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Correlation between magnetic resonance imaging and arthroscopy in internal derangement of knee

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ABSTRACT

Background: Ligament injuries apart from fractures are more common in the knee joint owing to its complex anatomy. They account for a large number of referrals to our hospital, both from the general practitioner and from the accident and emergency department. Although there have been studies in literature comparing MRI with arthroscopy, the continuing improvement in diagnostic methods now available makes it especially important to compare the results and recommendations offered in the literature.
Methods: The aim of this study was to find out the diagnostic accuracy of MRI scans and to examine the value of MRI as a standard preoperative examination correlating them with the gold standard of arthroscopy. This is a prospective study involving 57 patients who were admitted in Department of Orthopaedics, Mahatma Gandhi Medical College and Research Institute, with the history of injury to the knee and diagnosed to have internal derangement of the knee clinically, using standardized clinical tests. MRI of the affected knee joint was done for all these patients either before or after admission. The patients were then subjected to diagnostic and therapeutic arthroscopy.
Results: The sensitivity of MRI in comparison with Arthroscopy was 100% in all studied lesions. The specificity of MRI in comparison with Arthroscopy was 94.1%, 98.1%, 100% and 97.6% for ACL, PCL, Medial meniscus and Lateral meniscus respectively.
Conclusions: According to our study MRI is a very good at determining the normal anatomy of the intra articular structures of the knee joint and is highly reliable in excluding pathology, in our case tear in ligaments. Hence we recommend MRI in doubtful cases of internal derangement of the knee joint whereby unnecessary diagnostic arthroscopy can be avoided which can significantly bring down the economic burden among rural population.

Keywords: MRI, Arthroscopy, IDK

INTRODUCTION

The dramatic increase in road traffic accidents and the highly demanding sporting life style makes the knee joint one of the most commonly injured joints in the body, either as a frequent component in a polytrauma patient or as isolated injury. Ligament injuries apart from fractures are more common in the knee joint owing to its complex anatomy. They account for a large number of referrals to our hospital, both from the general practitioner and from the accident and emergency department.

The knee is a complex joint, consisting of two condylar joints between the corresponding condyles of femur and tibia and a sellar joint between the patella and femur.[1] The principal intraarticular structures in knee are the two menisci, the two cruciate ligaments, and the two collateral ligaments. The menisci serve to distribute joint fluid, cartilage nutrition, mechanical shock absorption, increasing the surface area of the joint and therefore the stresses, serve to stabilize the joint, and a weight bearing function. The cruciate ligaments function as stabilizers of the knee in both forward and backward motions of the

tibia on the femur and provide an axis around which both medial and lateral rotary movements are assisted.[2] The injury to these intraarticular structures is generally termed as "Internal derangement of knee" which was first coined by William Hey in 1784.[3]

The clinical evaluation of knee injuries remains a difficult problem even today. The accuracy of a clinical diagnosis, reported in various series, varies between 64-85 percent, which suggests that even in the most experienced hands, a clinical diagnosis cannot be ascertained in about 20 percent of cases.[4]

Magnetic resonance imaging (MRI) is a diagnostic method most often used in diagnosis of internal derangements of the knee, because it is non-invasive, painless and has no risk of radiation. However it's an expensive investigation and it has a tendency to be misused and overused, to confirm diagnosis before proceeding with surgical intervention. The accuracy rate of MRI scans also varies. As knee injuries are on the rise and with varied accuracy rates of scans, it would be useful to know the accuracy of the MRI findings and correlate this with arthroscopy findings.

Arthroscopy has been used for many years as a diagnostic and therapeutic tool in knee disorders. It is considered a gold standard for the same as it allows direct visualization of the interior of the knee. Although there have been studies in literature comparing MRI with arthroscopy, the continuing improvement in diagnostic methods now available makes it especially important to compare the results and recommendations offered in the literature.

The aim of this study was to find out the diagnostic accuracy of MRI scans and to examine the value of MRI as a standard preoperative examination correlating them with the gold standard of arthroscopy.

METHODS

The aim of this study was to study the efficacy of Arthroscopy over MRI in diagnosing meniscal and ligament injuries of the knee joint; to compare the sensitivity and specificity of MRI and knee arthroscopy & to emphasize the accuracy of diagnosis in knee arthroscopy.

Inclusion criteria

Patients between 18-45 years of age with knee pain with or without instability and patients with symptoms of locking of knee were included in the study.

