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Diagnostic accuracy of MRI in internal derangement of knee in comparison to arthroscopy MRI vs Arthroscopy in knee injury

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Abstract---Background: The knee joint (KJ) is one of the largest as well as most complicated joints in the human body. The knee is one of the most frequently injured joints, either as a separated injury or as a common portion in patients with multiple traumas. MRI has completely transformed the field of radio diagnosis because it provides superior soft tissue (ST) contrast. Also, it has appeared to be highly useful in muscle, brain, abdominal, and soft tissue imaging. The MRI is non-invasive which provides significantly better ST contrast, and requires less imaging time while having fewer artefacts. Aims & Objectives: To compare the accuracy of diagnostic [True Positive (TP), True Negative (TN), False Positive (FP), as well as False Negative (FN)] of MRI & arthroscopy in diagnosing internal derangement (ID) of the knee. To determine the function of MRI in selecting patients for arthroscopy. Material and Methods: This research is a cross-sectional investigation wherein patients who were thought to have an internal knee dislocation (IKD) were given an MRI and some were chosen for an arthroscopy. Most MRIs were done on a 1.5 tesla MRI scanner. The results of the MRI were written down. Patients who had MRI results that pointed to a problem inside the knee were looked at for arthroscopy. Under anaesthesia, arthroscopy was done while the patient was lying on his back. Conclusion: If an expert radiologist

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does the MRI, we can figure out that it is a very good way to tell if a knee ligament is broken. It also assist the referring surgeon choose which patients should have an arthroscopy and tells the surgeon what needs to be done.

***Keywords*---**MRI, Meniscal Tear, Arthroscopy, Ligament.

Introduction

The KJ is one of our biggest and most complicated joints. It is a complicated joint made up of the patella, the femur, as well as the tibia. The tibiofemoral joint (TJ) is a kind of joint with two condyles. This joint is kept strong by the ligaments, muscles, menisci, as well as capsule that are all around it. The KJ is one of the most frequently injuries sustained joints, whether as a single injury or as a portion in various trauma patients[1-3]. The fibrocartilaginous meniscus of the knee has a C-shape. More injuries happen to the medial meniscus (MM) than to the lateral meniscus (LM)[4].

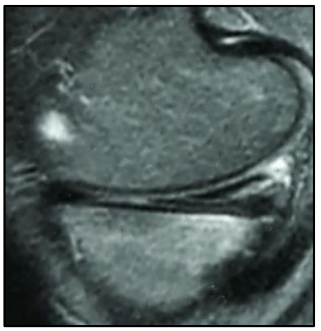


Figure 1: Grade 2 intra meniscal signal

A frequent occurrence is horizontal tears (HT) of the menisci, which are also termed as "degenerative tears"[3]. They are frequently found in conjunction with parameniscal cysts.

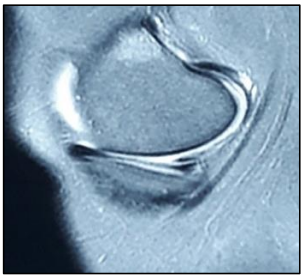


Figure 2: Horizontal tear reaching to superior articular margin

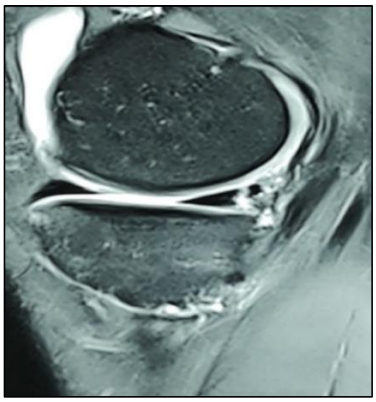


Figure 3: Horizontal tear reaching to superior articular margin

On MRI, HT emerge as horizontally-oriented hyper intense lines extending to the inferior/superior articular surface (AS)[3]. These tears have a vertical orientation of hyper-intense signal that extends along the circumference of the meniscus, and they are generally linked with knee injury based on their location[3].

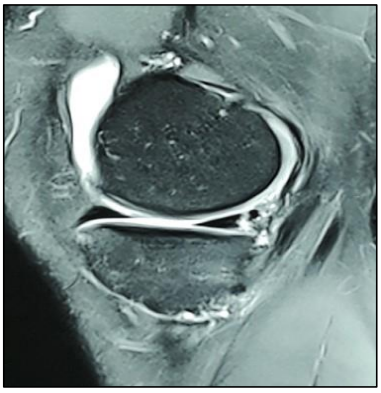


Figure 4: Vertical tear in peripheral part of medial meniscus

Figure 5: Vertical tear of peripheral part of MM

Meniscal contusions (MC) are most commonly caused by flexion injuries resulting in compression of posterior of the MM between the tibia & the condyle.

