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Evaluation of knee joint injury by MRI

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Abstract

Background: Injury is a common cause of internal derangement of the knee (IDK) in the young adults and athletes leading to joint pain and morbidity. Although arthroscopy is considered as the gold standard but is invasive and associated with complications. MRI being non invasive and radiation free is widely used in evaluation of internal derangement of the knee joint. The following study was conducted to correlate the clinical, MRI and arthroscopic findings in diagnosing ligament and meniscal tears in knee joint injuries.

Material and Methods: A prospective study was done during a period of 2015-2017 in Guru Nanak Dev Hospital, Amritsar on patients who presented to orthopedics department with chief complaints of trauma and suspicion of internal derangement of knee and were referred to the Radiodiagnosis Department for evaluation.

Patients: A total of 50 patients were randomly selected who were referred with a clinical suspicion of internal derangement of knee. After taking history detailed clinical examination was done and MRI (1.5 Tesla) was performed in all the patients and arthroscopy in selected cases only.

Results: Sensitivity (100%) and negative predictive value (100%) of MR examination was very high in diagnosing ACL tears while it was 71.42% and 50% respectively for clinical examination. Sensitivity (83.83%) and negative predictive value (90.90%) of MR examination was also high in diagnosing meniscus tears while it was 50% and 78.57% respectively for clinical examination.

Interpretation and Conclusions: This study concluded that MRI is a useful non-invasive, non-ionizing modality having an excellent soft tissue contrast and multiplanar capability. It can accurately locate and detect the different types of IDK and gives excellent information about the internal anatomy of the knee and thus guiding in proper management of the injured knee. Because of its high diagnostic accuracy, sensitivity and negative predictive value it a very reliable screening modality for diagnosing internal derangements of knee.

Keywords: Arthroscopy; ACL (Anterior Cruciate Ligament), Clinical Examination; IDK (Internal derangement of the knee), PCL (Posterior Cruciate Ligament); Menisci; MRI (Magnetic Resonance Imaging).

Introduction

The knee joint is the largest and the most complex joint of the human body. The twisting injuries cause tearing of the meniscus and ligaments.¹

The incidence of knee injuries is on rise due to road side accidents and increased sports participation. An early and accurate diagnosis is crucial for proper treatment, early restoration of function and to lessen the disability.²

The knee joint injuries are more common in certain group of patients like athletes, children and military persons.³

A thorough history and physical examination are very important in the diagnosis of acute knee injuries. Examination includes a variety of tests like valgus and varus testing which provides assessment of the collateral ligaments. To evaluate of the anterior cruciate ligament Lachman and pivot shift tests are used. For evaluation of the posterior cruciate ligament posterior drawer is used. The meniscal injury is best diagnosed by McMurray's test and Apley's grind test.⁴

Knowing the mechanism of the injury is of great help in making diagnosis for example hyperextension with an audible pop indicate ACL tear.⁵

Internal derangements of traumatic knee can be diagnosed by imaging techniques like Ultrasound, Arthrography, Computed Tomography, Arthroscopy and Magnetic Resonance Imaging⁶

Conventional radiography although widely available and relatively cheap could not detect soft tissue, meniscal and ligamentous injuries. Moreover in severely injured patients positioning is very difficult and there is risk of radiations with repeated exposures.⁷

Although arthroscopy and arthrography are more accurate, both are invasive and can cause complications. MRI is completely non invasive diagnostic modality and there is no risk of ionizing radiation. MRI with an excellent contrast provides very good images of the soft tissues of the knee

without any complications of the above mentioned modalities with a cost comparable with that of arthroscopy. In acutely painful knee the physical examination is not always possible and its diagnostic role is limited in acute setting. So for early diagnosis MRI is recommended in acutely painful knee.⁸

The magnetic resonance imaging has distinct advantage of high accuracy and negative predictive value in evaluating the menisci and anterior cruciate ligament. So selection of the patients who are candidate for therapeutic arthroscopies can be made on the basis of MRI examination.⁹

Aims and Objective

To study clinical, MRI and arthroscopic findings of knee joint injury and to correlate them with each other.