Exclusion criteria

Patients with open fractures of the knee, patients with bony injuries of the affected limb, those below the age of 18yrs & above the age of 45 years, patients with previous surgeries to the knee, patients with signs of infection, patients with ankylosed knee joint and those unfit for MRI study were excluded from the study.

This is a prospective study involving 57 patients who were admitted in Department of Orthopaedics, Mahatma Gandhi Medical College and Research Institute, with the history of injury to the knee and was diagnosed to have internal derangement of the knee clinically, using standardized clinical tests. MRI of the affected knee joint was done for all these patients either before or after admission. The patients were then subjected to diagnostic and therapeutic arthroscopy. MRI was done in 1.5T field strength in our institution and was reported on an objective proforma by a single senior consultant radiologist. All the arthroscopies were performed by a single orthopaedic surgeon.

The findings of MRI and arthroscopy were compared and analyzed in detail. It is a prospective comparative study done in the Department of Orthopaedics, Mahatma Gandhi Medical College & Research Institute, Pondicherry from May 2010 to September 2012.

Methods of assessment

Prior to surgery

1. Presenting complaints, history of presenting complaints, past history, personal history, general physical examination and complete local examination of affected knee were done that included complete inspection, medial joint line tenderness, McMurrays test, Apleys grinding test, Lachmann's test, anterior and posterior drawer test, pivot shift & Mcintosh test.

2. Radiographs of the involved knee anteroposterior and lateral views to rule out any bony injury.

MRI of the affected knee with the following sequences

- Localizer sequences in sagittal, coronal and axial planes
- Fat suppressed T2 axial turbo spin echo
- T1 Spin echo Sagittal.

Preoperative workup

- Routine hemogram, urine routine, biochemical parameters of blood, ECG & chest radiographs.

Preanaesthetic check-up and ASA grading for fitness for surgery

Surgery

All the arthroscopic procedures were performed under spinal anaesthesia after applying pneumatic tourniquet with patient in supine position and knee in 90 degrees

flexion. 30° arthroscope was used in all cases and the operative findings were documented and recorded simultaneously by the floor assistant: anatomical structure viewed and the presence or absence of tears, its location and additional details wherever possible.

The composite data was tabulated and studied for correlation with MRI findings and grouped into four categories.

- True-Positive: If the MRI diagnosis was confirmed by arthroscopic evaluation.
- True-Negative: When MRI negative for lesion but arthroscopy was negative.
- False-Positive: When MRI shows lesion but arthroscopy was negative.
- False-Negative: When arthroscopy showed lesion but MRI was 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 MRI results. Based on the above categories, five parameters were calculated to assess the reliability of the MRI results.

Sensitivity

Sensitivity of MRI is the ability of the MRI to detect an abnormality. It is determined by the equation:

True-positive/ (true positive + false negative) × 100 per cent.

Specificity

Specificity of MRI is the ability of MRI to give how many detected tears are usually accurate. It is determined by the equation:

True-negative/ (true negative + false positive) × 100 per cent.

Positive predictive value

It correlates a positive result of MRI with findings at arthroscopy. It is calculated by the equation:

True-positive/ (true positive + false positive) × 100 per cent.

Negative predictive value

It correlates a negative result on MRI with the findings at arthroscopy. It is calculated by the equation:

True-negative/ (true negative + false negative) × 100 per cent.

Accuracy

It is given by the equation:

True positive + true negative/ total number of patients in the study.

Statistical analysis

Collected data was presented in the form of tables. Data was analyzed for the significant correlation between MRI knee and arthroscopic findings. Pearson correlation coefficient and T test used as statistical tool to analyze the data in our study.

Interpretation of sensitivity

Table 1: Interpretation of sensitivity.

Percentage	Grade
90% - 100%	Excellent
80% - 90%	Very Good
70% - 80%	Good
70% - 60%	Average
< 60%	Poor

RESULT

Sex distribution

The study had 57 patients of which 15 were females and 42 males which accounts to about 26.3% females and 73.7% males respectively as given in Table 2.

Table 2: Sex distribution.

Sex	No of cases	Percentage
Male	42	73.7
Female	15	26.3

Age distribution

The patients who suffered injury were in the age group ranging from 18 to 45years. The mean age was around 33.58. Some of the other interesting observations noted in our study are, as age increases right side injuries are more compared to that of the left side and frequency of road traffic accidents are more.

