

Assessment of Meniscal and Ligamentous Injuries of the Knee Using Mri : Comparison with Arthroscopy



Medical Science

KEYWORDS : Knee, Trauma, Arthroscopy, MRI

Dr. Sangram Panda Postgraduate Trainee, Dept. of Radiodiagnosis, Nilratan Sircar Medical College, Kolkata, * Corresponding Author

Dr. Santosh Sahu Postgraduate Trainee, Dept. of Orthopaedics, Nilratan Sircar Medical College, Kolkata

Prof. Jibankrishna De Head of Dept. of Radiodiagnosis, Nilratan Sircar Medical College, Kolkata

Dr. S.Suneeti Kanyari Postgraduate Trainee, Dept. of Community Medicine, SCB Medical College, Cuttack

ABSTRACT

Knee injuries are conventionally assessed clinically and subjected to radiographs for diagnosis. The use of arthroscopy improves the accuracy of diagnosis and simultaneously can provide therapeutic intervention to treat the underlying derangement. Now a days MRI of the knee has been regarded as the non-invasive alternative to diagnostic arthroscopy. Objectives- To assess the ligamentous and meniscal injuries of knee using MRI and to detect the reliability of MRI in detecting meniscal tears and cruciate ligament tears by calculating Sensitivity, Specificity, Positive predictive value (PPV), Negative predictive value (NPV) and Accuracy. Method- A one year prospective cross-sectional study from January 2014 to February 2016 was performed on 100 Patients who came to Orthopaedics department of NRS Medical College with history of knee injury and subsequently underwent MRI and Arthroscopy of knee for suspected internal derangement. Results- The Sensitivity, Specificity, PPV, NPV and Accuracy of MRI were respectively- 91.8%, 90.2%, 90%, 92% and 91% for medial meniscus (MM) tear; 87.5%, 96.5%, 82.3%, 97.6% and 95% for lateral meniscus (LM) tear; 86.1%, 89.1%, 81.6%, 91.9% and 88% for Anterior cruciate ligament (ACL) tear; 87.5%, 97.8%, 77.8%, 98.9% and 97% for Posterior cruciate ligament (PCL) tear. Conclusion- MRI is an accurate non-invasive modality for the assessment of meniscal and ligamentous injuries of knee.

INTRODUCTION

Knee joint is the largest and complex joint of the body^[1]. It is stabilized by many supporting ligaments; with two fibrocartilaginous menisci improving the congruence between the femoral and tibial articular surfaces forming this joint. It is also one of the most frequently injured joint with majority of injuries resulting from direct trauma to the joint or is caused by torsional or angulatory forces. These injuries vary in severity from simple ligamentous strain to complex injuries involving ligamentous disruption with meniscal damage and associated fracture^[2].

An accurate diagnosis regarding the involvement of structures and the extent of injuries is essential for early operative as well as non-operative treatment. This requires an accurate clinical history, a thorough physical examination and complementary diagnostic tools.

Now a days, the most widely used diagnostic modalities to assess the knee joint injuries are MRI and Arthroscopy.

Arthroscopy is the gold standard to diagnose the intra-articular knee pathology but it is an invasive and expensive procedure with risk of complications.

Hence Magnetic resonance imaging (MRI) is increasingly being used for diagnosis over the past decade^[3].

MRI of knee done prior to more expensive arthroscopic studies can reduce the need for arthroscopy^[4,5].

MRI has now been accepted as the best imaging modality for non-invasive evaluation of knee injuries^[6].

Since its introduction for clinical use in the mid-1980s, the role of MRI in the diagnosis of knee lesions has been well established.

The ability of MRI to predict intra-articular knee pathology has been compared with findings of arthroscopic results at previous reports^[3].

The accuracy, sensitivity and specificity of MRI vary in different studies.

This variation is due to the rapid changes in the MRI technology, different imaging sequences, radiologist expertise, diagnostic criteria, location and composition of structure analyzed and the kind of knee injury.

Current literature reports 95 - 100% accuracy of MRI for ACL tears, 90 - 95% for MM tears and 85 - 90% for LM tears^[7-9].

