ROLE OF MAGNETIC RESONANCE IMAGING IN THE EVALUATION OF INTERNAL DERANGEMENT OF KNEE JOINT

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ABSTRACT

BACKGROUND

Knee injuries are very common due to sports and repetitive activities. Accurate evaluation of the knee injuries is very essential for the proper management and outcome.

The objective of this study is to correlate the findings of MRI in cases of knee injuries with arthroscopy.

MATERIALS AND METHODS

This is a prospective study of 100 patients with history of knee complaints who are referred to Department of Radiodiagnosis, SLIMS, Pondicherry for Magnetic Resonance Imaging (MRI) followed by Arthroscopy whenever needed. MRI images are studied for evidence of injuries to the cruciate, menisci ligaments, collateral ligaments, tendons around the knee joint, fluid collections, bony contusions and soft tissue injuries, then these findings are confirmed with arthroscopy. The patients were chosen for the study by a process of purposive random sampling and the data was analysed for sensitivity, specificity, predictive values and by Kappa statistics.

RESULTS

Out of 100 cases, 70 are males and 30 are females. Right knee is commonly involved compared to left accounting for 55 cases. Young patients suffered maximum number of knee injuries which comprised predominantly of patients in 21-40 years age group with mean age of 30.5 yrs. The most common complaint of patients is pain and instability. Anterior Cruciate Ligament (ACL) injury is the most common injury followed by medial meniscus injury.

CONCLUSION

Accurate evaluation of knee injuries is very crucial for the proper management. MRI is the primary modality of choice to investigate all cases of knee complaints, since it is very accurate in detecting both intra and extra articular pathology. Both MRI and arthroscopy have limitations as individual modalities and it can be overcome by combining both modalities when clinically indicated.

KEYWORDS

Painful Knee, MRI, Arthroscopy, IDK, Injuries.

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BACKGROUND

Knee injury may result in damage to the menisci, cartilage, ligaments or bone. Traumatic knee is very difficult to handle due to pain and restricted range of movements, so imaging is a very good modality to assess the injury.[1] Even though arthroscopy is the gold standard for diagnosing the various meniscal and ligament injuries for which patient has to be hospitalized and operated under anaesthesia which has its own complication. The use of magnetic resonance imaging (MRI) in the knee was started in the year 1980s.[2] From that time the accuracy of MRI in diagnosing knee injury, especially soft tissue component has been accurate 75-95%.[3]

MRI of the knee is currently the diagnostic modality of choice for the diagnosis of injuries to the menisci, ligaments and tendons as well as bone bruises and occult fractures in the knee,[4] and in most centres, it has replaced arthrography and diagnostic arthroscopy.[5]

Failure to accurate diagnosis and improper management can result in diminished lifestyle and premature osteoarthritis. Critical evaluation of the nature of these injuries is a prerequisite for appropriate therapy.

Arthroscopy is an invasive method with certain risks and discomfort to the patient. MRI provides superior anatomical and pathological definition of soft tissues, ligaments, fibro-cartilage, and articular cartilage. MRI techniques such as fast spin echo and fat suppression have even improved the

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sensitivity and specificity of MRI in the detection of articular cartilage, meniscal and cruciate ligament injuries.

MRI detects bone contusions, marrow changes and tibial plateau fractures. MRI with its superior tissue contrast and multiplanar reconstruction leads to accurate evaluation of internal structure as well as the surface of the ligaments. In this study, we are comparing MRI findings with arthroscopy and surgical findings to show its efficacy as a primary tool in knee imaging to guide the management.

MATERIALS AND METHODS

Source of Data

This is a prospective study on the patients, clinically suspected of internal derangement of the knee joint referred from OPD and Casualty to the Department of Radio-diagnosis at Sri Lakshmi Narayana Institute of Medical Sciences, Pondicherry.

Sample Size - 100

Period of Study – December 2016 - September 2018 (Duration-2 years).