Figure 6: Complex tear of MM

MRI reveals a diffuse intrameniscal hyperintensity, which could be a fissure. Subchondral bone contusions present with a MC can be distinguished from a real fissure[5].

Figure 7: Complex tear of MM with radial tear and horizontal component extending to joint capsule

On MRI[3], an entire discoid meniscus (DM) is readily identifiable. It is significant to mention that the Anterior Cruciate Ligament (ACL) is the most frequently injured ligament of the knee, appearing in as many as one in 30,500 people per year. An ACL tear involves flexion, valgus, as well as external rotation[6]. MRI evaluation of partial tears of ACL is challenging with relatively low diagnostic accuracy[6]. PCL injury is usually associated with high grade road traffic accidents. Direct impact on knee with its posterior translation is the usual cause[7].

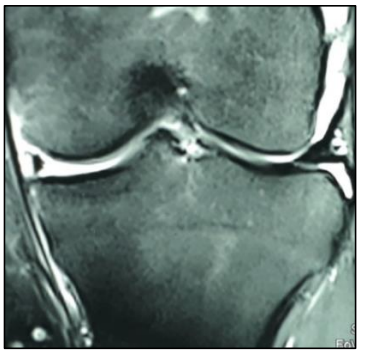


Figure 8: Bucket handle tear of MM with displaced fragment in front of PCL (Double PCL sign)

MRI has revolutionised the field of radio diagnosis as it provides better soft tissue contrast and has been found very useful in brain, abdominal, muscle and soft tissue imaging. MRI is still the best imaging method for showing abnormalities in articular cartilage & soft tissue (ST) injuries in ligaments, tendons, as well as menisci. This is because MRI has superior ST contrast[8]. The diagnosis of injury problems to intraarticular structures such as the menisci as well as cruciate ligaments is improved when compared to arthroscopy. This is still primarily designed for diagnosing these injuries. The MRI is non-invasive and provides significantly improved ST contrast. It has a relatively short time of imaging with fewer artefacts. Furthermore, it permits imaging in various planes and does not expose the patient to radiation[9]. By using MRI, unnecessary diagnosing of arthroscopies can be avoided.

Materials and Methods

The present study, titled *"Diagnostic Accuracy of MRI in Internal Knee Derangement Compared to Arthroscopy,"* was undertaken for 18 months at the Postgraduate Department of Radiodiagnosis, Govt. Medical College in Srinagar, JK, India, and the associated Bone and Joint Hospital. This study is a cross-sectional study in which patients who were considered to have an IKD were given an MRI, and some were chosen for an arthroscopy. A proper history of patients was taken along with clinical examination. Written consent of patients was taken for the study. The findings of MRI and arthroscopy were documented and compared.

Criteria for inclusion:

1) Patients who have experienced trauma to the KJ (sports & non-sports)
2) Patients with clinical symptoms such as pain, swelling, limitation of movements, locking of joint, and knee instability.
3) Patient with degenerative diseases of knee such as osteoarthritis and rheumatoid arthritis with clinical suspicion of IKD joint.
4) Patient with +ve medical tests like the Anterior drawer, the Lachman, the Valgus, the Posterior drawer, the Pivot test, the Varus test, as well as the McMurray.
5) Patients between the ages of 18 & 70.

Criteria for exclusion:

1) Patients having open injuries around KJ.
2) Patients with infective aetiology of knee joint such as tuberculosis of knee joint and knee joint infections.
3) Patients who do not give consent for the procedure.
4) Patients with previous history of metallic implants like aneurysm clips, metallic valves, nails, plates, pins and other metallic implants.
5) Patients not fit for anaesthesia and those with claustrophobia.

