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Dr. Arushi Dhall
JR-III, Department of
Radiodiagnosis, Subharti
Medical College, Meerut,
Uttar Pradesh, India

Dr. Sachin Agrawal
Assistant Professor,
Department of
Radiodiagnosis, Subharti
Medical College, Meerut,
Uttar Pradesh, India

Dr. BB Thukral
Professor and HOD,
Department of Radiodiagnosis,
Subharti Medical College,
Meerut, Uttar Pradesh, India

Dr. Arunim Swarup
Professor and HOD,
Department of Orthopaedics,
Subharti Medical College,
Meerut, Uttar Pradesh, India

Corresponding Author:
Dr. Arushi Dhall
JR-III, Department of
Radiodiagnosis, Subharti
Medical College, Meerut,
Uttar Pradesh, India

MRI evaluation of knee trauma and its correlation with clinical examination and arthroscopic findings

Dr. Arushi Dhall, Dr. Sachin Agrawal, Dr. BB Thukral and Dr. Arunim Swarup

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Abstract

Knee joint is the largest and complex joint of the body and also most frequently injured joint in sportsmen due to the lack of bony support. The stability of the joint is highly dependent on its supporting ligamentous structures; therefore, injuries of ligaments and menisci are extremely common. MRI has virtually replaced conventional arthrography and other modalities for the evaluation of menisci and cruciate ligaments [3]. Compared with CT scans, MRI provides superior anatomic and pathological status of soft tissues, ligaments, fibro cartilage and articular cartilage. Since the 1980's, diagnostic arthroscopy has been used frequently to show intra-articular abnormalities with more than 95% accuracy depending on the expertise of the arthroscopist [6]. During arthroscopy, all the internal structures are visualized, the abnormality detected and treated as well. MRI has enormous impact on musculoskeletal imaging and knee is the most frequently imaged joint. It is non-invasive and does not require ionizing radiation. Advantages of MRI include excellent inherent soft tissue contrast, multiplanar imaging capability, lack of patient exposure to radiation, ability to visualize ligaments, tendons, articular cartilages, menisci, para-articular soft tissues and the bone marrow.

Keywords: MRI evaluation, knee trauma, clinical examination, arthroscopic findings

Introduction

Materials and Methods

After approval of Subharti Medical Research Committee, this prospective study was conducted for a period of 21 months from 1st November 2018 to 1st August 2020 on 50 knee trauma cases referred to Department of Radio diagnosis, Imaging and Interventional Radiology from Department of Orthopaedics of C.S.S. Hospital.

Inclusion criteria

1. All adult patients with history of significant knee joint injury, who underwent MRI scan and arthroscopic surgery.
2. All patients who gave written consent for inclusion in the study.

Exclusion criteria

1. Patient less than 18 years of age.
2. Patients with contraindications for MRI, e.g., those with ferromagnetic implants, pacemakers, and aneurysm clips.
3. Patients with co-existing knee joint pathologies, e, g., neoplasm, inflammations and infections.
4. Patients who have had previous arthroscopic reconstructions.
5. Patients not consenting for the study.

Method of collection of data

Clinical findings and diagnosis

By performing standard clinical tests to diagnose ligamento-meniscal injuries, viz., Drawer's test, Lachmann test, McMurray's test, Varus & Valgus stress test.

MRI

Patients were subjected to MRI according to the following available infrastructure

- a. MRI equipment: Signa Contour GE 1.5 Tesla Whole body MR scanner
- b. Protocol for imaging: Patients were placed in supine position with the knee in a closely coupled knee array coil.

The knee was externally rotated 15–20° to facilitate the visualization of anterior cruciate ligament (ACL) completely on sagittal images and the following sequences were taken.

- T1 weighted sequences in sagittal and axial planes.
- T2- weighted sequences in coronal and sagittal planes.
- PD-fat sat FSE weighted sequences in axial, coronal and sagittal planes.
- 3D FSPGR images in sagittal and coronal planes.

A FOV of 18x18 cm, matrix size of 320x256 and slice thickness of 2 mm was used.

ACL Tear was diagnosed by: Abnormal signal intensity, Abnormal course and Blumensaat angle > 9.5 degrees. PCL Tear was similarly diagnosed by abnormal signal intensity, abnormal course and discontinuity.

Meniscal tears [56, 57, 58] were graded as:

- Grade 1- Meniscal signal change is globular and do not communicate with articular surface.
- Grade 2- Meniscal signal change is linear, intrasubstance and do not communicate with articular surface.
- Grade 3 - Meniscal signal change that extends to the articular surface.
 - a. Linear intrameniscal signal intensity abutting articular surface.
 - b. Irregular signal intensity abutting articular surface.
- Grade 4 - Menisci are distorted in addition to signal changes similar to grade 3.