Materials and Methods

This was a prospective study where the patients presenting with knee injury were referred from Department of Orthopaedics to the Department of Radiodiagnosis And Imaging, Guru Nanak Dev Hospital, Amritsar were studied starting from January 2016 to September 2017. A total 50 patients were randomly selected who were referred with a clinical suspicion of internal derangement of the knee. Consent was obtained from each patient and a detailed history was elicited from all patients. Relevant past history was also recorded. Findings of general, physical and specific system examination was recorded in detail.

The age group of these patients ranges from 11 years to 70 years. Out of 50 patients 37 were males and 13 were females. Different types of clinical tests were used like McMurray's test, Apley's Grinding test for menisci, anterior and posterior Drawer tests, Lachman's test and Pivot shift test for cruciate ligaments. Clinical diagnosis was made. MRI examination was done and MRI diagnosis was made. Selected patients (20) underwent arthroscopic examination and surgical diagnosis was made and the results were correlated.

Observations and Analysis

Table 1 Age wise distribution of the subjects

Age distribution (in years)	Number of subjects N	Percentage
1-10	0	0%
11-20	9	18%
21-30	23	46%
31-40	7	14%
41-50	6	12%
51-60	4	8%
61 -70	1	2%
Total	50	100.0

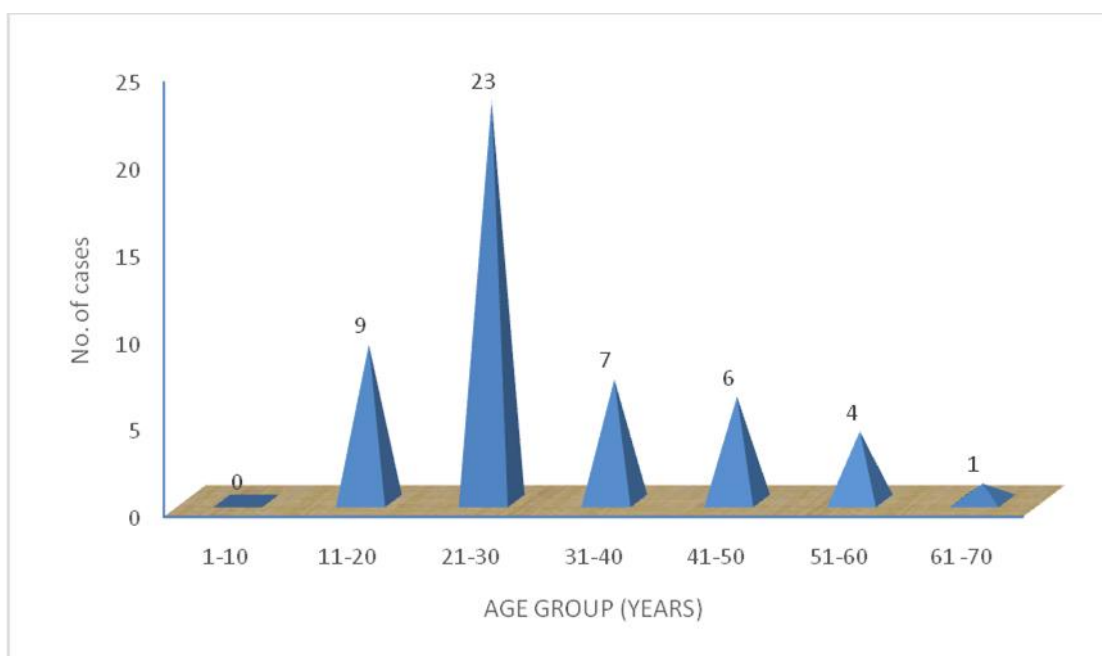


Figure 1

1. Age distribution: There were 50 subjects in the age group of 11-70 years with a mean age of 29.36 years. Majority of the subjects belonged to the young age group with maximum of 23 (46%) subjects in age group 21-30 years.