Methods:

- Patients' medical histories and the tests used to diagnose them were written down correctly. After the screening process was done, informed and written permission for the research was given.
- MRI was primarily performed at 1.5 tesla MRI machine (Brevo 355GE) located at Bone and Joint Hospital, Srinagar which is an associated hospital of GMC Srinagar.
- Dedicated extremity coil was used with patient lying supine on the table with feet first to minimise claustrophobia. The examination protocol includes TWTCor PD Fat Sat for coronal images with slice thickness of 4mm for coronal scans. TWTSag PD T2 FS, TWTSag T1 FSE, TWT Sag MERGE with slice thickness of 4mm for axial scan. TR for T2/PD was around 3000 and TR for T1 was below 700. Thin sagittal cuts were preferred for ACL and PCL tears. For Fat Sat sequences, applying of shim was necessary for homogeneity and fat suppression.
- The results of the MRI were written down. Patients who had MRI results that pointed to a problem inside the knee were looked at for arthroscopy. Additionally, arthroscopy was performed on patients with normal MRI observations but major clinical presumption.
- The patient was anaesthetised and placed in a supine position for the procedure. Two ports were placed along joint line; one along anteromedial and another along posterolateral aspect of knee joint. One port was used as camera port and other as a working port and vice versa. All the findings were noted and documented.
- Stepwise diagnostic approach has been followed. The results of MRI and arthroscopy have been contrasted for statistical purposes. After arthroscopy correlation, MRI diagnoses have been put into four groups: TP, TV, FP, and FN. You can see how accurate the results are in terms of Positive PV (predictive value) as well as Negative PV.

Results

Our research was a prospective study where patients suspected of IKD were studied for MRI and then taken for arthroscopy based on MRI and arthroscopic findings. The study was performed for 18 months between December 2017 to June 2019 in GMC Srinagar and its associated bone and joint hospital. One hundred patients were studied in our study. The following parameters were calculated.

TP: Patients were +ve on both MRI & Arthroscopy. FP: Patients were +ve on MRI but -ve on Arthroscopy.

TN: Patients were -ve on both MRI & Arthroscopy. FN: Patients were -ve on MRI but +ve on MRI.

Specificity (Sp.): TN/TN+FP Sensitivity (Sn.): TP/TP+FN

Positive PV (PPV): TP/TP+FP Negative PV (NPV): TN/TN+FN

Accuracy: TP+TN/TP+FP+TN+FN Patients were also investigated statistically using the P value.

Sensitivity Analysis

Percentage (%)	Status
90 to 100	Ex.
80 to 90	VG
70 to 80	G
60 to 70	Av.
Below 60	P

*Ex. – Excellent, VG – Very Good, G – Good, Av. – Average, P – Poor

Analysis of Kappa Statistics

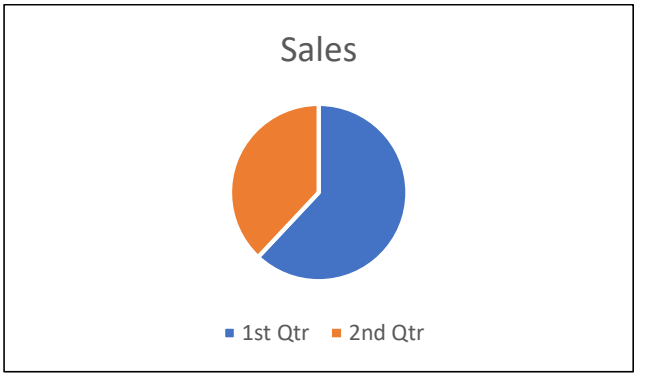
0.00	PA
0.00 to 0.20	SA
0.21 to 0.40	FA
0.41 to 0.60	M
0.61 to 0.80	S
0.81 to 1.00	AP

P<0.05: Significant, P<0.01, HS, P>0.05: NS

*PA - Poor Agreement, SA - Slight Agreement, FA - Fair Agreement, M – Moderate, S – Substantial, AP - Almost perfect, HS - Highly significant, NS - Not significant

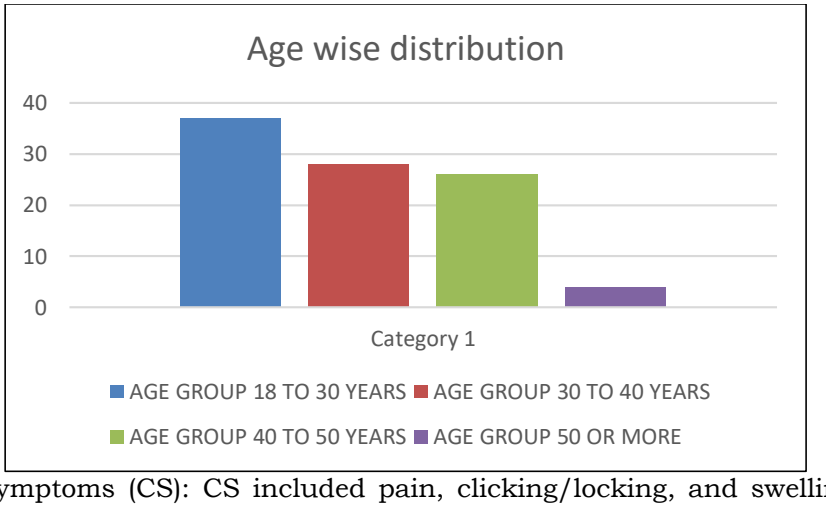
Gender Distribution: Number of Males = 62 Number of Females =38 Total Number of Patients = 100

