

Role of Magnetic Resonance Imaging (MRI) in Evaluation of Internal Derangement of Knee Joint

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ABSTRACT

The purpose of this study, to evaluation of the knee injuries is very essential for the proper management and outcome. This study has been done to know the pattern of distribution of different types and incidence of injuries in traumatic knee joint by MR imaging.

Material and Methods: MR imaging of the knee on the advice of the referring doctor symptomatic patients who were referred from various service referral hospitals and units with history of trauma and clinical suspicion (IDK) in the department of Radiodiagnosis served as the subjects for this study from December 2016 – September 2018. Because of its, evident potential, we designed the present study with the goals of evaluating the utility of MRI.

Results: MRI in detecting cruciate ligament and meniscal injuries as compared to arthroscopy

Conclusion: MRI is a used as a high sensitivity, specificity and accuracy in diagnosing cruciate ligament and meniscal injuries.

1. Introduction

Trauma to the knee may result in injury to the menisci, cartilage, ligaments, or bone. Traumatic knee is very difficult to handle due to pain and restricted range of movements, so imaging is a very good modality to assess the injury. [1] Even though arthroscopy is the gold standard for diagnosing the various meniscal and ligament injuries for which patient has to be hospitalized and operated under anaesthesia which has its own complication. The use of magnetic resonance imaging (MRI) in the knee was started in the year 1980s. From that time the accuracy of MRI in diagnosing knee injury, especially soft tissue component has been accurate 75-95%. MRI of the knee is currently the diagnostic procedure of choice for the diagnosis of injuries to the menisci, ligaments, and tendons as well as bone bruises and occult fractures in the knee, and in most centres, it has replaced arthrography and diagnostic arthroscopy. [2-5]

Failure to recognize and properly manage knee injuries can result in diminished lifestyle, time of work, and premature osteoarthritis. [6] Accurate assessment of the nature of these injuries is a prerequisite for appropriate therapy. MRI detects bone contusions, marrow changes, and tibia plateau fractures. MRI has unique ability to evaluate internal structure as well as the surface of the ligaments. [7] MRI is clearly the primary tool and is a significant advancement in knee imaging to guide the management of pain. With the development of new sequences, improved signal to noise ratio, higher resolution, reduced artefacts, shorter imaging times, and improved accuracy, MRI has changed the traditional algorithm for workup of meniscal and cruciate ligamentous tears. MRI has made it possible to look into the injured knee noninvasively, thereby avoiding invasive procedures and further morbidity. [8-10]

2. Materials And Method

Source of data

This is a prospective study on the patients, clinically suspected of internal derangement of the knee joint referred to the department of Radio-diagnosis at Sri Lakshmi Narayana Institute of Medical Sciences, Pondicherry.

Sample size - 100

Period of Study – December 2016 – September 2018 (period of 2 years)

Method of collection of data

Relevant history followed by patient or patient's attender consent for magnetic resonance imaging will be taken. The patient will be examined using a 1.5 T Siemens MagnetomEssenza with Tim and dot system using various relevant sequence. Images were studied for meniscal, cruciate ligament, collateral ligaments tear, fluid collections in and around the joint and also for any signal changes in the surrounding bones, muscles and tendons. Then these cases were subjected to arthroscopy.

Method of data analysis

Collected data was presented in the form of tables and diagrams. Sensitivity, specificity and predictive values were calculated. Using data was analysed for finding the significant correlation between MRI knee and arthroscopic findings by kappa statistics.

Interpretation of sensitivity

0.9 – 1	Excellent
0.8-0.9	Very Good
0.7 – 0.8	Good
0.6 -0.7	Average
< 0.6	Poor

Interpretation of Kappa Statistics

< 0.20	Poor agreement
0.21 – 0.4	Fair agreement
0.4 – 0.6	Moderate
0.61 – 0.8	Good
0.81 – 1.0	Very good

Interpretation of 'P' value

P < 0.05 - Significant

P < 0.01 - Highly significant

P > 0.05 - Not significant

Inclusion criteria

The study will include 100 patients between the age group of 11-60 years, clinically suspected of internal derangement of the knee joint. Acute traumatic internal derangement of knee joint.

