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Original Research Article

A Study to Assess MRI in Evaluation of Knee Injuries as Compared to Clinical Examination

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Conflict of interest: Nil

Abstract:

Introduction: Knee joint trauma is a significant cause of morbidity, especially among young and active individuals, including athletes, military recruits, and trained warriors. The advancement of minimally invasive surgical treatments has increased the importance of imaging techniques for knee joint evaluation. Magnetic resonance imaging (MRI) is commonly used techniques for assessing knee joint injuries.

Aim and Objectives: Assess the MRI appearances of ligaments and meniscal tears in cases of knee injury and to correlate the MRI findings of knee injury with clinical observations.

Material and Methods: The present cross sectional study is a comparative study conducted in the Department of Radio diagnosis, SRMS Bareilly during the period from June 2022 to May 2023 after taking permission from ethical committee and informed consent from the patients. Patients presenting with knee joint injuries were included. Patients meeting with the inclusion criteria will undergo clinical examination, knee examination and subsequently MR Imaging.

Results: On MRI 52 study subjects had ACL tear positive in which only 52 study subjects were positive clinically. Whereas 18 subjects shows tear on clinical test in MRI negative study subjects. The sensitivity of clinical test to detect ACL tear was 96.15%, specificity was 62.5%, PPV was 73.53% and NPV was 93.75%. On MRI 43 study subjects had PCL tear positive in which all 40 study subjects were positive clinically. The sensitivity of clinical test to diagnose PCL was93.02%, specificity was 91.23%, ppv was 89.58 and NPV was 94.54%.

Conclusions: In the present study, the sensitivity of clinical tests for diagnosing ACL tear was 96.15%, indicating a high accuracy in detecting this specific ligament injury. For PCL tear, the clinical tests showed a sensitivity of 93.02%, suggesting a reliable ability to identify PCL injuries. MCL tear had a sensitivity of 80.0% on clinical tests, indicating a good diagnostic performance for this ligament tear.

Keywords: ACL, PCL, LCL, MCL, MRI.

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Introduction

The knee joint is a complex hinge joint that primarily moves in the flexion and extension directions within the sagittal plane. It also allows for varus and valgus rotation in the frontal plane. Additionally, it enables medial rotation at the end of knee flexion and lateral rotation at the end of knee extension in the transverse plane. The knee joint maintains stability and control during various loading scenarios. It comprises two main bony articulations: the femur-tibia articulation, which bears most of the body weight, and the patella-femur articulation, which facilitates the smooth transfer of forces generated by the contraction of the quadriceps femoris muscle [1].

The femorotibial and patellofemoral joints enable the knee to move in three separate planes: sagittal, transverse, and frontal. This allows for flexion and extension in the sagittal planes, internal and external rotation in the transverse plane, and varus and valgus stress in the frontal plane. Due to its location between the longest lever arms of the body, the femur and tibia, and its weight-bearing function, the knee joint is susceptible to injury [2].

Knee joint trauma is a significant cause of morbidity, especially among young and active individuals, including athletes, military recruits, and trained warriors. The advancement of minimally invasive surgical treatments has increased the importance of imaging techniques for knee joint evaluation [3]. Arthroscopy and magnetic resonance imaging (MRI) are commonly used techniques for assessing knee joint injuries. However, MRI is costly procedure. In cases of knee injuries, reduced range of motion, and mechanical complaints, MRI is considered a valuable diagnostic tool [4]. Since its introduction in the

early 1980s, magnetic resonance imaging (MRI) has revolutionized the diagnostic imaging of the knee. MRI of the knee is effective in detecting lesions that may not be visible during arthroscopy, assisting in the planning and treatment of meniscal and ligament damage. [5]

