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## Original research article

# Categorization of discrepancies in findings of menisci and cruciate ligament between arthroscopy and MRI

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### Abstract

**Background:** The stability of the joint is highly dependent on its supporting ligamentous structures, therefore injuries of ligaments and menisci are extremely common.

**Objective:** To categorize discrepancies in findings of menisci and cruciate ligament between arthroscopy and MRI.

**Methodology:** This prospective, comparative observational study was conducted at Ramkrishna Care Hospital, Raipur, Chhattisgarh. Informed consent was taken from all patients undergoing this study. We prospectively studied 67 patients with complaints of knee pain or instability/locking/giving away sensation with history of knee injury between the age group of 15-60 years over a period of 24 months starting from November 2014 to October 2016.

**Results:** MRI showed 100% sensitivity and negative predictive value for ACL tear while specificity was 66.67% and accuracy of 95.52% with positive predictive value of 95.08%. MRI showed 100% positive predictive value for PCL tear while negative predictive value was 98.48%, alongwith sensitivity of 50% with specificity of 100% and accuracy of 98.51%. MRI showed positive predictive value of 57.58% for MM tear while negative predictive value was 88.24%, alongwith sensitivity of 82.61%, specificity of 68.18% and accuracy of 73.13%. MRI showed 75% positive predictive value for LM tear with a negative predictive value of 93.62%, alongwith sensitivity of 83.33%, specificity of 89.80% and accuracy of 88.06%.

**Conclusion:** It was concluded MRI has high accuracy in diagnosing both meniscal and cruciate ligament injuries. The sensitivity for ACL tear is higher as compared to PCL while that of meniscal tear are almost equal.

**Keywords:** Sensitivity, specificity, MRI, arthroscopy, meniscal injuries, cruciate ligament injuries

### Introduction

The principle intra-articular structures in knee are the two menisci, two cruciate ligaments and the two collateral ligaments. The menisci serve to distribute the joint fluid, cartilage nutrition, mechanical shock absorption, increasing the surface area of the joint and therefore the stresses, serve to stabilise the joint and a weight bearing function. The cruciate ligaments function as stabilisers of the knee in both forward and backward motion of tibia on femur and provide an axis around which both medial and lateral rotatory movement are assisted [1]. The injury of these intra-articular structures is generally termed as "Internal Derangement of Knee" which was first coined by William Hey in 18744.

Traumatic injuries of the knee joint either due to road traffic accidents or sports related constitute a large proportion of musculoskeletal trauma encountered in emergency department, so a detailed clinical examination with numerous stability test provide an almost 70% accuracy in diagnosing pathology [2, 3, 4]. However in acute stage following injury, clinical tests may not be appropriate due to pain, thus an MRI is preferred modality of investigation. It is non-invasive and considered to be highly sensitive to meniscal injuries [5, 6, 7] but is less so for the anterior cruciate ligaments injuries [8]. Many factors affect the accuracy of MRI in detecting meniscal lesions like experience of radiologist in interpreting studies. Many pitfalls occur in interpretation e.g. in studying the central portion of menisci, the menisco-femoral ligament and

transverse meniscal ligament, elderly patients often exhibit increased intra-meniscal signal that can be mistaken for tear. In case of medial collateral ligament injury, mild degrees of injury correlate well; imaging is less accurate in grading more severe injuries<sup>[9]</sup>. The various imaging modalities currently used to evaluate pathological conditions of knee include conventional radiography, sonography, computed tomography, nuclear medicine and MRI.

When compared with other diagnostic methods, MRI has the advantage of demonstrating the cartilages, bones, soft tissues and ligaments directly in detail non-invasively in different planes<sup>[10]</sup>.

Orthopaedic surgeons relied completely on clinical examination in the late 1960 and early 70's till numerous reports suggested the role of arthroscopy in diagnosis and treatment of various knee disorders<sup>[11]</sup>. At present arthroscopy is considered as gold standard among the investigative modalities for diagnosis of traumatic intra-articular knee lesions; however it is an invasive procedure requiring hospitalisation and anaesthesia<sup>[12]</sup>.

