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Clinical examination, MRI and arthroscopy in ligamentous knee Injuries: A prospective study

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Abstract
Data from 475 knee arthroscopies performed by an experienced knee surgeon between March 2017 and August 2018 at the IMS&SUM Hospital, Bhubaneswar, for ligament injuries, loose body removals, lateral release of the patellar retinaculum, plica division, and adhesiolysis was prospectively collected. A subset of 100 patients from the above group who sequentially had clinical examination, MRI and arthroscopy for suspected meniscal and ligament injuries were considered for the present study and the data was reviewed. Patients with previous menisectomies, knee ligament repairs or reconstructions and knee arthroscopies were excluded from the study. MRI was requested for confirmation of diagnosis and for additional information in all these patients. Two experienced radiologists reported MRI films. Clinical and MRI findings were compared with Arthroscopy as the gold standard. A thorough clinical examination along with KT-1000 performed by a skilled examiner more accurately correlated at Arthroscopy. A negative MRI did not prevent an arthroscopy. In this study, specificity, positive and negative predictive values were more favourable for clinical examination though MRI was more sensitive for meniscal injuries. The use of MRI as a supplemental tool in the management of meniscal and ligament injuries should be highly individualised by an experienced surgeon. 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 an acute or sub-acute presentation. An accurate clinical diagnosis requires experience although difficult to quantify. Magnetic resonance imaging [MRI] has revolutionised the diagnosis and management of intra-articular pathology and ligamentous injuries. Being noninvasive and a highly sensitive tool of investigation, early and subtle changes in the soft tissues often are picked up by MRI. Arthroscopy being highly sensitive and specific procedure is both diagnostic and therapeutic, but is invasive. The aim of this study was to correlate the different modalities of diagnosis with arthroscopy as the gold standard and whether a negative MRI could justifiably deny an arthroscopy.

Keywords: ligamentous, modalities, arthroscopy, justifiably

Introduction

Data from 475 consecutive knee arthroscopies performed at IMS&SUM Hospital, Bhubaneswar by an experienced knee surgeon between March 2017 to August 2018 for ligament injuries, loose body removals, lateral release of the patellar retinaculum, plica division, and adhesiolysis were prospectively collected. From the above data, a subset of 100 patients who sequentially had clinical examination, MRI and arthroscopy for suspected meniscal and ligament injuries were considered for the present study and the data was reviewed. Patients with previous menisectomies, knee ligament repairs or reconstructions and knee arthroscopies were excluded from the study. Clinical data including patient demographics, wait period between MRI and arthroscopy, suggestive symptoms including effusion, presence of a "pop", locking, mechanism of injury, clinical diagnosis, KT-1000 and operative details were documented and analysed. All patients were examined by two experienced orthopaedic consultants. Clinical tests included Mcmurrays' for meniscal damage, Lachmen's test, Draw tests and KT-1000 for cruciate damage, and valgus and varus stress tests for collateral ligament integrity. A clinical diagnosis was made and an MRI of the affected knee was requested in all 109 patients. MRI was requested for confirmation of clinical diagnosis and for obtaining additional information. MRI was performed with a dedicated magnetic extremity coil of 1.5 tesla strength. Each film provided 19 slices of T1and T2 images of 4 mm thickness and 160 mm field of view. The radiologists were provided patient identifying data, and the provisional clinical diagnosis. Two experienced radiology consultants reported on all the MRI scans. MRI films and reports were retrieved from the Synapse software system. Arthroscopies were performed under Spinal or general anaesthesia as appropriate. Operative findings were documented in the operation theatre, which included the anatomical structure involved with the presence or absence of tear, its location, status of the articular cartilage and additional details when available. The composite data was tabulated on Microsoft excel spreadsheet and studied for correlation. Full agreement was when the modalities correlated accurately. Any disparity between clinical examination and MRI at arthroscopy was considered no agreement. Partial agreement was when there was partial correlation between the modalities.