Method of Collection of Data

Relevant History by Questionnaire method followed by patient or patient's attender consent for magnetic resonance imaging will be taken.

The patient will be examined using a 1.5 T Siemens Magnetom Essenza with Tim and dot system using various relevant sequence.

Images were studied for meniscal, cruciate ligament, collateral ligaments tear, fluid collections in and around the joint and also for any signal changes in the surrounding bones, muscles and tendons. Then these cases were subjected to arthroscopy.

Method of Data Analysis

Collected data was presented in the form of tables and diagrams. Sensitivity, specificity and predictive values were calculated. Using data, analysis was done for finding the significant correlation between MRI knee and arthroscopic findings by kappa statistics.

0.9 - 1	Excellent
0.8-0.9	Very Good
0.7 - 0.8	Good
0.6 - 0.7	Average
< 0.6	Poor

Table 1. Interpretation of Sensitivity

<0.20	Poor Agreement
0.21 – 0.4	Fair Agreement
0.4 – 0.6	Moderate
0.61 – 0.8	Good
0.81 – 1.0	Very Good

Table 2. Interpretation of Kappa Statistics

Interpretation of 'P' value

P <0.05 – Significant.

P <0.001 - critically significant.

P >0.05 - Not significant.

Inclusion Criteria

- The study includes all patients clinically suspected as internal derangement of the knee.
- All patients following trauma with clinical suspicion of ligament and meniscal tears

Exclusion Criteria

- Patients with history of previous surgery, degenerative arthritis, infections and neoplasm of knee
- Any absolute contraindication for MRI.

Imaging Protocol

Specific imaging techniques can increase the sensitivity and specificity for particular knee disorders, so a short relevant clinical history greatly helps to optimize the protocol for maximum diagnostic information.

Equipment

The patient will be examined using a 1.5 T Siemens Magnetom Essenza with Tim and dot system using various relevant sequence.

Pulse Sequences and Imaging Planes

i. T1 & PD weighted sequences in sagittal and coronal planes.
ii. T2 weighted in axial, coronal and sagittal planes.
iii. Fat suppressed T2 or STIR sequences wherever indicated.

We used SE, fast sequences such as GRE, FSE OR STIR sequences as required. The three standard imaging planes used are the direct coronal, sagittal and axial views. We examined the knee in these three planes using a FOV of 16 x 16 cm, 256 x 256 matrix & 3 mm slice thickness.

An axial acquisition through patellofemoral joint is used as initial localizer for subsequent sagittal and coronal plane images. The coronal plane optimally evaluates the collateral ligament and body of the menisci. The sagittal plane reveals the cruciate ligaments, menisci and synovial anatomy especially the suprapatellar pouch. Overall the bones, muscles, tendons and neurovascular structures are fully evaluated with integration of all three planes.

