Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 8
Open Access

# Accuracy Of Clinical Examination, Magnetic Resonance Imaging, And Arthroscopy In Diagnosing Meniscal And Anterior Cruciate Ligament Injuries

**[*1]Mushtaq Abdulkhaleq Khorsheed, [2]Aree Mohammad Ismaeel, [3]Sabir Hamed M. Ameen**

[*1]Department 1M.B.Ch.B, F.K.B.M.S (Trauma & Ortho), Kurdistan Ministry of Health, Erbil Health Department, Erbil Teaching Hospital, Erbil, Iraq

[2]M.B.Ch.B, A.B.H.S(Ortho), Kurdistan Ministry of Health, Erbil Health Department, Erbil Teaching Hospital, Erbil, Iraq .

[3]M.B.Ch.B., F.K.B.M.S(Trauma & Ortho), Kurdistan Ministry of Health, Erbil Health Department, Erbil Teaching Hospital, Erbil, Iraq

[*1]Corresponding Email : drmushtaq8590@ymail.com

Cite this paper as: Mushtaq Abdulkhaleq Khorsheed, Aree Mohammad Ismaeel, Sabir Hamed M. Ameen, (2024) Accuracy Of Clinical Examination, Magnetic Resonance Imaging, And Arthroscopy In Diagnosing Meniscal And Anterior Cruciate Ligament Injuries. *Frontiers in Health Informatics*, *13(8) 661-671*

## ABSTRACT

**Background:** Accurate diagnosis of knee injuries is critically dependent on thorough patient history and detailed clinical examination. Meniscal and ligamentous injuries within the knee are frequently assessed using magnetic resonance imaging (MRI), which serves as an adjunct diagnostic tool. This study aimed to evaluate the precision of clinical tests in diagnosing meniscal (Thessaly, joint line tenderness, and McMurray tests) and anterior cruciate ligament (ACL) (Lachman, Anterior Drawer (ADT), and Pivot Shift tests (PST)) injuries and to compare these findings with MRI and arthroscopic results, the latter of which is considered the diagnostic gold standard.

**Material and methods**: This study was done prospectively from October (Year) to October (Year). The study included a total of 79 individuals who had knee arthroscopy for different reasons at Erbil Teaching Hospital. Orthopedic doctors conducted clinical assessments using specialized techniques to evaluate meniscal and ACL damage. MRI was used to validate these clinical symptoms, then followed by arthroscopy to obtain the definitive diagnosis.

**Results:** The Lachman test demonstrated high diagnostic accuracy (92.4%) in identifying ACL ruptures. Similarly, the Thessaly test was highly accurate for detecting tears in the medial (91.1%) and lateral (89.5%) menisci. Joint line tenderness (JLT) achieved an accuracy of 84.8% for medial and 89.7% for lateral meniscus tears. The validity of these clinical tests was benchmarked against MRI findings and arthroscopic confirmation. The accuracy of clinical diagnoses for medial and lateral meniscal lesions was comparable to MRI (91% vs. 89% and 89% vs. 86%, respectively). Clinical diagnosis of ACL injuries also showed superior accuracy compared to MRI (92.4% vs. 87.3%).

**Conclusions:** Among the clinical tests evaluated, the Lachman test was the most precise for diagnosing ACL ruptures, and the Thessaly test, coupled with JLT, was the most reliable for identifying meniscal tears. Clinical examinations proved as accurate as MRI in diagnosing meniscal injuries, and even more so for ACL injuries, highlighting the effectiveness of careful clinical assessment in the diagnostic process.

**Keywords**:

Clinical Examination, Magnetic Resonance Imaging and Arthroscopy, Knee Injury, MRI, Arthroscopy

## Introduction

Accurate diagnosis of knee injuries heavily relies on thorough historical documentation and meticulous clinical examinations (1). Magnetic resonance imaging (MRI) plays a crucial role in identifying meniscal and ligamentous injuries of the knee by providing detailed images that highlight specific morphological abnormalities (2, 3). It is recognized as a reliable adjunctive tool for evaluating knee pathologies (4).

Meniscal tears, particularly common among knee injuries requiring surgical intervention, more frequently affect the medial meniscus (MM) compared to the lateral meniscus (LM) (5). Nevertheless, tears in the LMs are predominantly associated with concurrent ACL ruptures. Young athletes often sustain traumatic meniscal tears during sports activities (6).

Anterior tibial translation and internal tibial rotation combined with a valgus load during almost full extension of the knee is often the etiology of ACL injuries, which account for 40–50% of all knee ligament injuries (7, 8). Posterior cruciate ligament (PCL) injuries are most often the result of a direct impact to the anterior tibia while the knee is flexed (the "dashboard injury"), or due to hyperflexion or hyperextension (9).