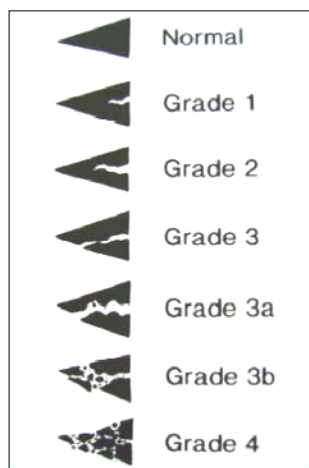


Fig 1: Grading of meniscal tears

Arthroscopy was carried out in hospital operation theatres by Orthopedic surgeons as indicated for diagnostic or therapeutic purposes using Karl Storz Arthroscope 25 ° and cold light source (Xenon Nova), with Telecam camera (SL II) making standard anterolateral and anteromedial portals. Statistical analysis was used to calculate sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), in order to assess the reliability of

the Arthroscopy and MRI results.

To evaluate the sensitivity, specificity and accuracy of MRI, the findings at arthroscopy were taken to be the true diagnosis.

- Sensitivity was calculated from the number of true positive results divided by the sum of the true positive results and the false negative results.
- Specificity was calculated from the number of true negative results divided by the sum of the true negative results and the false positive results.
- Accuracy was calculated from the sum of the true positive and the true negative results divided by the total number of patients who underwent arthroscopy.

The composite data was tabulated and studied for correlation with MRI findings and grouped into four categories:

1. True-positive- if the MRI diagnosis was confirmed by arthroscopy.
2. True-negative- when MRI negative for lesion and confirmed by arthroscopy.
3. False-positive- when MRI shows lesion but the arthroscopy was negative.
4. False-negative- result when arthroscopy was positive but the MRI showed negative finding.

The data was analyzed using SPSS package.

Illustrative case

Case – I

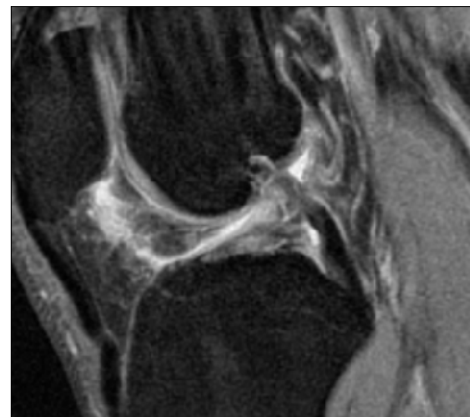


Fig 2: MRI showing ACL tear

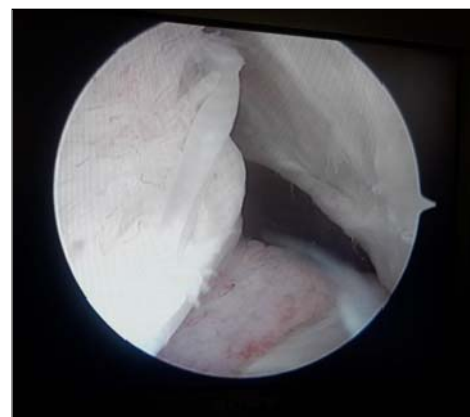


Fig 3: Arthroscopic image showing ACL tear

Table 1: Findings in case I

Clinical findings	MRI findings	Arthroscopic findings
Anterior drawer test – positive Lachmann test – positive Posterior drawer test – negative McMurray test – negative	Complete ACL tear and buckling of PCL	ACL tear only

Clinical examination, MRI and arthroscopy showing anterior cruciate ligament tear and are correlated to each other.

Results

In this series of 50 patients of knee injury; 18 had sports injury 22 had vehicular trauma and 10 came with domestic falls.

In this study it was seen that right knee (66%) was more affected than left (34%).

Most affected age group was between 21 to 30 years with male: female ratio of 3.2:1.

The study shows that ACL is the most common structure

involved in internal derangement of the knee followed by medial meniscal tear.

Comparison of clinical examination to MR imaging

In study of 50 cases of clinically diagnosed injury, there was accurate correlation in the clinical diagnosis and MRI interpretation for 34 ACL injuries. In 3 injuries MRI shows partial ACL tear which was not diagnosed clinically. Clinically, 8 patients had “posterior drawer test” positive suggesting PCL tear out of which 4 cases accurately correlated on MRI. In 5 injuries, MRI shows PCL tear which was not diagnosed clinically and 3 cases were falsely positive clinically. A total of 23 cases had positive McMurray test for medial meniscus injury, 22 out of which correlated with MRI. 1 case had a false positive McMurray test for medial meniscal tear and 5 cases of medial meniscal tear were missed clinically. MRI of patients with knee trauma shows 14 cases of lateral meniscus tear but clinically only 11 injuries had positive McMurray test for lateral meniscus tear.

Table 2: In this study of 50 knee trauma, showing sensitivity and specificity of clinical examination when compared to MR imaging for cruciates and menisci

ACL		PCL		Medial meniscus		Lateral meniscus	
Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity
91.8%	100%	44.4%	92.6%	81.4%	95.6%	78.6%	100%

In our study, clinical examination when compared to MR imaging showed really high specificity for ligament injuries but low sensitivity.

The sensitivity and specificity of clinical findings as compared to MRI are as follows- for ACL 91.8% & 100% for PCL 44.4% & 92.6%; for medial meniscus 81.4% & 95.6%; and for lateral meniscus 78.6% & 100%.