Results and analysis

The results obtained from clinical findings, MRI and arthroscopic examination of the study population were analyzed. The clinical and MRI diagnoses were placed into one of the four categories after arthroscopic evaluation 1)True positive: When an abnormal finding (meniscus, ACL) reported by MRI or clinical examination and confirmed at arthroscopy surgery.2)True negative: had no abnormalities noted clinically or by MRI or at Arthroscopy.3) False positive: if the clinical examination or MRI reported an abnormality but was not confirmed at arthroscopic operation.4) False negative: had a negative clinical examination or MRI report and a positive finding at operation. Based on the above categories, five parameters were calculated to assess the reliability of the MRI results: 1) Sensitivity: It is the ability of clinica examinations or MRI to detect the proportion of abnormal cases (Tear) in the study population that are correctly identified as such by Arthroscopy. It is determined by the equation: True-positive/ (True-positive+False negative) X 100 per cent. 2)Specificity: It is the ability of clinical examination or MRI to detect the proportion of normal cases (Without Tear) that are correctly identified as such by Arthroscopy. It is determined by the equation: True-negative/ (True-negative + False-positive) X 100 per cent. 3) Positive predictive value / Precision: It is the proportion of actual abnormal cases (With Tear) among the cases that are detected as abnormal by clinical examination or MRI. It is calculated by the equation: True-positive/ (True-positive + False-positive) X 100 per cent. 4) Negative predictive value: It is the proportion of actual normal cases (Without Tear) among the cases that are detected as normal by clinical examination or MRI. It is calculated by the equation: True-negative/ (True-negative + False-negative) X 100 per cent. 5) Accuracy: It is the ability of clinical examination or MRI to detect the actual normal cases (With Tear) and actual abnormal cases (Without Tear) among the total study population. It is calculated by the equation: (True-positive + True - negative) (True-positive + False-positive +True-negative + False-negative) X 100 per cent.

All the analyses were done by using SPSS 21 version. The compiled data along with the analytical results are represented in the following Tables.

Table 1: Age distribution

Age dgroup (Yrs)	No. of Patients	% of Study Population
10-20	7	7
21-30	38	38
31-40	26	26
41-50	16	16
> 50	13	13

Mean age of the study population is 34.3 Yr

Table 2: Sex distribution

Sex	No. Of Patients	% of Patients
Male	60	60
Female	40	40
Total	100	100

- Ratio of Male to Female patients in this study population is 3:2.

Table 3: Incidence of different internal injuries of Knee in the study Population as detected by MRI and clinical examination.

Meniscus/ Cruciate Ligament	MRI Finding		Clinical examination findings	
	Normal	Tear	Normal	Tear
MED. Meniscus	50	50	51	49
LAT. Meniscus	83	17	84	16
ACL	62	38	64	36
PCL	91	9	92	

- Medial meniscus is more commonly injured than Lateral meniscus. ACL is more commonly injured than PCL.

Table 4: Prevalence of Meniscal Tears of Knee as detected by Arthroscopy and their Sex-wise distribution in the study Population.

Meniscus	Arthroscopy Finding			
	Normal		Tear	
	Total	Male	Female	Total
MED. Meniscus	51	27	22	49
Lat. Meniscus	84	11	5	16

(Chi square=0.925, df =1, p=0.336)

- Meniscal tears are more common in Young – adults (21-40 Yrs).

Table 6: Distribution of Different Sites of Meniscus Tears among the study Population as detected by Arthroscopy.

Site Of Tear	Med. Meniscus	Lat. Meniscus
Post. Horn	31	10
Body	15	4
Ant. Horn	3	2

- Posterior horns of menisci are more commonly injured.

Table 7: distribution of Different Types of Meniscus Tears among the study Population as detected by Arthroscopy

Type Of Tear	Med. Meniscus	Lat. Meniscus
Horizontal	13	3

Vertical	17	5
Complex	19	8

- Complex type of tears are more common than other types of tears.

