

“ A Prospective Comparative Study Correlating Arthroscopic Findings And Magnetic Resonance Imaging In Internal Derangement Of Knee Joint”

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Abstract

Background: The dramatic increase in road traffic accidents and sporting lifestyle makes the knee joint one of the most commonly injured joints in the body. The accuracy of clinical diagnosis, reported in various series varies between 64-85 percent. Magnetic resonance imaging (MRI) is a diagnostic method most often used in diagnosis of internal derangements of the knee. The accuracy rate of MRI scans also varies. Arthroscopy has been used for many years as a diagnostic and therapeutic tool in knee disorders. It is considered 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.

Material and Methods: This is a prospective comparative study involving 57 patients who were admitted in Department of Orthopedics, Yashoda Superspeciality hospital, Somajiguda, Hyderabad, between March 2015 to May 2016 with the history of injury to the knee. Patients between age group of 18-45 years fulfilling inclusion and exclusion criteria, who sustained injury to their knee and presented with pain or instability were subjected to standardized clinical tests and diagnosed clinically as Internal Derangement of Knee. MRI was done in these patients for the affected knee and diagnosis of injury to menisci or cruciate ligaments were confirmed in MRI. Subsequent arthroscopic surgery to the injured knee was performed in these patients and findings of MRI were compared to that of 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. MRI has 100% negative predictive value with a variable positive predictive value of 97.6%, 83.3%, 100%, 97.6% for ACL, PCL, Medial meniscus and Lateral meniscus respectively.

Conclusion: 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 ligament tears. The treating surgeon has to go through the complete set of images available in all possible views to come to a definitive conclusion on the pathology. With MRI, in doubtful cases of IDK unnecessary diagnostic arthroscopy can be avoided, which can significantly bring down the economic burden among rural population.

Key Words: Internal Derangement of Knee, MRI, Arthroscopy, ACL, PCL.

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I. Introduction

The dramatic increase in road traffic accidents and highly demanding sporting lifestyle 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. The injury to the intra-articular structures is generally termed as Internal derangement of knee which was first coined by William Hey in 1784 ^[1]. 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 ^[2]. 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 is 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. Arthroscopy has been used for many years as a diagnostic and therapeutic tool in knee disorders. Arthroscopy allows direct visualization of the interior of the knee. This study is about comparing knee arthroscopy and MRI in

diagnosing IDK. All studies were assessed by one reviewer, so there is no inter-observer bias. The purpose of this study was to find out the diagnostic accuracy of MRI scans and to examine the value of MRI as a standard pre-operative examination correlating them with the gold standard of arthroscopy.

Aims: To study the efficacy of Arthroscopy over MRI in diagnosing meniscal and ligament injuries of the knee joint.

Objectives: To compare the sensitivity and specificity of MRI and knee arthroscopy and to emphasize the diagnostic accuracy of MRI and Diagnostic knee Arthroscopy.

II. Materials & Methods

This is a prospective comparative study involving 57 patients who were admitted in Department of Orthopedics, Yashoda Superspeciality hospital, Somajiguda, Hyderabad, between March 2015 to May 2016 with the history of injury to the knee

Study population: Patients between age group of 18-45 years fulfilling inclusion and exclusion criteria, who sustained injury to their knee and presented with pain or instability were subjected to standardized clinical tests and diagnosed clinically as Internal Derangement of Knee. MRI was done in these patients for the affected knee and diagnosis of injury to menisci or cruciate ligaments were confirmed in MRI. Subsequent arthroscopic surgery to the injured knee was performed in these patients and findings of MRI were compared to that of arthroscopy.

Inclusion criteria:-

1. Patients with knee pain with or without instability.
2. Patients with symptoms of locking of knee.
3. Age between 18– 45 years of either sex.
4. MRI images taken in 1.5 Tesla.

Exclusion criteria:-

1. Patients with open fractures of the knee.
2. Patients with bony injuries of the affected limb.
3. Patients who have not consented for study.
4. Patients with previous surgeries to the knee.
5. Patients with signs of infection.
6. Patients with ankylosed knee joint.
7. Patients unfit for MRI study.

