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Sensitivity and specificity of MRI in detecting meniscal tears, confirmed subsequently with arthroscopy

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Abstract
Background: Knee joint is the largest and complex joint of the body consisting of two condylar joint between the corresponding condyles of femur and tibia and a sellar joint between patella and femur.
Objective: to observe the sensitivity and specificity of MRI in detecting meniscal tears, confirmed subsequently with arthroscopy.
Methodology: Following approval from the Hospital Ethical Committee, 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 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. The accuracy of medial meniscal injury by MRI examination in concordance with arthroscopic finding was found to be 73.13% while sensitivity was 82.61% and specificity 68.18%. 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%.
Conclusion: It was concluded that MRI has high accuracy in diagnosing meniscal injuries. This makes it most appropriate screening tool for therapeautic arthroscopy.

Keywords: Sensitivity, specificity, MRI, arthroscopy, Meniscal injuries

Introduction
The stability of knee joint is highly dependent on its supporting ligamentous structures, therefore injuries of ligaments and menisci is extremely common [1], which vary in severity from simple ligamentous strain to complex injuries involving ligamentous disruption with meniscal damage and associated fractures. These injuries can be either acute or chronic and they constitute a major cause of knee pain and instability.
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 [2].
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 [3, 4, 5].
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 [6].
At present arthroscopy is considered as gold standard among the investigative modalities [7, 8] for diagnosis of traumatic intra-articular knee lesions, however it is an invasive procedure requiring hospitalisation and anaesthesia [9]. Advantages of arthroscopy far outweigh the disadvantages. The advantages are 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 [10]. The disadvantages of arthroscopy are intra-articular damage to surface, haemarthrosis, thrombophlebitis, infection, tourniquet paresis [11].

The purpose of this study is to observe the sensitivity and specificity of MRI in detecting meniscal tears, confirmed subsequently with arthroscopy.

Materials & Methods: Following approval from the Hospital Ethical Committee, 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.

Sample size

P= Diagnostic accuracy of MRI=95.5%
E= Precision, usually 5% i.e. 0.05
Z=1.96, Z value for 5% confidence level
Minimum Sample size N = ( ) = 67

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 interpretated 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 were 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. 11.94% were below 20 years, 53.73% were between 21-30 years, 26.87% between 31-40 years, 4.48% between 41-50 years and 2.29% of the study population were more than 50 years. 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%.

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.

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% as shown in Table 1, 2.

Table 1: correlation between MRI and arthroscopic findings for MM tear

MM Tear	**Arthroscopy**		
+ve		**-ve**	**Total**
MRI +ve	19	14	33
-ve	4	30	34
Total	23	44	67

Table 2: correlation between MRI and arthroscopic findings for MM tear

Medial Meniscus Tear	**Value (%)**
Sensitivity	82.61
Specificity	68.18
Positive Predictive Value	57.58
Negative Predictive Value	88.24
Accuracy	73.13

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% as depicted in Table 3, 4.

Table 3: correlation between MRI and arthroscopic findings for LM tear

LM Tear	Arthroscopy		
+ve		**-ve**	**Total**
MRI +ve	15	5	20
-ve	3	44	47
Total	18	49	67

Table 4: correlation between MRI and arthroscopic findings for LM tear

LM Tear	**Value**
Sensitivity	83.33
Specificity	89.80
Positive Predictive Value	75
Negative Predictive Value	93.62
Accuracy	88.06

Table 5: Gross correlation between MRI and arthroscopic findings

TP		TN	FP	FN	Sensitivity	Specificity	PPV	NPV	Accuracy
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%

Discussion

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*. [12] Ali Akbar Jah *et al*. [13] and S Gupta *et al*. [14] showed sensitivity between 80-90% where as Oei *et al*. [15] and Singh JP *et al*. [16] found sensitivity between 90-100%. Specificity between 60-80% was found by previous studies like S Gupta *et al*. [14] while 80-100% was found in studies done by Oei and colleagues [15], Singh JP *et al*. [16] Gupta MK *et al*. [12] Accuracy of MRI examination for medial meniscal tear between 70-85% was found in Ali Akbar Jah and colleagues [13], Rose *et al*. [17], while that between 86-100% was found by Singh JP *et al*. [16] Gupta MK and colleague [12].

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* [12]. 49- 91%, S Gupta *et al*. [14] while F Rayan *et al*. [18] 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 [15], while that done by Gupta MK[12] found 83.3%, S Gupta and colleagues [14] calculated sensitivity of 83.3%. Studies showing specificity around our result were Ali Akbar Jah and colleague [13] with 86.2%, S Gupta and colleague [14] with 91.67%, F Rayan and colleague [18] 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 meniscal injuries. This makes it most appropriate screening tool for therapeautic arthroscopy.

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