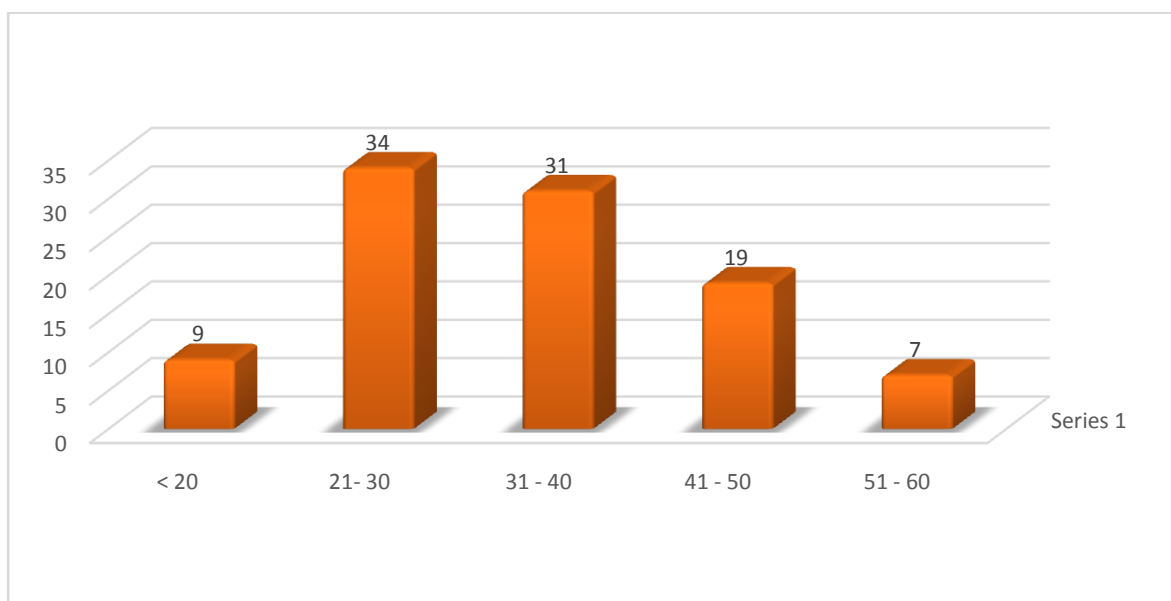
Exclusion criteria:

Age related degenerative arthrosis of knee joint. Any absolute contraindication for MRI

Imaging protocol:

Specific imaging techniques can increase the sensitivity and specificity for particular knee disorders, so a short relevant clinical history greatly helps to optimize the protocol for maximum diagnostic information protocols.

Equipment: The patient will be examined using a 1.5 T Siemens MagnetomEssenza with Tim and dot system using various relevant sequence.

3. Results**Figure 1:** Age distribution of the patients.

21-30 age group comprises the maximum number of patients which suffered knee injuries. i.e. 34 % of the patients are in this group followed by 31%, 9%, 19% and 7% in the age group of 31-40, 11-20, 41-50 and 51-60 respectively.

Table 1: Proportion of Internal Derangement Observation Based On MRI

	Number of Cases	Percentage (%)
Anterior Cruciate Ligament	49	49
Posterior Cruciate Ligament	8	8
Medial Meniscus	40	40
Lateral Meniscus	22	22
Medial Collateral Ligament	6	6
Lateral Collateral Ligament	17	17
Bone Marrow Edema	28	28

Joint Effusion	99	99
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Figure 2: Proportion of Internal Derangement Observation Based On MRI