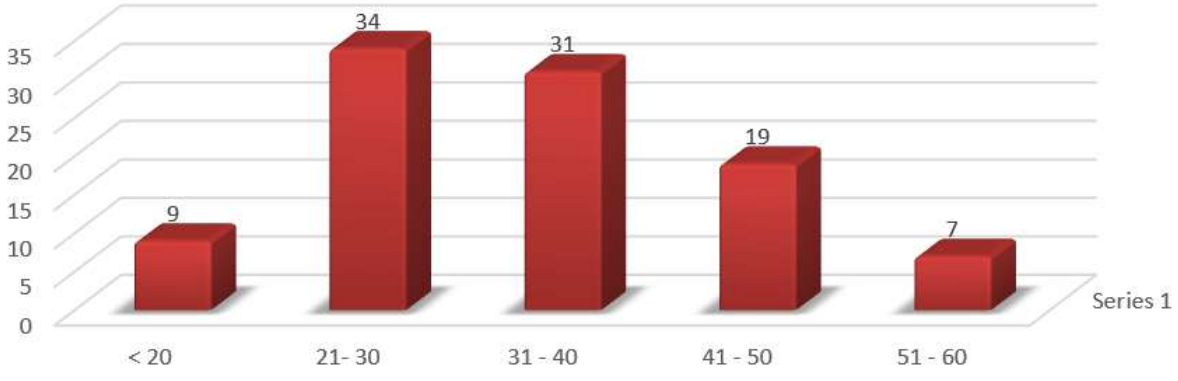
Positioning and Coil Selection

Patient is placed in supine position with extremity coil in close contact. The knee is externally rotated 15-20°, in order to visualize ACL completely on sagittal images. The knee is flexed slightly 5-10°, to assess the patellofemoral compartment and patellar alignment.

The MRI was performed within a time period of 6 days to 30 days from the date of injury. The time lag between MRI and arthroscopy was 1 day to 30 days with an average of 7 days. All observations were made from the workstation monitor and films. The images were reviewed for the presence or absence of meniscal tears and evaluated for ACL

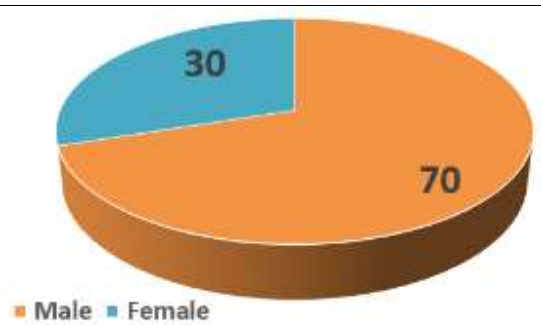
or PCL tears. The criteria that was used for determining the presence of a meniscal tear was the presence of a high signal that extended to one of the articular borders of the meniscus. Arthroscopy was performed through anteromedial and anterolateral portals to look for suprapatellar pouch, medial gutter, medial joint space, intra condylar space, lateral joint space, lateral gutter and patellofemoral space.

RESULTS



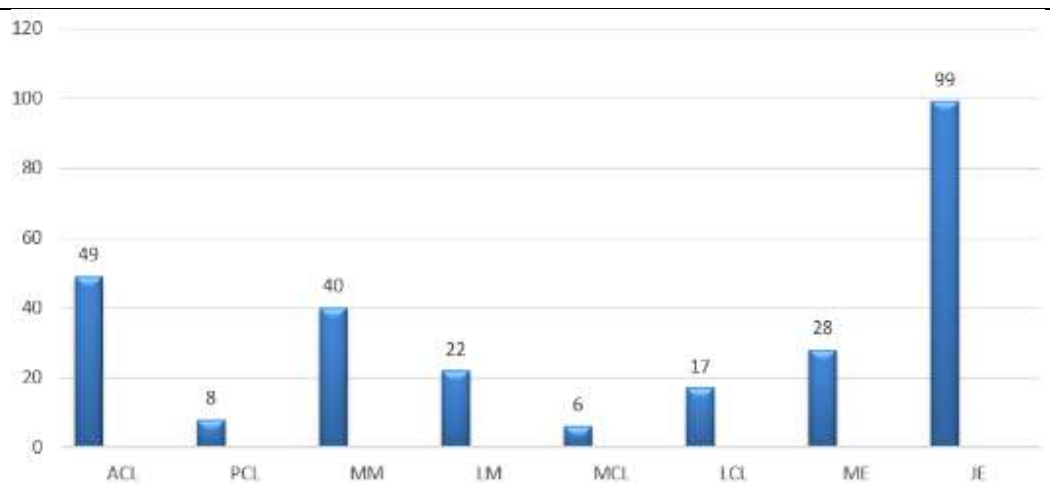
Graph 1. Age Distribution of The Patients

21-30 age group comprises the maximum number of patients which suffered knee injuries i.e. 34 % of the patients are in this group followed by 31%, 19%, 9% and 7% in the age group of 31-40, 41-50, 11-20 and 51-60 respectively.