Advantages of arthroscopy far outweigh the disadvantages. The advantages can be used as both diagnostic as well as therapeutic, smaller incisions, reduced post-operative morbidity (where patient can return to work in 1-2 weeks after most arthroscopic procedures), less intense inflammatory response than standard arthrotomy<sup>[13]</sup>. The disadvantages of arthroscopy are intra-articular damage to surface, haemarthrosis, thrombophlebitis, infection, tourniquet paresis<sup>[14]</sup>.

The purpose of this study is to find out the various types of traumatic lesions of the MRI, to correlate the result with arthroscopy and to establish the accuracy of MRI in detecting ligament and Meniscal injury considering arthroscopy as gold standard.

## Materials & Methods

This prospective, comparative observational study was conducted at Ramkrishna Care Hospital, Raipur, Chhattisgarh. We prospectively studied 67 patients with complaints of knee pain or instability/locking/giving away sensation with history of knee injury between the age group of 15-60 years over a period of 24 months starting from November 2014 to October 2016. Ethical approval was taken from the Hospital Ethical Committee. Informed consent was taken from all patients undergoing this study.

## Inclusion Criteria

- 1) All the patients with new and old injuries to either of the knee joints are included in this study.
- 2) Patients with recent symptoms of locking of knee.
- 3) Patients with MRI suggestive of Internal Derangement of knee.
- 4) Children with undiagnosed knee pain and doubtful knee injury.
- 5) Patients who give consent of the study.

## Exclusion Criteria

- 1) Patients with signs of acute infection.
- 2) Cases with ankylosed knee.
- 3) Cases with severe osteo-arthritis.
- 4) Cases who have undergone previous arthroscopy.
- 5) Cases treated with Anti-tubercular treatment.
- 6) Patients not willing to participate in the study.
- 7) Patients with ferromagnetic implants, pacemakers and aneurysm clip.

- 8) Patients with knee joint neoplasm.

The MR Imaging in all the patients included in this study was performed on Siemens MAGNETOM Avanto 32 Channel Tim-Dot 1.5 Tesla MRI Machine and Karl Storz arthroscope was used for arthroscopy. Relevant clinical history and clinical findings are taken into consideration in performing MRI interpretation

After reaching to a MRI diagnosis which was interpreted by individual radiologist. All the patients underwent Arthroscopy by a qualified single orthopaedic surgeon. Surgeon was unaware of MRI findings in all the cases prior to arthroscopy. Subsequently the findings of MRI and Arthroscopy were compared and analysed.

**Data Entry and Statistical Analysis:** Data entry and statistical analysis were carried out using SPSS version 19.0. Significant difference was determined using Chi-square test or fisher's exact test. Sensitivity, Specificity, Positive predictive value and negative predictive value was used for comparison between MRI and Arthroscopy.

MRI diagnosis was placed into one of the four categories after arthroscopic evaluation.

- 1) True positive (TP): when MRI diagnosis of tear was confirmed on arthroscopic evaluation.
- 2) True negative (TN): If the diagnosis of no tear was confirmed on arthroscopy.
- 3) False positive (FP): If MRI showed a tear but arthroscopy was negative.
- 4) False negative (FN): If MRI images were negative but arthroscopy showed a tear.

**Results:** Our study population comprised of 67 patients with age ranged between 15-60 yrs. The mean age was 29 years and the maximum number of patients affected belonged to the aged grouped of 21-30 years. Male comprised 83.58% of the cases and females 16.42%.

Total number of injured structure on basis of MRI and Arthroscopic findings out of the 67 study population, 61 (91.04%) patients showed ACL tear on MRI however on arthroscopy only 58 (86.57%) patient showed ACL tear. Out of 2 (2.99%) patients with PCL tear only 1 (1.49%) showed positive result on MRI. MRI finding showed MM injury in 33 (49.25%) patients while 23 (34.33%) had positive result arthroscopically. 20 (29.85%) patients showed MRI positivity for LM injury out of which 18 (26.87%) were positive arthroscopically. Table 1

**Table 1:** showing structure injured in MRI and Arthroscopy

	MRI	Arthroscopy
ACL	61	58
PCL	1	2
MM	33	23
LM	20	18

Out of 61 patients showing positive findings in MRI 58 showed ACL tear in arthroscopy while 3 were false positive. 6 patients who showed intact ACL in MRI had same result arthroscopically. Out of 2 patients showing positive findings in Arthroscopy only 1 showed positive findings in MRI. 66 patients who showed intact PCL in MRI had 65 patients with true negative result while only 1 was false negative. Table 2

