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COMPARATIVE STUDY OF MRI & ARTHROSCOPY IN DIAGNOSIS OF INTERNAL DERANGEMENT OF KNEE

Orthopaedics

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ABSTRACT

Background: The knee joint is a common site of injury, mainly due to trauma, repetitive activities and sports activities. The term internal derangement is loosely applied clinically to describe variety of intra-articular disturbances with or without extra-articular disturbances, usually of traumatic origin. It comprises of injuries to menisci, cruciate ligaments, collateral ligaments and other structures of the knee joint. Clinical tests used in the diagnosis of meniscal and cruciate ligament damage have limitations and it may not be possible to elicit objective signs repeatedly, more so in a busy orthopaedic clinic and being painful in acute and subacute presentation. An accurate clinical diagnosis requires experience although difficult to quantify. Magnetic resonance imaging (MRI) has revolutionised the diagnosis of intra-articular pathologies. Arthroscopy being more sensitive and specific procedure in both diagnostic and therapeutic aspects. It is the pioneering work in the field of Orthopaedics.

Aim:

- To compare the sensitivity of MRI in diagnosis of IDK with Arthroscopy
- To study the feasibility of performing arthroscopy procedure based on clinical judgement alone without MRI in IDK lesions.

Materials and Methods This is a prospective study involving 36 patients with history of knee injuries who were admitted in the Department of Orthopaedics, Apollo institute of Medical sciences & Research centre, Chittoor, AP. Clincal examination and MRI of the knee joint was done for all these patients after admission. The patients were then subjected to diagnostic and therapeutic arthroscopy, between January 2019 to January 2021 (two years). **Results :**The accuracy of MRI in medial and lateral meniscal tears was 69.4% and 83.3% respectively, while for ACL and PCL rupture was 88.8 % and 100 % respectively. **Conclusion:** The present study supports that MRI is helpful in diagnosing meniscal and cruciate ligament injuries. Arthroscopy still remains the gold standard in diagnosing the internal knee lesions.

KEYWORDS

Internal derangement of Knee (IDK), Magnetic Resonance Imaging (MRI), Arthroscopy.

INTRODUCTION

The knee joint is a common site of injury, mainly due to trauma, repetitive activities and sports. Multiple imaging modalities are currently used to evaluate pathologic conditions of the knee like conventional radiography, fluoroscopy, sonography, nuclear Scintigraphy and MR imaging. The use of fluoroscopy and sonography to guide interventional procedures and Computerised Tomography (CT) to evaluate complex fractures has become a routine practice[2]. Magnetic resonance imaging has a better soft tissue contrast and multi planar slice capability which has revolutionized and has become the ideal modality for imaging complex anatomy of the knee joint[4]. Another advanced modality in the management of internal derangement of knee joint is Arthroscopy, which can be used in its dual mode, either as diagnostic and/or as therapeutic tool.[7]

AIMS AND OBJECTIVES

- To compare the sensitivity of MRI in diagnosis of IDK with Arthroscopy
- To study the feasibility of performing arthroscopy procedure based on clinical judgement alone without MRI in IDK lesions.
- To show if MRI is mandatory in all IDK lesions.

MATERIALS AND METHODS:

During the period of 2 years (January 2019 to January 2021) Patients who reported with knee symptoms suggestive of Internal derangement and underwent arthroscopy following a thorough clinical and MRI evaluation were the subjects of the study

***Inclusion Criteria*:**

1. Patients suffering from knee problems like pain, instability for more than 6 wks duration. 2. Patients with recent symptoms of locking of knee or effusion. 3. Patients who have undergone MRI due to any other indication which confirms IDK. 4. Patients with chronic knee pain and doubtful knee injury. 5. Patients aged between 18-60 yrs

***Exclusion Criteria*:**

1. Patients with signs of acute infections. 2. Cases with severe osteoarthritis 3. Cases with ankylosed knee 4. Cases who have undergone previous arthroscopy 5. Cases treated for chronic septic arthritis or with ATT as doubtful TB KNEE 6. Patients below the age of 18yrs and above 60yrs.