Hence in this study the diagnostic accuracy of MRI in case of knee injuries is assessed with respect to Arthroscopy keeping in view the statistical results of previous studies and literatures.

MATERIALS AND METHODS

1. STUDY AREA:-

Department of Radiodiagnosis and Department of Orthopaedics of Nilratan Sircar Medical College & Hospital, Kolkata.

2. STUDY PERIOD :-

January- 2014 to February- 2016

3. STUDY MATERIAL:-

INCLUSION CRITERIA-

Patients referred to Orthopaedics department with history of knee joint injury and who subsequently underwent an MRI, followed by Arthroscopy of the knee for suspected internal derangement of knee joint.

EXCLUSION CRITERIA-

Patients with ferromagnetic implants, pacemakers, and aneurysm clips.

Patient < 10 years of age.

Patients with knee joint neoplasm.

Patients with Inflammatory and Infectious conditions of knee joint.

SAMPLE SIZE- 100

4. STUDY DESIGN:- Cross-sectional study.

5. STUDY TOOLS:-

1.5 Tesla MR scanner (GE)

Arthroscopce

6. STUDY PROCEDURE :-

Protocol for MRI of Knee-

A dedicated surface coil was used with a small field of view (14-16cm).

A slice thickness of 4mm was used with an interslice gap of 0.4mm.

The matrix size used is 256x192 / 256x256.

Patients were placed in supine position within the MRI Scanner with injured knee in 5 degree external rotation and while obtaining sagittal images the knee was flexed to 15 degree for better visualization of ACL.

MRI Sequences used-

i. Sagittal Proton Density (PD) with fat suppression for menisci.

ii. Sagittal FSE- T2-weighted with fat suppression for cruciate ligaments, cartilage and bones.

iii. Sagittal T2*-weighted gradient echo image for cruciate ligaments and cartilage.

iv. Axial T1-weighted sequences for articular cartilage of the patellofemoral joint.

v. Coronal proton-density fat-suppressed high-resolution images for bone marrow lesions and meniscal tears

vi. Coronal T2 weighted with fat suppression for collateral ligaments, cruciate ligaments, menisco-capsular separation

vii. Axial T2 weighted image- patellar cartilage, trochlear cartilage, medial patellar plicae, collateral and cruciate ligaments(Additional look)

viii. Sagittal STIR

ix. Coronal STIR

Grading of Meniscal Injury-

- A modified version of the classification system of Lotysch et al to score meniscal injuries on MR images was used.

- A meniscal tear on MRI is defined as a grade 3 signal in-

tensity (i.e. intrameniscal signal intensity unequivocally extending to an articular surface).

Grading of Cruciate ligament Injury-

A ligament was considered *partially torn* when there is abnormal signal intensity within the ligament or when otherwise intact fibers appear wavy on sagittal or coronal dual SE images, and considered *completely torn* if there was disruption of all fibers or if it was not discernible at all on MRI.

Arthroscopy of Knee-

All arthroscopic examinations were performed by an experienced orthopaedic surgeon. The arthroscope, with a 30° viewing angle, was introduced into the knee through two inferior parapatellar portals under general/or spinal anesthesia and all structures were probed as well as visualized sequentially. The arthroscopic findings were recorded and depending on the findings, the arthroscopic procedure was either continued with the therapeutic part of the procedure or terminated without any intervention.

RESULTS AND ANALYSIS

The results obtained from both MRI and arthroscopic examinations of the study population were analyzed.

After arthroscopic evaluation the MRI diagnoses were categorised into 4 categories - True positive, False positive, True negative or False negative.

Based on the above categories, the reliability of the MRI results were assessed by calculating different parameters like-

1.Sensitivity: True-positive/ (true-positive>true negative) X 100 percent

2.Specificity: True-negative/ (True-negative + False-positive) X 100 percent.

3.Positive predictive value / Precision: True-positive/ (True-positive+False-positive) X 100 percent.

4.Negative predictive value: True-negative/ (True-negative+False-negative) X 100 percent.