Total Number in the Group	Gender	Sex Distribution	Percentage Distribution by Age
100	Males	62	62%
100	Females	38	32%



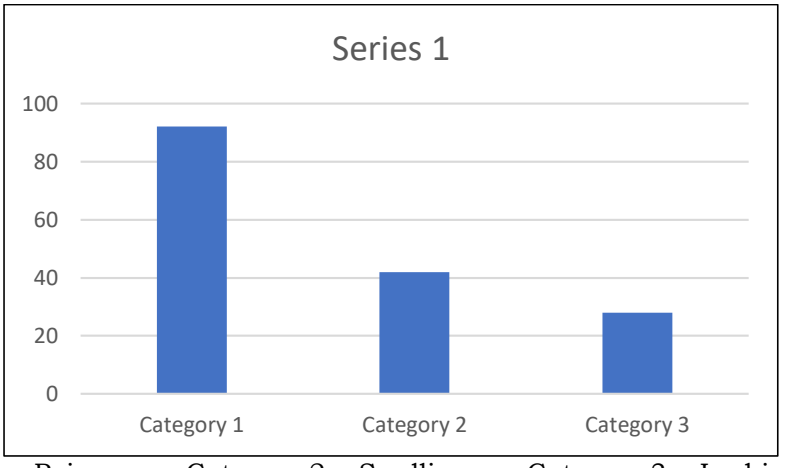
The vast majority of patients were between the ages of 18 and 40. Age-wise distribution is tabulated as follows:

Age Group	Number of Patients
18 - 30 yrs.	37
30 - 40 yrs.	33
40 - 50 yrs.	26
50 yrs. or more	4

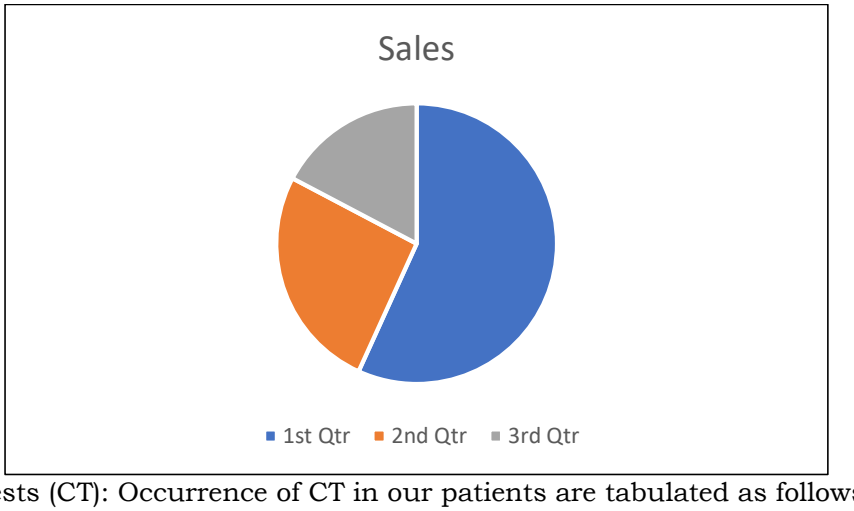


Clinical symptoms (CS): CS included pain, clicking/locking, and swelling. Their relative percentage of occurrence has been tabulated as follows:

Complaints	Number of Patients in Study Group	Number of Patients with the Complaints	Percentage with Complaints
PAIN	100	92	92%
SWELLING	100	42	42%
LOCKING/CLICKING	100	28	28%