Sample size and sample technique: Statistical analysis done in SPSS 19.0 and Microsoft Excel (Licensed version) and sample size was estimated to be 57 patients. Images recorded and documented in capture IT pro (Licensed version).

Tools used - G E MRI 1.5 Tesla machine and Arthrex Arthroscopic system.

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 single orthopedic surgeon. The findings of MRI and arthroscopy were compared and analyzed in detail. Magnetic resonance imaging can show osseous and soft-tissue structures without the use of ionizing radiation, and it is non invasive. The knee is the most frequently studied joint and specialized extremity coil is available for this purpose^[5]. This surface coil allows high-resolution images of the commonly injured internal structures of the joint^[6]. Sagittal images are best used to evaluate the anterior and posterior cruciate ligaments. They also provide excellent visualization of the menisci^[7]. Coronal images are best used to evaluate the collateral ligaments anatomy^[7].

Sequential Methods Of Assessment: Presenting complaints, History of presenting complaints, Past history, Personal history, General physical examination, Complete local examination of affected knee.

Complete inspection of knee - Medial joint line tenderness, Mc Murray's test, Apley's grinding test, Lachmann's test, Anterior and posterior drawer test, Pivot shift & Mcintosh test.

Radiographs of the involved knee antero-posterior and lateral views to rule out any bony injury.

MRI of the affected knee with the following sequences

1. Localizer sequences in sagittal, coronal and axial planes
2. Fats up pressed T2 axial turbo spin echo.

3. T1 Spin echo Sagittal.

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

Pre-anaesthetic check-up and ASA grading for fitness for surgery.

Surgery: All the arthroscopic procedures were performed under spinal anesthesia 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 in the following order: 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.

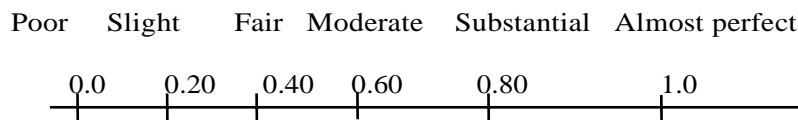
1. True-Positive: If the MRI diagnosis was confirmed by arthroscopic evaluation.
2. True-Negative: When MRI negative for lesion but arthroscopy was negative.
3. False-Positive: When MRI shows lesion but arthroscopy was negative.
4. False-Negative: When arthroscopy showed lesion but MRI was negative.

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.

Table 1: Interpretation of sensitivity

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

Interpretation of Kappa



Kappa Agreement

<0	Less than chance agreement
0.01–0.20	Slight agreement
0.21–0.40	Fair agreement
0.41–0.60	Moderate agreement
0.61–0.80	Substantial agreement
0.81–0.99	Almost perfect agreement

III. Observation And Results

57 patients who were admitted in Department of Orthopedics, Yashoda hospital, with the history of injury to their knee joint and were 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. These patients were then subjected to diagnostic and therapeutic arthroscopy consecutively and findings in MRI were compared to that of arthroscopy and results were tabulated.

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.

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 45 years. 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.

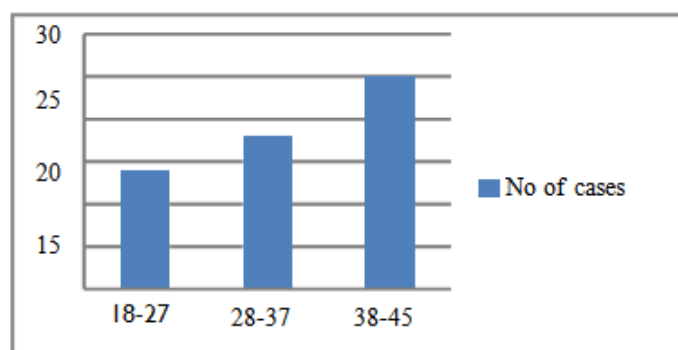


Figure 1: Age distribution

Side involved

The right knee joint was found to be more commonly involved 35 cases (61.4%), than the left knee joint, 22cases (38.6%) and there were no cases with bilateral knee involvement in our series.

Table 3: Side Involved

Side	Frequency	Percent
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%).