2. Sex distribution: There were 37 (74%) male and 13 (26%) female subjects out of total 50 subjects.

Table 2 Distribution of the subjects according to the sex and the side injured

	Right knee injury n_1 (%)	Left knee injury n_2 (%)	Right + Left knee injury $(n_1 + n_2)$ (%)
Males	23 (46%)	14 (28%)	37 (74%)
Females	7 (14%)	6 (12%)	13 (26%)
Males +Females	30 (60%)	20 (40%)	50 (100%)

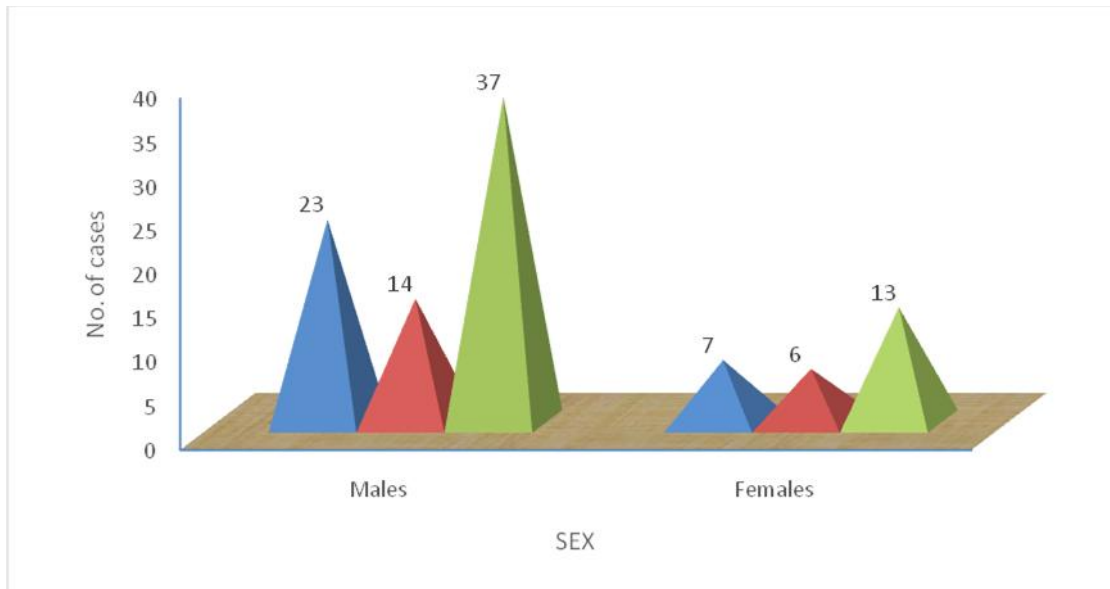


Figure 2

3. Side distribution: Right knee was injured in 30 (60%) subjects (23 males;7 females) while left knee was injured in 20 (40%) subjects (14 males;6 females).

4. Nature of injury: Most common cause of knee injuries was due to sports injuries (17) followed by road side accidents (16) , falls (10) and at last slipping injuries(7).

Table 3 Distribution of the subjects according to etiology of knee injury

Etiology of injury	No. of cases	Percentage
Sports injuries	17	34%
Roadside accidents	16	32%
Falls	10	20%
Slipped injuries	7	14%