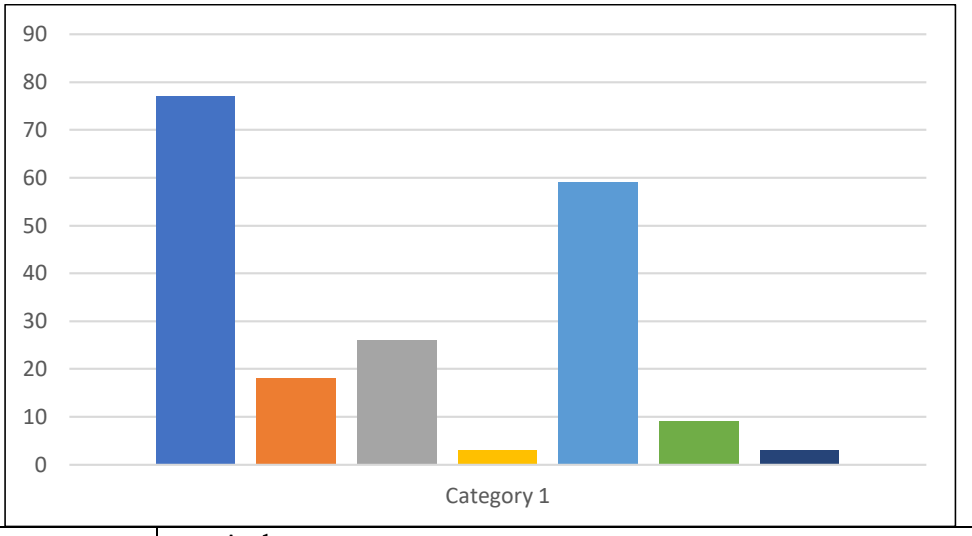


Category 1 = Pain Category 2 = Swelling Category 3 = Locking/Clicking



Clinical Tests (CT): Occurrence of CT in our patients are tabulated as follows:

Tests	Joint Line Tenderness	Lachmann Test	ADT	PDT	McMurray Test	Thessalay Test	Pivot Shift Test
Total Number of Patients	100	100	100	100	100	100	100
Number with Positive Test	77	18	26	3	59	9	3
Percentage with Positive Test	77%	18%	26%	3%	59%	9%	3%



	Arthroscopy		
CT	+ve	-ve	
+ve	77	4	81
-ve	16	3	19
	93	7	100

*+ve : Positive, -ve : Negative

TP = 77 FP = 4 TN = 3
FN =16 Sn. = 82.8% Sp. = 42.9%
PPV = 95% NPV =15.8% Accuracy = 80%
Kappa = P value =

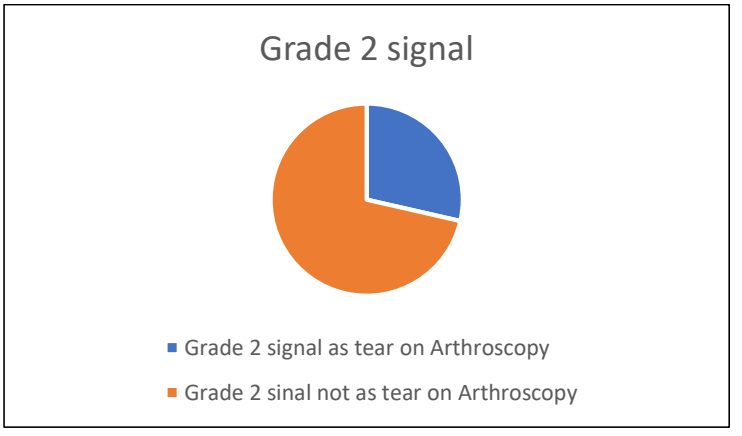
MEDIAL MENISCUS

	Arthroscopy		
MRI	+ve	-ve	
+ve	67	7	74
-ve	2	24	26
	69	31	100

TP = 67 TN = 26 FP = 7
FN = 2 Sn. = 97.1% Sp. = 77.4%
PPV = 90.5% NPV = 92.9% Accuracy = 91%
Kappa = P value =

MM Grade 2 signal

Approximately 7 patients were diagnosed with grade 2 signal on MRI. Among them were patients whose arthroscopy revealed a tear. The percentage of tears diagnosed with grade 2 signal on MRI but came as positive for a tear was about 28.6%.



