

## COMPARING THE DIAGNOSTIC ACCURACY OF MAGNETIC RESONANCE IMAGING AND ARTHROSCOPY IN LIGAMENTOUS KNEE INJURIES

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### Abstract

**Background:** This study aims to compare the diagnostic Accuracy of magnetic resonance imaging (MRI) against the arthroscopic findings in ligamentous knee injuries. MRI is currently available for diagnosis in the acutely injured painful knee where the clinical examination is non-conclusive because of high negative value. The study aims to correlate the results of MRI in internal derangement of the knee with arthroscopy findings to determine the efficacy of MRI in different intraarticular knee injuries. The aim & Objectives are to know the specificity and sensitivity of MRI in evaluating cruciate ligament tears and meniscal tears, which are subsequently confirmed with arthroscopy. And also, to categorically mention the variations in menisci and cruciate ligament findings between arthroscopy and MRI, to know the Positive Predictive Value, Negative Predictive Value and Accuracy of MRI in the evaluation of ligamentous injuries of knee versus arthroscopy & to observe the Sensitivity and Specificity of MRI in detecting ligamentous injuries. **Materials and Methods:** All patients clinically suspected of internal derangement of the knee presented in the department of orthopaedics BLDE Medical College and Hospital, Vijayapura, will be evaluated with clinical history and MRI. A surface coil is used, and MRI will be performed using a 1.5 tesla MRI scanner (Philips MRI System). Axial, coronal & sagittal T1, T2, PD & STIR images were taken. The patient underwent Diagnostic arthroscopy and was further evaluated. **Result:** Of the 32 patients evaluated, the most common injury was ACL and PCL injury was less common. A medial meniscus injury is most common than a lateral meniscus injury. Osseous lesions & joint effusion were most commonly associated with these injuries. On arthroscopy, most of the findings correlated very well. **Conclusion:** MRI is a non-invasive and reliable investigation of ligament pathologies. It helps diagnose ligament injuries, helping in proper conservative or surgical management. However, a few medial meniscal injuries go unnoticed in MRI, reducing its Sensitivity to diagnose the injury. MRI can even give false positive results in patients with medial osteochondral defects. However, one must carefully evaluate and re-evaluate before ruling out an internal derangement in a knee, even when MRI shows no evidence of injury. It was also found that MRI to detect ACL and lateral meniscal injuries correlates highly with arthroscopic findings.p



## INTRODUCTION

Trauma to the knee joint is a significant cause of morbidity in active young individuals, especially among athletes and military and police recruits. The knee is put through many forces while doing activities of daily living or any athletic activity.<sup>[1]</sup> Joint reactive forces in knee joints can reach up to three times while walking upstairs and up to six times while in a full squatting position. Internal derangement of the knee refers to injured structures of the knee, including meniscal injury, loose bodies, ligamentous injury and collateral injury.<sup>[2,3]</sup> The most common presenting complaints in ligament tear is pain and instability. Instability symptoms are directly proportional to the degree of tear.<sup>[4]</sup> Early detection is vital for adequately treating intraarticular ligament injuries, meniscal injury and articular cartilage to prevent further degeneration and mechanical instability by available surgical options. Various imaging techniques can diagnose internal derangement.<sup>[5]</sup>

A detailed and thorough history with the clinical examination is important in diagnosing ligamentous knee injuries. However, in many situations, particularly with meniscal injuries(s), the clinical evaluation may need to be more precise and conclusive.<sup>[6]</sup> Just 58% of meniscal tears are reported to be detected by clinical tests like the McMurray test for meniscus, and a negative McMurray test does not rule out a meniscal tear.<sup>[7]</sup> When it comes to clinical examination, it is subject to an increased chance of inter-observer variations.<sup>[8]</sup> Diagnostic arthroscopy is the gold standard in diagnosing ACL and meniscal injuries. However, it is associated with complications like infection and the need for anaesthesia. MRI is a sensitive (90-98%) and specific (90-100%) imaging method for diagnosing ACL injuries.<sup>[9-11]</sup>

## MATERIALS AND METHODS

It is a prospective study performed between November 2020 and September 2022 in BLDEA's Shri B. M. Patil Medical College and Hospital, Bijapur. All cases admitted to the orthopaedic department for evaluation of traumatic knee following MRI and arthroscopy as a definitive treatment plan or as diagnostic who satisfied the inclusion criteria were included in the study.

With expected sensitivity 88%, specificity 82% and incidence of medial meniscus tear is 8% the sample size required is 32 to achieve the precision of 0.15.