Historically, special tests have been integral to the physical examination for evaluating musculoskeletal knee pain (9). Several of these tests, including McMurray's test, JLT, Apley's test, and the more recent Thessaly test, are employed to diagnose meniscal tears, with the latter showing high diagnostic accuracy (10).

The introduction of MRI for diagnosing knee disorders by Kean et al. in 1980 marked a significant advancement (11). Continued technical enhancements and growing expertise have established MRI as an essential diagnostic instrument, achieving average accuracy rates as high as 93% (12, 13). In contemporary clinical practice, MRI scanning is frequently used to substantiate diagnoses of meniscal or ACL injuries before proceeding to arthroscopic evaluation and potential surgery (14).

The current study aimed to evaluate the accuracy of clinical tests (including the Thessaly, JLT, and McMurray tests for meniscal injuries, as well as the Lachman, ADT, and PST for ACL injuries) in comparison to MRI findings and arthroscopic verification, with arthroscopy considered the definitive standard for diagnosis.

## Patients and Methods

In this prospective comparison research, 79 patients who were admitted to Erbil Teaching Hospital in Hawler between October (year) and October (year) for elective knee arthroscopy were included.

Those with unilateral knee injuries between the ages of 18 and 45 were included. Patients with loose bodies, degenerative arthritis, chondral injuries, femoropatellar pathological disorders, MRI contraindications, or fracture sequelae were also excluded from the study.

### *The study setting*

The study encompassed 79 patients admitted for elective knee arthroscopy. Each patient was clinically evaluated through comprehensive history-taking and a detailed clinical examination. Subsequently, all participants underwent an MRI of the knee followed by knee arthroscopy. The primary indications for these surgical interventions included symptoms such as knee pain, locking, giving way, and recurrent knee swelling.

### *Knee swelling*

A specialist orthopedic surgeon, experienced in diagnosing and treating pathological knee conditions, conducted the clinical examinations. The evaluation of meniscal injuries involved JLT, the McMurray test, and the Thessaly test. The ACL injuries were assessed using the Lachman test, ADT, and PST. Additionally, the posterior drawer test was utilized for PCL injuries, along with valgus and varus stress tests. Following these assessments, an MRI was recommended for all 79 patients to confirm the clinical diagnosis and provide additional information.

### *MRI Protocol*

Using a 1.5 Tesla strong magnetic extremities coil, four distinct imaging institutes in Erbil city conducted the MRI scans. T1 and T2 sequences with a 4 mm slice thickness were supplied by each MRI.

An experienced radiologist, who had no prior contact with the patients, interpreted the MRI scans. Meniscal tears were classified into four grades, with grades three and four considered positive for significant tearing. In order to improve visibility of the ACL during sagittal imaging, patients were placed supine and the affected knee was externally rotated 10 to 15 degrees throughout the scans. A consistent low-signal intensity along the length of the intercondylar notch through origin to insertion suggested that the ACL remained intact. If this signal pattern was missing, inconsistent, non-homogenous, or had anomalies in origin or insertion, an ACL rupture was indicated.

### *Data Collection*

Data were collected using a questionnaire designed by the researcher, gathering information on age, sex, affected knee (right or left), chief complaint, injury duration and mechanism, and dates of MRI and arthroscopy. The presence of tears in the knee menisci and ACL was recorded based on both MRI and arthroscopy findings.

### *The surgical procedure*

All surgeries were conducted under general or spinal anesthesia by four orthopedic surgeons. Ligament stability was reassessed under anesthesia. Arthroscopy involved two-port anteromedial and anterolateral portals. A systematic examination of the entire knee was performed during the arthroscopic procedure, assessing areas such as the suprapatellar pouch, patellofemoral joint, medial and lateral compartments, and the intercondylar notch. Any type of meniscal tear, regardless of its configuration, was recorded, and the specific meniscus (LM or MM) was noted. Similarly, the ACL and PCL were evaluated for normalcy or rupture. When assessing meniscal and ligament problems, arthroscopy was thought to be the best option.

### *Research ethics*

The study obtained permission from the research ethics committee of the College of Medicine at Hawler Medical University. Before taking part in the experiment, every patient gave written informed permission.