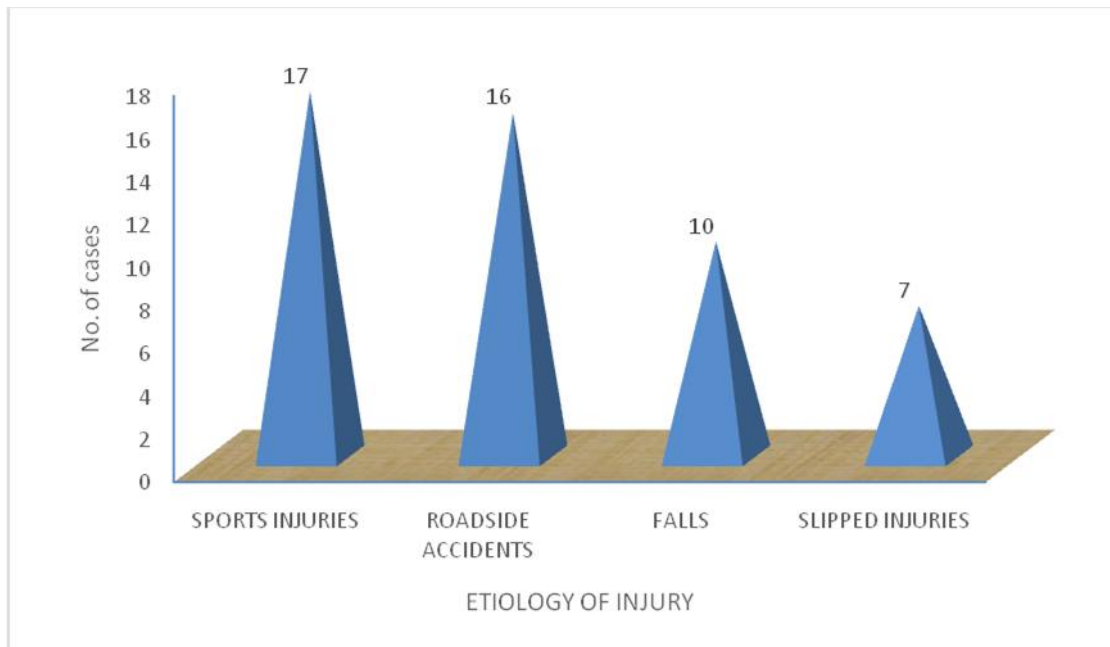


Figure 3

5. Site of injury :Most common site of injury/tear was found in the mid-substance region. Injury at femoral attachment was more common than the tibial /fibular attachment. Most common site of meniscal tear was

tear involving both posterior horn and body (52% of the total meniscal tears) followed by posterior horn only (20% of total meniscal tears).

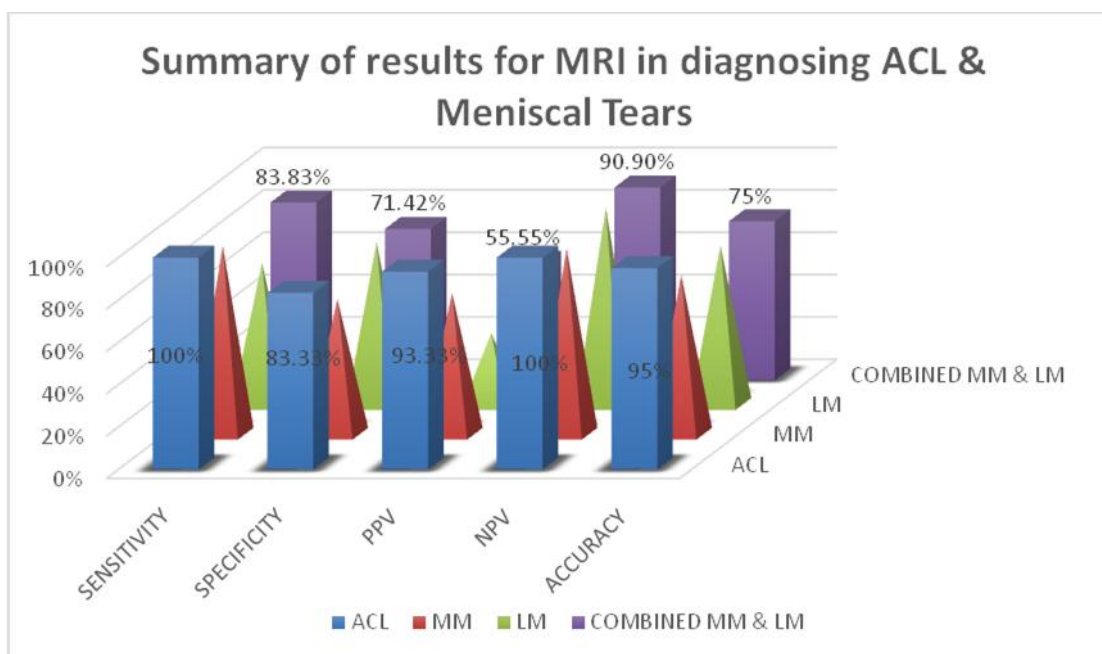
Table 4 Incidence of ligamentous and meniscal tears

Tears	No. of tears	Percentage
ACL	39	78 %
PCL	4	8%
MCL	11	22%
LCL	7	14%
Medial meniscus tear	17	34%
Lateral meniscus tear	8	16%
Total tear	86	

ACL tears had the highest incidence of 78% with medial meniscal tears second in the order (34%). PCL had the lowest incidence of 8%.