### Inclusion Criteria

- Patients with a recent knee injury (within two months) to either or both knee joints.
- Patients who are planned for their ligamentous reconstructive surgery within three months of pre-operative MRI of the knee
- Based on MRI, patients undergo arthroscopic surgeries for meniscus, ACL or PCL.
- The age group of over 18 years

### Exclusion criteria

- Knee injuries other than internal derangement
- Patients who underwent multiple ligamentous reconstructions in knee injuries.
- The patient is not willing for surgery.
- Patients over 55 years
- Patients undergoing arthroscopy for ACL and meniscal injuries without MRI

Each patient with a knee injury will be evaluated clinically for evidence of internal derangement knee by clinical test followed by

- MRI, and
- Diagnostic Arthroscopy

Each MRI was carried out according to the 1.5 TESLA MRI G SIGMA EXPLORE protocol., 16 CHANNELS. T1 & T2 weighed sequences were done on coronal and sagittal planes. MRI films were evaluated and reported by a senior consultant radiologist. The status of the menisci, cruciate ligament, cartilage and subchondral bone were noted. All the patients were planned for an arthroscopic surgery within three months of MRI evaluation. An experienced orthopaedic surgeon performed the arthroscopy under spinal or general anaesthesia. The sequence in the assessment of arthroscopy was:

1. Suprapatellar pouch and patellofemoral joint
2. Medial gutter
3. Medial compartment
4. Intercondylar notch
5. Posteromedial compartment
6. Lateral compartment
7. Lateral gutter and posterolateral compartment

After performing a thorough knee arthroscopy, the injured structure was identified and treated accordingly.

To evaluate the reliability of the results from the arthroscopy and MRI, statistical analysis was utilised to calculate Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and Accuracy. The results of the arthroscopy were considered to be the correct diagnosis to assess the sensitivity, specificity, and accuracy of the MRI.

The number of true positive outcomes divided by the total of true positive and false negative results was used to assess sensitivity. The number of true negative findings divided by the total of true negative and false positive results served as the basis for calculating specificity.

The positive predictive value was calculated by true positive divided by the sum of true and false positive results multiplied by 100. The negative predictive value was calculated by true negative divided by the sum of true and false negative results multiplied by 100.

The accuracy was determined by dividing the total number of arthroscopy patients by the sum of the true positive and true negative outcomes. This data was analysed using SPSS 17.26 version. The following were the results of the study.

## RESULTS

Thirty-two patients who met the inclusion and exclusion criteria requirements were considered for

the study. Most of the patients were between 20 and 40 years of age [Table 1], sports injury was the most common mode of injury [Table 2], and knee pain was the most common presenting symptom [Table 3].

**Table 1: Age wise distribution**

Age (Years)	No. of patients	Percentage
<30	9	28.1
30 -39	15	46.9
40 -49	5	15.6
50+	3	9.4
Total	32	100.0

**Table 2: Mode of injury**

Mode of Injury	Number	Percentage
Others	8	25.0
RTA	7	21.9
Self-fall	6	18.8
Sports Injury	11	34.4
Total	32	100

**Table 3: Presenting symptoms of patients**

Presenting symptoms	Number
Instability	2
Knee pain	17
Knee pain and instability	4
Knee pain and locking	2
Knee pain and swelling	6
Swelling, locking and instability	1
Total	32

### Arthroscopic findings

Longitudinal tears were the most common medial meniscal tears, followed by bucket handle tears. Longitudinal tears were the most common type of lateral meniscal tear, followed by radial tears. Thirteen patients had isolated ACL tears, eight patients had ACL and medial meniscus tears, three patients had isolated medial meniscus tears, and two patients had isolated lateral meniscus tears. Osteochondral defects were noted in 9 patients.

### Correlation of MRI findings with Arthroscopic Examination of medial meniscal tears:

The correlation of MRI with respect to arthroscopic findings for medial meniscus [Table 4] shows sensitivity of 57%, specificity of 94%, Positive Predictive Value of 88%, Negative Predictive value of 73% and Accuracy of 78% [Table 5].

**Table 4: Correlation of MRI findings with Arthroscopic Examination of Medial Meniscal tears (MM – Medial Meniscus)**

MRI-MM	Arthroscopy findings of MM			Chi-square test	P value
	Yes	No	Total		
Yes	8	1	9	10.367	0.001
%	57.1%	5.6%	28.1%		
No	6	17	23		
%	42.9%	94.4%	71.9%		
Total	14	18	32		
%	100.0%	100.0%	100.0%		

**Table 5: Shows Sensitivity, specificity, PPV, NPV and accuracy of medial meniscus tears in MRI in correlation to arthroscopic findings**

Statistic	Value
Sensitivity	57.14%
Specificity	94.44%
Positive Predictive Value (*)	88.89%
Negative Predictive Value (*)	73.91%
Accuracy (*)	78.12%

### Correlation of MRI findings with Arthroscopic Examination of Lateral Meniscal tears:

The correlation of MRI with respect to arthroscopic findings for lateral meniscus [Table 6] showed Sensitivity was 87%, Specificity was 100%, Positive Predictive Value was 100%, and Negative Predictive value was 96% and Accuracy was 96% [Table 7].