### *Statistical analysis*

The data were analyzed using the SPSS, specifically version 26. Frequency and proportion calculations were performed, and the McNemar test was used to compare the results obtained from clinical testing and MRI findings with those obtained via arthroscopy.

| Characteristics | | Arthroscopy | |
|---|---|---|---|
| | | Positive | Negative |
| Clinical test MRI | Positive | TP | FP |
| | Negative | FN | TN |
| Total | | TP+FN | FP+TN |

**TP-True positive; TN-True negative; FP=False positive; and FN=False negative**

$$\text{Sensitivity} = \frac{TP}{TP+FN} \times 100$$

$$\text{Specificity} = \frac{TN}{FP+TN} \times 100$$

$$\text{Positive predictive value} = \frac{TP}{TP+FP} \times 100$$

$$\text{Negative predictive value} = \frac{TN}{FN+TN} \times 100$$

$$\text{Accuracy} = \frac{TP+TN}{\text{Total}} \times 100$$

**A p value $\leq 0.05$ was considered statistically significant.**

**Figure 1. Crosstabs for Statistical Analysis**

## Result

This study involved 79 patients, comprising 68 males (86.1%) and 11 females (13.1%), aged between 19 and 44 years, with a median age of 29. The patient cohort included 42 individuals (53.2%) with right knee issues and 37 (46.8%) with left knee issues. Treatment administered to 52 patients included knee support, physiotherapy, and symptomatic management over a period of 14 to 90 days. The interval between MRI and knee arthroscopy ranged from 3 to 12 weeks, during which no new injuries were reported. The injuries were attributed to sports 51 (64.5%), trauma 18 (22.7%), or idiopathic 10 (12.6%), with no prior history of trauma (Table 2).

**Table 2. Distribution socio-demographics and of the Cases According to Etiology**

(No. of the cases = 79)

| **Characteristics** | | **Frequency** | **Percent** |
|---|---|---|---|
| Median Age | | 29 (19-44) | |
| Sex | Male | 68 | 86.1 |
| | Female | 11 | 13.1 |
| Location | Right | 42 | 53.2 |
| | Left | 37 | 46.8 |
| Median interval between MRI and surgery | | 8 (3-12) | |
| Etiology | Sport | 51 | 64.5 |
| | Trauma | 18 | 22.7 |
| | Idiopathic | 10 | 12.6 |

**JLT:** Clinical examination using JLT indicated suspected MM tears in 32 patients, confirmed via arthroscopy in 29 cases. This yielded a sensitivity of 76%, specificity of 92%, positive predictive value (PPV) of 90%, negative predictive value (NPV) of 80%, and an accuracy of 84.8%. Suspected LM tears were identified in 18 patients, with 17 confirmations on arthroscopy, resulting in a sensitivity of 70%, specificity of 98%, PPV of 94%, NPV of 88%, and an accuracy of 89.7% (Table 3).

**Table 3. Recordings of JLT at 90-Degree Knee Flexion, and Diagnostic Value of JLT**

| **Arthroscopic decision** | | | |
|---|---|---|---|
| | Positive | Negative | Total |
| Median meniscus injuries | | | |
| Positive | 29 (a) | 3 (b) | 32 (a+b) |
| Negative | 9 (c) | 38 (d) | 47 (c+d) |
| Total | 38 (a+c) | 41 (b+d) | 79 |
| LMs injuries | | | |
| Positive | 17 (a) | 1 (b) | 19 (a+b) |
| Negative | 7 (c) | 54 (d) | 61 (c+d) |
| Total | 24 (a+c) | 55 (b+d) | 79 |
| (a) True positive, (b) False positive, (c) False negative, (d) False positive | | | |
| **Diagnosis** | | | |
| | | Median meniscus | LMs |
| Sensitivity % | | 76.3 | 70.8 |
| Specificity % | | 92.3 | 98.1 |
| PPV % | | 90.6 | 94.4 |
| NPV % | | 80.8 | 88.5 |
| Accuracy | | 84.71 | 89.7 |
| P-value | | 0.14 | 0.7 |

***McMurray test***

Application of the McMurray test suggested MM tears in 26 patients, with arthroscopy confirming 21 cases. The sensitivity was 55%, specificity 87%, PPV 80.7%, NPV 67.2%, and accuracy 72%. For LM tears, 17 patients were suspected, and 13 were confirmed, resulting in a sensitivity of 54.1%, specificity of 92.7%, PPV of 76.4%, NPV of 82%, and accuracy of 81% (Table 4).