5.Accuracy: (True-positive + True-negative)/ (True-positive + False-positive +True-negative + False-negative) X 100 percent.

All the analyses were done by using SPSS 21 version.

The compiled data along with the analytical results are shown in the following tables-

Table-1

| Technique | MRI | | ARTHROSCOPY | |
|-----------|---------|------|-------------|------|
| | NOR-MAL | TEAR | NOR-MAL | TEAR |
| MM | 50 | 50 | 51 | 49 |
| LM | 83 | 17 | 84 | 49 |
| ACL | 62 | 38 | 64 | 36 |
| PCL | 91 | 9 | 92 | 8 |

Table-2

| Category | TRUE POSITIVE | FALSE POSITIVE | TRUE NEGATIVE | FALSE NEGATIVE |
|--------------------------|---------------|----------------|---------------|----------------|
| Meniscus / Cruciate Lig. | | | | |
| MM | 45 | 5 | 46 | 4 |
| LM | 14 | 3 | 81 | 2 |

| | | | | |
|-----|----|---|----|---|
| ACL | 31 | 7 | 57 | 5 |
| PCL | 7 | 2 | 90 | 1 |

Table-3

| Parameter Meniscus / Cruciate Lig. | SENSI-TIVITY | SPECI-FICITY | POS. PRED. VALUE | NEG. PRED. VAL-UE | ACCU-RACY |
|------------------------------------|--------------|--------------|------------------|-------------------|-----------|
| MM | 91.8 | 90.2 | 90 | 92 | 91 |
| LM | 87.5 | 96.5 | 82.3 | 97.6 | 95 |
| ACL | 86.1 | 89.1 | 81.6 | 91.9 | 88 |
| PCL | 87.5 | 97.8 | 77.8 | 98.9 | 97 |

IMAGES

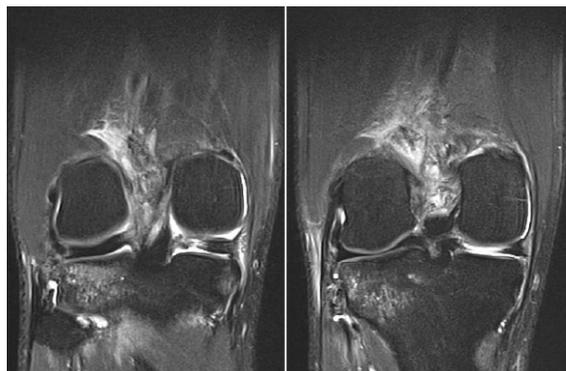


Figure-1
Anterior cruciate ligament rupture with medial meniscus bucket handle tear (double PCL sign)

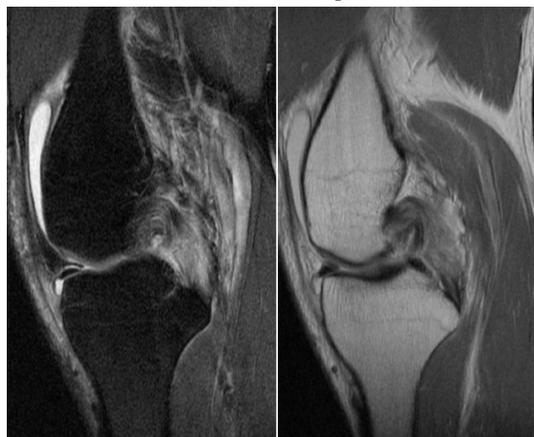


Figure-2
Posterior cruciate ligament tear



Figure-3
Lateral meniscus (Bucket handle tear)

DISCUSSION

1. 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 in this study.

2. 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 in this study.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. The false negative results were 4 for the medial and 2 for the lateral meniscus. These were due to appearance of the tears as intra substance degeneration on MRI.

10. Imaging of the cruciate ligaments in this study showed 9 false positive and 6 false negative results; out of which 7 false positive, 5 false negative were for the ACL and 2 false positive, 1 false negative results were for the PCL .

