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Arthroscopic correlation of clinical and M.R.I. findings in anterior cruciate ligament and meniscal tear

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***Abstract*---**ACL and meniscal tears are common among individuals with knee injuries. MRI is a good non-invasive method for diagnosing soft tissue injuries of the Knee, but an Orthopaedic surgeon can diagnose an ACL or meniscal tear safely with the help of a careful physical examination, and MRI may not be required in such cases. The progression of arthroscopy has encouraged its use for diagnosing knee injuries. 1. Correlate clinical and MRI findings with arthroscopic findings in cases of anterior cruciate ligament and meniscal tear. 2. Find out the specificity, sensitivity, negative and positive predictive values of these methods compared to arthroscopy. 3. Justify whether MRI can be omitted as a definitive investigation and reserved only for complex cases. Study was conducted on patients presenting with a knee injury with features of instability in the Orthopaedics outpatient department over two years. Patients between the ages 18 and 65 who were suspected of having an ACL and meniscus tear were included. A thorough clinical examination, MRI, and arthroscopy were performed on the affected Knee joint. The clinical, MRI, and arthroscopic findings were recorded and compared. Our study revealed that clinical examination had no significant difference in sensitivity, specificity, and predictive values than MRI scan in the diagnosis of ACL tears.

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These parameters showed the only marginal difference in lateral meniscal and medial meniscal injuries, with clinical examination having a better specificity and PPV. Clinical examination is a very good diagnostic modality for ACL, medial meniscus, and lateral meniscus injuries to the Knee, and when performed with precision, it yields results comparable to the findings seen on a 1.5 Tesla MRI. An MRI may be reserved for cases with doubtful clinical examination findings.

***Keywords*---**clinical examination, MRI, knee injury, anterior crucial ligament, meniscus, arthroscopy.

Introduction

The Knee is one of the largest joints of the human body [1]; it is provided stability by the complex anatomy of passive stabilizers (collateral ligaments, cruciate ligaments, menisci, and joint capsules) and active stabilizers (muscles surrounding the Knee) [2]. The knee joint is commonly involved in injuries due to road traffic accidents and sports activities [3-5] through direct trauma or twisting movements at the Knee leading to valgus or varus strain, hyperflexion or hyperextension, and violent rotation [6]. Different ways to diagnose ACL and meniscus tears have been implemented to accurately get a clear perspective of these injuries, including clinical examination, MRI, ultrasonography, or arthroscopy. Clinical diagnosis of meniscus or ACL tear is based on history and clinical findings. In clinical findings, apart from the joint line tenderness, different special tests are performed on the injured Knee, such as the Lachman test, anterior drawer test, pivot shift test for ACL, McMurray's test, Thessaly test, and Apley's test for meniscus.

MRI may still be considered the best non-invasive method for diagnosing soft tissue injuries of the Knee [7], but it was established that an orthopaedic surgeon could diagnose an ACL or meniscal tear safely with the help of a careful physical examination adequately trained in performing it and MRI is not required in such cases. The progression of arthroscopy recently and correctly performed clinical examinations with an additional advantage of low morbidity of the surgical procedure compared to open surgeries has encouraged its use for diagnosing and treating these types of knee injuries. Despite being an invasive procedure, arthroscopy may be considered the gold standard in diagnosing knee pathologies due to its added accuracy and therapeutic advantage. Diagnosis and interpretation of instability in the Knee are quite tricky and controversial [8]; hence a proper protocol to overcome this problem and achieve high diagnostic accuracy is necessary. A systematic review of studies assessing MRI versus Arthroscopy in the diagnosis of knee pathology has not been compared definitively, which empowered us to conduct unbiased and detailed research correlating arthroscopic findings with clinical examination and MRI findings [9].

Materials and Methods

The study was conducted on patients presenting with a knee injury with features of instability at the orthopaedics outpatient department of Maharishi Markandeshwar Medical College and Hospital over a period of two years. A total of 40 patients who presented to the outpatient department with features suggesting ACL tear or medial meniscal injury were selected for the study after randomization.