Graph 2. Sex Distribution of The Patients

Male patients are more in number compared to females.



Graph 3. Proportion of Internal Derangement Observation Based On MRI

ACL- Anterior Cruciate Ligament, **PCL**- Posterior Cruciate Ligament, **MM**- Medial Meniscus, **LM**- Lateral Meniscus, **MCL**- Medial Collateral Ligament, **LCL**- Lateral Collateral Ligament, **ME**- Marrow Oedema, **JE**- Joint Effusion.

MRI		Arthroscopy	
	Positive	Negative	Total
Positive	49	8	57
Negative	0	43	43
Total	49	51	100

Table 3. Distribution of Anterior Cruciate Ligament (ACL Tears) Among the Study Population

Sensitivity - 100%
Specificity – 84.31%
Positive predictive value – 85.96%
Negative predictive value – 100%.
Kappa - 0.85 – Very good
P < 0.001, critically significant

Sensitivity and Specificity of MRI with respect to Arthroscopy is 100% and 84.31%.
Which means MRI is excellent in diagnosing ACL tears.

MRI		Arthroscopy	
	Positive	Negative	Total
Positive	8	0	8
Negative	0	92	92
Total	8	92	100

Table 4. Distribution of Posterior Cruciate Ligament (PCL Tears) Among the Study Population

Sensitivity - 100%
Specificity - 100%
Positive predictive value – 100%
Negative predictive value –100%
Kappa - 1.00 - Very good
P <0.001, critically significant

Both sensitivity and specificity of MRI in relation to Arthroscopy is 100% shows excellent correlation.

MRI		Arthroscopy	
	Positive	**Negative**	**Total**
Positive	40	2	42
Negative	0	58	58
Total	40	60	100
Sensitivity- 100%		Specificity- 96.67%	
Positive Predictive Value- 95.4%		Negative Predictive Value- 100%	
Kappa - 0.95- Very good		P <0.001- Critically Significant	

Table 5. Distribution of Medial Meniscus Injuries Among the Study Population

Sensitivity and Specificity of MRI with respect to Arthroscopy is 100% and 96.67% and is excellent in detecting medial meniscus injury. MRI detected more number of cases compared to Arthroscopy since grade I and grade II injuries may not be picked up by arthroscopy.

MRI		Arthroscopy	
	Positive	**Negative**	**Total**
Positive	22	0	22
Negative	4	74	78
Total	26	74	100

Table 6. Distribution of Lateral Meniscus Injuries Among the Study Population

Sensitivity - 84.62%
Specificity – 100%
Positive predictive value – 100%
negative predictive value– 94.87%
Kappa - 0.51 – Moderate
P < 0.0001, critically significant

Sensitivity and Specificity of MRI compared to Arthroscopy is 100% and 94.87% and is excellent in detecting lateral meniscus injury. MRI detected more number of cases compared to Arthroscopy since grade I and grade II injuries may not be picked up by arthroscopy.

DISCUSSION

MRI images are studied for evidence of injuries to menisci, cruciate ligaments, collateral ligaments, articular cartilage, loose bodies, meniscal cysts and bony contusions, evidence of soft tissue injuries around the knee joint. Arthroscopy was done to look for injuries to menisci, cruciate ligaments, collateral ligaments, articular cartilage, loose bodies and meniscal cysts.

In the present study out of 100 patients 70 were males and 30 were females. The age group ranging from 21 to 40 years with mean age of 30.5 years.

In the present study males comprise the predominant number of patients who suffered knee injuries who are active in sports like football. Young patients of age group 21-40 yrs. are the maximum who suffered knee injuries. Out of 100 patient knee injuries, right knee is involved in 55 cases and left is involved in 45 cases. Right knee is involved more compared to left.