**Table 4.**

**Recordings of McMurray Test, and Diagnostic Value of McMurray Test**

| Arthroscopic decision | | | |
|---|---|---|---|
| | Positive | Negative | Total |
| Median meniscus injuries | | | |
| Positive | 24 (a) | 5 (b) | 26 (a+b) |
| Negative | 17 (c) | 36 (d) | 53 (c+d) |
| Total | 38 (a+c) | 41 (b+d) | 79 |
| LMs injuries | | | |
| Positive | 13 (a) | 4 (b) | 17 (a+b) |
| Negative | 11 (c) | 55 (d) | 62 (c+d) |
| Total | 24 (a+c) | 55 (b+d) | 79 |
| (a) True positive, (b) False positive, (c) False negative, (d) False positive | | | |
| **Diagnosis** | | | |
| | | Median meniscus | LMs |
| Sensitivity % | | 55.26 | 54.1 |
| Specificity % | | 87.8 | 92.7 |
| PPV % | | 80.7 | 76.4 |
| NPV % | | 67.2 | 82.2 |
| Accuracy | | 72.4 | 81 |
| P-value | | 0.01 | 0.11 |

***Thessaly Test***

The Thessaly test indicated suspected MM tears in 37 patients, with 34 confirmed by arthroscopy, reflecting a sensitivity of 89.4%, specificity of 92.6%, PPV of 91.8%, NPV of 90.4%, and accuracy of 91.1%. Suspected lateral tears were seen in 20 patients, with 18 confirmed, providing a sensitivity of 75.2%, specificity of 96.3%, PPV of 90%, NPV of 89.8%, and accuracy of 89.8% (Table 5).

**Table 5. Recordings of Thessaly at 20 Degree Knee Flexion, and Diagnostic Value of Thessaly**

| **Arthroscopic decision** | | | |
|---|---|---|---|
| | Positive | Negative | Total |
| Median meniscus injuries | | | |
| Positive | 34 (a) | 3 (b) | 37 (a+b) |
| Negative | 4 (c) | 38 (d) | 42 (c+d) |
| Total | 38 (a+c) | 41 (b+d) | 79 |
| LMs injuries | | | |
| Positive | 18 (a) | 2 (b) | 20 (a+b) |
| Negative | 6 (c) | 53 (d) | 59 (c+d) |
| Total | 24 (a+c) | 55 (b+d) | 79 |
| (a) True positive, (b) False positive, (c) False negative, (d) False positive | | | |
| **Diagnosis** | | | |
| | | Median meniscus | LMs |
| Sensitivity % | | 89.4 | 75.2 |
| Specificity % | | 92.6 | 96.3 |
| PPV % | | 91.8 | 90 |

| | | |
|---|---|---|
| NPV % | 90.4 | 89.8 |
| Accuracy | 91.1 | 89.8 |
| P-value | 1 | 0.11 |

***Medial Meniscus Injuries***

Among 37 knees with clinically suspected MMs tears, arthroscopy confirmed 34 cases, including 12 bucket handle tears. The sensitivity was 89.4%, specificity 92.6%, PPV 91.8%, NPV 91.4%, and accuracy 91%. MRI identified MM tears in 35 cases, with 32 confirmations via arthroscopy, resulting in a sensitivity of 84.2%, specificity of 92.6%, PPV of 91.4%, NPV of 86.3%, and accuracy of 89% (Table 7).

***Lateral meniscus injuries***

Clinical examination suspected LMs tears in 20 knees, with 18 confirmed by arthroscopy, including 4 bucket handles and 2 discoid meniscal tears. This resulted in a sensitivity of 75%, specificity of 96.3%, PPV of 90%, NPV of 89%, and accuracy of 89%. MRI suggested LM tears in 16 cases, with 15 confirmations on arthroscopy, indicating a sensitivity of 62%, specificity of 98%, PPV of 93%, NPV of 85%, and accuracy of 87% (Tables 6 and 7).

**Table 6. Diagnostic Value of MRI**

| | Median meniscus tear | LMs tear |
|---|---|---|
| Sensitivity % | 84.2% | 62% |
| Specificity % | 92.6% | 98% |
| PPV % | 91.4% | 93% |
| NPV % | 86.3% | 85% |
| Accuracy | 88.6% | 87% |
| P-value | 0.5 | 0.02 |

**Table 7. Comparing Clinical Finding with MRI Finding**

| | **Median meniscus** | | **LMs** | |
|---|---|---|---|---|
| | Clinical | MRI | Clinical | MRI |
| Sensitivity % | 89 | 84 | 75 | 62 |
| Specificity % | 92 | 92 | 96 | 98 |
| PPV % | 91 | 91 | 90 | 93 |
| NPV % | 90 | 86 | 89 | 85 |
| Accuracy | 91 | 89 | 89 | 87 |
| P-value | 1 | 0.5 | 0.11 | 0.02 |