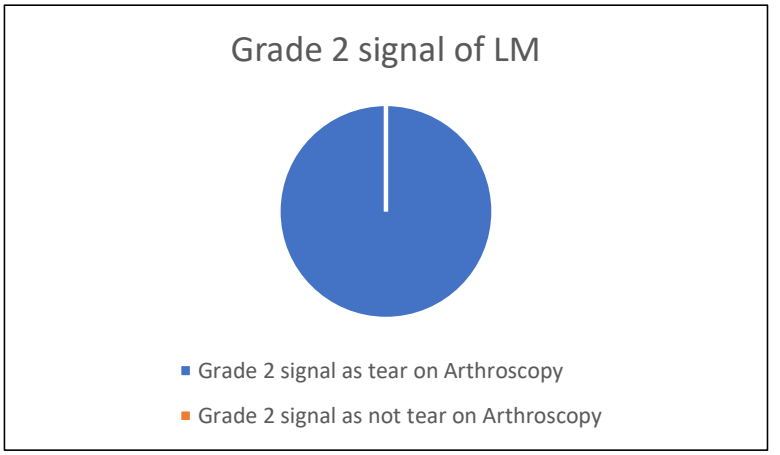
LATERAL MENSCUS

	Arthroscopy		
MRI	+ve	-ve	
+ve	11	1	12
-ve	3	85	88
	14	86	100

TP = 11 FP = 1 TN = 88
FN = 3 Sn.= 78.6% Sp. = 98.8%
PPV = 91.7% NPV = 96.6% Accuracy = 96%
Kappa = P value =

LM as Grade 2 Signal

There were about 3 patients with grade 2 signal on MRI. All of them were seen as tears on Arthroscopy.



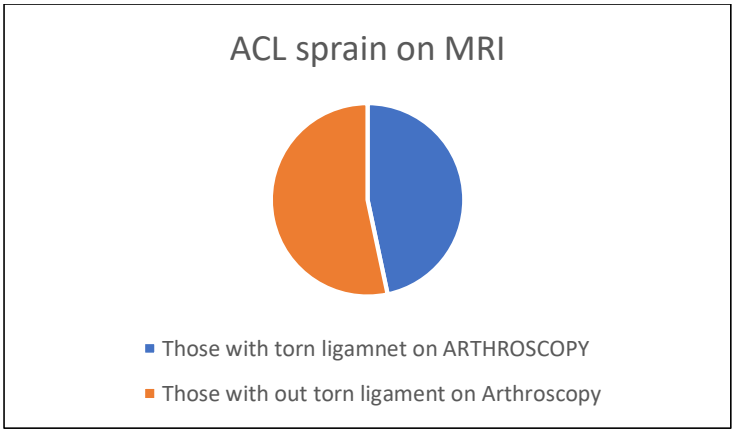
Anterior Cruciate Ligament

	ARTHROSCOPY		
MRI	**+ve**	**-ve**	
+ve	26	1	27
-ve	7	66	73
	34	66	100

TP = 26 FP = 7 TN = 66
FN = 1 Sn. = 96.3% Sp. = 91.3%
PPV = 96.3% NPV = 92.3% Accuracy = 91%
Kappa = P value =

ACL Sprain with No Obvious Tear on MRI

There were approximately 15 patients with oedematous ACL who had altered signal intensity on MRI but no significant disruption. On Arthroscopy, approximately 7 of them were found to have significant disruption, accounting for approximately 46.7% of the cases.



Posterior Cruciate Ligament

	Arthroscopy		
MRI	+ve	-ve	
+ve	1	0	1
-ve	0	99	99
	1	99	100

TP = 1 FP = 0 TN = 99
FN = 0 Sn. =100% Sp. = 100%
PPV = 100% NPV = 100% Accuracy = 100%
Kappa = 1 P value =

Para Meniscal Cysts

There was a total of 72 knees positive for meniscal tears. Para meniscal cysts were compared with these cases.

	Meniscal tears on arthroscopy		
Meniscal Tears with para meniscal cysts on MRI	Positive	Negative	
+ve	7	0	7
-ve	65	28	93
	72	28	100

TP = 7 FP = 0 TN = 28
FN = 65 Sn. = 9.7% Sp. = 100%.
PPV= 100% NPV = 30.1% Accuracy = 35%
Percentage of meniscal tears with meniscal cysts =9.7%

Anterior Translation of Tibia

Anterior translation of the knee is the MRI equivalent of ADT in clinical examination. We examined it in relation to ACL tears.

	PCL tears on Arthroscopy		
Anterior translation of tibia on MRI	Positive	Negative	
+ve	5	0	5
-ve	28	67	95
	33	67	100

TP = 5 FP = 0 TN = 67
FN = 28. Sn. = 15.2% Sp. = 100%
PPV = 100% NPV = 70.5% Accuracy =72%

Loose Bodies

	Arthroscopy		
MRI	+ve	-ve	
+ve	2	1	3
-ve	0	97	97
	2	98	100

TP = 2 FP = 0 TN = 97
FN = 1 Sn. = 67.7% Sp. = 100%
PPV = 100% NPV = 99% Accuracy = 99%

Joint Effusion

Joint effusion was observed in 60 cases, or 60% of scanned patients.