There was an increase in frequency of knee injuries as age advanced in our study, 25 cases were in the age group of 18-27 years, 18 cases were in the age group of 28-37 years and 14 cases were in the age group of 18-27 years.

Side involved

The right knee joint was found to be more commonly involved 35 cases (61.4%), than the left knee joint, 22

cases (38.6%) and there were no cases with bilateral knee involvement in our series as shown in Table 3.

Table 3: Side involved.

	Frequency	Percentage
Left	22	38.6
Right	35	61.4
Total	57	100

Mode of injury

Road traffic accident was the most common mode of injury involving 47 cases (82.46%) followed by sport injury involving 10 cases (17.54%) as given in Table 4.

Table 4: Mode of injury.

	Frequency	Percentage
Sports injury	10	17.5
RTA	47	82.5
Total	57	100

Structures injured

There are several explanations for the misleading results of MRI regarding the menisci and cruciate ligaments. Firstly, meniscal tears and meniscus degenerative changes have the same appearance in MRI, by giving high signal within the meniscus. Diagnosis then depends on the expansion of the high signal line towards meniscus articular surface.

Table 5: Structures injured.

Structure injured	MRI	Arthroscopy
ACL	41	40
PCL	6	5
Medial meniscus	32	32
Lateral meniscus	16	15

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. McKenzie et al summarized the four most common reasons for false positive diagnosis; wrong diagnosis due to variable anatomic structures, overestimation of pathology countered as meniscus tear (for example chondral injuries that mimic meniscus tears) false negative arthroscopic findings and tears within the meniscus without expansion to the articular surface.

Statistical analysis of tear of individual structures

Anterior cruciate ligament

Observing the pattern of ACL tears revealed a total of 40 cases with torn ACL shown in Table 6.

Table 6: Comparing ACL in MRI vs. Arthroscopy.

MRI ACL	Scopy ACL		
	Tear	Normal	Total
Tear	40	1	41
Normal	0	16	16
Total	40	17	57

In our study there was one false positive result in MRI while diagnosing anterior cruciate ligament tear.

The sensitivity and specificity of MRI with respect to Arthroscopy is 100% and 94.1%.

The positive predictive value and negative predictive value is 97.6% and 100% respectively.

Posterior cruciate ligament

Total number of PCL tears accounted to about 5 cases out of the 57 studied as shown in Table 7.

Table 7: Comparing PCL in MRI vs. arthroscopy.

MRI PCL	Scopy PCL		
	Tear	Normal	Total
Tear	5	1	6
Normal	0	51	51
Total	5	52	57

In our study there was one false positive result in MRI while diagnosing posterior cruciate ligament tear, the loss of signal intensity near the femoral attachment was considered as partial tear of PCL but on arthroscopic evaluation there was no evidence of tear in PCL.

The sensitivity and specificity of MRI with respect to Arthroscopy is 100% and 98.1%.

The positive predictive value and negative predictive value is 83.3% and 100% respectively.

Medial meniscus

Out of the 57, 32 cases had torn medial meniscus and 25 normal medial meniscus as shown in Table 8.

Table 8: Comparing medial meniscus in MRI vs. arthroscopy.

MRI M.MEN	Scopy M. MEN		
	Tear	Normal	Total
Tear	32	0	32
Normal	0	25	25
Total	32	25	57

In our study there were no discrepancies in the diagnosis of tears in medial meniscus between MRI and

Arthroscopy. Both these modalities correlated well in the diagnosis of medial meniscal tears.

The sensitivity and specificity of MRI with respect to Arthroscopy is 100% and 100%.

The positive predictive value and negative predictive value is 100% and 100% respectively.

Lateral meniscus

Total number of lateral meniscal tears reported is 15 as shown in Table 9.

Table 9: Comparing lateral meniscus in MRI vs. arthroscopy.

MRI L.MEN	Scopy L. MEN		
	Tear	Normal	Total
Tear	15	1	16
Normal	0	41	41
Total	15	42	57

In our study there was 1 false positive result in the diagnosis of tears in lateral meniscus between MRI and Arthroscopy. The sensitivity and specificity of MRI with respect to Arthroscopy is 100% and 97.6% respectively.

The positive predictive value and negative predictive value is 97.6% and 100% respectively.

DISCUSSION

This study was a prospective study done among 57 patients who were admitted with provisional diagnosis of Internal Derangement of Knee in the Department of Orthopaedics, Mahatma Gandhi Medical College and Research Institute, Pondicherry

The current study was done to determine the efficacy of Arthroscopy over MRI in diagnosing meniscus and ligament injuries of the knee joint.