***ACL Injuries***

Clinical assessments for ACL tears were conducted using three tests. The Lachman test, applied to 54 patients, detected 52 ACL tears, yielding a sensitivity of 92.8%, a specificity of 91%, a PPV of 96.2%, a NPV of 84%, and an overall accuracy of 92.4% (Tables 8 and 9). The ADT, conducted on 37 patients, identified 35 ACL tears, resulting in a sensitivity of 62.5%, specificity of 91.3%, a PPV of 94.6%, a NPV of 50%, and an accuracy of 70.8% (Tables 8 and 9). The PST was performed on 33 patients, revealing 32 ACL tears, with a sensitivity of 57.1%, specificity of 95.6%, a PPV of 88.8%, a NPV of 47.8%, and an accuracy of 68.3% (Tables 8 and 9). The Lachman test demonstrated the highest sensitivity and specificity among the tests evaluated (Table 9).

**Table 8. Recordings of Lachman, ADT and PST**

| **Arthroscopic decision** |
|---|

**Table 9.**

| | Positive | Negative | Total |
|---|---|---|---|
| **Lachman test** | | | |
| Positive | 52 (a) | 2 (b) | 54 (a+b) |
| Negative | 4 (c) | 21 (d) | 25 (c+d) |
| Total | 56 (a+c) | 23 (b+d) | 79 |
| **ADT** | | | |
| Positive | 35 (a) | 2 (b) | 37 (a+b) |
| Negative | 21 (c) | 21 (d) | 42 (c+d) |
| Total | 56 (a+c) | 23 (b+d) | 79 |
| **PST** | | | |
| Positive | 32 (a) | 1 (b) | 33 (a+b) |
| Negative | 24 (c) | 22 (d) | 46 (c+d) |
| Total | 56 (a+c) | 23 (b+d) | 79 |
| (a) True positive, (b) False positive, (c) False negative, (d) False positive | | | |

**Diagnostic Value of Lachman, ADT and PST**

| | **Sensitivity %** | **Specificity %** | **PPV %** | **NPV %** | **Accuracy** | **P-value** |
|---|---|---|---|---|---|---|
| Lachman test | 92.8 | 91 | 96.2 | 84 | 92.4 | 0.68 |
| ADT | 62.5 | 91.3 | 94.6 | 50 | 70.3 | 0 |
| PST | 57.1 | 95.6 | 88.8 | 47.8 | 68.3 | 0 |

The MRI evaluations revealed ACL ruptures in 56 patients, of which 51 were confirmed by arthroscopy. This resulted in a 91.1% sensitivity, 78.3% specificity, 91.1% positive and NPVs, and an accuracy of 87.3%. Therefore, clinical examinations exhibited slightly higher diagnostic accuracy than MRI (Table 10).

**Table 10. Comparative Analysis of Clinical Examination and MRI in Detecting ACL Rupture**

| | Clinical finding | MRI finding |
|---|---|---|
| Sensitivity % | 92.8 | 91.2 |
| Specificity % | 91 | 78.3 |
| PPV % | 96.2 | 91.1 |
| NPV % | 84 | 78.3 |
| Accuracy | 92.4 | 87.3 |
| P-value | 0.68 | 1 |

**Table 11. Recordings of MRI regarding MM, LM and ACL**

| **Arthroscopic decision** | | | |
|---|---|---|---|
| | Positive | Negative | Total |
| **Median meniscus injuries** | | | |
| Positive | 32 (a) | 3 (b) | 35 (a+b) |
| Negative | 6 (c) | 38 (d) | 44 (c+d) |
| Total | 38 (a+c) | 41 (b+d) | 79 |
| **LMs injuries** | | | |
| Positive | 15 (a) | 9 (b) | 16 (a+b) |

| | | | |
|---|---|---|---|
| Negative | 9 (c) | 54 (d) | 63 (c+d) |
| Total | 24 (a+c) | 55 (b+d) | 79 |
| **ACL injuries** | | | |
| Positive | 51 (a) | 5 (b) | 56 (a+b) |
| Negative | 5 (c) | 18 (d) | 23 (c+d) |
| Total | 56 (a+c) | 23 (b+d) | 79 |
| (a) True positive, (b) False positive, (c) False negative, (d) False positive | | | |

***Combined Injury***

In the present research, 56 instances of ACL injuries were found; of these, 16 cases additionally included a MMs damage, 9 cases had a LMs injury, 7 cases involved injuries to both menisci and 24 cases were isolated ACL injuries. ACL injuries were linked to 23 out of the 38 occurrences of MMs injury. ACL tears were linked to 16 of the 24 occurrences of LMs injuries. Medial and LM tears were seen in nine instances.