MRI has several advantages over other imaging modalities such as computed tomography (CT), traditional arthroscopy, and radiography. It offers superior soft tissue contrast, high resolution, reduced artifacts, faster imaging time, and improved accuracy [6]. The multiplanar capabilities and inherent tissue contrast of MRI are particularly beneficial in localizing and determining the extent of knee lesions. It allows for noninvasive examination of the injured knee, avoiding the need for invasive procedures and additional morbidity. MRI has become the preferred imaging modality for assessing meniscal and ligament issues, as it can detect both internal and external abnormalities in the meniscus [7]. Additionally, MRI is useful in evaluating individuals who have undergone partial or complete meniscectomy or primary arthroscopic repairs of the meniscus, as it provides valuable information that may be challenging to interpret otherwise. Patients typically tolerate MRI well, and it is widely recognized by healthcare professionals. It assists in differentiating between various pathological knee conditions that may present with similar clinical signs and symptoms [8]. When selecting the appropriate MRI sequence and imaging plane, it is crucial to consider the specific diagnostic investigation required. Proton density imaging with a long repetition time (TR) and short echo time (TE) is optimal for evaluating the knee menisci, while ligament assessment may necessitate a higher T2 weighting [9]

Aim and Objectives

1. Assess the MRI appearances of ligaments and meniscal tears in cases of knee injury.

2. To correlate the MRI findings of knee injury with clinical observations.

Material and methods

The present cross sectional study is a comparative study conducted in the Department of Radio diagnosis, SRMS Bareilly during the period from June 2022 to May 2023 after taking permission from ethical committee and informed consent from the patients. Patients presenting with knee joint injuries were included. Patient having history of metallic implants insertion, cardiac pacemakers and metallic foreign body in situ and having claustrophobia were excluded from the study. Patients meeting with the inclusion criteria will undergo clinical examination, knee examination and subsequently MR Imaging.

Study procedure:

After receiving clearance from the Institutional Ethical Committee, all patients will be chosen according to inclusion and exclusion criteria. All patients will receive a comprehensive medical history, a thorough physical examination, and standard and relevant investigations.

Technique:

Before beginning the MR study, the technique will be explained to the patient in his or her native tongue in order to relieve his or her fears and anxieties, and written informed consent will be obtained. The patient will be informed that the duration of the magnet study may range from 30 to 45 minutes. Throughout the duration of the process, the patient will communicate with the technologist/doctor via a two-way intercom system. To eliminate artifacts caused by patient movement, anesthesia will be administered to children and recalcitrant patients. All research will be conducted utilizing a 128-slice scanner (Ingenuity CT, Philips Healthcare, Best, The Netherlands). Scan will be performed when the patient is supine.

Results

In the present study, the distribution of study subjects based on age groups was as follows: 47% were in the age group of 20-29 years, 27% were in the age group of 30-39 years, 14% were in the age group of 40-49 years, and 5% were in the age group of 50 years or older. In terms of gender, 82% of the study subjects were male, while 18% were female. Regarding the causes of injury among the study subjects, 60% were a result of road traffic accidents (RTA), 21% were sports-related injuries, 9% were due to self-falls, 7% were caused by being hit by a bull, and the remaining subjects had injuries from other modes of injury. When considering the affected side, 53% of the study subjects had injuries on the right side, while 47% had injuries on the left side.

Table 1: Distribution of study subjects as per ligament injury on clinical test

Ligament	YES	NO
ACL	68	32
PCL	45	55
MCL	24	76
LCL	16	84
LM	31	69
MM	51	49

Table 1 shows Distribution of study subjects as per ligament injury on clinical test, 68% subjects had clinical test positive for ACL tear, 45% had PCL tear, 24% had MCL tear, 16% study subjects had LCL, 31% subjects were had lateral meniscal tear whereas 51% subjects were had medial meniscal tear on clinical test.

Table 2: Distribution of study subjects as per ligament injury on MRI

	YES	NO
ACL	52	48
PCL	43	57
MCL	25	75
LCL	17	83
Medial patellofemoral	16	84
Arcuate	12	88
Popliteal	6	94
popliteofibular	13	87
LM	29	71
MM	30	70

Table 2 shows Distribution of study subjects as per ligament injury on MRI, 52% subjects had MRI test positive for ACL tear, 43% had PCL tear, 25% had MCL tear, 17% study subjects had LCL, 29% subjects were had lateral meniscal tear whereas 30% subjects were had medial meniscal tear on MRI, 16%subjects had medial patellofemoral, 12% subjects had arcuate ligament injury, 6% subjects had popliteal ligament injury on MRI.