Cruciate Ligament Lesions

The ACL through its oblique course is intraarticular but extra-synovial.[6] There are two distinct anatomical fiber bundles (anteromedial & posteromedial), which are not usually distinguishable on MR images. AM bundle is taut during flexion & larger PM bundle is taut during extension[7] is thicker and has a midline sagittal course and is therefore best visualized on sagittal images.[8] This ligament serves as a stabilizer of knee in flexion, extension and internal rotation. Tears of the PCL occur with posterior force to the flexed knee or forced hyperextension.[9]

Among the structure involved in knee injuries, ACL injury is the most common accounts for 49 cases in MRI with percentage of 49%, arthroscopy detected 43 cases. Sensitivity and Specificity of MRI with respect to Arthroscopy is 100% and 84.31% and is excellent in diagnosing ACL tears. Positive predictive value of MRI is 85.96%. Negative predictive value of MRI is 100%.

Out of 100 cases MRI detected 8 PCL injuries and arthroscopy detected 8 cases. Sensitivity and specificity of MRI in relation to Arthroscopy is 100% with positive and negative predictive value 100% and shows excellent correlation in detecting PCL injuries. PCL injuries are most commonly associated with chip fractures near the tibial attachment.

In tears of the anterior cruciate ligament, the sensitivity, specificity and accuracy were found to be 100, 85% and 87%, which were corresponding to Fischer et al study.[10] MRI is accurate in identification of ACL tears, ranging from 93% to 97%. The sensitivity and specificity in various studies have shown to range between 61% and 100%, and 82% and 97% respectively.[11]

In our study the positive predictive value and negative predictive value was 85.96 and 100 respectively.

8 cases of PCL tears were detected both by MRI and Arthroscopy. The use of MRI to identify PCL tears has proven to be extremely accurate. This might be expected in light of the fact that the PCL is usually very easily visualized as a homogenous, continuous low-signal structure.

Several studies have reported sensitivity, specificity, accuracy, positive predictive value and negative predictive value to be 99-100%.[10] In our study too the sensitivity, specificity, accuracy, positive predictive value and negative predictive value was 100%.[11]

Figure 1(a, b): T2 Sagittal Image Shows Complete Tear of ACL Distal to Femoral Attachment Site and PCL Distal to Tibial Attachment Site

Meniscal Injuries

Semi-circular rings of tough fibrous-cartilage tissue called the lateral and medial menisci act as shock absorbers and the bones of the knee are surrounded by a thin, smooth capsule lined by a thin synovial membrane which releases a special fluid that lubricates the knee, reducing friction to nearly zero in a healthy knee.[12] Medial meniscus injury is the second most common type of injury comprising 40 cases (40%). MRI detected 40 cases of medial meniscus injury, arthroscopy detected only 38 cases. Sensitivity and specificity of MRI with respect to Arthroscopy is 100% and 96.67%. MRI is excellent in diagnosing medial meniscal injury. In our study the sensitivity, specificity and accuracy for detecting medial-meniscal tears was corresponding to the Fischer et al.[10]

Figure 2 (a, b). Shows Medial Meniscus Bucket Handle Tear as Evidenced by Double PCL Sign in Sagittal Section and Centrally Displaced Inner Part in Coronal Section

In our study MRI detected 22 cases of lateral meniscal injury and arthroscopy positive cases are 18 out of 100 cases. Sensitivity and specificity of MRI in relation to Arthroscopy is 84.31% and 100%. MRI is excellent in detecting lateral meniscus injuries. Positive predictive value of MRI in detecting lateral meniscus injuries is 100% with negative predictive value of 94.87%. Sensitivity of MRI is more compared to arthroscopy because grade I and grade II tears unlike grade III tears may not be detected by arthroscopy. So, MRI is more useful for detection of grade I and grade II injuries. So, MRI is more sensitive in detection of meniscal injuries.