**Discussion**

This study assessed 79 patients for meniscal and ACL injuries through detailed patient histories, clinical examinations, MRI, and arthroscopy. Regarding sex distribution, 68 male and 11 female subjects were identified with knee injuries. It was observed that the right knee was more frequently affected (42 cases) than the left (37 cases), a finding that aligns with Clayton et al. on the epidemiology of musculoskeletal injuries (15).

***Meniscus***

The McMurray test, commonly employed to detect torn menisci, exhibited a sensitivity of 55.2% and specificity of 87.8% for MMs tears, and 54% sensitivity with 92% specificity for lateral tears. These findings are comparable to those reported by Karacholios et al., where sensitivity ranged from 48-65% and specificity from 86-94%. The Thessaly test at 20 degrees of knee flexion, utilized as a primary diagnostic tool for meniscal tears, demonstrated accuracies of 94% and 96% for medial and LM tears, respectively, in previous studies. However, in this analysis, the accuracy rates were 91% for medial and 89% for lateral tears (16).

***ACL***

Differentiating between total and partial ACL ruptures posed challenges in some studies. DeFranco et al. (17), and Colombet et al. (18), provided definitions for partial ACL tears, which were arthroscopically documented as ligaments with no loss of competence and the majority of ligament fibers intact, respectively. Based on these criteria, partial tears were not classified as complete ACL ruptures in this analysis.

***Anterior Drawrer test***

The ADT demonstrated a sensitivity of 62.5% and a specificity of 91.3%. Morita et al. identified three factors contributing to false-negative results in this test: hemarthrosis and reactive synovitis limiting knee flexion, protective hamstring contractions due to joint pain, and the posterior horn of the MMs impeding the tibia's anterior movement (19).

***Lachman Test***

The findings of this research demonstrate that the Lachman test has the highest diagnostic accuracy for detecting ACL damage, with a remarkable sensitivity of 92.8% and a good specificity of 91%. The knee position during this test, with a flexion of 20-30 degrees, is less unpleasant compared to the knee position during the ADT. This positioning helps minimize muscular contraction and prevents knee movement throughout the examination (20). Moreover, the diagnosis of an ACL injury may be challenging, particularly in cases of acute injuries accompanied by hemarthrosis. When a patient is assessed without general anesthesia for acute ruptures, the Lachman test's diagnostic accuracy is higher than the ADT's (21).

***PST***

The results of the PST indicated high specificity (95.6%) but relatively low sensitivity (57.1%). Indicative of ACL damage, this test assesses the tibia's combined anterior translation and tibiofemoral internal rotation (22). These findings align closely with those reported by Scholten et al., wherein the PST demonstrated high specificity (98%) but notably lower sensitivity (24%). Conversely, the Lachman test emerged as the most sensitive method for diagnosing ACL tears, with sensitivity and specificity rates of 85% and 94%, respectively (23).

***Comparing clinical finding with MRI finding***

The findings of an arthroscopic examination corroborated research by Kocabey et al. that found no notable significant differences between the detection of ligament and meniscal injuries by MRI and physical examination. Competent orthopedic surgeons may efficiently identify meniscal and ACL problems by relying on clinical exams (24).

Furthermore, a study by Sanjay et al. supported the use of MRI as a complementary tool alongside clinical examinations for identifying meniscus and ligament injuries. The sensitivity and specificity values for MRI in diagnosing ACL, MMs, and LMs injuries were 96% 82%, 94% 91%, 93%, and 96%, respectively, when compared to arthroscopic findings (12).

The current research assessed and compared both clinical evaluation and MRI with arthroscopy. The findings are expected to be similar to those of earlier investigations. The diagnostic precision of physical tests in detecting MM injuries was 91%, but MRI accuracy was somewhat lower at 89%. For LM injuries, physical examination accuracy was 89%, and MRI accuracy was 87%. For ACL injuries, physical examination accuracy was slightly higher at 92% compared to 87% for MRI.

Notably, physical examinations demonstrated comparable, if not superior, accuracy to MRI for diagnosing meniscal injuries. However, this was not uniformly the case, as illustrated by Yan et al., who reported higher accuracy, sensitivity, and NPV s for MRI compared to clinical examinations in diagnosing meniscal injuries. Specifically, the accuracy, sensitivity, and NPV s for MRI versus clinical examination were 83.33% versus 69.44%, 92.50% versus 75%, and 88.46% versus 66.66% for the MMs; and 81.94% versus 79.16%, 65% versus 47.82%, and 86.79% versus 79.31% for the LMs (25).