Inclusion criteria

- Traumatic knee injury within the past 1yr of reporting.
- Patients with pain over the joint line during weight-bearing.
- History of locking episodes/buckling/giving away/collapse apprehension of the Knee
- Complain of painful "pop" or "clunk" sensation in the Knee

Exclusion criteria

- Diagnosed acute infectious knee disease.
- Previous articular fractures of the Knee.
- Previous surgery on Knee.
- Patients with contraindications to MRI.
- Meniscal Cysts.
- Diagnosed osteoarthritis of the Knee.

Methodology

The patients were thoroughly examined clinically for ACL and Meniscal tear. In case they were found to have any positive findings on clinical examination or relevant history; subsequently, they underwent MRI and Arthroscopy. Clinical examination was thoroughly conducted by an experienced surgeon testing for anterior drawer test, pivot shift test, and Lachman test for suspected anterior cruciate ligament injury (ACL). A pivot shift test was performed at the operating table under the effect of spinal anaesthesia. We also checked for McMurray's test, Apley's test, and Thessaly test in a suspected meniscal tear which combines to reproduce high sensitivity and specificity values when performed in the patient with a meniscus injury. These tests were performed by an experienced orthopaedic surgeon as per the instructions given in the textbook for clinical examination [10].

The arthroscopic procedure began by looking for loose bodies in the suprapatellar pouch with the Knee fully extended. Second, they looked at the patellofemoral cartilage and patellofemoral tracking in the patellofemoral joint. Probe the lateral meniscus in the lateral compartment, then with the Knee flexed to 90 degrees, go to the medial compartment to check for medial meniscus integrity. The surgeon then looked for the ACL and PCL in the intercondylar notch. Finish in the lateral compartment with the Knee in the figure-four posture to check for the lateral meniscus and lateral femoral condyle cartilage [11]. Further treatment

undertaken regarding the abnormality was performed as per the requirement and deemed appropriate to the surgeon but has not been discussed as it is out of the scope of this study. The arthroscopic condition of ACL was defined as follows:

- Intact ligament
- Partially torn or Lax ligament
- Completely torn ligament

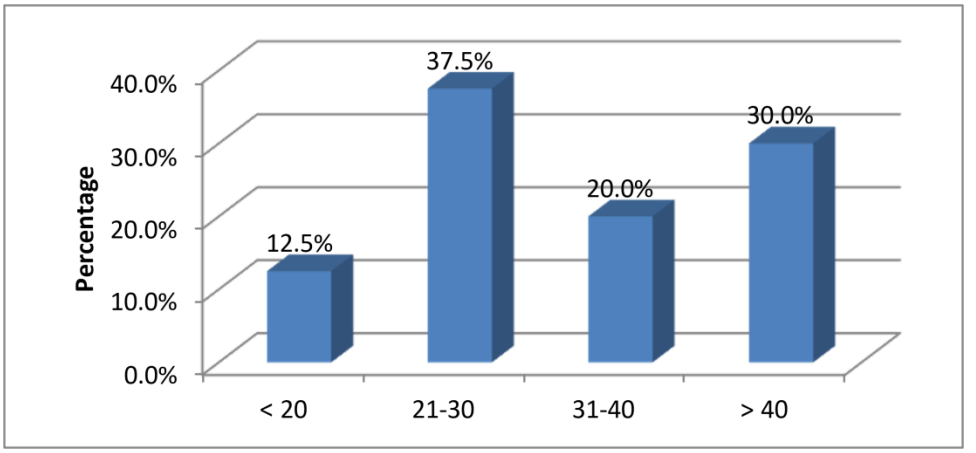
To classify the location of meniscal tear arthroscopically, each meniscus had been divided into three equal segments: anterior horn, body, and the posterior horn [12] and categorized as having an intact or a torn meniscus at any of the above-listed segments. The surgeon was blinded regarding MRI findings while performing clinical examination if patients came with a prior MRI. The clinical findings were not revealed to the radiologist reporting the MRI. The surgeon was made aware of the MRI findings before an arthroscopic procedure was performed. Investigations performed during the study included an MRI knee, X-ray B/L knee, and pre-operative baseline investigations.