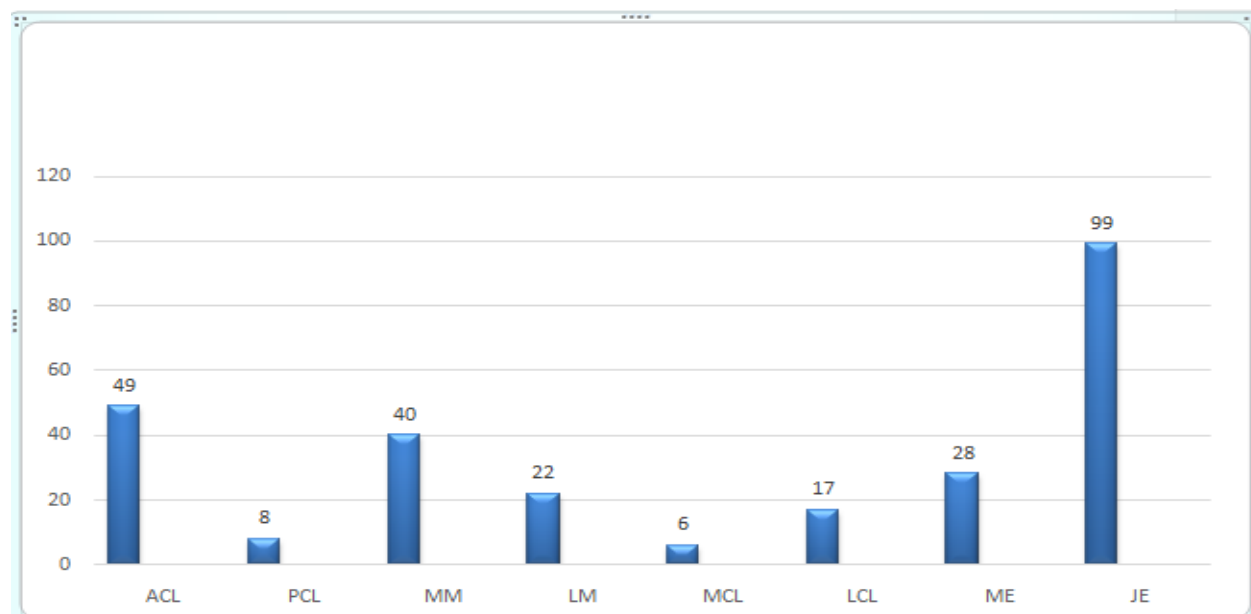


Table 2: Distribution of Medial Meniscus injuries among the Study population.

MRI	Arthroscopy		
	Positive	Negative	Total
Positive	40	2	42
Negative	0	58	58
Total	40	60	100

Sensitivity – 100%

Specificity – 96.67%

Positive predictive value – 95.4%

Negative predictive value – 100%

Kappa - 0.95 - Very good

P <0.001, H. S

Sensitivity and Specificity of MRI with respect to Arthroscopy is 100% and 96.67% and is excellent in detecting medial meniscus injury. MRI detected more number of cases compared to Arthroscopy since grade I and grade II injuries may not be picked up by arthroscopy.

Table No. 3: Distribution of Lateral Meniscus injuries among the Study population.

MRI	Arthroscopy		
	Positive	Negative	Total
Positive	22	0	22
Negative	4	74	78
Total	26	74	100

Sensitivity - 84.62% Specificity - 100% ,%, Positive predictive value - 100% Negative predictive value- 94.87%, Kappa - 0.51 – Moderate $P < 0.0001$, H.S, Sensitivity and Specificity of MRI compared to Arthroscopy is 100% and 94.87% and is excellent in detecting lateral meniscus injury. MRI detected more number of cases compared to Arthroscopy since grade I and grade II injuries may not be picked up by arthroscopy.

4. Discussion

This is a prospective study involving 100 patients with history of knee injuries who had undergone MRI in department of Radiodiagnosis, Sri Lakshmi Narayana Medical College Hospital with 1.5T MRI unit (Siemens Magnetom). [11] Then these patients underwent diagnostic and therapeutic arthroscopy. MRI images are 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. [12-15] Arthroscopy was done to look for injuries to menisci, cruciate ligaments collateral ligaments, articular cartilage, loose bodies and meniscal cysts. In the present study out of 100 patients 70 were males and 30 were females. The age group ranging from 21 to 40 years with mean age of 30.5 years. [16,17] A Study done by Fritz et al [11] showed males are most likely to suffer knee injuries since they are active in sports and right knee injuries are more common than left. In the present study males comprise the predominant number of patients who suffered knee injuries who are active in sports like football. Young patients of age group 21-40yrs are the maximum who suffered knee injuries. Out of 100 patient knee injuries, right knee is involved in 55 cases and left is involved in 45 cases. Right knee is involved more compared to left. [18,19]