A strength of this study was the utilization of multiple clinical maneuvers to assess both menisci and ACL injuries. The interval between MRI scans and surgical procedures did not exceed 12 weeks. All MRIs were interpreted by radiology specialists with expertise in knee imaging. However, a limitation was the performance of MRIs in four different imaging centers in Erbil City, which might have influenced the consistency of film quality and data dispersion.

**Conclusions**

1. The Thessaly test performed at a knee flexion angle of 20 degrees is the most precise clinical examination for identifying meniscal tears, followed by JLT.

2. The Lachman test is highly regarded for its diagnostic accuracy in terms of sensitivity and specificity for ACL injuries.

3. The PST, with its high specificity, is recommended for suspected cases of ACL tear.

4. A negative Lachman test almost rules out an ACL rupture, while a positive PST strongly confirms an ACL rupture.

5. Clinical examinations performed by well-qualified orthopedic surgeons show superior diagnostic accuracy compared to MRI for ACL injuries, indicating its utility in guiding decisions for arthroscopy.

6. Clinical examinations are as effective as MRI in diagnosing meniscal injuries, with MRI serving as a supplementary diagnostic tool.

7. For inconclusive clinical findings, MRI aids significantly in the decision-making process for arthroscopy.

8. Both clinical and MRI diagnostics demonstrate high accuracy and reliability in the diagnosis of ACL and meniscal tears.

**Recommendations**

1. Clinical examinations should remain the cornerstone for diagnosing meniscal and ACL injuries.

2. MRI is valuable for resolving inconclusive clinical findings and assessing complex knee injuries.

**Acknowledgments:** We extend our sincere gratitude to all participants and contributors for their invaluable involvement in this study.

**Conflict of interest:** No conflict of interest is declared by the authors concerning the publication of this paper.

**Data availability:** Upon a reasonable request, the corresponding author will provide the study's data.

**Consent for publications:** The authors have reviewed and approved the final version of the manuscript for publication.

**Authors' contributions:** The authors have equally contributed to this study.

**Funding:** Not applicable

**REFERENCES**

1. Orlando Júnior N, de Souza Leão MG, de Oliveira NH. Diagnosis of knee injuries: comparison of the physical examination and magnetic resonance imaging with the findings from arthroscopy. Rev Bras Ortop. 2015;50(6):712-9. https://doi.org/10.1016/j.rboe.2015.10.007
2. Chien A, Weaver JS, Kinne E, Omar I. Magnetic resonance imaging of the knee. Pol J Radiol. 2020;85:e509-e31. https://doi.org/10.5114/pjr.2020.99415
3. Lecouvet F, Van Haver T, Acid S, Perlepe V, Kirchgesner T, Vande Berg B, et al. Magnetic resonance imaging (MRI) of the knee: Identification of difficult-to-diagnose meniscal lesions. Diagn Interv Imaging. 2018;99(2):55-64. https://doi.org/10.1016/j.diii.2017.12.005
4. Zhao M, Zhou Y, Chang J, Hu J, Liu H, Wang S, et al. The accuracy of MRI in the diagnosis of anterior cruciate ligament injury. Ann Transl Med. 2020;8(24):1657. https://doi.org/10.21037/atm-20-7391
5. Luvsannyam E, Jain MS, Leitao AR, Maikawa N, Leitao AE. Meniscus Tear: Pathology, Incidence, and Management. Cureus. 2022;14(5):e25121. https://doi.org/10.7759/cureus.25121
6. Venkataraman S, Ethiraj P, Shanthappa AH, Vellingiri K. Association of Meniscus Injuries in Patients With Anterior Cruciate Ligament Injuries. Cureus. 2022;14(6):e25878. https://doi.org/10.7759/cureus.25878
7. Cancino B, Muñoz C, Tuca MJ, Birrer EAM, Sepúlveda MF. Anterior Cruciate Ligament Rupture in Skeletally Immature Patients. J Am Acad Orthop Surg Glob Res Rev. 2022;6(5):1. https://doi.org/10.5435/JAAOSGlobal-D-21-00166
8. Beaulieu ML, Ashton-Miller JA, Wojtys EM. Loading mechanisms of the anterior cruciate ligament. Sports Biomech. 2023;22(1):1-29. https://doi.org/10.1080/14763141.2021.1916578
9. Lundblad M, Hägglund M, Thomeé C, Hamrin Senorski E, Ekstrand J, Karlsson J, et al. Epidemiological Data on LCL and PCL Injuries Over 17 Seasons in Men's Professional Soccer: The UEFA Elite Club Injury Study. Open Access J Sports Med. 2020;11:105-12. https://doi.org/10.2147/oajsm.S237997
10. Shekarchi B, Panahi A, Raeissadat SA, Maleki N, Nayebabbas S, Farhadi P. Comparison of Thessaly Test with Joint Line Tenderness and McMurray Test in the Diagnosis of Meniscal Tears. Malays Orthop J. 2020;14(2):94-100. https://doi.org/10.5704/moj.2007.018
11. Prickett WD, Ward SI, Matava MJ. Magnetic resonance imaging of the knee. Sports Med. 2001;31(14):997-1019. https://doi.org/10.2165/00007256-200131140-00004
12. Sanjay N, Shanthappa AH, Kurahatti A, Kumaar A. Comparison of Clinical, Magnetic Resonance Imaging (MRI) and Arthroscopic Findings in Assessment of Cartilage Defects and Internal Derangement of Knee. Cureus. 2023;15(6):e40110. https://doi.org/10.7759/cureus.40110
13. Shantanu K, Singh S, Srivastava S, Saroj AK. The Validation of Clinical Examination and MRI as a Diagnostic Tool for Cruciate Ligaments and Meniscus Injuries of the Knee Against Diagnostic Arthroscopy. Cureus.