Table 3: Association of ACL tears on clinical test versus MRI

		ACL MRI		Total
		Present	**Absent**	
ACL tear clinical	Present	50	18	68
	Absent	2	30	32
Total		52	48	100
Chi-square value – 39.46, p value- 0.0, significant				

Table 3 shows Association of ACL tear on clinical test versus MRI, On MRI 52 study subjects had ACL tear positive in which only 52 study subjects were positive clinically. Whereas 18 subjects shows tear on clinical test in MRI negative study subjects. The sensitivity of clinical test to detect ACL tear was 96.15%, specificity was 62.5%, PPV was 73.53% and NPV was 93.75%

Table 4: Association of PCL tears on clinical test versus MRI

		PCL MRI		Total
		Present	**Absent**	
Pcl Clinical	Present	40	5	45
	Absent	3	52	55
Total		43	57	100
Chi-Square Test – 70.29, P Value- 0.0, Significant				

Table 4 shows Association of PCL tear on clinical test versus MRI, On MRI 43 study subjects had PCL tear positive in which all 40 study subjects were positive clinically. Whereas out of 57 study subjects negative on MRI, 52 were clinically negative and 5 subjects were clinically positive. The sensitivity of clinical test to diagnose PCL was93.02%, specificity was 91.23%, ppv was 89.58 and NPV was 94.54%

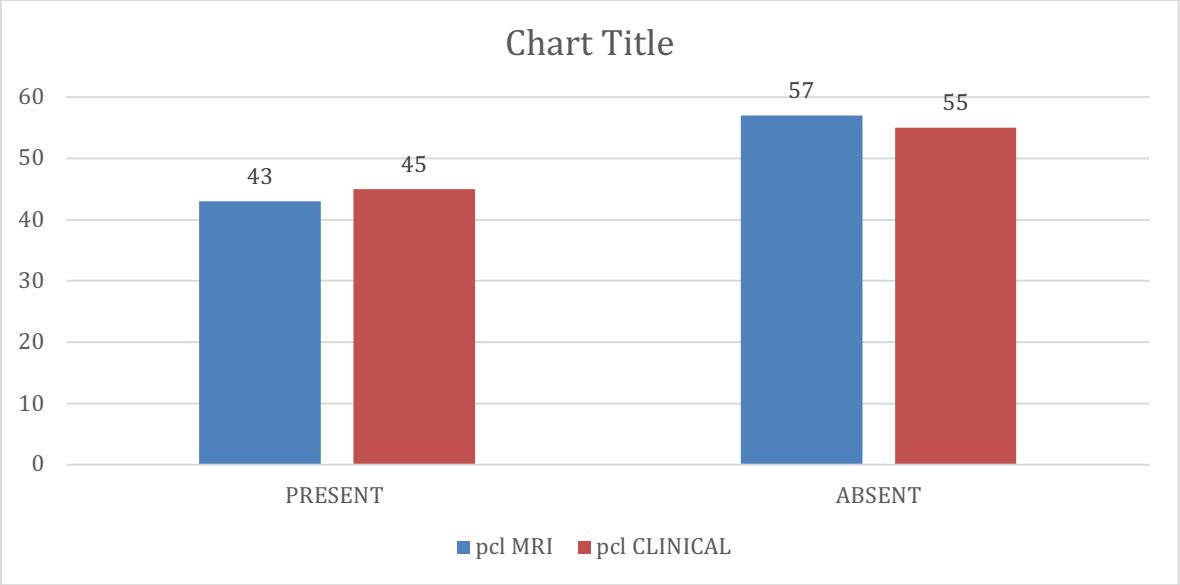

Figure 1: Association of PCL tear on clinical test versus MRI

Table 5: Association of MCL tears on clinical test versus MRI

		MCL MRI		Total
		Absent	Present	
MCL Clinical	Absent	20	4	24
	Present	5	71	76
Total		25	75	100
Chi-Square Value- 57.31, P Value- 0.0, Significant				

Table 5 shows Association of MCL tear on clinical test versus MRI, On MRI 25 study subjects had MCL tear positive in which 20 study subjects were positive clinically. Whereas four of the subjects shows tear on clinical test in 75 MRI negative study subjects.

The sensitivity of clinical test to diagnose MCL tear was 80%, specificity was 94.66%, PPV was 86.21% and NPV was 93.42%Fig 2 shows Association of ACL tear on clinical test versus MRI, On MRI 17 study subjects had LCL tear positive in which 11 study subjects were positive clinically.