11. The false positive results for ACL were attributed to the presence of large ligamentum mucosum, which was reported as a tear in the substance of ACL.

12. 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.

13. The discriminative ability of MRI to distinguish between a tear and normal pathology was assessed by Receiver operating characteristic (ROC) analysis. 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.

14. The results of this study is in accordance to the literature.

15. Various mimickers of meniscal tear are intra articular

pathologies of the knee such as loose bodies, chondral fractures, degenerative changes, plicae. Muroid and eosinophilic degeneration can cause false positive results on MRI⁷.

16. Post operative cases with metallic implants around the knee produce artifacts on MR images and an erroneous interpretation of the images is likely in such cases.

17. Magnetic resonance imaging is useful as a diagnostic tool in internal derangements of knee. It is useful in circumstances where there is a need for detailed differential diagnosis. It is also an important diagnostic tool in cases of acute and painful knees, where clinical examination is difficult to perform.

18. Currently MRI is gaining popularity as a diagnostic tool in knee injuries due to increasing sports injuries, and road traffic accidents.

19. A further improvement in the techniques and increasing experience in interpretation of the images is likely to reduce the false positive and false negative results in future.

20. Magnetic resonance imaging also helps the surgeon to plan the definitive management of a tear during the same session.

SUMMARY & CONCLUSION

1. Magnetic resonance imaging is an appropriate screening tool for therapeutic arthroscopy and prevents unnecessary diagnostic arthroscopy in most patients.

2. MRI is also useful as a pre-operative diagnostic tool in selected cases where a clinical examination cannot be performed as in acute injuries or in cases where clinical examination is inconclusive.

3. Our study revealed high sensitivity, specificity and accuracy of MRI in detection of meniscus and ligaments injuries of knee.

4. Sensitivity for medial meniscal tear is higher as compared to lateral meniscus and high for PCL as compared to ACL.

5. MRI has a very high accuracy in diagnosing a tear of PCL.

6. For PCL tears, MRI has a high negative predictive value which indicates that with a negative result for PCL on MRI, a diagnostic arthroscopy can be avoided.

REFERENCES

1. Walter H. *Fundamental Anatomy*. Lipincott Williams.2008; 299.
2. David K B Li, Mark E Adams, J Pat McConkey. *Magnetic Resonance Imaging of Ligaments and Menisci of the Knee*. *Radiol Clin North Am*.1986; 24(2):209-227.
3. Mahmoud KM, Hamid BB. *The Accuracy of Magnetic Imaging Compared with Arthroscopic Finding in Intra-articular Traumatic Knee Injury*. *Journal Applied Sciences*.2005; 5(4): 686-688.
4. Bui-Mansfield LT, Youngberg RA, Warine W, et al. *Potential cost savings of MR imaging obtained before arthroscopy of the knee: evaluation of 50 consecutive patients*. *AJR Am J Roentgenol*.1997;168:913-918
5. Vincken PWJ, Terbraak BPM, Van Erkel AR, et al. *Effectiveness of MR imaging in selection of patients for arthroscopy of the knee*. *Radiology*.2002;223:739-746.
6. Winters K, Tregoning R. *Journal of the New Zealand and Medical Association*.2005; 118:No1209.
7. Herman LJ, Beltran J: *Pitfalls in MR imaging of the knee*, *Radiology*.1988;167:775,

8. Ahirwar LP, Ahirwar C. "Can MRI replace diagnostic arthroscopy in evaluation of internal derangement of knee joint – a prospective study". *Journal of Evolution of Medical and Dental Sciences*.2013; Vol2,Issue-40,October 07;Page:7621-7631.
9. Thomas S, Pullaqrura M, Robinson E, Cohen A, Banaskiewicz P. *The value of magnetic resonance imaging in our current management of ACL and meniscal injuries*. *Knee Surg Sports traumatol Athrosc*.2007;15(5):533-6.
10. Vaz CE, Camargo OP, Santana PJ, Valezi AC. *Accuracy of magnetic resonance in identifying traumatic intraarticular lesion*. *Clinics (Sao Paulo)*.2005,Dec;60(6):445-50.