2021;13(6):e15727. https://doi.org/10.7759/cureus.15727

14. Bin Abd Razak HR, Sayampanathan AA, Koh T-HB, Tan H-CA. Diagnosis of ligamentous and meniscal pathologies in patients with anterior cruciate ligament injury: comparison of magnetic resonance imaging and arthroscopic findings. Annals of Translational Medicine. 2015;3(17):243.
15. Clayton RA, Court-Brown CM. The epidemiology of musculoskeletal tendinous and ligamentous injuries. Injury. 2008;39(12):1338-44. https://doi.org/10.1016/j.injury.2008.06.021
16. Karachalios T, Hantes M, Zibis AH, Zachos V, Karantanas AH, Malizos KN. Diagnostic accuracy of a new clinical test (the Thessaly test) for early detection of meniscal tears. J Bone Joint Surg Am. 2005;87(5):955-62. https://doi.org/10.2106/jbjs.D.02338
17. DeFranco MDM, Bach B. A Comprehensive Review of Partial Anterior Cruciate Ligament Tears. The Journal of bone and joint surgery American volume. 2009;91:198-208. https://doi.org/10.2106/JBJS.H.00819
18. Colombet P, Dejour D, Panisset JC, Siebold R. Current concept of partial anterior cruciate ligament ruptures. Orthop Traumatol Surg Res. 2010;96(8 Suppl):S109-18. https://doi.org/10.1016/j.otsr.2010.09.003
19. Morita Y, Tajima T, Yamaguchi N, Yokoe T, Nagasawa M, Ota T, et al. Risk factors of failure results after double-bundle reconstruction with autogenous hamstring grafts for isolated posterior cruciate ligament rupture cases. Sci Rep. 2024;14(1):6192. https://doi.org/10.1038/s41598-024-56953-y
20. Benjaminse A, Gokeler A, van der Schans CP. Clinical diagnosis of an anterior cruciate ligament rupture: a meta-analysis. J Orthop Sports Phys Ther. 2006;36(5):267-88. https://doi.org/10.2519/jospt.2006.2011
21. Gul A, Khan Z. The Role of MRI Scan in Sports-Related Anterior Cruciate Ligament Injuries: A Case Report-Based Literature Review. Cureus. 2024;16(3):e55941. https://doi.org/10.7759/cureus.55941
22. Vaudreuil NJ, Rothrauff BB, de Sa D, Musahl V. The Pivot Shift: Current Experimental Methodology and Clinical Utility for Anterior Cruciate Ligament Rupture and Associated Injury. Curr Rev Musculoskelet Med. 2019;12(1):41-9. https://doi.org/10.1007/s12178-019-09529-7
23. Scholten RJ, Opstelten W, van der Plas CG, Bijl D, Deville WL, Bouter LM. Accuracy of physical diagnostic tests for assessing ruptures of the anterior cruciate ligament: a meta-analysis. J Fam Pract. 2003;52(9):689-94.
24. Kocabey Y, Tetik O, Isbell WM, Atay OA, Johnson DL. The value of clinical examination versus magnetic resonance imaging in the diagnosis of meniscal tears and anterior cruciate ligament rupture. Arthroscopy. 2004;20(7):696-700. https://doi.org/10.1016/j.arthro.2004.06.008
25. Yan R, Wang H, Yang Z, Ji ZH, Guo YM. Predicted probability of meniscus tears: comparing history and physical examination with MRI. Swiss Med Wkly. 2011;141:w13314. https://doi.org/10.4414/smw.2011.13314