Statistical analysis

The data recorded was compared and analysed based on sensitivity, specificity, positive predictive value, and negative predictive value of both modalities, i.e., clinical examination and MRI with Arthroscopy to be considered the gold standard.

Results

The patients in the study ranged in age from 18 to 63 years old, with a mean age of 34.38 years. The majority of the patients were males (26) out of 40 patients, therefore signifying a male preponderance of the pathology. The predominant side involved was the left side (55%) as compared to the right side (45%), being the dominant leg in most cases was lesser involved. The age distribution, when further elaborated according to age groups, revealed the following data (Graph 1) with five patients belonging to 18-20 years ago (12.5%), 15 belonging to 21-30 years ago (37.5%), eight belonged to 31-40 years (20%) of age and 12 belonging to more than 40 years of age (30%).



Graph 1. Graphic distribution of Age group for study subjects

The data manifests that 15 (37.5%) patients presented within the first three months of injury, 10 (25%) patients from 3 to 6 months since the injury, 5 (12.5%) within nine months since the injury, and the rest 20 patients presented with time duration extending beyond nine months to 2years. Most cases suffered a knee injury through trivial trauma or a knee twisting (17), leading to either a meniscal injury or ACL injury, or both. These patients mostly suffered trauma while climbing downhill since the population surrounding our medical college belonged to a hilly area. Therefore, we had a high number of jumps from height (12) cases as well. The people involved in sports activities (6) or RTA (5) were comparatively fewer.

The findings depict that a total of 29 patients were diagnosed with an ACL tear on clinical examination with similar results on Anterior Drawer and Pivot shift test (28 positives) but better results with Lachman Test (29 positives) when compared to arthroscopy. The most significant number of favorable results were seen with the Lachmann test, which depicted a total of 29 (72.5%) positive cases and anterior drawer and pivot shift showing the same number of positives (28) and negatives (12). The sensitivity and specificity of clinical examination for ACL tears were 96.6% and 100%, respectively, which was comparable to that of MRI. The data also manifests that on clinical examination, 22 patients had a meniscal tear, out of which 18 (45%) had a medial meniscus tear, and 4 (10%) had a lateral meniscus tear with similar values for McMurray's and Apley's grinding test but are different for Thessaly's test.

In the present study, based on clinical examination, true positives for medial meniscus were 16 (40%), false positives were 4 (10%), the false-negative was 8 (20%), and the true negative was 12(30%). For lateral meniscus, true positive patients were 4 (10 %), false positives were 1 (2.5%), false negative were 3 (7.5%), and a true negative was 32 (80%) when combining values for all three tests performed. The combined values of tests performed for clinical examination were calculated with sensitivity, specificity, PPV, and NPV of 72.3%, 89.2%, 86.2%, and 78.3%, for medial meniscus, and 50%, 99.2%, 94.5%, and 93.2% respectively for lateral meniscus. Moving on to the observations done based on the MRI reporting done for our patients, the following data and findings could be observed among

the 40 cases included in the study, 29 had an ACL tear, and 23 suffered a medial meniscus tear, and 8 had a lateral meniscus tear. Out of 40 cases included in the study, 30 had an ACL tear, 19 suffered a Medial Meniscus tear, and 4 had a Lateral Meniscus tear as visualized on arthroscopy. This data has been demonstrated in a tabular comparative form in Table1.