	Tears on Arthroscopy		
Joint Effusion on MRI	+ve	-ve	
+ve	60	36	96
-ve	0	4	4
	60	40	100

TP = 60 FP = 0 FN = 36
TN = 4 Sn. = 62.5% Sp. = 100%
PPV = 100% NPV = 10% Accuracy = 64%
Kappa = P value =

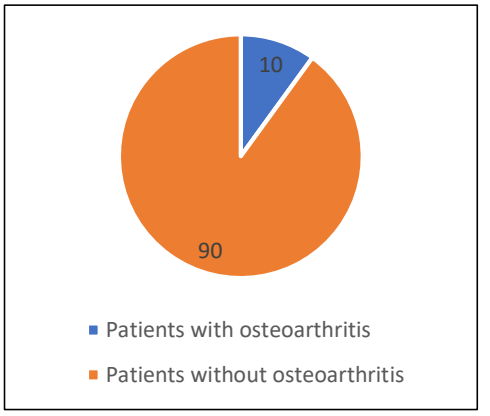
Bone Contusion

	Arthroscopy		
MRI showing Bone Contusion	+ve	-ve	
+ve	8	1	9
-ve	88	3	91
	96	4	100

TP = 8 FP = 1 TN = 3
FN = 88 Sn. = 8.3% Sp. = 98.9%
PPV = 88.9% NPV = 33% Accuracy = 11%

Osteoarthritis

Among 100 patients, 10 were diagnosed with osteoarthritis. Therefore, approximately 10% of arthroscopy patients had osteoarthritic changes.



MRI & clinical examination (CE) accuracy is tabulated as:

Entity	Sn.	Sp.	PPV	NPV	Accuracy
CE	82.8%	42.9%	95%	15%	80%
MM	97.1%	77.4%	90.5%	92.9%	91%
LM	78.6%	98.8%	91.7%	96.6%	96%
ACL	96.3%	91.3%	96.3%	92.3%	91%
PCL	100%	100%	100%	100%	100%
Loose bodies	67.7%	100%	100%	99%	99%
Parameniscal cyst	9.7%	100%	100%	30%	35%
Joint effusion	62.5%	100%	100%	10%	64%
Bone contusion	8.3%	98.9%	88.9%	33%	11%
Anterior translation of tibia	15.7%	100%	100%	70.5%	72%

Discussion

We found MRI useful for our research. Compared to clinical tests, the sensitivity of all ligament injuries except for LM was greater, except LM. MRI distinguishes itself based on its specificity. CE alone is insufficient to exclude IKD. In terms of excluding tears, MRI is preferable.

Compared to MRI, where the NPV ranged from 90 to 100%, the NPV of clinical tests in our study group was relatively low, around 15%. This also demonstrates that CE performs poorly in excluding tears. This can be used to justify the need for patients to have preoperative Arthroscopy. As a result, MRI can help to avoid unnecessary arthroscopies. In a study, Imhoff et al. discovered that MRI has an NPV of about 94 percent in identifying IKD and stated that MRI is superb in excluding ligament tears. Also, that unnecessary arthroscopies can be ignored by using MRI.

Weinstabl et al. used 10 randomly distributed patients into two groups with clinical positive findings (PF). In one group, preoperative MRI was performed, and it was discovered that only two percent of patients lacked PF. In another group, arthroscopy was done based on clinical findings alone, with arthroscopy showing PF in 30% only. They proved that preoperative MRI increases the likelihood of excluding the tears of the knee and helps in selection of patients for Arthroscopy.
There is wide variation in Sn. and Sp. as reported by various authors. Rubin et al.[11] described 93 percent Sn. for detecting the ACL tears.

Ketan Gupta et al[12] in 2013 found Sn., Sp., as well as accuracy of –

- MM to be 100%, 20%, & 46%
- ACL to be 100%, 57%, & 63%
- LM to be 75%, 20%, & 53%

Mordesai SC et al[13] found Sn., Sp., as well as accuracy of MRI for –

- MM to be 85.7%, 70.8%, & 76.3%
- ACL to be to 87.5%, 70.8%, & 76.3%

Uppin et al [14] in 2016 found Sn., Sp., as well as accuracy of MRI for –

- MM to be 70%, 78%, & 80%
- ACL to be 100%, 95%, & 98%
- LM to be 72%, 70%, & 69%

Vellanki Sarath et al[15] in 2018 found Sn., Sp., as well as accuracy of MRI for –

- ACL to be 97.29%, 89.47%, & 96.46%
- PCL to be 100%, 100%, &100%
- MM to be 100%, 93.3%, & 98.21%
- LM to be 93.10%, 92.59%, & 92.85%

We have already mentioned the possible reasons for the misdiagnosis of ligament tears. Additionally, arthroscopy is a complicated process with a long LC (learning curve). We have chosen arthroscopy as the benchmark for diagnosing ligament tears, but it has constraints and isn't 100 percent accurate. In addition, the orthopaedician must be a specialist in arthroscopic research.