**Table 6: Correlation of MRI findings with Arthroscopic Examination of Lateral Meniscal tears. (LM – Lateral meniscus)**

MRI-LM	Arthroscopy findings of LM			Chi-square test	P value
	Yes	No	Total		
Yes	7	0	7	26.880	0.001
%	87.5%	0.0%	21.9%		
No	1	24	25		
%	12.5%	100.0%	78.1%		
Total	8	24	32		
%	100.0%	100.0%	100.0%		

**Table 7: Shows the Sensitivity, specificity, PPV, NPV and accuracy of lateral meniscus tears in MRI in correlation to arthroscopic findings of the lateral meniscus.**

Statistic	Value
Sensitivity	87.50%
Specificity	100.00%
Positive Predictive Value (*)	100.00%
Negative Predictive Value (*)	96.00%
Accuracy (*)	96.88%

**Table 8: Correlation of MRI findings with Arthroscopic Examination of ACL tears. (ACL – Anterior cruciate ligament)**

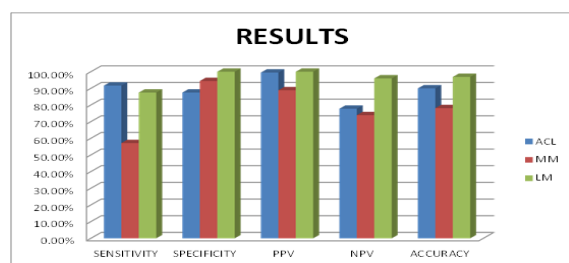
MRI-ACL	Arthroscopy findings of ACL			Chi-square test	P value
	Yes	No	Total		
Yes	22	1	23	18.602	0.001
%	91.7%	12.5%	71.9%		
No	2	7	9		
%	8.3%	87.5%	28.1%		
Total	24	8	32		
%	100.0%	100.0%	100.0%		

**Table 9: Shows Sensitivity, specificity, PPV, NPV and accuracy of ACL tears in MRI in correlation to arthroscopy findings of ACL tear**

Statistic	Value
Sensitivity	91.67%
Specificity	87.50%
Positive Predictive Value (*)	95.65%
Negative Predictive Value (*)	77.78%
Accuracy (*)	90.62%

**Table 10: Comparison of MRI findings for ACL, Medial Meniscus and Lateral Meniscus. (ACL – Anterior cruciate ligament, MM – Medial meniscus, LL – Lateral meniscus, PPV – Positive predictive value, NPV – Negative predictive value)**

Results	Sensitivity	Specificity	PPV	NPV	Accuracy
ACL	91.67%	87.50%	99.5%	77.78%	90%
MM	57.14%	94.44%	88.89%	73.91%	78.12%
LM	87.5%	100%	100%	96%	96.88%



**Figure 1: Bar diagram showing a comparison of MRI findings for ACL, Medial Meniscus and Lateral Meniscus. (ACL – anterior cruciate ligament, MM – Medial meniscus, LL – Lateral meniscus, PPV – Positive predictive value, NPV – Negative predictive value)**

### Correlation of MRI findings with Arthroscopic Examination of ACL tears:

The correlation of MRI with respect to arthroscopic findings for ACL tears [Table 8] shows Sensitivity was 91%, Specificity was 87%, Positive Predictive Value was 77%, Negative Predictive value was 77%, and Accuracy was 90% [Table 9].

### Comparison of MRI findings for ACL, Medial Meniscus and Lateral Meniscus:

The Table 10 and Figure 1 summarises the diagnostic power of MRI with respect to arthroscopy while comparing its sensitivity, specificity, positive predictive value, negative predictive value and accuracy.

## DISCUSSION

In our study, MRI findings were very well correlated; however, in a few cases, a mid-substance tear of ACL (grade I) could be correlated because hyperintensity on PD/T2WI sequences appeared to be grade I (tear). On arthroscopy, it was a false negative.

Meniscal injury showed a grade I tear of the inferior surface of the meniscus, and arthroscopy findings could not be correlated; however, MRI was well associated with arthroscopy in ACL tears. In the past, a thorough clinical examination was the primary method used to identify ligamentous injuries to the knee.