Table 1
Comparative analysis of clinical, M.R.I. and arthroscopic findings

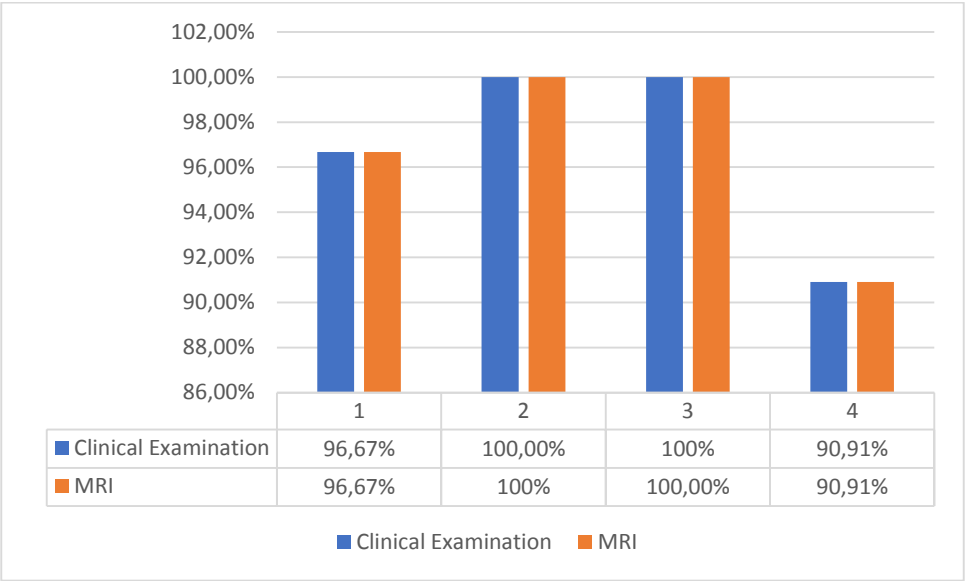
Pathology	Clinical findings	M.R.I. findings	Arthroscopic findings
A.C.L. Tear	29	29	30
MM Tear	18	23	19
LM Tear	4	7	4

In the present series, MRI for ACL tear was positive in 29 patients, out of which 29 (100%) were confirmed positive, and no patients were false positive. In the remaining 11 patients in which MRI was negative for an ACL tear, 1 (2.5 %) patient was a false negative, and the rest 10 (25%) were confirmed negative. A sensitivity of 96.5%, specificity of 100%, a positive predictive value of 100%, and a negative predictive value of 91.6% for the ACL tears in MRI against arthroscopy. The sensitivity and specificity of MRI were 78.9% and 65%, respectively, for medial meniscus tear, 60% and 88.5% for a lateral meniscus tear, and 96.5% and 100% for ACL tear (Table2).

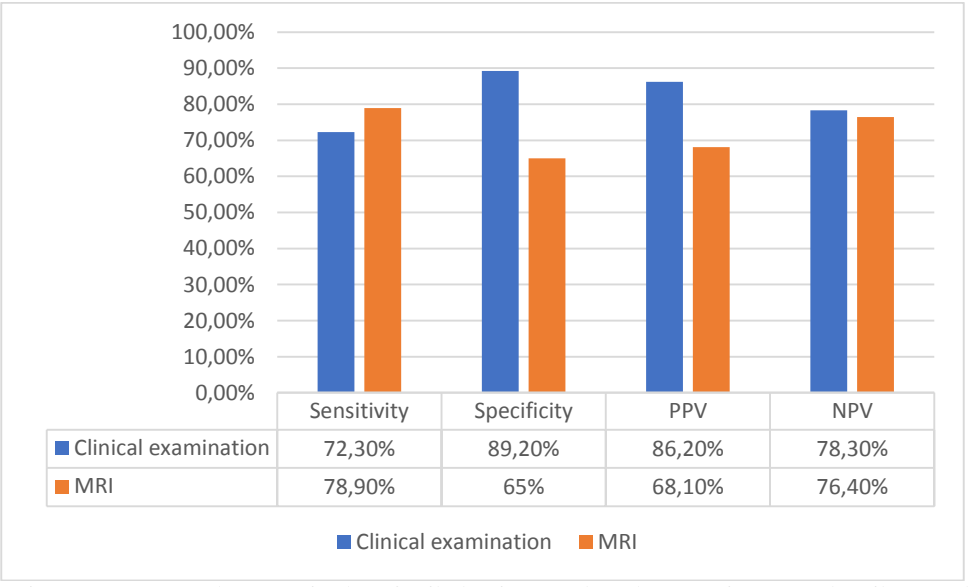
Table 2
M.R.I. results with arthroscopy as the gold standard

