fat Sat	18	4/skip0.5	320 x 224	2
Sagittal PD Fat Sat	16	4/skip0.5	320 x 224	2
Coronal PD Fat Sat	16	4/skip0.5	320 x 194	4
Axial T2 FSE	18	5/skip 1	320 x 194	4
Sagittal T2 FSE	16	4/skip0.5	320 x 224	2
Coronal T2 FSE	16	4/skip0.5	320 x 224	4
Sagittal T1 FSE	16	4/skip0.5	320 x 224	2

Patient Position:
Supine position and feet first in MR imager, with knee to be imaged in approximately 15-20-degree external rotation to aid the imaging of anterior cruciate ligament in the sagittal plane. Knee was also flexed 5-10 degrees for assessing patellofemoral compartment.

Statistical Analysis:
Data entry, processing and statistical analysis was carried out using MedCalc ver. 18.2.1 (MedCalc, Ostend, Belgium). Tests of significance (Kruskal-Wallis, Wilcoxon's, Chi square, logistic regression analysis, and Spearman's correlation) were used. Data were presented and suitable analysis was done according to the type of data (parametric and non-parametric) obtained for each variable. P values less than 0.05 (5%) was considered to be statistically significant.

Descriptive Statistics:
Mean, Standard deviation (± SD) and range for parametric numerical data, while Median and Inter-quartile range (IQR) for non-parametric numerical data. Frequency and percentage of non-numerical data.

Analytical Statistics:
Kruskal-Wallis test was used to assess the statistical significance of the difference of a non-parametric variable between more than two study groups.

RESULTS AND OBSERVATION:
Interpretation Of Data: the study was evaluated for
1. Age, sex distribution
2. ACL tear – Only edema present
   a. Partial/complete
3. PCL tear - Only edema present
   a. Partial/complete
4. MM tear – Present/Absent
   a. Grade – 1/2/3
   b. Location & Type
5. LM tear - Present/Absent
   a. Grade – 1/2/3
   b. Location & Type
6. MCL tear - Present/Absent
   a. Grade – 1/2/3
7. LCL tear - Present/Absent
   a. Grade – 1/2/3
8. Osteochondral lesions - Present/Absent

Table 1: Age Distribution Of Patients Studied

Age(yrs.)	Number	Percent
<20	5	5.6
21-30	32	35.6
31-40	27	30.0
41-50	22	24.4
50+	4	4.4
Total	90	100.0

Table 2: Sex Distribution Of Patients Studied

Sex	Number	Percent
Female	19	21.1
Male	71	78.9
Total	90	100.0

Table 3: Types Of ACL And PCL Tear

MRI Findings	No Tear	Partial Tear	Complete Tear	Total Number
ACL	37 (41.1%)	41 (45.6%)	12 (13.3%)	90 (100%)
PCL	87 (96.7%)	02 (2.2%)	01 (1.1%)	90 (100%)

Table 4: Grades Of MM, LM, MCL, LCL, MPR & LPR Tear; (medial Meniscus, Lateral Meniscus, Medial Collateral Ligament, Lateral Collateral Ligament, Medial And Lateral Patellar Retinaculum Respectively).

MRI Findings	No Tear	Grade-1	Grade-2	Grade-3	Total Number
MM	18 (20%)	13 (14.4%)	42 (46.7%)	17 (18.9%)	90 (100%)
LM	65 (72.2%)	11 (12.2%)	07 (7.8%)	07 (7.8%)	90 (100%)
MCL	50 (55.6%)	21 (23.3%)	17 (18.9%)	02 (2.2%)	90 (100%)
LCL	78 (86.7%)	10 (11.1%)	02 (2.2%)	--	90 (100%)
MPR	68 (75.6%)	18 (20.0%)	03 (3.3%)	01 (1.1%)	90 (100%)
LPR	86 (95.6%)	04 (4.4%)	--	--	90 (100%)

Table 5: Type Of Medial And Lateral Meniscus Tear.