A study by Elvenes et al[13] showed accuracy rate of 90% for MRI in the detection of Meniscal tears compared with the arthroscopy and found the sensitivity, specificity, positive and negative predictive value of MRI for medial meniscus tears were 100%, 77%, 71% & 100%. In present study sensitivity, specificity, positive and negative predictive value are 100%, 96.67%, 95.4% and 100% respectively and correlated with the findings of Elvenes et al.[13] Silva and Silver[14] have studied the probability of a tear being identified at arthroscopy for each grade MRI signal. The probability of tear with grade I signal is about 5%, grade II 17-20% and grade III 80%-95%. False positive meniscal tears at MRI imaging has been noted earlier. There are explanations for this apparent discrepancy between findings at MR Imaging and arthroscopy Mink J H et al.[15]

Figure 3(a, b). PD Sagittal Image Shows Horizontal Tear of LM and Coronal Section Showing Grade II Lateral Collateral Ligament Injury

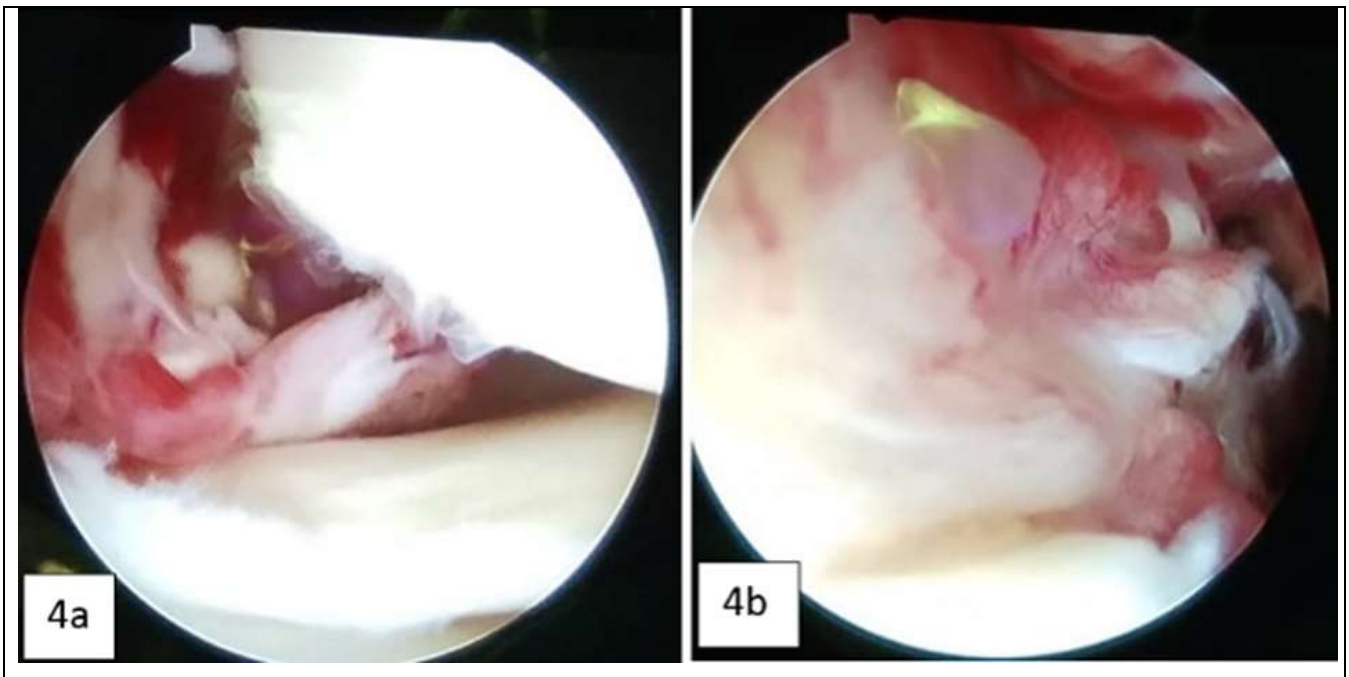


Figure 4(a, b). Arthroscopy Shows Partial ACL Tear (L) and Complete PCL Tear (R)