Pathology	TP	FN	TN	F.P.	Sensitivity	Specificity	PPV	NPV
ACL Tear	29	1	10	00	96.5%	100%	100%	90.91%
MM Tear	15	04	13	08	78.9%	65%	68.1%	76.4%
LM Tear	04	01	32	03	60%	88.5%	57.1%	93.9%

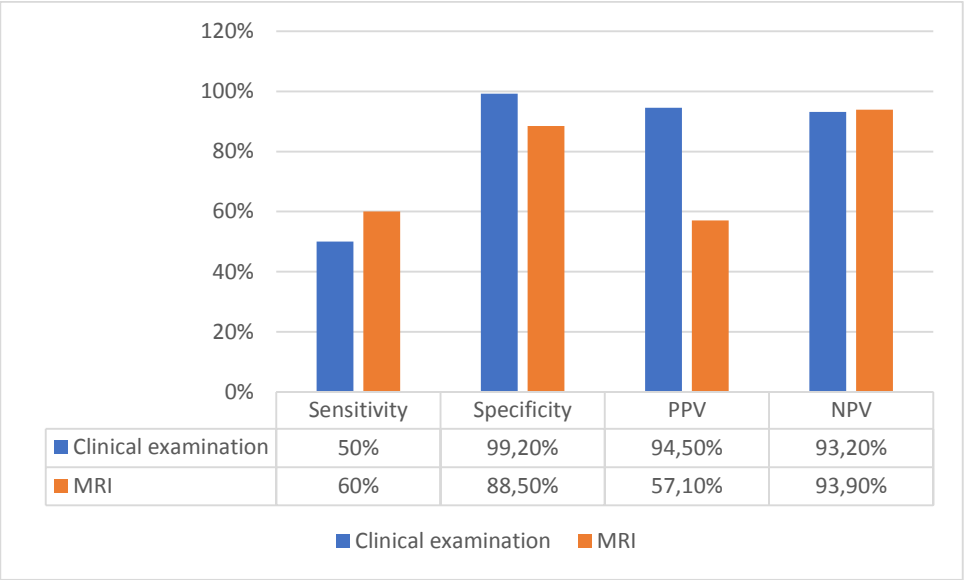
To summarize the statistics for clinical examination vs. MRI for ACL, MM, and LM tears, the data was compiled, keeping arthroscopy as the gold standard as presented in Graph 2,3,4.



Graph 2. Comparative analysis of Clinical examination and M.R.I. in diagnosing A.C.L. tear



Graph 3. Comparative analysis of Clinical examination and M.R.I. in diagnosing MM tear



Graph 4. Comparative analysis of Clinical examination and M.R.I. in diagnosing L.M. tear

The data comparison depicts marginal or no between the values in graphs with near-identical findings when comparing clinical examination tests to MRI in knee injury cases involving ACL tears, MM tears, or LM tears, except PPV, which was significantly higher with clinical examination as compared to MRI in case of LM injury.

Discussion

Owing to the number of soft tissues in and around the Knee, injuries to the Knee joint are complex problems requiring accurate diagnosis and appropriate treatment. It is difficult to pinpoint precisely the involved structure in knee injuries clinically. David A. Turner et al. [13] used specimens from cadavers to evaluate the sensitivity of MRI in detecting iatrogenic defects of the articular surface. They consistently identified lesions that were as small as three millimetres in diameter. MRI adequately demonstrates the status of ACL and Meniscus with a few limitations. We designed the present study to evaluate the efficacy of clinical examination and MRI as a method of detecting lesions of menisci and ACL in comparison with arthroscopic findings.