Table 8: Prevalence of Cruciate Ligament Tears of Knee detected by Arthroscopy and their Sex-wise distribution in the study Population

Cruciate Ligament	**Arthroscopy Finding**			
	Normal	**Tear**		
	Total	**Male**	**Female**	**Total**
Ant. Cruciate Lig. (ACL)	64	19	17	36
Post. Cruciate Lig. (PCL)	92	7	1	8

(Chi square=3.26, df=1, p=0.071)

- ACL Tears are almost of equal incidence in both sexes, whereas PCL tears are more common in males

Table 9: Shows Age-wise distribution of Cruciate Ligament Tears in the study Population detected by Arthroscopy

Age Groups (Years)	**No. of Patients**	
	ACL Tear	**PCL Tear**
10-20	4	1
21-30	12	3
31-40	11	1
41-50	6	2
> 51	3	1

021(Chi square=1.20, df=4, p=0.878)

- Cruciate ligament tears are more common in young –adult (21-40 Yrs) age group.

Table 10: Distribution of Different Sites of Cruciate ligament Tears among the study Population as detected by Arthroscopy

Site Of Tear	**Ant. Cruciate Lig.**	**Post. Cruciate Lig.**
Femoral	12	2
Attachment		
Mid-Substance	18	5
Tibial Attachment	6	1

- Cruciate Ligament tears are more common in mid- part.

Comparison of MRI Findings with Arthroscopy Findings-

Table 11: Shows comparison of the findings of MRI with those of arthroscopy with regards to tears of medial meniscus

MRI/ Arthroscopy	**Tear**	**Normal**
Tear	45	4
	True Positive	False Negative
Normal	5 False Positive	46 True Negative

Sensitivity- 91.8%, Specificity- 90.2%, Positive Predictive Value- 90%, Negative Predictive Value- 92%, Accuracy- 91%.

Table 12: Comparison of the findings of MRI with those of arthroscopy with regards to tears of Lateral meniscus

MRI/ Arthroscopy	**Tear**	**Normal**
Tear	14	2
	True Positive	False Negative
Normal	3 False Positive	81 True Negative

Sensitivity- 87.5%,Specificity- 96.5 %,Positive Predictive Value- 82.3% Negative Predictive Value- 97.6% Accuracy- 95%.

Table 13: Comparison of the findings of MRI with those of arthroscopy with regards to tears of Anterior Cruciate Ligament

MRI/Arthroscopy	**Tear**	**Normal**
Tear	31True Positive	5False Negative
Normal	7False Positive	57True Negative

Sensitivity- 86.1%,Specificity- 89.1%,Positive Predictive Value- 81.6% Negative Predictive Value- 91.9%, Accuracy- 88%

Table 14: Shows comparison of the findings of MRI with those of arthroscopy with regards to tears of Posterior Cruciate Ligament

MRI/Arthroscopy	**Tear**	**Normal**
Tear	7 True Positive	1 False Negative
Normal	2 False Positive	90 True Negative

Sensitivity- 87.5%, Specificity- 97.8%, Positive Predictive Value- 77.8%, Negative Predictive Value- 98.9%, Accuracy- 97%.Accuracy of MRI for diagnosing PCL injury is very high.

Comparison of Clinical Findings with Arthroscopy Findings

Table 15: Shows comparison of the findings of Clinical examination with those of arthroscopy with regards to tears of medial meniscus.

Clinical/ Arthroscopy	Tear	Normal
Tear	43	6
	True Positive	False Negative
Normal	3 False Positive	48 True Negative

Sensitivity- 87.7%, Specificity- 94.1%, Positive Predictive Value- 93.4%, Negative Predictive Value- 88.8%, Accuracy- 91%

Table 16: Shows comparison of the findings of Clinical examination with those of arthroscopy with regards to tears of Lateral meniscus

Clinical Arthroscopy	**Tear**	**Normal**
Tear	12	4
	True Positive	False Negative
Normal	5 False Positive	79 True Negative

Sensitivity- 75%,Specificity- 94 %,Positive Predictive Value- 70.5%, Negative Predictive Value- 95.1%, Accuracy- 91%.