**Table 2:** Correlation between MRI and arthroscopic findings for cruciate ligaments tear

MRI		Arthroscopy		
		+ve	-ve	Total
ACL	+ve	58	3	61
	-ve	0	6	6
	Total	58	9	67
PCL	+ve	1	0	1
	-ve	1	65	66
	Total	2	65	67

Out of 20 patients showing positive findings in MRI only 15 patients showed LM tear in arthroscopy while 5 were false positive. 47 patients who showed intact LM in MRI having 44 patients with true negative results with 3 false positive results. Out of 33 patients showing positive findings in MRI only 19

showed MM tear in arthroscopy while 14 were false positive. Out of 34 patients who showed intact MM on MRI only 30 patients was found to be intact on arthroscopy while 4 patient showed false negative results. Table 3

**Table 3:** correlation between MRI and arthroscopic findings for Meniscal tear

MRI		Arthroscopy		
		+ve	-ve	Total
LM Tear	+ve	15	5	20
	-ve	3	44	47
	Total	18	49	67
MM Tear	+ve	19	14	33
	-ve	4	30	34
	Total	23	44	67

MRI showed 100% sensitivity and negative predictive value for ACL tear while specificity was 66.67% and accuracy of 95.52% with positive predictive value of 95.08%. MRI showed 100% positive predictive value for PCL tear while negative predictive value was 98.48%, alongwith sensitivity of 50% with specificity of 100% and accuracy of 98.51%. MRI showed positive predictive value of 57.58% for MM tear

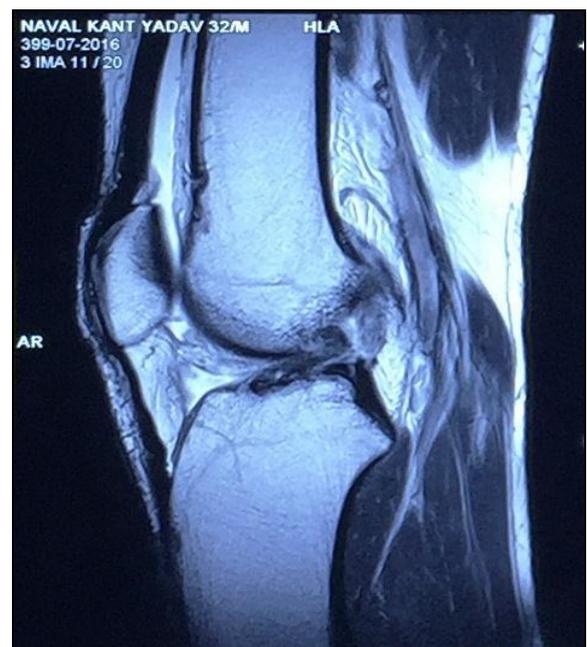
while negative predictive value was 88.24%, alongwith sensitivity of 82.61%, specificity of 68.18% and accuracy of 73.13%. MRI showed 75% positive predictive value for LM tear with a negative predictive value of 93.62%, alongwith sensitivity of 83.33%, specificity of 89.80% and accuracy of 88.06%. Table 4

**Table 4:** Gross correlation between MRI and Arthroscopic findings

	TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	Accuracy
ACL	58	6	3	0	100.00%	66.67 %	95.08%	100.00 %	95.52%
PCL	1	65	0	1	50%	100%	100%	98.48%	98.51%
MM	19	30	14	4	82.61%	68.18%	57.58%	88.24%	73.13%
LM	15	44	5	3	83.33%	89.80%	75%	93.62%	88.06%



**Fig 1:** MRI in sagittal section showing midsubstance tear of ACL. Note the increase in signal (hyperintense) within the course of ACL.



**Fig 2:** MRI in sagittal section showing tear of ACL from femoral attachment. Note the increase in signal (hyperintense) at femoral end.