In our study, most of the patients were young adults belonging to a local mountain population catered to by our hospital. The sex distribution was analyzed as being male preponderant. Previous studies among athletes have shown a female preponderance of ACL and meniscal tears in the Knee, like that of Karen M Sutton and James Montgomery Bullock, in which the rate of anterior cruciate ligament (ACL) rupture is three times higher in female athletes.[14] As summarized in a study by Thomas L Sanders et al. in 2016, studies on identifying the population-based incidence of ACL tear found that male patients (81.7 vs.

55.3 per 100,000) had considerably higher rates of ACL tear than female patients (81.7 vs. 55.3 per 100,000).[15]. Our study shows a similar result with a lower male to female ratio than other studies since the hormonal, biomechanical, and physical factors play a significant role in females.[16]

The mean age of our study (34.8) is also a little higher because our study included more patients belonging to the general population rather than athletes. This mean age is beyond the usual peak incidence age for both males and females.[16] In the present case series, the most typical mode of injury was trivial trauma from a twisting injury, followed by a jump from a height, sports activities, and the least resulting after a road traffic accident. Other studies demonstrate many athletic injuries as the commonest cause of ACL tears in sports such as football, basketball, and volleyball players, followed by meniscal injury in street runners.[17]. In the present study, 60% had presented within six months of the injury, and 40% had presented from six months up to two years. This is due to increasing awareness among the public about the severity and complications in the long term after sustaining an ACL or meniscal injury and increasing healthcare establishments in urban as well as rural India.

The non-dominant side (left in all cases) Knee was involved in 55% of the cases. This does not compare to previous studies, which may be due to a few reasons. The population included in other studies belongs to a plain geographical region, and the mechanism of injury is very different in the mountains. Secondly, the commonest causes in other studies are athletic injuries or road traffic accidents which are not the case in our study. While going downhill on uneven ground or road causes an incorrect stepping, or sudden stopping on the left Knee causes a jerk or twisting of the Knee. This leads to a strain on the cruciate ligaments and meniscus. Whereas in patients suffering from ACL and meniscal lesions due to jumping and sports, including running, football, and basketball, there is an increased strain on the dominant right Knee.

Anterior cruciate ligament

The sensitivity and specificity of clinical examination for ACL tears, which was comparable to that of MRI, shows that for a definite ACL tear, clinical examination may be regarded enough to confirm the diagnosis. This can be because the pivot shift test, Lachmann test, and anterior drawer sign are very accurate in diagnosing ACL tear. In the study conducted by Huang W. et al., the sensitivity and specificity of clinical examination for ACL tear were 87% and 97%, respectively [18]. This compares to a study by KP Barry et al. in which high-tesla unit and low-tesla unit MRI for ACL tear combined results of both field strengths yielded the overall sensitivity and specificity were 93% and 89%, respectively.[19] These values are similar to the findings of our study or slightly better in our study due to the accurately performed clinical examination with an additional number of clinical tests.

On clinical examination, out of 30 ACL ruptures, one case was not diagnosed accurately or was doubtful on physical examination. This was a case of chronic anterior cruciate ligament tear, and more than 12 months had elapsed since the injury. This case, when viewed arthroscopically, was found to have stump fibrosis

of torn anterior cruciate ligament fibres and its attachment with the posterior cruciate ligament (Figure 1). A false negative clinical examination may have occurred as a result of this reason. The Lachman test was the most sensitive diagnostic for ACL injuries, allowing 29 patients to be diagnosed with ACL tears. The Lachman test had a sensitivity of 96.6 percent, as well as a specificity of 100 percent.