Because radiographs alone could not do so, even in the hands of skilled practitioners, clinical examination yielded incorrect diagnosis rates between 40% and 85%, particularly for meniscal lesions.<sup>[12]</sup> Interobserver differences can also occur during a clinical evaluation. The effectiveness of combining clinical examination and diagnostic arthroscopy in the identification of meniscal and ACL injuries was then the subject of numerous investigations.

When arthroscopy was used as a diagnostic procedure on patients with acute traumatic hemarthrosis, DeHaven et al. reported a relatively high incidence of ACL tears and meniscal injuries.<sup>[13]</sup> When Johnson LL et al. compared diagnostic arthroscopy to clinical examination, they discovered many additional diagnoses, some previously unknown. Concerning 396 knee arthroscopies, Curran et al. found that the overall clinical accuracy rate was 71%.<sup>[14]</sup> Their accuracy rates for diagnostic arthroscopy rose to 97%. Today, the primary investigative technique is an MRI of the knee, which has developed into a reliable tool for identifying knee problems. It is non-invasive and enables examination of all the soft tissues, articular cartilage, and bone structures. More than 90% of MRI diagnoses of ligamentous injuries are sensitive and specific.<sup>[15]</sup>

A literature review shows a good link between ACL injuries that are first examined clinically and subsequently by MRI and arthroscopy. However, there is less correlation between clinical examination, MRI, and arthroscopy when evaluating whether meniscal injuries are clinically suspected. Rayan et al. performed a similar study on 131 patients. They discovered that when clinical examination and an arthroscopic discovery of a medial meniscal tear were correlated, the Accuracy, Sensitivity, Specificity, positive predictive value, and negative predictive value were all 79%, 86%, 73%, and 83%, respectively.<sup>[16]</sup>

The clinical examination with MRI and arthroscopy for ACL rupture had significantly greater accuracy, sensitivity, specificity, positive predictive value, and negative predictive value, measuring 93%, 77%, 100%, and 95%, respectively.<sup>[17]</sup>

Comparative research conducted by other authors, such as Navali et al., Nikolaou et al., and Loo WH et

al., has produced similar findings when connecting with MRI and arthroscopy in diagnosing ligamentous knee injuries.<sup>[18-20]</sup> The current investigation aims to establish the function of magnetic resonance imaging in diagnosing internal knee joint derangements. The knee joint is the most crucial and intricate weight-bearing joint in the human body. Due to the complexity of its structural design and the many pressures it is exposed to, it is vulnerable to damage. The primary examination method for determining internal knee joint derangements has emerged as magnetic resonance imaging. It offers excellent soft tissue demonstration, is non-invasive, doesn't use ionising radiation, and has multiplanar capacity. Arthroscopy is invasive and can only assess surface problems, although it provides a grand vision of the joint's interior.

In the present study, 32 patients with knee joint symptoms referred for magnetic resonance imaging of the knee joint were evaluated. The most common presenting symptoms were knee joint pain, acute or longstanding and swelling. The most common age group involved was between 30-40 years. The following patterns of knee injuries were seen:

1. The most common injury was ACL tear, of which complete tears were more common.
2. Medial meniscal tears are more frequent than lateral meniscal tears among meniscal injuries, and grade 3 tears are more frequent in both.
3. In 11 individuals (33%), osteochondral lesions were discovered.

The ligamentous & meniscal-associated injuries are more severe than the available literature, which can be attributable to the severity of RTA and injuries in young individuals. Our study's MRI accuracy for the medial meniscus was lower than that of another research but by a smaller margin. This can be explained by the fact that arthroscopy revealed an osteochondral defect in many instances where testing for a medial meniscus was positive.

All the study participants had their MRIs evaluated in a 1.5 Tesla machine without using particular imaging sequences for articular cartilage. Therefore, the MRI should have noticed these flaws. Our study's findings are comparable to those of earlier research looking at ACL and lateral meniscal injuries. As a result, a patient who has undergone clinical examination and been determined to have either ACL damage or lateral meniscal injury can be counselled to treat these injuries with better surety. Before placing a patient under anaesthesia, pre-operative MRI scans should be carried out.

## CONCLUSION

MRI is a non-invasive and reliable investigation for ligament pathologies, which helps diagnose meniscal and ligament injuries and helps in proper management by planning treatment. However, arthroscopy remains the gold standard for diagnosis and treatment at the same time.

We have arrived at these conclusions from our study.

1. MRI to detect ACL and lateral meniscal injuries correlates highly with arthroscopy.
2. MRI to detect medial meniscal tears have a low degree of correlation when compared with arthroscopy.
3. MRI to detect medial meniscal injuries can be a false positive for Osteochondral defects of the medial compartment of the knee.
4. When treating Osteochondral defects, the surgeon should be prepared to treat unsuspected medial meniscal tears found at arthroscopy, especially when a sub-optimal MRI has been done.

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