Comparison of MR imaging to arthroscopic findings

Of the total 50 knee trauma patients who had under gone MRI and arthroscopic evaluation, on correlation it was found that patients with ACL injury n- 37 had gone through arthroscopic evaluation n - 34 cases were found to be in correlation, while in 4 cases MRI showed ACL injury no pathology was noted on arthroscopy. The patients with PCL

injury, on MRI findings (n-7) had gone through arthroscopic evaluation and all were accurately found to be in correlation.

MRI findings of Medial meniscus and lateral meniscus when correlated with arthroscopic findings; MRI of knee trauma showed 27 cases with medial meniscus tear and 17 cases with lateral meniscus tear. Out of which, 17 injuries of medial meniscus tear were confirmed on arthroscopy while 10 cases were found to have normal medial menisci. On arthroscopy, 10 lateral meniscus tears were detected but 7 cases of lateral meniscus tear were not confirmed on arthroscopy. 1 case of lateral meniscal tear was noted on arthroscopy which was falsely deemed normal on MRI examination.

Table 3: In this study of 50 knee trauma, showing sensitivity and specificity of MR imaging when compared to arthroscopy for cruciates and menisci

ACL		PCL		Medial meniscus		Lateral meniscus	
Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity
100%	75%	100%	100%	100%	69.7%	90.1%	82.1%

In our study, MRI on comparison to arthroscopy showed high sensitivity for all knee ligament injuries but low specificity.

In our study, the sensitivity and specificity of MRI as compared with arthroscopic findings are as follows- for ACL 100% & 75%; for PCL 100% & 100%; for medial meniscus 100% & 69.7%; and for lateral meniscus 90.1% & 82.1%

Discussion

Traumatic lesion of the knee joint is often difficult to diagnose clinically because of soft tissue structure in and around the knee joint. The précised diagnosis of internal derangement of the knee can be illusive, since the signs and

symptoms are frequently similar for the different diagnosis and conventional methods are non-specific for diagnostic purpose.

Over the past several years the role of MRI in knee imaging has steadily increased and is often the main or the only non-invasive imaging modality for the evaluation of internal derangement of the knee.

The combination of the clinical examination with provisional diagnosis and evaluation of MRI provides most accurate diagnosis in traumatic lesions of the knee joint.

Arthroscopy is accepted as the gold standard ^[1, 2, 3] and in experienced hands can reach a diagnostic accuracy up to 98%. With high level of specificity and sensitivity in the detection of menisci and cruciate ligament injury. However,

arthroscopy is invasive procedure and carries the risk of complications like infections, pain, deep vein thrombosis, blood loss and anesthetic problems.

The advantage of the arthroscopy is that it can act as both diagnostic and therapeutic. Our study has confirmed the

ability of the MRI to identify internal derangement of knee. The multiplanar imaging capabilities, good resolution, absence of artifact caused by superimposition of osseous structures, cost benefit and non- invasiveness make MRI an important diagnostic modality.

Table 4: Showing sensitivity and specificity of MR imaging when compared to arthroscopy for cruciates and menisci in various studies

Reference	ACL		PCL		Medial meniscus		Lateral meniscus	
	Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity
Kinnunen <i>et al.</i> (1994) ^[8, 9]	83	85	83	85	88	80	25	97
Grevitt <i>et al.</i> (1992) ^[11]	100	80	100	80	92	90	88	98
Kersting <i>et al.</i> (1995) ^[2]	95	87	95	87	73	76	33	98
Glashow <i>et al.</i> (1989)	61	82	61	82	77	71	93	94
Rappeport <i>et al.</i> (1997)	89	97	89	97	86	73	40	98
Polly <i>et al.</i> (1988)	100	97	100	100	96	100	67	95
Fischer <i>et al.</i> (1991) ^[6]	93	93	93	99	93	84	69	94
Spiers <i>et al.</i> (1993) ^[3]	100	98	100	98	100	71	99	100

In our study, the accuracy of MRI in medial and lateral meniscal tears was 80% and 84% respectively, while for ACL and PCL rupture was 92% and 100% respectively which is similar to the results posted by various previous studies.

In the existing bibliography, the accuracy of MRI reaches 90 percent in medial meniscus and ACL injuries, is lesser in lateral meniscus injuries and slightly higher in PCL injuries. Most of the studies agree that MRI has low accuracy and sensitivity as far as chondral defects concerns.

In comparison with the arthroscopy, MRI results shows less specificity in diagnosing knee trauma in this study. MRI is advantageous in conditions where arthroscopy is not useful like peripheral meniscal tears and inferior surface tears.

Conclusion

The routine use of MRI scan to confirm diagnosis is substantiated as the negative predictive value of a scan was found to be high for all structures of the knee joint and hence a 'normal' scan can be used to exclude a pathology, thus sparing patients from expensive and unnecessary surgery and also freeing up valuable theatre time.

Our study found that the accuracy of the MRI scan in diagnosing knee trauma is in the order of PCL > ACL > MENISCAL lesions.

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