Table 4: Mode of injury

Mode of Injury	Frequency	Percent
Sports injury	10	17.5
RTA	47	82.5
Total	57	100

Structures Injured

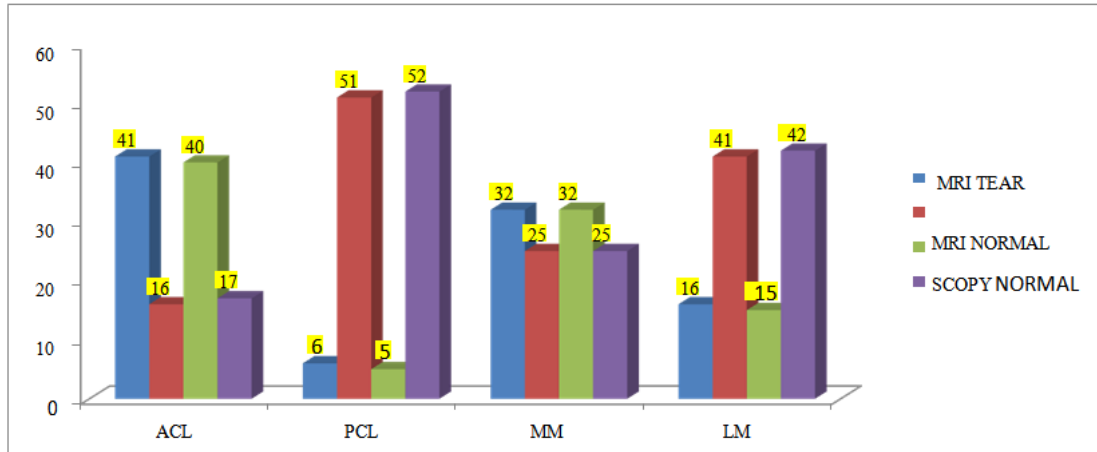
The total number of anterior cruciate ligament (ACL) tears reported - MRI (ACL tears) : Arthroscopy (ACL tears) is - 41 : 40.

The total number of posterior cruciate ligament (PCL) tears reported - MRI (PCL tears) : Arthroscopy (PCL tears) is - 6 : 5

The total number of Medial meniscus tears reported - MRI (MM tears) : Arthroscopy (MM tears) is 32 : 32.

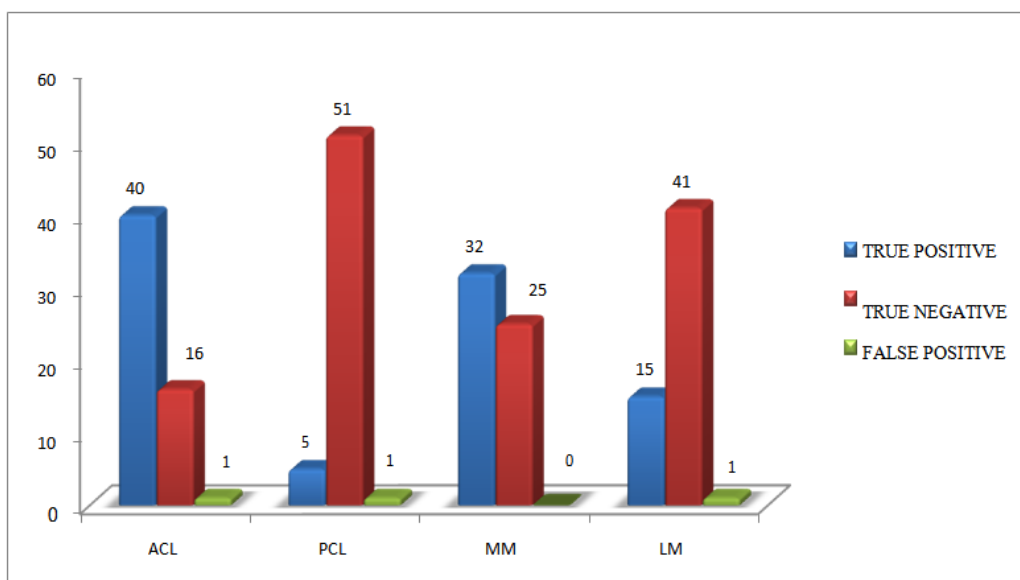
The total number of Lateral meniscus tears reported - MRI (LM tears) : Arthroscopy (LM tears) is 16 : 15

Figure 1 –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. 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, over estimation of pathology countered as meniscus tear(for example chondral injuries that mimic meniscus tears) false negative arthroscopic findings and tears with in the meniscus without expansion to the articular surface.