Summary of results for MRI in diagnosing ACL and Meniscal tears

	ACL	MM	LM	COMBINED MM & LM
Sensitivity	100%	88.88%	66.66%	83.83%
Specificity	83.33%	63.63%	76.47%	71.42%
Positive predictive value (PPV)	93.33%	66.66%	33.33%	55.55%
Negative predictive value(NPV)	100%	87.57%	92.85%	90.90%
Accuracy	95%	75%	75%	75%



Summary of results for clinical diagnosis in diagnosing ACL and meniscal tears

	ACL	MM	LM	Combined MM & LM
Sensitivity	71.42%	55.55%	33.33%	50.00%
Specificity	66.66%	63.66%	88.23%	78.57%
Positive predictive value (PPV)	83.33%	55.55%	33.33%	50.00%
Negative predictive value (NPV)	50.00%	63.66%	88.23%	78.57%
Accuracy	70%	60%	80%	70%

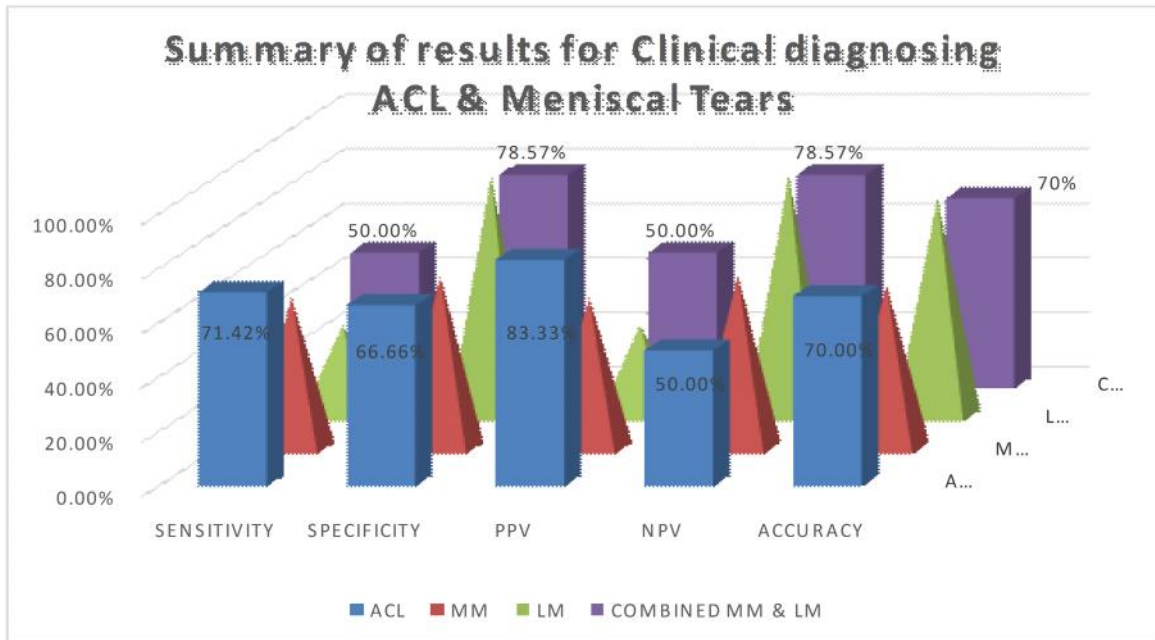


IMAGE 1: Sagittal PD FS sequence showing hyperintensity in the substance of ACL: COMPLETE ACL TEAR