MRI Findings	No Tear	Obliqu e	Horizo ntal	Complex	Bucket Handle	Total
Medial meniscus tear type	18 (20%)	38 (42.2%)	27 (30%)	05 (5.6%)	02 (2.2%)	90 (100%)
Lateral meniscus tear type	65 (72.2%)	14 (15.6%)	06 (6.7%)	03 (3.3%)	02 (2.2%)	90 (100%)

Table 6: Site Of Medial And Lateral Meniscus Tear (PH-Posterior horn, AH-Anterior horn, BO-Body of meniscus).

MRI Findin gs	No Tear	PH	AH	PH+ BO	BO	AH+ BO +PH	ROO T	Total
Medial menisc us	18 (20%)	66 (73.3 %)	01 (1.1%)	01 (1.1%)	--	02 (2.2%)	02 (2.2%)	90 (100%)
Lateral menisc us	65 (72.2 %)	14 (15.6 %)	07 (7.8%)	01 (1.1%)	01 (1.1%)	02 (2.2%)	--	90 (100%)

DISCUSSION
This is a descriptive study involving 90 patients with a history of knee injuries who had undergone MRI in the department of Radiodiagnosis, Indira Gandhi Government Medical College and Hospital with 3.0 T

MRI unit (Siemens Magnetom Skyra).

In our study, we examined 90 knee joint MRI images, with all patients being imagined for unilateral knee joint**.** MRI images were studied for evidence of injuries to menisci, cruciate ligaments, collateral ligaments, articular cartilage, loose bodies, meniscal cysts and bony contusions, evidence of soft tissue injuries around the knee joint.

The role of MRI has steadily increased and now it has become the investigation of choice for most of the lesions of knee. It is also being used for pre-and post-operative evaluation. It is a noninvasive technique that does not require contrast administration and is not operator dependent [8].

In our study of 90 patients, injuries were predominantly seen in younger age group ranging from 21 to 40 years. Our results are in agreement with study of Gul-e-khanda et al showed out of 50 cases, the left knee was involved in 30 (60%) cases as in our case out of 90 patients left knee is involved in 55 (61.1%) cases [9].

Cruciate Ligament Lesions:
Among the structure involved in knee injuries, ACL injury is the most common, accounting for 53 patients (58.9 %) in our study which is in agreement with the study done by Aniruddha Basu et al who showed that among the 25 patients who had injuries of their knees, 15 patients (60%) had ACL injuries and ACL tears were more common than other ligamentous injuries [10].

PCL injuries are less common than ACL injuries and reported rates vary from 3% to 20%. In our study PCL tear was noted in only 3 patients accounting for 3% out of 90 patients which are in agreement with study done by Bin Abd Razak et al who found the incidence of PCL tear to be 3%, with 11 patients having PCL tear among the 320 cases of knee injury [11].

Collateral Ligaments:
In our study, MCL tears (44.4%) were found to be more common than the LCL (13.3%) which are in agreement with the study done by D. Guenoun et al [12].

Meniscal Tears:
The medial meniscus was commoner to get torn as it is a less mobile structure and transmits more force during weight-bearing.

In our study meniscal tear was found in 74 cases, 80% of cases involved only the medial meniscus, 27.8% of cases involved the lateral meniscus and 25.5% cases involved both menisci which are in agreement with the study done by Singh JP et al, in a series of 173 cases, they found MM tear in 57 (38.23%) patients and LM tear in 28 (29.41%) patients [13].

In our study, the posterior horn of medial meniscus was the commonest site, involved in 73.3% cases which are in agreement with the study done by Jee et al who reported the prevalence of torn posterior horn of medial meniscus to be about 56% [14].

In our study, we found the occurrence of bucket handle tear type to be 2.2% while the study done by Helms et al reported that 10% of tears of medial meniscus were of bucket handle type [15].

Silva and Silverhave studied the probability of a tear being identified at arthroscopy for each grade MRI signal. The probability of tear with grade I signal is about 5%, grade II 17- 20% and grade III 80%-95% [16].