Figure 2: Graph plotted comparing the true positive, true negative and false positive results.



Statistical Analysis of Tear of Individual Structures:

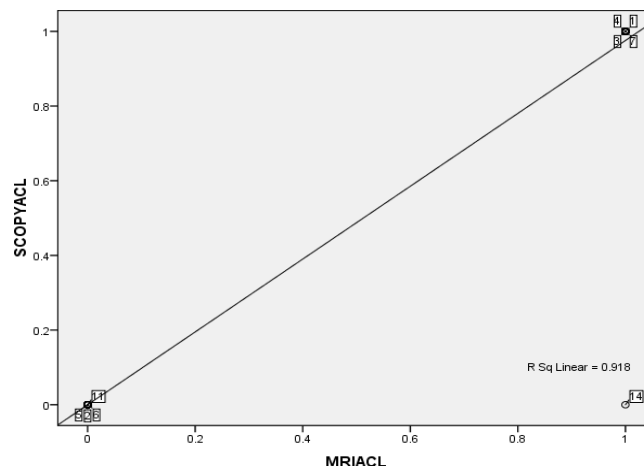
1. Anterior Cruciate Ligament: Observing the pattern of ACL tears (Table4) revealed a total of 40 cases with torn ACL

Table 5 : Comparing ACL in MRI vs Arthroscopy.

MRI \ SCOPY		TEAR	NORMAL	TOTAL
		TEAR	01	41
NORMAL		00	16	16
TOTAL		40	17	57

Table 6: Statistical value for diagnosis pertaining to ACL using various tests.

ACL	SENSITIVITY	SPECIFICITY	PPV	NPV	KAPPA	ACCURACY	P
	100%	94.1%	97.6%	100%	0.95	98%	0.00



Graph 1: Scatter Diagram Showing Linear Pattern Suggestive Of Perfect Correlation With Regard To Acl

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. The inter-observer agreement using Kappa statistics showed almost perfect agreement with value of 0.95. The accuracy of MRI in diagnosing ACL tear is 98% with significant P value of 0.00 (Table 6). The values when plotted on a scatter diagram showed a linear graph with a Sq linear value of 0.918 (Graph 1) which is interpreted as strong correlation between the two studied diagnostic modalities.

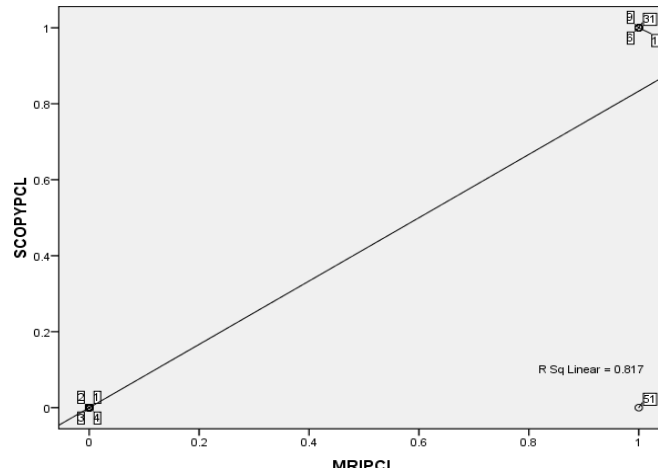
2. Posterior Cruciate Ligament: Total number of PCL tears accounted to about 5 cases out of the 57 studied.

Table 7: Table Comparing Pcl In Mri Vs Arthroscopy

MRI \ SCOPY		TEAR	NORMAL	TOTAL
		TEAR	01	06
NORMAL		00	51	51
TOTAL		05	52	57

Table 8 : Statistical value for diagnosis pertaining to PCL using various tests.