Table 17: Shows comparison of the findings of clinical examination with those of arthroscopy with regards to tears of Anterior Cruciate Ligament

Clinical Arthroscopy	**Tear**	**Normal**
Tear	33 True Positive	3 False Negative
Normal	1 False Positive	63 True Negative

Sensitivity- 91.6%,Specificity- 98.4%,Positive Predictive Value- 97%, Negative Predictive Value- 95.4%, Accuracy- 96%

Table 18: Shows comparison of the findings of Clinical examination with those of arthroscopy with regards to tears of Posterior Cruciate Ligament

MRI/ Arthroscopy	Tear	Normal
Tear	6 True Positive	2 False Negative
Normal	1 False Positive	91 True Negative

Sensitivity- 75%, Specificity- 98.9%, Positive Predictive Value- 85.7%, Negative Predictive Value- 97.8%, Accuracy- 97%.Accuracy of MRI for diagnosing PCL injury is very high.

Discussion

The demographics of the population focused in our study were comparable and more than 50% were in the 4th and 5th decade. With increasing life expectancy and activity levels, we believe this age group will be a major subset of population seen in orthopaedic clinics in the India. A good history with particular reference to the nature of injury and a well-performed clinical examination will in most situations indicate the underlying problem. This is improved by experience, and arthroscopy may be justified on clinical grounds alone [1]. Though the accuracy of clinical diagnosis of meniscal and ligament injuries has been varied in the literature [2, 3], a thorough clinical examination carried out by an experienced examiner in most situations will indicate the nature of the intra-articular injury. Clinical examination is as accurate as MRI and MRI should be reserved for confusing and special cases [4]. The decision to use an expensive investigative tool like MRI should be based on the criteria that the test will confirm or expand the diagnosis or change the diagnosis in such a way that this is going to alter the proposed treatment. It should supplement to formulate a therapeutic decision as well [5]. This entirely rests on the treating physician. In unclear situations, the clinician requests an MRI for additional information to aid plan the operation and to predict the prognosis. This is compounded by high patient expectations, high degree of awareness amongst the public and availability of MRI In knees with multiple ligament injuries, the diagnostic specificity of MRI for ligament tears decreases, as does the sensitivity for medial meniscus tears [6]. MRI added valuable information in 4 clinically confirmed patients which helped the surgeon for better planning. MRI is useful but should be reserved for situations in which an experienced clinician requires further information before arriving at a diagnosis [7]. Our observations agree with the above findings. Though MRI has been recommended as a clarifying diagnostic tool [8], as in other studies we found MRI added little information to an already established clinical diagnosis [9]. Interestingly in our study, patients in whom all the modalities fully agreed consisted of younger patients. Those with highly suggestive symptoms but with negative clinical tests had arthritic changes on plain radiographs, which were confirmed at arthroscopy. An accurate examination may be difficult even for an experienced examiner in this situation and it may be that an arthritic knee may not allow a complete examination. A conclusive diagnosis was therefore not possible. This may account for the low sensitivity of clinical tests in our study. In these situations, the value of MRI is heightened and invariably is requested for confirming the diagnosis. In the middle aged and elderly patients a lower threshold of suspicion is warranted for meniscal tears as they follow minor trauma [10] and MR signal alterations are significantly higher in older population [11]. MRI accuracy depends to a large extent on the structure studied, technical factors including imaging parameters, coil strength, surface coil use and planes of image [5]. Partial tears of ACL may be identified as an altered signal alone and imaging may not be accurate due to the overlying synovial reaction [5]. Further, the sensitivity of MRI for medial and lateral menisci being different there would be many lateral meniscal tears being missed and medial meniscal tears being over diagnosed [3]. A high reliability on the MRI for a diagnosis and additional information will in these situations be a futile attempt [9]. We agree with the above findings. A sound clinical judgment and experience is therefore required in the presence of a normal MRI. However the decision to do an arthroscopy was already made in these patients considering the clinical picture and MRI scans in these patients would have misled the surgeon into not doing an arthroscopy. Cartilage lesions have not been addressed in the present study. Earlier studies suggested that MRI has a doubtful value in cartilage lesions [8]. Even though un-enhanced MRI using a 1.5-Tesla magnet with conventional sequences (proton density-weighted, T1-weighted, and T2-weighted) is most accurate at revealing deeper lesions and defects at the patellae, a considerable number of lesions will remain undetected until arthroscopy [12]. MRI scans with 3-Tesla field strength however improves the visualisation of hyaline cartilage with comparatively good diagnostic values but the positive predictive values remains low for all grades of lesions [13]. High quality MRI films may therefore still be useful in delineating the anatomical location and the geometry of the tear, as treatment options differ. This would thus help the surgeon in better planning but may not completely avoid an arthroscopy procedure. We presume that the plicae were symptomatic in a few patients as the symptoms resolved following removal. Reports from radiology literature have highlighted the importance of quality reporting by experienced musculoskeletal radiologists [14-16]. As in other studies a negative MRI did not prevent us from doing an arthroscopy [5]. We recognise the limitations of this study in terms of the small numbers but believe that the groups studied are representative of the population normally attending the orthopaedic clinics in India.