Methods of Assessment

1. Clinical examination of knee was carried out with particular emphasis on tests for meniscal tears like medial joint line tenderness, Mcmurrays test, Apleys grinding tests, tests for cruciate ligament tears like Lachman test, Anterior and Posterior drawer tests, Pivot shift tests, tests for Collateral ligament injuries like Valgus / Varus stress tests. Pre- Operative X ray of involved knee AP and Lateral views to rule out any bony injury

2. Routine tests -haemogram, urine routine, biochemical parameters of blood, ECG Imaging protocol

3. MRI KNEE-

The protocol for imaging the knee included following sequences. A. Localizer sequences in sagittal, coronal and axial planes. B. Fat suppressed T2 axial turbo spin echo. C. T1 spin echo sagittal iv. Pre-anaesthetic check-up and ASA grading for fitness for surgery

Arthroscopic Examination of the Knee:

After performing a thorough arthroscopy of the knee, the pathological lesions were identified and further surgery was carried out accordingly (partial/subtotal meniscectomy for meniscal tears, ACL reconstructions for ACL tears).

Documentation:

Operative findings were documented in the operation theatre, which included the survey of the entire joint and anatomical structure, lesions involved with the presence or absence of tear, its location, status of the articular cartilage and others.. The composite data was tabulated and studied for correlation with MRI findings and grouped into four categories. 1. True-positive - if the MRI diagnosis was confirmed by arthroscopic evaluation. 2. True-negative - if the MRI diagnosis is

negative for lesion and confirmed by arthroscopy 3. False-positive - If MRI shows lesion and Arthroscopy was Negative. 4. False-negative - If Arthroscopy was positive and MRI shows negative. Statistical analysis was used to calculate the sensitivity, specificity, positive predictive value (PPV) and the negative predictive value (NPV), in order to assess the reliability of the MRI results. Purposive random technique was used to select 36 patients with history of knee trauma admitted and treated in the department of Orthopaedics.

ANALYSIS AND RESULTS:

Table 1: Structures Injured

Structures injured	Clinical Exam	MRI	Arthroscopy
ACL	24	25	25
PCL	00	1	1
Medial meniscus	09	18	11
Lateral meniscus	04	08	06
Osteochondral defect	00	1	1

From the study we extracted the relevant data, we calculated true positive, true negative, false positive and false negatives values. The accuracy, sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV) were calculated using the following equations, PPV = TP/(TP + FP), NPV = TN/(TN + FN), sensitivity = TP/(TP + FN), specificity = TN/(FP + TN) and accuracy = (TP + TN)/(TP + TN + FP + FN).

Table 2: Anterior Cruciate Ligament (Acl) Tears

MRI	ARTHROSCOPY		
	Positive	Negative	
Positive	23	2	25
Negative	2	09	11
	25	11	36

Sensitivity – 92%	Positive predictive value –92%	
Specificity – 81.8%	Negative predictive value –81.8 %	
Accuracy - 88.8%	Kappa-0.737-substantial	P value-0.001-significant

The sensitivity and specificity of MRI with respect to arthroscopy in ACL tear is 92% and 81.8%

Table 3: Posterior Cruciate Ligament (PCL) Tears

MRI	ARTHROSCOPY		
	Positive	Negative	
Positive	1	00	1
Negative	00	35	35
	1	35	36

Sensitivity – 100%	Positive predictive value – 100%	
Specificity – 100%	Negative predictive value – 100 %	
Accuracy - 100%	Kappa-1-almost perfect	P value-0.0238-significant

The sensitivity and specificity of MRI with respect to arthroscopy in PCL tear is 100% and 100% respectively.