PCL	SENSITIVITY	SPECIFICITY	PPV	NPV	KAPPA	ACCURACY	P
	100%	98.1%	83.3%	100%	0.90	98%	0.00



Graph 2: Scatter diagram showing linear pattern suggestive of perfect correlation with regard to PCL

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. The inter observer agreement using Kappa statistics showed almost perfect agreement with value of 0.90. The accuracy of MRI in diagnosing PCL tear is 98% with significant P value of 0.00 (Table 8). The values when plotted on a scatter diagram showed a linear graph with a Sq linear value of 0.817 (Graph 2) which is interpreted as strong correlation between the two studied diagnostic modalities.

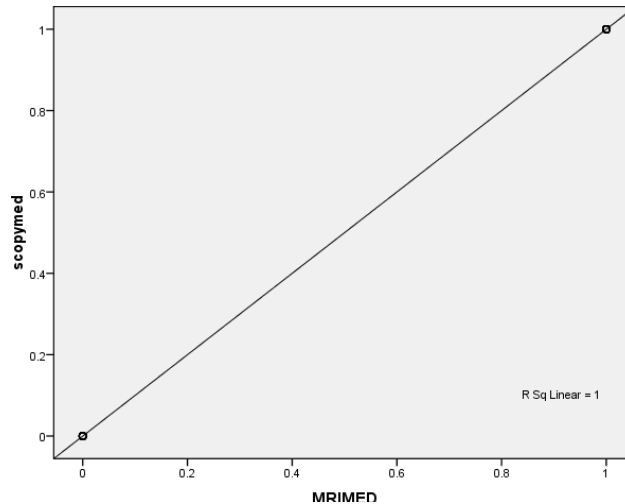
3. Medial meniscus: Out of the 57 cases, 32 cases had torn medial meniscus and 25 normal medial meniscus

Table 9: Table Comparing Medial Meniscus In Mri Vs Arthroscopy.

SCOPE		MRI		
		TEAR	NORMAL	TOTAL
MRI	TEAR	32	00	32
	NORMAL	00	25	25
TOTAL		32	25	57

Table 10: Statistical value for diagnosis pertaining to Medial meniscus using various tests.

M.M	SENSITIVITY	SPECIFICITY	PPV	NPV	KAPPA	ACCURACY	P
	100%	100%	100%	100%	1.0	100%	0.00



Graph 3: Scatter diagram showing linear pattern suggestive of perfect correlation with regard to Medial meniscus.

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. The inter observer agreement using Kappa statistic showed almost perfect agreement with value of 1. The accuracy of MRI in diagnosing Medial meniscus tear is 100% with significant P value of 0.00 (Table 10). The values when plotted on a scatter diagram showed a linear graph with a Sq linear value of 1 (Graph 3) which is interpreted as very strong correlation between the two studied diagnostic modalities.

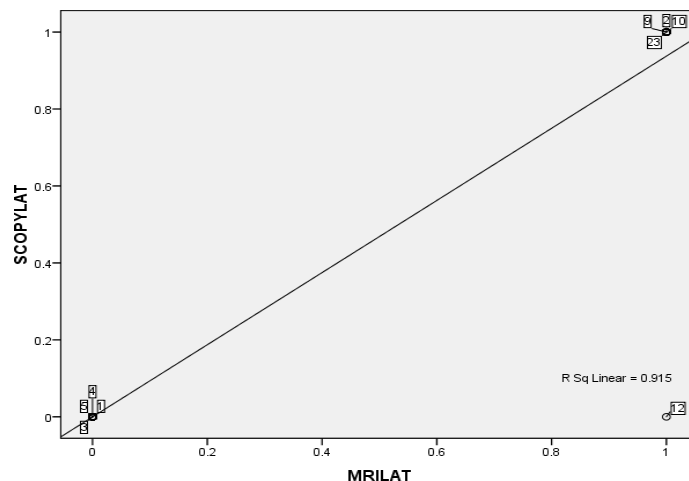
4. Lateral meniscus: Total number of Lateral meniscal tears reported is 15.

Table 11: Comparing Lateral Meniscus In Mri Vs Arthroscopy.