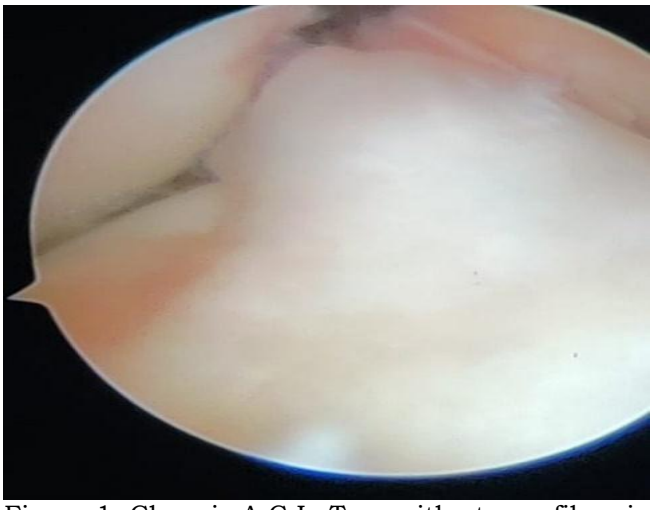


Figure 1. Chronic A.C.L. Tear with stump fibrosis

Even though the anterior drawer test and pivot shift test showed equal sensitivity (93.3% each) minutely lesser than the Lachmann test, but specificity was 100%, these values of clinical examination, when combined, were comparable to the estimates done on MRI. Previous literature reports a sensitivity of 66% - 100%, specificity of 67% - 98%, positive predictive value of 75% - 81%, negative predictive value of 79% - 100% for the ACL tears in MRI against arthroscopy.[20] Whereas we found them to be 96.5%, 100%, 100%, and 91.6%, respectively, a picture similar to the other studies apart from the PPV, which was slighter higher than the range in previous studies. It was found in previous studies that false positives were associated with other abnormalities like ligamentous laxity, knee effusions, and degenerative changes of ACL but no tear. For these changes in ACL, MRI can be considered too sensitive in detecting ligamentous changes that do not result in laxity. These factors were not a matter of concern due to thorough screening and definitive exclusion of patients according to the criteria.

MENISCI

The maximum sensitivity among the clinical examination methods for meniscal tear was 84%, whereas that of MRI was 79% which is lower than clinical examination. The reason can be that grade 1 and 2 tears of menisci are not easily picked up by MRI and may also be missed on McMurray and Apley's test (sensitivity 68% and 58%, respectively), but Thessaly test and joint line tenderness are very sensitive (84% and 79% respectively) for meniscal tears. In 40 patients, the diagnosis was correct in 35 (87.5%) and incorrect in 5 (12.5%) patients for medial meniscus and correct in 38 (95%) and incorrect in 2 (5%)

patients for lateral meniscus based on thorough clinical examination. A total of 19 medial meniscal tears and four lateral meniscal tears were identified at arthroscopy.

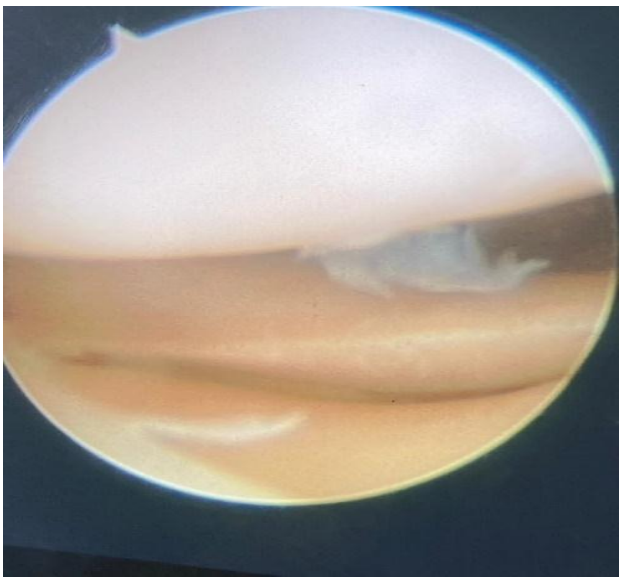


Figure 2. Normal medial meniscus on arthroscopy

Figure 3. Meniscus tear on M.R.I.

The variation in the number of medial to lateral tears may be due to a more common involvement of the medial meniscus in chronic knee injury than an acute ACL tear which would involve a lateral meniscus tear more often [21]. In our study, since only 15 cases presented with an acute presentation, this may be

a reason for a higher number of medial meniscus involvement. The lateral meniscus was diagnosed in cases presenting with acute injury to the Knee and, therefore, fewer positive cases, with only 15 patients presenting acutely. When compared to MRI, these values reveal no significant difference and indicate that clinical examination may be an equally got diagnostic modality when performed accurately compared to a 1.5T M.R.I.