If conducted by specialist radiologists, MRI is very reliable for diagnosing knee ligament tears, according to our research. It also assists in the identification of patients for arthroscopy and informs the referring surgeon of the necessary treatments. A peripheral tear of the meniscus has a high chance of healing due to its high vascularity, and meniscal repair or meniscectomy is not required. MRI also detects various tears, letting the surgeon to undertake the major treatment with appropriate surgical planning.

There are conflicting findings regarding whether or not an MRI should be done prior to surgery. Rose et al discovered that CE is as reliable as MRI and that pre-operative MRI is unnecessary. On the other hand, Robash BP et al.[16] discovered that prior to surgery, MRI can prevent unnecessary arthroscopy in 50% of patients, making it extremely beneficial and mandatory in all patients. CE, according to Boerre et al.[17], is of minor importance, with sensitivity in detecting MM, LM, and ACL of 67%, 48% and 55% respectively.

According to our findings, MRI is an excellent tool to identify ligament tears, with high Sn., Sp., as well as accuracy. Despite its sensitivity, CE has a low Sp. and accuracy. Thus, MRI plays a role in the selection of patient for Arthroscopy and therefore should be done prior to surgery to avoid unnecessary arthroscopies.

Epresentative Cases

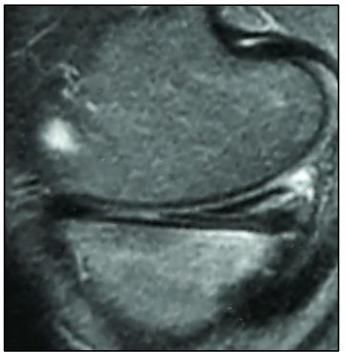


Figure 1: Grade 2 intra meniscal signal

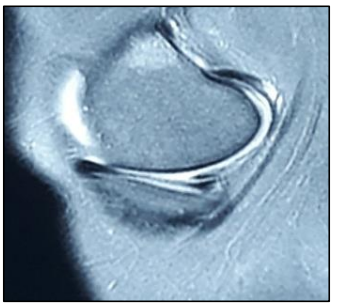


Figure 2: Horizontal tear reaching to superior articular margin

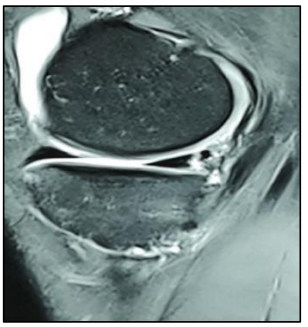


Figure 3: Horizontal tear reaching to superior articular margin

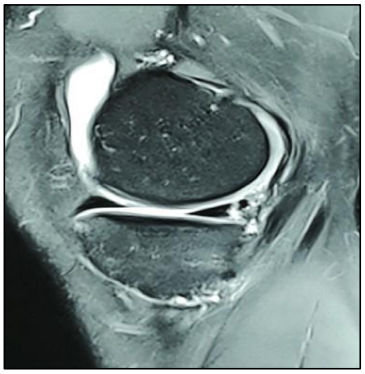


Figure 4: Vertical tear in peripheral part of medial meniscus

Figure 5: Vertical tear of peripheral part of MM.

Figure 6: Complex tear of MM with radial tear and horizontal component extending to joint capsule

Figure 7: Complex tear of MM

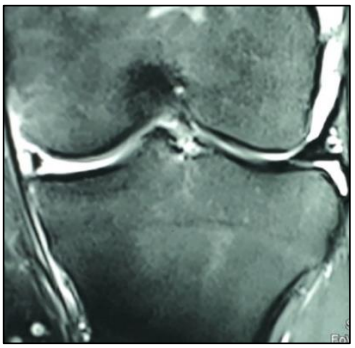


Figure 8: Bucket handle tear of MM with displaced fragment in front of PCL (Double PCL sign)

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