Table 4: Medial Meniscus Tears

MRI	ARTHROSCOPY		
	Positive	Negative	
Positive	09	09	18
Negative	02	16	18
	11	25	36

Sensitivity – 81.8%	Positive predictive value – 50%	
Specificity – 64%	Negative predictive value – 88.8 %	
Accuracy - 69.4%	Kappa-0.323-fair	P value-0.0488-significant

The sensitivity and specificity of MRI with respect to arthroscopy in MEDIAL MENISCAL tears is 81.8% and 64% respectively

Table 5: Lateral Meniscus Tears

MRI	ARTHROSCOPY		
	Positive	Negative	
Positive	04	04	08
Negative	02	26	28
	06	30	36

The sensitivity and specificity of MRI with respect to arthroscopy for LATERAL MENISCAL tears is 66.6% and 86.6% respectively

Table 6: Osteochondral Defects

MRI	ARTHROSCOPY		
	Positive	Negative	
Positive	1	0	1
Negative	0	35	35
	1	35	36

Sensitivity – 100%	Positive predictive value – 100%	
Specificity – 100%	Negative predictive value – 100 %	
Accuracy - 100%	Kappa-1-almost perfect	P value-0.0238-significant

The sensitivity and specificity of MRI with respect to arthroscopy in OSTEOCHONDRAL INJURIES is 100% and 100%.

Table 7: Accuracy of MRI

Structure	Sensitivity	Specificity	Accuracy
	Sensitivity	Specificity	Accuracy
ACL	92%	81.8%	88.8%
PCL	100%	100%	100%
Medial meniscus	81.8%	64%	69.4%
Lateral meniscus	66.6%	86.6%	88.09%
Osteo-chondral defect	100%	100%	100%

DISCUSSION:

Meniscal Injuries:

Medial meniscus injury and lateral meniscus injury occurred with equal frequency. There were 14 medial menisci injuries and 14 lateral menisci injuries in this study. MRI detected 18 cases of medial menisci injury, arthroscopy confirmed only 11 cases. Sensitivity and specificity of MRI with respect to Arthroscopy is 81.8% and 64% showing an average correlation with arthroscopy in diagnosing medial meniscal injuries. A study by Pappenport etal showed accuracy rate of 90% for MRI in the detection of Meniscal tears compared with the arthroscopy. Elvenes et al[5] in their study found the sensitivity, specificity, positive and negative predictive value of MRI for medial meniscus tears were 100%, 77%, 71% & 100% respectively. In the present study sensitivity, specificity, positive and negative predictive value are 81.8%, 64%, 50% and 88.8% respectively and did not correlate with the findings of above mentioned studies. Overall, MRI has a higher sensitivity (81.8%) than specificity (64%), and a higher NPV (88.8%) than the PPV (50%). In our study we found that sensitivity, specificity, positive and negative predictive value of MRI compared to arthroscopy was less compared to the other studies.

In our study MRI detected 08 cases of lateral meniscal injury and arthroscopy positive cases are 06 out of 36 cases. Sensitivity and specificity of MRI in relation to Arthroscopy is 66.6% and 86.6%. It had a fair correlation with arthroscopy in diagnosing lateral meniscal injuries. Positive predictive value of MRI in detecting lateral meniscus injuries is 50% with negative predictive value of 92.85%. Overall, MRI has a higher specificity (86.6%) than sensitivity (66.6%), and a higher NPV (92.85) than the PPV (50%). Elvenes et al[5] in their study found that sensitivity, specificity, positive and negative predictive value of MRI for MM were 100%, 77%, 71 % & 100% respectively, while values for LM were 40%, 89%, 33 %, & 91% respectively.

Overall accuracy of MRI for MM & LM combined was 84%. On basis of high negative predictive value, they concluded that MRI is useful to exclude patients from unnecessary arthroscopy. In our study MRI has a higher false positives i.e high sensitivity and low specificity in detecting meniscal tears. If MRI is used as the only form of pre-operative screening for this condition, then there may well be unnecessary arthroscopies performed.

False positive MRI scans seen in the posterior horn of the medial meniscus may reflect an inability to completely visualize the area. The occurrence of the false positive and false negative meniscal tears at MRI imaging has been noted earlier.

There are explanations for this apparent discrepancy between findings at MR Imaging and arthroscopy Mink et al[4] Misinterpretation of normal anatomy like menisco femoral ligaments etc.