MRI of the knee joint was done in all these patients and then these patients underwent diagnostic and therapeutic arthroscopy whenever necessary in the same institution.

The main strength of the study is the use of only one MRI machine Philips 1.5 Tesla and interpretation of examination by a single radiologist, thus making the results more reproducible. This is in congruence with the analysis done by Runkel et al which showed arthroscopies done could be reduced if the MRI was reported by an experienced radiologist .[5]

MRI images were studied for evidence of injuries to menisci and cruciate ligaments and other associated structures and soft tissues around the knee joint. Diagnostic arthroscopy was performed on all these patients to confirm the MRI findings and results were documented.

In the present study, of the 57 patients 42 were male and 15 were female patients. The age groups were ranging from 18 to 45 years with mean age of 33.58. The youngest patient was 18 years and the oldest was 45 years of age. The youngest male patient was aged 18 years and the oldest male patient was 45 years old, likewise the youngest female patient was aged 18 years and the oldest female patient was 45 years old. This showed that the tendency of being injured and getting operated at an earlier age was common in both male and female patients.

A study by Munk et al showed males are most likely to suffer knee injuries since they are active in sports and the right knee was more frequently injured than the left knee.[6] As mentioned earlier in our study also males comprise the predominant number of patients who suffered knee injuries owing to their highly active social and sporting life style.

Sports injuries were more common in male patients than in females, out of the 10 cases who suffered injuries in this mode there was only 1 female patient in this category. The overall percentage of sports injuries were 17.5% (10 cases) when compared to 82.5% (47 cases) who sustained injury through road traffic accident.

Meniscal injuries, anterior cruciate ligament and posterior cruciate ligaments injuries were classed as either torn or not torn.

Anterior cruciate ligament injures occurred in about 40 patients (70.2%). Posterior cruciate ligament injuries occurred in 5 patients (8.8%). The frequencies of injuries to medial meniscus (56.1%), in 32 patients were almost one fold higher than that of injuries to lateral meniscus (26.3%), in 15 patients.

False positive and false negative results

MRI studies have higher false positives than false negative results confirmed by literature and it was the same finding in our study too, even though the false positive results were very minimal which accounts to only 3 cases out of the 57 cases evaluated. Each of the false positive results was encountered in ACL, PCL and Lateral meniscus respectively whereas there were no discrepancies in Medial meniscal lesions.

The false positive results in our study are described below:

- The reported degenerative tear of a lateral meniscus was not visualized in arthroscopic examination.
- A reported right side ACL tear in MRI showed mild laxity and increased signal intensity of ACL near its tibial attachment which was interpreted as partial ACL tear, but

in arthroscopic examination there was no evidence of tear at the given location.

- Posterior Cruciate ligament of the right knee in a patient showed an intrasubstance cyst / tear in MRI, was not revealed in arthroscopic examination.

Sensitivity and specificity

The sensitivity of MRI in comparison with Arthroscopy was 100% in all studied lesions.

The specificity of MRI in comparison with Arthroscopy was 94.1%, 98.1%, 100% and 97.6% for ACL, PCL, Medial meniscus and Lateral meniscus respectively.

Positive and negative predictive value

Statistics revealed MRI has 100% negative predictive value with a variable positive predictive value of 97.6%, 83.3%, 100%, and 97.6% for ACL, PCL, medial meniscus and lateral meniscus respectively.

Thus according to our study MRI is a very good at determining the normal anatomy of the intra articular structures of the knee joint and is highly reliable in excluding pathology, in our case tear in ligaments. Hence we recommend MRI in doubtful cases of internal derangement of the knee joint whereby unnecessary diagnostic arthroscopy can be avoided which can significantly bring down the economic burden among rural population.

CONCLUSION

The use of MRI and arthroscopy of the knee has evolved substantially over the last several decades and the advancement in surgical treatment of traumatic ligament injuries of the knee has been improved because of both technologies. The astute orthopaedic surgeon must be able to associate the findings on MRI in the decision making before and during arthroscopy. Moreover for a better correlation of findings the surgeon has to go through the complete set of images available in all possible views to come to a definitive conclusion on the pathology. An accurate understanding of the surgical anatomy and pathology found on both clinical examination and preoperative imaging will help the surgeon to improve the surgical technique at the time of arthroscopy and ultimately improve patient outcomes.

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