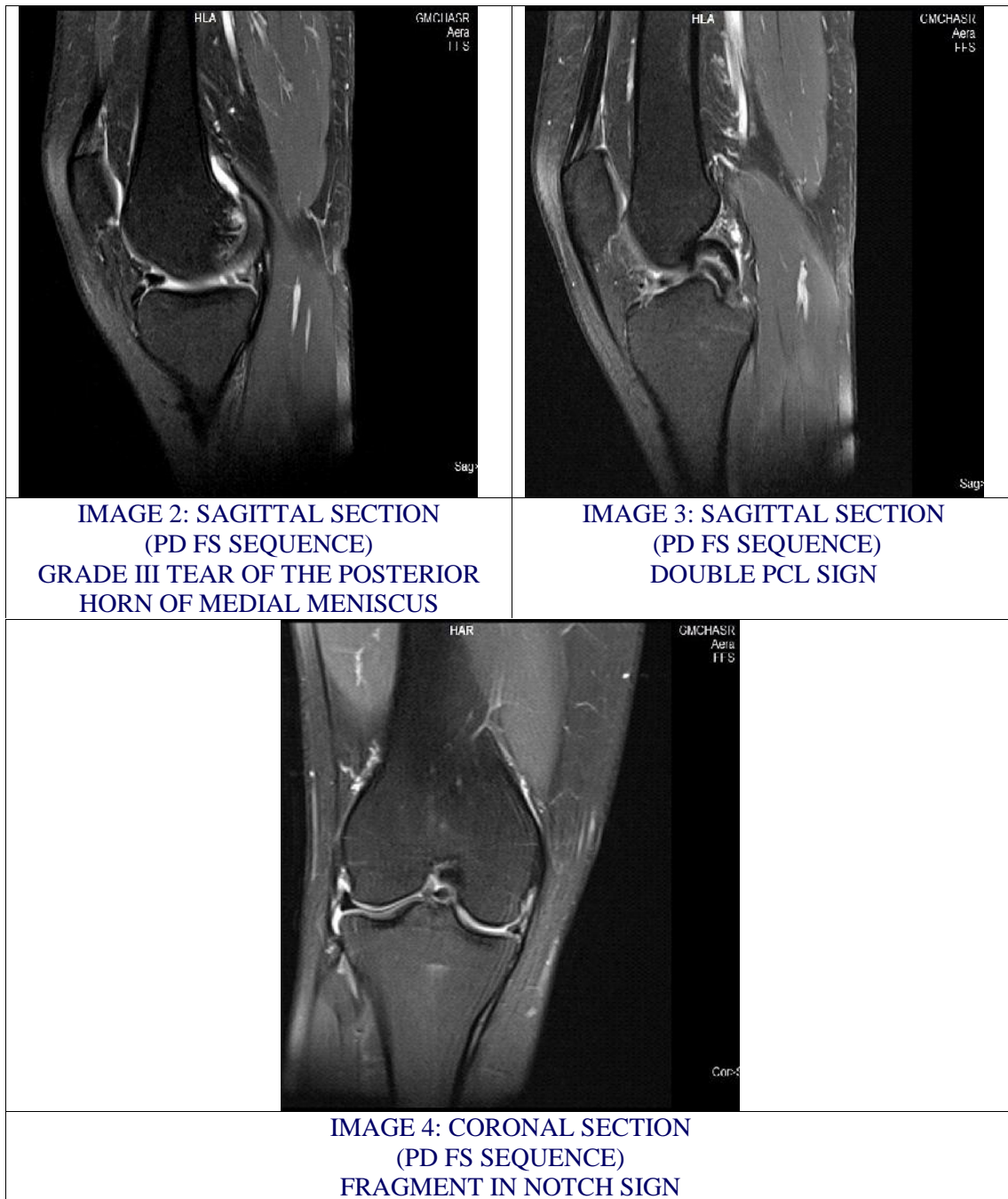


Image 2-4: The imaging features are diagnostic of a “bucket handle tear”.