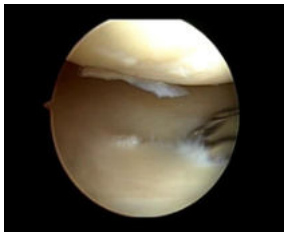

Fig: 01 Radial Tear of Medial Meniscus

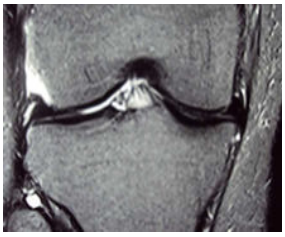

Fig: 02 Mri of Medial Meniscal Tear

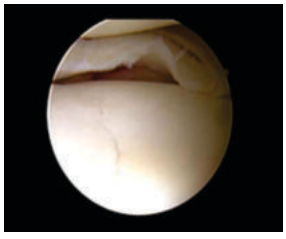

Fig: 03 Longitudinal Tear of Medial Meniscus

Fig: 04 Bucket Handle Medial Meniscal Tear

Osteochondral flap avulsion lesions mimic meniscal tears accounting for false positive cases in seven of our patients accounting for 20% incidence which correlates well with the literature---

- The observer dependency of MRI
- The presence of loose bodies.
- Radial meniscal tears are difficult to visualize on MRI; hence, they account for a large number of tears missed by MRI.
- Some false positive findings on MRI can be attributed to inadequate visualization of the meniscus at surgery and to the fact that the diagnosis of a tear can be subjective.
- False positive MRI scans seen in the posterior horn of the medial meniscus may reflect an inability to completely visualize the area at arthroscopy, and tears that extend to the inferior surface of the meniscus may be difficult to see.

Cruciate ligament lesions:

Among the structures involved in knee injuries ACL injury is the most common accounting for 25 cases in MRI of which 2 were false positives and arthroscopy detected 23 of the 25 cases plus 2 new cases from the remaining (false negative of MRI).

Sensitivity and Specificity of MRI with respect to Arthroscopy is 92% and 81.8% fair correlation with arthroscopy in diagnosing ACL tears. Positive predictive value of MRI is 92%. Negative predictive value of MRI is 81.8%.

Out of 36 cases MRI detected 1 PCL injury which was confirmed by arthroscopy and hence Sensitivity, specificity and positive and negative predictive values remains at 100% and shows excellent correlation in detecting PCL injuries. PCL injuries are most commonly associated with chip fractures near the tibial attachment

MRI is accurate in identification of ACL tears, ranging from 93% to 97%. In one of our chronic IDK knee MRI shows ACL incompetence but intact fibres, however clinically patient had instability and at arthroscopy showed a chronic tear partially healed by fibrosis which was inefficient and required a reconstruction.

Fig: 05 MRI OF ACL TEAR

Fig: 06 ACL Tear

The sensitivity and specificity in various studies have shown to range between 61% and 100%, and 82% and 97% respectively[7].

In our study the positive predictive value and negative predictive value was 92% and 81.8% respectively. The positive predictive value and negative predictive value range from 70% to 76% and 70% to 100% respectively[7].

Fig: 07 PCL TEAR

1 case of PCL tear was 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. Several studies have reported sensitivity, specificity, accuracy, positive predictive value and negative predictive value to be 99-100%[6]. In our study too the sensitivity, specificity, accuracy, positive predictive value and negative predictive value was 100% [7].

Articular cartilage injuries:

Out at 36 cases of knee injuries MRI detected 1 case of Osteochondral defect and arthroscopy 1 case. Sensitivity of MRI is 100% with specificity of 100% shows excellent correlation with Arthroscopy in diagnosing articular cartilage injuries. Positive predictive value of MRI is 100% with negative predictive value of 100%. The high accuracy of detection of Osteochondral defect in comparison with the meniscal results is unusual. This might be explained because there were fewer cases available.