In our study the sensitivity of MRI was 91.8 percent for the medial meniscus, 87.5 percent for the lateral meniscus, 86.1 percent for ACL, and 87.5 percent for PCL whereas the sensitivity of clinical tests was 91.8 percent for the medial meniscus, 87.5 percent for the lateral meniscus, 86.1 percent for ACL, and 87.5 percent for PCL in our study. The specificity of MRI was 90.2 percent for the medial meniscus, 96.5 percent for the lateral meniscus, 89.1 percent for ACL, and 97.8 percent for PCL whereas the specificity of clinical tests was 90.2 percent for the medial meniscus, 96.5 percent for the lateral meniscus, 89.1 percent for ACL, and 97.8 percent for PCL. The positive predictive value of MRI was 90 percent for the medial meniscus, 82.3 percent for the lateral meniscus, 81.6 percent for ACL, and 77.8 percent for PCL in this study. The negative predictive value of MRI was 92 percent for the medial meniscus, 97.6 percent for the lateral meniscus, 91.9 percent for ACL, and 98.9 percent for

PCL in this study. The accuracy of MRI was 91 percent for the medial meniscus, 95 percent for the lateral meniscus, 88 percent for ACL, and 97 percent for PCL in this study. Imaging of the menisci showed 8 false positive and 6 false negative results of which 5 false positive results were of medial meniscus, and 3 of lateral meniscus; 4 false negative images were of medial meniscus and 2 of the lateral meniscus. Among the 5 false positive results of medial meniscus, 4 menisci showed significant fraying due to degeneration, which was reported as a tear on MRI, and 1 knee showed a loose body whose signal was falsely reported as a tear in medial meniscus. Among the 3 false positive results of lateral menisci two were due to the normal signal of the transverse meniscal ligament which were reported as tear of anterior horn and one false positive was due to degenerative fraying of meniscus. The false positive results for ACL were attributed to the presence of large ligamentum mucosum, which was report das a tear in the substance of ACL. In 3 of the 5 false negative results, the ACL was found to be lax on probing, which was probably due to a partial tear, and 2 tears were proximal and ACL was found attached to the PCL, which was hence reported as normal. The receiver operating characteristic (ROC) analysis was used to validate the discriminative ability of MRI in distinguishing between a tear and normal pathology, which was confirmed or proven wrong by arthroscopy. The area under the curve (AUC) was 91%, 95% 88%, and 97% respectively for medial meniscus, lateral meniscus, ACL and PCL respectively, which is statistically significant The results of this study is in accordance to the literature.

Conclusion

An accurately performed clinical examination by an experienced examiner with positive signs alone will be justified for arthroscopy. A normal MRI will not be a sufficient evidence to deny an arthroscopy particularly in individuals with arthritic knees. The use of MRI as a supplemental tool for clinical decision-making should be highly individualised.

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