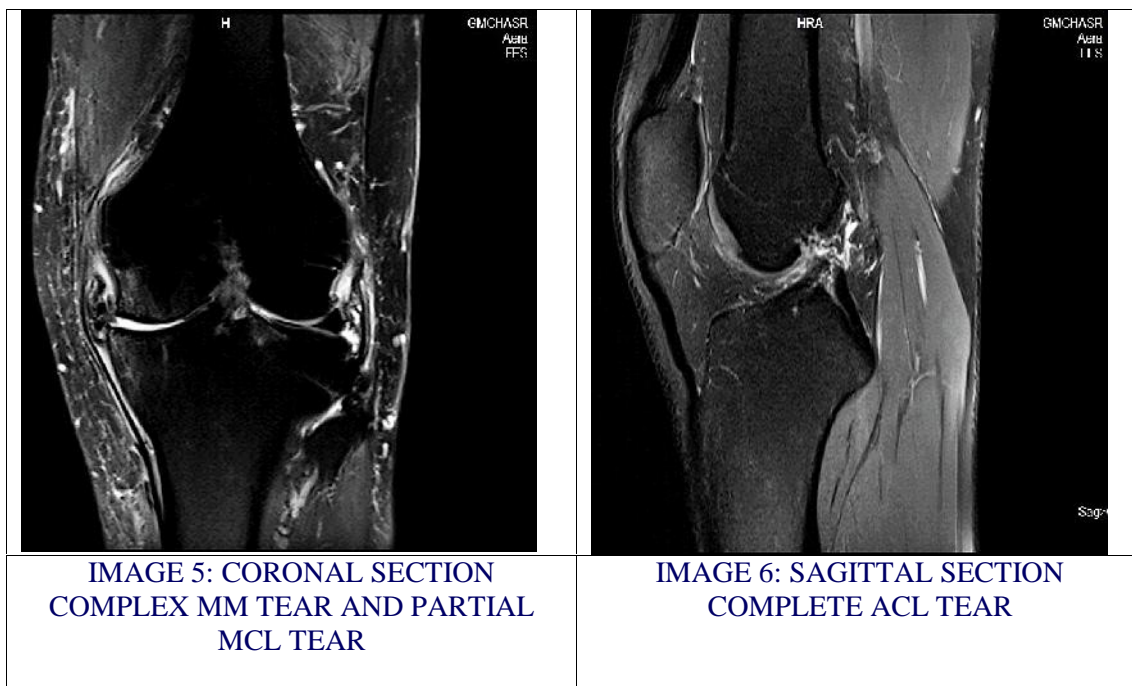


IMAGE 5-6: This combination of MM tear, MCL tear and ACL tear is known as “unhappy triad” or O’Donoghue’s triad.



Image 7: Sagittal section (PD FS Sequence) showing Grade III tear of posterior horn of lateral meniscus

Discussion

The maximum number of patients were young adults (78%) with a mean age of 29.36 years. Similar results were shown by Frobell et al and Chavadaki et al.^{11,6}

The knee joint injuries was more common in males (74%) compared to females (26%). The incidence of meniscal and ligamentous injuries was higher in males as compared to the females .Overall right knee (60%) was more commonly injured than the left knee (40%). Similar results were shown by Bari et al¹², Shahani et al¹³, Makhmalbaf H et al.¹⁴, Frobell et al.¹¹ and Clayton et al.¹⁵

Knee injuries represent roughly 6% of all acute injuries treated in the emergency department of which 27% to 48% were related to sports (Panigrahi et al and Frobell et al).^{2,11} The incidence of sports related knee injuries in previous studies matches with the incidence shown in our study.

The most common sport causing knee injury was football (47%).This was confirmed by a recent study done by Kerr et al.¹⁶, Kujala UM et al, Frobell et al and Gilquist J et al.^{27,11,29}

The incidence of ACL, PCL, medial and lateral meniscus tears turned out to be 78%, 8%, 34% and 16% respectively. In our study which corresponds to studies done done by Bari et al¹², Winters et al²⁰ and Avcu S et al²¹.

The most common site of a ligament tear in our study was the mid-substance (57.37%) and injury at femoral attachment (27.86%) was more common than tibial/fibular attachment (14.75%) corresponding with the findings of Wing Hung et al and Singh et al.^{22,23}

Grade III signal abnormality was seen in 17 medial menisci (34%) and 8 lateral menisci (16%).There was a preponderance of MM over LM in our study which corresponded with the study done by Bari et al.¹²

The ACL tears had incidence 78% followed by meniscal tears at 50% (34% medial menisci and 16% lateral menisci).