	SCOPY			
MRI		TEAR	NORMAL	TOTAL
TEAR		15	01	16
NORMAL		00	41	41
TOTAL		15	42	57

Table 12: Statistical value for diagnosis pertaining to Lateral meniscus using various tests.

L.M	SENSITIVITY	SPECIFICITY	PPV	NPV	KAPPA	ACCURACY	P
	100%	97.6%	93.8	100%	0.95	98%	0.00



Graph 4: Scatter diagram showing linear pattern suggestive of perfect correlation with regard to Lateral meniscus.

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 97.6% respectively. The inter observer agreement using Kappa statistic showed perfect agreement with value of 0.95 (Table12). The accuracy of MRI in diagnosing ACL tear is 100% with significant P value of 0.00. The values when plotted on a scatter diagram showed a linear graph with a Sq linear value of 0.915 (Graph 4) which is interpreted as strong correlation between the two studied diagnostic modalities.

IV. 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 Orthopedics Yashoda hospital, Hyderabad. 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 GE 1.5 Tesla and interpretation of examination by a single radiologist, thus making the results more reproducible. This is incongruence with the analysis done by Runkel et al which showed arthroscopies done could be reduced if the MRI was reported by an experienced radiologist^[3]. 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 Fritz 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 leftknee.^[4] 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 lifestyle. 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% (10cases) when compared to 82.5% (47cases) 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.

Studies in the literature have shown a range of 61–97% in the sensitivity of MRI in detecting ACL tears and a specificity of 82–97%^[8,9,10,11,12]. William's et al. suggested that MRI results in fast and accurate diagnosis and it allows the surgeon to plan the surgical procedure^[13]. Results of various studies demonstrate that meniscal and cruciate ligament injuries of the knee can be accurately diagnosed by MRI and they support the findings of other studies^[14]. Vaz et al. concluded that MRI has high accuracy for diagnosing knee meniscal and cruciate ligament lesions^[15]. In 2012 Lokannavar HS, Yang X, Guduru H. examined MR imaging study of 146 patients showed high accuracy (98.08%) and negative predictive value (98.62%) for MRI in comparison with arthroscopy^[16]. In 2013 Justin W. Griffin, Mark D. Miller concluded that MRI have remarkable correlation with arthroscopic findings^[17]. In 2014 Kostov H, Stojmenski S, Kostova E concluded that MRI is an appropriate screening tool for therapeutic arthroscopy, making diagnostic arthroscopy unnecessary in most patients^[18].

Yaqoob J, Alam MS, Khalid in their study conducted in 2015 concluded that the sensitivity, specificity and accuracy of MR imaging for menisci and ACL injury were labeled to be 100% sensitivity, 88.4% specificity, 90% positive predictive value, 100% negative predictive value, and 94.4% accuracy were noted for medial meniscal injury. Similarly, MR had sensitivity of 85.7%, specificity of 95%, positive predictive value of 85.7%, negative predictive value of 95%, and accuracy of 92.5% for lateral meniscal injuries. Likewise, anterior cruciate ligament had 91.6% sensitivity, 95.2% specificity, 84.6% positive predictive value, 97.5% negative predictive value, and 94.4% accuracy^[19].

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 were encountered in ACL, PCL and Lateral meniscus respectively where as there was no discrepancies in Medial meniscal lesions.

The false positive results in our study are described below:

1. The reported degenerative tear of the lateral meniscus in case 10 was not visualized in arthroscopic examination.
2. The reported right side ACL tear in MRI in case 12 showed mild laxity and increased signal intensity of ACL near its tibial attachment which was interpreted as partial ACL tear, but in arthroscopic examination here was no evidence of tear at the given location.
3. Posterior Cruciate ligament of the right knee in case 51 showed an intra substance 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%, 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 commend MRI in doubtful cases of internal derangement of the knee joint where by unnecessary diagnostic arthroscopy can be avoided which can significantly bring down the economic burden among rural population.

V. 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 orthopedic 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 pre-operative imaging will help the surgeon to improve the surgical technique at the time of arthroscopy and ultimately improve patient outcomes.

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