A study by Elvenes et al showed an accuracy rate of 90% for MRI in the detection of meniscal tears compared with the arthroscopy and found the sensitivity, specificity, positive and negative predictive value of MRI for medial meniscus tears were 100%, 77%, 71% & 100% [17].

Osseous And Osteochondral Injuries:
In our study, Osseous and osteochondral injuries were seen in 49 (54.4%) patients. Most of these were bony contusions involving the femoral and tibial condyles these findings are in agreement with the study done by Thomas H Berquist [18].

All cases demonstrated joint effusion and 1 case was associated with lipohemoarthrosis.

The findings of a partial tear of quadriceps muscle/tendon were noted in 7 cases.

Other Findings:
Femoral trochlear dysplasia was noted in 2 patients. One patient had patella Alta, mucoid degeneration of ACL was noted in 2 patients and exostosis of lower end of the femur was noted in 1 patient.

CONCLUSION

MRI is an excellent, non-invasive, radiation-free imaging modality with multiplanar capabilities and excellent soft-tissue delineation. It can accurately detect, localize and characterize various internal derangements of the knee joint and help in arriving at a correct diagnosis thereby guiding further management of the patient.

Knee joint injuries are common. The need to accurately evaluate the knee injuries is very crucial for the proper management and outcome, otherwise, it will lead to chronic debility to the patient.

Both MRI and arthroscopy have their limitations. These shortcomings might be overcome by combining both modalities when clinically indicated.

MRI should be the initial investigation of choice in the evaluation of all cases of knee joint injuries. Because it can detect both intra and extra-articular pathologies and also osseous structures. Based on the findings of MRI it acts as a road map for arthroscopy.

Summary
The present study attempts to determine the role of magnetic resonance imaging in the evaluation of traumatic knee injury among adults. MR examination is a non-invasive and precise diagnostic technique to evaluate ligamentous and other soft tissue structures around the knee. Appropriate sequences and analysis of images in all three planes increase the diagnostic yield. Anatomical variants, artifacts and other pitfalls of imaging should be cautiously interpreted and differentiated from pathological entities.

In the present study, 90 patients with a history of trauma, referred for MR imaging of knee joint were evaluated. The most common age group involved was between 21 to 40 years. The following patterns of knee injuries were seen:

- The most common injury was ACL tear of which partial tears were common. PCL tears were less common.
- Among the meniscal injuries, medial meniscal tears were more common than the lateral meniscus. Posterior horn tear was more common in both menisci.
- Medial collateral ligament tears outnumbered lateral collateral ligament tears and grade 1 tears were more common in MCL.
- Most of the osseous injuries were bony contusions involving femoral and tibial condyle.
- The results of the present study using MRI for the detection of lesions involving the articular cartilage, meniscus and cruciate ligament correlated well with other published studies.

Figure 1. 33-year male with a h/o fall, MRI right knee joint sagittal PDW image demonstrate altered fluid signal intensity in the posterior horn of medial meniscus reaching up to the superior and inferior articular surface suggestive of complex meniscal tear (Grade-III).

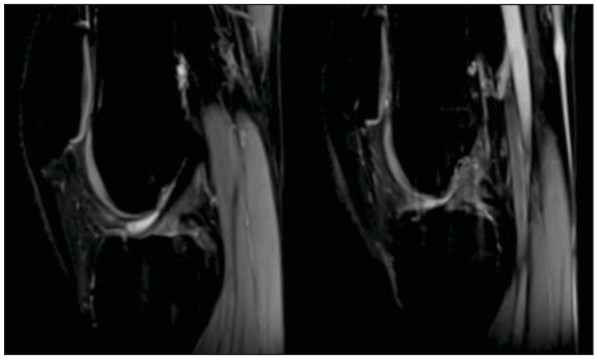

Figure 2. In a 19-year-old male with a history of trauma; MRI left knee joint sagittal PDW images demonstrate 'Single bundle tear' (a) ACL appears thinned out in one section (b) ACL is not visualized in its entire length and is replaced by altered signal intensity in another section., suggestive of partial ACL tear.

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