In this prospective study of 50 subjects, we compared the findings of MR and clinical examination with the arthroscopic findings. We calculated sensitivity, specificity, PPV, NPV, and accuracy of clinical and MR examination in diagnosing ligament and meniscus tears presuming arthroscopy to be gold standard.

In case of ACL tears, diagnostic accuracy for clinical examination (70%) was lower than MRI (95%). Sensitivity for diagnosing ACL tear by MR was 100% while it was 71.42% for clinical examination. So MR was more sensitive in diagnosing ACL tears.

Sensitivity, NPV and accuracy of MR examination for diagnosis of ACL tears turned out to 100%, 100% and 95% respectively in our study. Similar results were shown by Gujjar et al revealing sensitivity of 100%, NPV of 100% and accuracy of 90% respectively.²⁵

The negative predictive value (NPV) of MR for meniscus examination was high (90.90%) while the positive predictive value was low (55.55%) in the present study. Our results were similar to the results of study done by Barronian et al in which the negative predictive value and positive predictive values were 91% and 65% respectively for menisci which again indicated that MRI is a good investigation for menisci.²⁶ With a high negative predictive value, the MRI could be used as a negative diagnostic tool for the meniscal injury that helps in preventing unnecessary surgery.

These results regarding the diagnostic accuracy of menisci had also been shown in the previous study by Zairul-Nizam ZF et al who found accuracy of the clinical diagnosis of meniscus tears to be 46 to 65% compared with 80% to 84% for MRI. In our study, these values were 70% and 75% respectively.²⁷ The reason for this is unreliability of clinical examination which had already been stated by some studies. Also, the clinical tests for detecting menisci are particularly fallible. A study by Boeree NR et al had confirmed the unreliability of clinical diagnosis of meniscal and cruciate ligament.²⁸

The results of different studies for evaluation of the internal derangement of the knee with 1.5T MRI as follows: 74- 96% sensitivity, 63-89% specificity and 68-81% accuracy for diagnosis of the medial meniscal tear and 62-93% sensitivity, 88-95% specificity and 77-86% accuracy for diagnosis of the lateral meniscal tear (Laoruengthana A et al).²⁴

In the present study, the tear of medial meniscus yielded 88.88% sensitivity, 63.63% specificity and 75% accuracy while the lateral meniscus yielded 66.66% sensitivity, 76.47% specificity and 75% accuracy. So all the values of our study were within the range of previous studies done. In our study, we had correlated the MRI finding with arthroscopy.

Studies	Sensitivity			Specificity		
	ACL %	MM%	LM%	ACL %	MM%	LM%
Ali Akhbar Esmaili et al ²⁹	78.30	75.00	66.60	95.70	94.70	86.20
F. Rayan et al ³⁰	81.00	76.00	61.00	96.00	52.00	92.00
Noha et al ³¹	77.80	47.00	100	100	95.00	75.00
Bari et al ¹²	87.80	93.50	77.70	81.50	87.50	81.80
Gupta et al ³²	100	90.00	100	50.00	70.00	95.00
Our study	100	88.88	66.66	83.33	63.63	76.47

In terms of sensitivity and specificity our study showed results which were in agreement with the results of the studies of recent publications as mentioned in the table above.

So in our prospective study we found that sensitivity and negative predictive value of MR examination for diagnosing ACL and meniscal tears were quite high. Our study was in agreement with the findings of Panigrahi R et al, Gujjar et al and Laoruengthana A et al.^{2,25,24}

So with high sensitivity and negative predictive value one can rely on MRI to avoid diagnostic arthroscopy.

Conclusion

MRI is a useful non-invasive, non-ionizing modality with a high diagnostic accuracy, high sensitivity and negative predictive value which makes it a very reliable screening tool for diagnosing internal derangements of the knee. MRI saves many knees from unnecessary arthroscopies. MRI can also give information about the structures like peripheral, inferior and intrasubstance tears and bony contusion which are not accessible on arthroscopy.

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Conflict of interest: None declared

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