Whereas out of 16 study subjects positive clinically 11 were positive, and 5 study subjects were negative, The sensitivity of clinical study to diagnose LCL tear was 64.70%, specificity was 93.97%, PPV was 77.27%, and NPV was 92.85%.

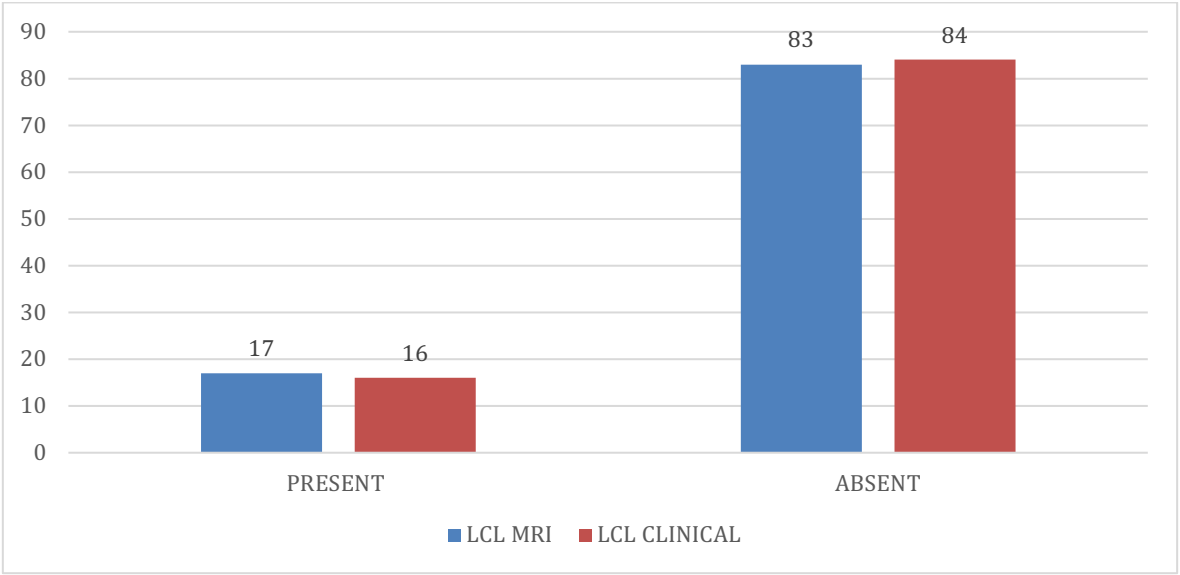

Figure 2: Association of LCL tear on clinical test versus MRI

Table 6: Association of Medial meniscal tear on clinical test versus MRI

		MMMRI		Total
		Present	Absent	
MMC Clinical	Present	27	24	51
	Absent	3	46	49
Total		30	70	100
Chi-square value- 26.08. p value- 0.0, significant				

Table 6 shows Association of medial meniscal tear on clinical test versus MRI; On MRI 30 study subjects had MM tear positive in which 27 study subjects were positive clinically. On clinically 51 study subjects were positive, in which 30 study subjects were positive and 24 subjects were negative. The sensitivity of clinical test for diagnosing medial meniscus tear was 90%, specificity was 65.71%, PPV was 55.54% and NPV was 93.88%. Fig 3 shows Association of Lateral meniscal tear on clinical test versus MRI, On MRI 29 study subjects had LM tear positive in which 25 study subjects were positive clinically. Of 71 negative on MRI, 6 were positive and 65 were negative.

The sensitivity of clinical test to diagnose lateral meniscal tear was 86.21%, specificity was 91.55%, PPV was 82.86%, and NPV was 94.20%.