In a study conducted by Kumar Shantanu et al., for medial and lateral meniscus injury, they performed only the McMurray test and compared it with arthroscopy.[22] The values of sensitivity, specificity, PPV, NPV, and diagnostic accuracy of 47.4%, 97.6%, 90.0%, 80%, and 81.7%, respectively, for medial meniscus and 50%, 98.07%, 80%, 92.72%, and 91.66%, respectively for lateral meniscus were in a lower range than the values of our clinical examination combined. This may be attributed to the inclusion of multiple tests to conclude the results of our examination. Our results had seven false negatives, of which all had a radial tear of the meniscus. These tears could not be visualized on an MRI due to their location at the middle and posterior third of the meniscus junction. This area cannot be easily visualized on Sagittal or coronal planes and needs a 3 Tesla M.R.I. to catch hold of such tears. MRI helps to diagnose cases better in cases where we suspect joint effusion, articular cartilage damage, or collateral ligament discontinuity.

The findings for sensitivity, specificity, positive predictive value, and negative predictive value of clinical examination with respect to arthroscopy for medial meniscus tears were similar to the study by Faizal Rayan et.al.[23], Other studies report a sensitivity of 86 percent to 96 percent, specificity of 33 percent to 87 percent, and accuracy of 73%. MRI sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 88.2 percent, 62.8 percent, 53.6 percent, 91.7 percent, and 71.2 percent, respectively. [24,25]. In centers like ours, patients presenting with such complaints are confined to the middle-class socioeconomic status, and hence subjecting a patient to a hefty investigation like MRI should be avoided as far as possible. Another thing to note is that the number of MRIs which take place in such centers is also very high, striking a hammer on the daily wage worker's pocket the longer one stays away from their job. Therefore, the authors believe that centres with 1.5 Tesla M.R.I. and a load of backward patients can omit it due to comparable results to clinical examination.

The cost of arthroscopy and the number of operating surgeons may be considered as an inversely proportional ratio. Since a more significant number of arthroscopy surgeons are coming up in various parts of the nation, arthroscopy costs are bound to come down as a competitive strategy ensues. If a retrospective analysis of these cases is to be done, MRI with 3 tesla unit can still improve the sensitivity, specificity, and diagnostic accuracy of ligament and meniscal injuries in the Knee. The 3 Tesla M.R.I. can better visualize the meniscal substance with respect to site, size, and extent of tear. At the same time, cases with a clear-cut ACL tear on the clinical ground have no need for MRI. A limitation of our study may be a lack of inter and intra-observer reliability testing. Due to the smaller sample size and single centric study, future research is necessary to determine if clinical diagnostic tests are more diagnostically accurate than MRI in diagnosing ACL tears with larger sample quantities and multi-centric studies. More studies will

need to be conducted to compare the specificity, sensitivity, PPV, NPV, and accuracy of clinical diagnostic tests and MRI and clinical diagnostic tests proficiency of the examiner; probably, a large randomized controlled trial is needed.

Conclusion

Clinical examination is a very good diagnostic modality for ACL, medial meniscus, and lateral meniscus injuries to the Knee, and when performed with precision, yields results comparable to the findings seen on a 1.5 Tesla MRI. Therefore, in patients with an established diagnosis on clinical examination, an MRI may not be needed to be performed for such cases and can thus be reserved for cases with doubtful clinical examination findings and complex knee injuries. This may be of help in reducing the patient load for MRI as well as reduce the burden of the expenses on patients of lower socioeconomic status.

Declarations

Ethical approval

This study received ethical approval from the Ethics committee of Maharishi Markandeshwar Medical College & Hospital.

Informed consent

Written informed consent was obtained from all patients.

Competing interests

The authors declare that they have no competing interests.

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