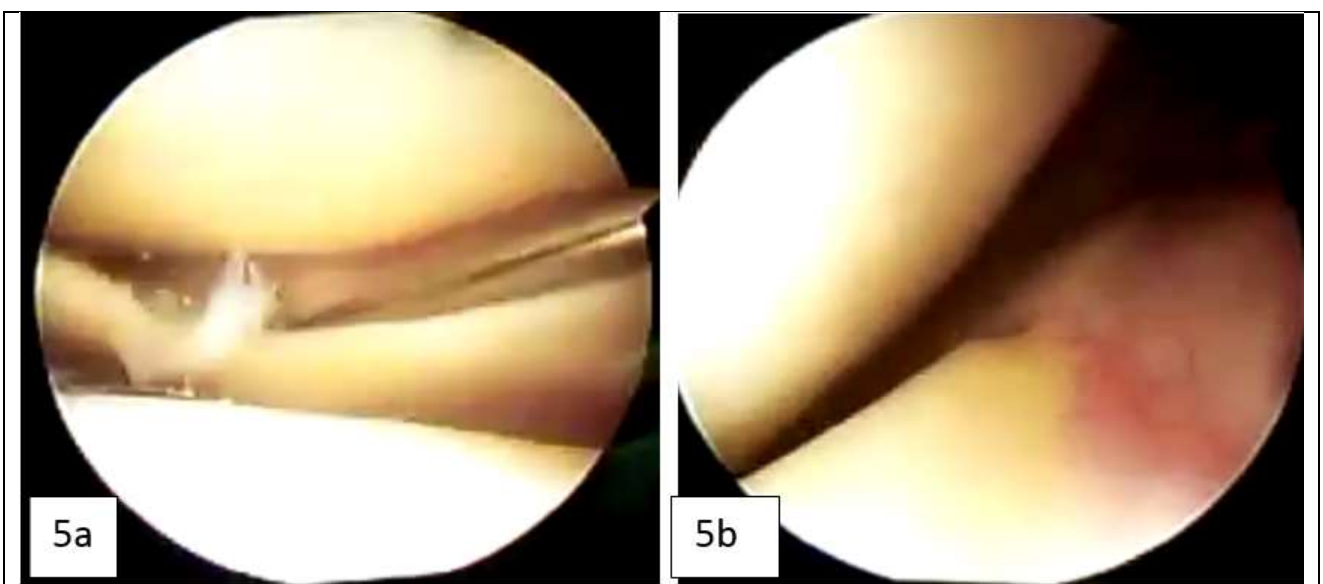


Figure 5(a, b). Arthroscopy Shows Radial Tear of MM with Meniscocapsular Junction

Articular Cartilage Injuries

Out of 100 cases of knee injuries MRI detected 14 cases of articular cartilage injuries and arthroscopy 16 cases. Sensitivity of MRI is 60% with specificity of 100% shows average correlation with Arthroscopy in diagnosing articular cartilage injuries. Positive predictive value of MRI is 100% with negative predictive value of 92.59%. Sensitivity of MRI can be increased by using newer sequences dedicated to articular cartilage imaging.

Unlike arthroscopy MRI is able to detect bony contusions, fluid collection in and around the knee joint, soft tissue injuries and collateral ligament injuries. MRI can also detect bone and soft tissue injuries around the knee joint.

CONCLUSION

MRI should be the initial investigation of choice in the evaluation of all cases of knee joint injuries as it is a radiation free imaging modality with multiplanar capabilities and excellent soft tissue delineation. It can detect both intra and extra articular pathologies and also osseous structures. Accurate evaluation of the knee injuries is important to avoid chronic disability in the patient. Both MRI and arthroscopy have their limitations. These shortcomings might be overcome by combining both modalities when clinically indicated. Findings of MRI acts as road map for arthroscopy. Later arthroscopy will be done as a diagnostic and also as therapeutic procedure.

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