**Fig 3:** Sagittal section of MRI showing avulsion of PCL from tibial attachment. Note the discontinuity of the hypointense curving band at the tibial end



**Fig 4:** Complete Mid-substance tear of ACL with ACL remnant stump on tibial attachment



**Fig 5:** Midsubstance tear of ACL



**Fig 6:** Complete ACL tear from femoral attachment

**Discussion**

In case of ACL tears diagnostic accuracy of MRI examination came out to be 95.52% with sensitivity of 100% and specificity of 66.67%. These might be explained by the presence of partial tears which may be missed on arthroscopies. Similar study conducted by Singh J P *et al.* [15] showed accuracy of 98.84% with sensitivity of 98.72% and specificity of 98.94%. A study done by Riel *et al.* [16] found similar results with accuracy of 97% and sensitivity and specificity of 98% both. Gupta MK *et al.* [17] conducted identical studies on 40 patients with knee injuries with comparable objectives found accuracy of MRI for ACL tear to be 90% with sensitivity of 91.3% and specificity of 88.2%. Similarly Ali Akbar Jah *et al.* [18] observed MRI accuracy for ACL tear to be 88.5% and sensitivity and specificity of 78.3% and 95.7% respectively. Our MRI diagnostic accuracy and sensitivity in ACL tear is similar to that reported by above mentioned studies while specificity has been slightly inferior which might be because of the degenerative changes that tend to increase the signal intensity.

Diagnostic accuracy of MRI for PCL tear to be 98.51% with sensitivity of 50% and specificity of 100%. Oei *et al.* [19] conducted a meta-analysis by combining 29 studies from 1991-2000 found sensitivity of 91% with specificity of 99%. S Gupta *et al.* [20] found MRI accuracy of 100% for PCL tear, the sensitivity and specificity observed by S Gupta *et al.* [20] for PCL injury was also 100%. Our result as mentioned above has comparable accuracy and specificity for PCL tear while sensitivity was found to be low which may be due to less number of positive cases.

The accuracy of medial meniscal injury by MRI examination in con-cordance with arthroscopic finding was found to be 73.13% while sensitivity was 82.61% and specificity 68.18%. Various studies like Gupta MK *et al.* [17], Ali Akbar Jah *et al.* [18] and S Gupta *et al.* [20] showed sensitivity between 80-90% where as Oei *et al.* [19] and Singh JP *et al.* [15] found sensitivity between 90-100%. Specificity between 60-80% was found by previous studies like S Gupta *et al.* [20] while 80-100% was found in studies done by Oei and colleagues [19], Singh JP *et al.* [15], Gupta MK *et al.* [17]

In our study MRI examination for lateral meniscal injury was found to have accuracy of 88.06%, with sensitivity of 83.33% and specificity of 89.80%. Similar results in accuracy were found by various study like: Gupta MK *et al.* [17], 49-91%, S Gupta *et al.* [20] while F Rayan *et al.* [21] found accuracy of 85%. The sensitivity of lateral meniscal tear by MRI examination was found to be 79% in a meta-analysis done by Oei and colleagues [19], while that done by Gupta MK [17] found 83.3%, S Gupta and colleagues [20] calculated

sensitivity of 83.3%. Studies showing specificity around our result were Ali Akbar Jah and colleague [18] with 86.2%, S Gupta and colleague [20] with 91.67%, F Rayan and colleague [21] had specificity of 92%.

In our study there were nineteen (14 medial and 5 lateral) false-positive interpretations of meniscal tears on MRI when compared with arthroscopy. These may be due to location of tears within the vascularised red zone of the meniscus. It is possible that these MRI findings that had the appearance of a tear were healed tears. This area can also be difficult to visualize at arthroscopy, so it is also possible that meniscal tears were present in these areas but were not seen during arthroscopy. Timing of MRI may also be an issue. A substantial delay between injury and MRI may allow the meniscus to heal, but intrameniscal signal may persist, leading to false positive MRI reading. Similarly a delay between MRI and arthroscopic evaluation could allow healing and a false positive result.

### Conclusion

It was concluded that MRI has high accuracy in diagnosing both meniscal and cruciate ligament injuries. This makes it most appropriate screening tool for therapeutic arthroscopy. The sensitivity for ACL tear is higher as compared to PCL while that of meniscal tear are almost equal. MRI has high negative predictive value for ACL but comparatively low PPV, this high NPV indicates that with negative result of ACL on MRI, a diagnostic arthroscopy can be avoided.

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