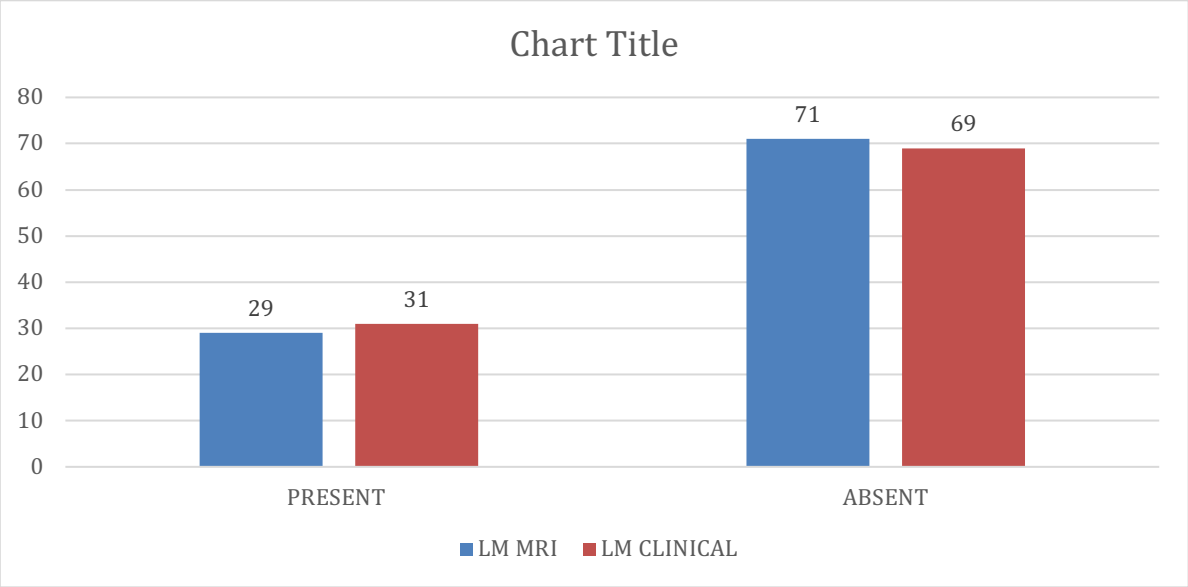

Figure 3: Association of Lateral meniscal tear on clinical test versus MRI

Discussion

Knee injury is a problem affecting both young and old individuals, as those aged over 65 years have been reported to suffer from one to three incidences of falls due to several factors, including self-reported knee instability.

It affects a varied population, including professional athletes older adults and recreational exercisers. The impact of knee instability can be severe, and may lead to an increased risk of falls and a long period of rehabilitation. These consequences of knee instability increase the cost to health care systems.

In the present study, the distribution of study subjects based on age groups aligns with similar studies. The majority of patients were in the age range of 20-30 years, followed by patients in the age groups of 11-20 years and 31-40 years. The male-to-female ratio in the study was also consistent with previous research, with a higher percentage of male subjects. Regarding the mode of injury, the present study showed a higher prevalence of road traffic accidents (RTA) as the leading cause of knee injuries, followed by sports-related injuries, self-falls, and injuries caused by being hit by a bull. These findings are in line with other studies that have reported a similar distribution of knee injuries related to sports, accidents, falls, and other modes of injury. Overall, the results of the present study closely align with previous research in terms of the age distribution, gender ratio, and mode of injury observed in knee injury cases.

In the present study, the distribution of affected sides showed that 53% of study subjects had the right side affected, while 47% had the left side affected. This is consistent with a study by Kucha et al [5]. which reported a higher prevalence of left knee injuries compared to right knee injuries. Regarding ligament injuries, the most common ligament tear observed in the present study was ACL (anterior cruciate ligament) tear. Clinical tests indicated ACL tear in 68% of subjects, while MRI

tests confirmed ACL tear in 52% of subjects. Among the 40 study subjects who underwent arthroscopy, 42% were diagnosed with ACL tear. These findings align with previous studies that have reported ACL tear as the most common ligament injury in knee injuries. For PCL (posterior cruciate ligament) tear, clinical examination indicated PCL tear in 45% of subjects, and MRI confirmed PCL tear in 43% of subjects. Among the study subjects who underwent arthroscopy, 44% were diagnosed with PCL tear. PCL injuries are less common than ACL injuries, with reported rates ranging from 3% to 20%. This is consistent with studies by William Rodriguez, Jr.[10] and Akisue et al.[11], which found a lower incidence of PCL tears compared to ACL tears.

In the present study, the prevalence of MCL (medial collateral ligament) tear was observed in 24% of subjects based on clinical tests, 25% based on MRI, and 40% based on arthroscopy. These findings are in line with studies by Madurwar AU et al[12]. and Yeli RK et al.[13], which reported similar percentages of MCL tears. Regarding LCL (lateral collateral ligament) tear, the present study found a prevalence of 16% based on clinical tests, 17% based on MRI, and 32% based on arthroscopy. The study by Yeli RK et al[13]. reported a similar percentage of LCL tears on MRI.