The extent of cartilage abnormalities can be concealed when MRI is used as the only diagnostic tool. Arthroscopic evaluation is more useful than radiographs or MRI to grade osteoarthritis and assess surface cartilage abnormalities.

There are studies that support the view that the diagnostic accuracy of the MRI could affect in a critical way the treatment pathway of knee injuries. Mc Kenzie et al[9] have studied 332 patients' diagnosis before and after MRI. The diagnosis was initially based on the clinical examination and the therapeutic procedure was decided before MRI. 57 from 113 clinically positive before MRI meniscal tears were not confirmed with MRI. This result lead to revaluation and differentiation of treatment in 62 percent of the patients. From those patients programmed for surgery only 38 percent finally underwent arthroscopy.

In another study, Weinstabl et al[10] randomly distributed patients with positive meniscus rupture tests in two groups. All the patients in the first group had MRI examination before arthroscopy. In this group only 2 percent of patients didn't have positive findings during arthroscopy. Second group patients underwent arthroscopy, based only to the findings of clinical examination. In this group, only in 30 percent of patients, arthroscopy confirmed the findings of clinical examination.

The sensitivity for diagnosing isolated medial meniscal tears in Rubin's series[11] was 98% and it decreased when other structures were also injurerd. The specificity in isolated lesions was 90%. In a multicentric analysis Fisher [12] reported an accuracy of 78-97% for the anterior cruciate ligament and 64-95% for medial meniscus tears.

The menisci are composed of fibrocartilage and appear as low signal structures on all pulse sequences. The sensitivity and specificity of MRI in detecting meniscal tears exceeds 90%. Ryan et al [14] in a prospective study of comparison of clinical examination, MRI, bone SPECT to detect meniscal tear reported high diagnostic ability of MRI along with bone SPECT to detect meniscal tears, with a sensitivity and specificity of 80% and 71% respectively.

Simultaneous injury to several supporting structures is relatively

common in the knee. When more than one lesion was present completely correct diagnosis was rendered only 30% the time. This phenomenon was reported by Rubin [11]

In a prospective study reported by Imhoff et al [15], the negative predictive value was 94% but the positive predictive value was only 54%. They concluded that due to a high negative predictive value, a normal MRI scan allows eliminating a meniscal lesion and so there is no need for a diagnostic arthroscopy. They suggested that due to low positive predictive value of MRI it should not be routinely used to confirm clinical diagnosis and its use should be limited to those cases where clinical examination is inconclusive. A diagnostic arthroscopy would be a better choice in those cases.

In our study, MRI showed false results in significant proportion. For example as far as medial meniscus concerns there were 09 false positive and 02 false negative diagnosis whereas for lateral meniscus there were 04 false positive and 02 false negative diagnosis (PPV 50% and 50%; NPV 88.8% and 92.85%; for medial meniscus and lateral meniscus tears respectively)

There are several explanations for the misleading results of MRI regarding the menisci. Firstly, meniscal tears and meniscus degenerative changes have the same appearance in MRI , by giving high signals within the meniscus. Diagnosis then depends on the expansion of the high signal line towards meniscus articular surface. Moreover, one of the most frequent causes for false positive MRI regarding the lateral meniscus is the misinterpretation of the signal coming from the inferior knee artery. Helman et al[26] accredited in this structure about 38% of false positive MRI results. Often, the popliteal bursa or Humphreys' ligament may mimic posterior lateral meniscal tears as well[17,26].

Mckenzie et al[18] summarized the four most common reasons for false positive diagnosis; i)Wrong diagnosis due to variable anatomic structures, ii)Over estimation of pathology countered as meniscus tear(for example chondral injuries that mimic meniscus tears),iii) False negative arthroscopic findings and tears within the meniscus without expansion to the articular surface. On the other hand the false negative results seem to occur exclusively from misinterpretation of MRI [12,17].