Among the structure involved in knee injuries. ACL injury is the most common accounts for 49 cases in MRI with percentage of 49%, arthroscopy detected 43 cases. Sensitivity and Specificity of MRI with respect to Arthroscopy is 100% and 84.31% and is excellent in diagnosing ACL tears. Positive predictive value of MRI is 85.96%. Negative predictive value of MRI is 100%. [20,21]

Out of 100 cases MRI detected 8 PCL injuries and arthroscopy detected 8 cases. Sensitivity and specificity of MRI in relation to Arthroscopy is 100% with positive and negative predictive value 100% and shows excellent correlation in detecting PCL injuries. PCL injuries are most commonly associated with chip fractures near the tibial attachment. [22] In tears of the anterior

cruciate ligament, the sensitivity, specificity and accuracy were found to be 100, 85% and 87%, which were corresponding to Fischer et al study⁵⁴. MRI is accurate in identification of ACL tears, ranging from 93% to 97%. The sensitivity and specificity in various studies have shown to range between 61% and 100%, and 82% and 97% respectively. [23] In our study the positive predictive value and negative predictive value was 85.96 and 100 respectively. The positive predictive value and negative predictive value range from 70% to 76% and 70% to 100% respectively. [24] The results of two large studies showed that MR imaging has relatively low sensitivity (40-75%) but moderate to high specificity (62%-94%) in diagnosis of partial tears. [21] T2 weighted images showed clearly the signal intensity changes seen with these tears as excellent contrast is provided by normal low signal intensity of ligaments. Mink et al⁸ cases of PCL tears were detected both by MRI and Arthroscopy. The use of MRI to identify PCL tears has proven to be extremely accurate. This might be expected in light of the fact that the PCL is usually very easily visualized as a homogenous, continuous low-signal structure. Medial meniscus injury is the second most common type of injury comprising 40 cases (40%). MRI detected 40 cases of medial meniscus injury, arthroscopy detected only 38 cases. Sensitivity and specificity of MRI with respect to Arthroscopy is 100% and 96.67%. MRI is excellent in diagnosing medial meniscal injury. In our study the sensitivity, specificity and accuracy for detecting medial meniscal tears was corresponding to the Fischer et al [25].

A study by Elvenes et al²¹ showed 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%. In present study sensitivity, specificity, positive and negative predictive value are 100%, 96.67%, 95.4% and 100% respectively and correlated with the findings of Elvenes et al. [26] Positive predictive value of MRI in detecting lateral meniscus injuries is 100% with negative predictive value of 94.87%. Silva and Silver⁵² have 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%. The occurrence of the false positive meniscal tears at MRI imaging has been noted earlier. [23]

Sensitivity of MRI is more compared to arthroscopy because grade I and grade II tears unlike grade III tears may not be detected by arthroscopy. So, MRI is more useful for detection of grade I and grade II injuries. So, MRI is more sensitive in detection of meniscal injuries. [27]

Out of 100 cases of knee injuries MRI detected 14 cases of articular cartilage injuries and arthroscopy 16 cases. Sensitivity of MRI is 60% with specificity of 100% shows average correlation with Arthroscopy in diagnosing articular cartilage injuries. Positive predictive value of MRI is 100% with negative predictive value of 92.59%. Sensitivity of MRI can be increased by using newer sequences dedicated to articular cartilage imaging. MRI in spite of detecting meniscal, cruciate ligament and collateral ligament injuries can detect bone and soft tissue injuries around the knee joint. [17]

This mechanism produces injury in the medial aspect of the knee. Tibial collateral ligaments and medial capsular ligaments will be injured by this mechanism. Anterior cruciate ligaments and medial meniscus may also be torn if the force of magnitude is more. [28] The mechanism of adduction, flexion and external rotation of the femur on the tibia produces injury to the lateral column of the knee which includes tibial collateral ligaments, capsular ligaments, arcuate ligaments, cruciate ligaments and lateral ligaments. Hyperextension mechanism usually injure

the anterior cruciate and if force may cause injury to anterior cruciate ligament and posterior cruciate ligament.

5. Conclusion

MRI is an excellent, non-invasive, radiation free imaging modality with multiplane 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 anatomical 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 disability to the patient. Later arthroscopy will be done as a diagnostic and also as therapeutic procedure.

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Ethical approval: The study was approved by the Institutional Ethics Committee

Conflict of interest

The authors declare no conflict of interest.

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