For lateral meniscus tear, the present study observed a prevalence of 31% based on clinical tests, 29% based on MRI, and 38% based on arthroscopy. These findings are in accordance with the study by Yeli RK et al[13]., which reported a 31% prevalence of lateral meniscus tears. Regarding medial meniscus tear, the present study found a prevalence of 51% based on clinical tests, 30% based on MRI, and 38% based on arthroscopy. These findings are consistent with studies by Yeli RK et al.[13], Madurwar AU et al[12]., Kucha V A et al[5].which reported similar percentages of medial meniscus tears

In the present study, the sensitivity of the clinical test to detect ACL tear was 96.15%, with a specificity of 62.5%, positive predictive value (PPV) of 73.53%, and negative predictive value (NPV) of 93.75%. These findings are consistent with the study by Yeli RK et al [13]., which reported an 80% agreement between clinical and MRI findings for ACL tear. Xusheng Li et al [3]. also found high sensitivity (90.7%) and moderate specificity (63.6%) of MRI in diagnosing ACL injuries. Similarly, Odgaard et al. [14] observed a correlation between clinical and MRI findings for ACL tears in 74% of cases, further supporting the findings of the present study. For PCL tear, the present study reported a sensitivity of 93.02% and specificity of 91.23% for the clinical test. The negative predictive value (NPV) was highest for PCL tear. This is in contrast to the study by Pushpa et al.[15], which found a 0% sensitivity of clinical tests for PCL tear. However, Sharma D et al [7]. Reported a sensitivity of 19% for PCL tear. The study by Artit Laoruengthana et al [16] also found high sensitivity (80-100%), specificity (97-100%), and accuracy (96-100%) of MRI in diagnosing PCL tears.

Regarding MCL tear, the present study reported a sensitivity of 80% and specificity of 94.66% for the clinical test. The PPV and NPV were 86.21% and 93.42% respectively. These findings are similar to the study by Yeli RK et al [13]. Which reported an 84% sensitivity of clinical tests versus MRI for MCL tear? For LCL tear, the present study reported a sensitivity of 64.70% and specificity of 93.97% for the clinical test. The PPV and NPV were 77.27% and 92.85% respectively. These findings are consistent with the study by Yeli RK et al [13]., which reported a sensitivity of 90% for clinical and MRI findings of LCL tear.

In the present study, the sensitivity of the clinical test for diagnosing medial meniscus tear was 90%, with a specificity of 65.71%, positive predictive value (PPV) of 55.54%, and negative predictive value (NPV) of 93.88%. Yeli RK et al [13]. Reported a 70% agreement between clinical and MRI findings for the presence or absence of medial meniscal tear, which is in line with the present study. Kucha V A et al [5]. Found meniscal tears in 66 patients on MRI evaluation, further supporting the findings. Jolene C.

Hardy et al [17]. reported a sensitivity of 93% and specificity of 55% for the McMurray test in diagnosing medial meniscus tear, which is consistent with the present study. For lateral meniscal tear, the present study found that 86.21% of the clinical test results corresponded to MRI findings of lateral meniscal tear, with a specificity of 91.55%, PPV of 82.86%, and NPV of 94.20%. Madurwar AU et al [12]. Reported a sensitivity of 69.23% and specificity of 86.66% for lateral meniscal tear, which aligns with the present study.

Conclusion

In the present study, the sensitivity of clinical tests for diagnosing ACL tear was 96.15%, indicating a high accuracy in detecting this specific ligament injury. For PCL tear, the clinical tests showed a sensitivity of 93.02%, suggesting a reliable ability to identify PCL injuries. MCL tear had a sensitivity of 80.0% on clinical tests, indicating a good diagnostic performance for this ligament tear. LCL tear demonstrated a sensitivity of 64.70% on clinical tests, indicating a moderate ability to detect this type of ligament injury. The clinical tests exhibited a sensitivity of 90% for diagnosing medial meniscus tear, indicating a high accuracy in detecting tears in this structure.

Lastly, the sensitivity of clinical tests for lateral meniscus tear was 86.21%, suggesting a relatively good ability to identify this specific meniscal injury.

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