As far as the cruciate ligaments are concerned, our study showed that from the 25 ACL ruptures diagnosed during arthroscopy 02 of them were missed by the MRI; leading to NPV of MRI for ACL ruptures of 81.8%. Causes of that target loss are easily recognised; firstly; in cases with ligament ruptures without mucosum rupture, MRI gives false negative results. Additionally, ruptures near ligaments' insertion may be missed and MRI examination reveals an intact ACL. On contrary, false positive ACL ruptures occur in cases of intrabody mucosal or eosinophilic degeneration of ACL [19].

The accuracy, sensitivity and specificity values for knee lesions vary widely in literature. Rubin et al [11] reported 93% sensitivity for diagnosing isolated ACL tears. Similarly several prospective studies have shown a sensitivity of 92-100% and specificity of 93-100% for the MR imaging diagnosis of ACL tears [12].

The posterior cruciate ligament can be examined very well with MRI. Bibliography refers accuracy in ruptures higher than 90% [12]. In our study we evaluated only 01 PCL rupture and it was identified by MRI (accuracy 100%; sensitivity 100%; specificity 100%). Even though our results agree with the bibliography data, the number of cases is too small for statistically significant conclusions. However, surgeons must always bear in mind that PCL is difficult to investigate during arthroscopy because of its anatomic position, and many times there are false negative results.

In many cases, subchondral bone bruises that are frequently described in MRI, are mistaken with chondral defects, leading to false positive results. They remain though important cause of pain and morbidity. Additionally, one must never forget that pre operative MRI mainly focuses on meniscal and cruciate ligament injuries. As a result, chondral lesions are often underestimated and misdiagnosed by MRI[20,21]. Postoperative new examination with MRI that focus on chondral defects leads to improvement of the diagnostic results [20,21].

Arthroscopy is a technically demanding procedure and the results are varying according to surgeon's experience, especially in difficult cases. From the 15 false positive results of our study, the majority referred to posterior meniscus tear. Nevertheless, the belief is that, even in these cases, the meniscal pathology existed but failed to be discovered during arthroscopy [16,25]. Especially the inferior surface of posterior aspect of the medial meniscus is difficult to be reached with a probe and often rupture at that point can be missed. Nowadays, the overall accuracy of arthroscopy varies between 70-100% depending on the surgeon's experience.

This fluctuation inevitably raises questions, regarding the reliability of the MRI results classification on true or false [18]. In the everyday practice, based on clinical examination that comes first, surgeons decide whether must proceed to further laboratory tests, MRI, conservative or surgical treatment. But how precise can clinical examination be**?** There seems to be disagreement regarding the answer to this question. Investigations support that the accuracy of clinical examination compared with arthroscopic findings ranges between 64-85%[22,23]. Rose et al [19] found that clinical examination is as accurate as MRI in diagnosing meniscal tears and ACL ruptures, so they concluded that MRI because of its high cost is not necessary in patients with clinical suspicion of meniscus and cruciate ligament tears.

On the other hand, Ruwe etal[8] reported that preoperative MRI can prevent unnecessary arthroscopy in 50% of Patients, so is of great value and must be done preoperatively. Boeree et al[24] believe that clinical examination is of minor significance with sensitivity in diagnosing medial meniscus, lateral meniscus and ACL tear of 67 %, 48% and 55% respectively.

CONCLUTIONS:

The present study supports that MRI is helpful in diagnosing meniscal and cruciate ligament injuries. It is concluded that arthroscopy still remains the gold standard in diagnosing the internal knee lesions. Undoubtedly new techniques and more powerful tomograms will improve MRI's accuracy leading to better diagnostic accuracy in knee injuries.Our study found that the accuracy of the MRI scan in diagnosing IDK is in the order of PCL, OCDs, ACL and MENISCAL lesions . The routine use of MRI scan to confirm diagnosis is not indicated, as the positive predictive value of the scan is low for all lesions. In the presence of positive clinical signs, proceeding to arthroscopy is recommended. The negative predictive value of a scan was found to be high for all structures of the knee joint and hence a 'normal' scan can be used to exclude a pathology, thus sparing patients from expensive and unnecessary surgery and also freeing up valuable theatre time. In this scenario the accurate and careful clinical examination remains the primary necessity in diagnosing IDK.

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