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History, clinical findings, magnetic resonance imaging, and arthroscopic correlation in meniscal lesions

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Abstract
Purpose The aim of this prospective study was to compare the accuracy of clinical examination and magnetic resonance imaging (MRI) versus arthroscopic findings and to determine the value of an experienced examiner in clinical decision making.
Methods A total of 30 patients with a preoperative MRI underwent arthroscopy over a 5-month period. All patients had a clinical examination performed by an experienced knee surgeon, a specialist in general orthopedics, a senior resident, and a fourth-year resident. These examiners recorded and evaluated the results of seven tests: the medial and lateral joint line tenderness test, the McMurray test, the Apley test, the Stienmann I test, the Payr's test, Childress' sign, and the Ege's test. The injury was classified as a meniscal tear if there were two positive tests. Clinical history, physical examination, and MRI findings were compared with the arthroscopic findings. The accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of these methods of evaluation were then calculated.
Results Clinical examination performed by an experienced knee surgeon had better specificity (90% vs. 60%), positive predictive value (95% vs. 83%), negative predictive value (90% vs. 86%), and diagnostic accuracy (93% vs. 83%) than MRI for medial meniscal tears. These parameters showed only a marginal difference in lateral meniscal tears. The experienced knee surgeon had better sensitivity, specificity, predictive values, and diagnostic accuracy parameters for medial meniscus tears in comparison with the other three examiners.
Conclusion These results indicate that clinical examination by an experienced examiner using multiple meniscus tests is sufficient for a diagnosis of a meniscal tear.
Level of evidence II.

Keywords Knee · Meniscus tears · MR imaging · Arthroscopy · Clinical examination

Introduction

Magnetic resonance imaging (MRI) is commonly used to diagnose meniscal pathology. Some studies have found that MRI is not superior to physical examination in the diagnosis of meniscal tears [7, 14, 17], whereas others have demonstrated its value as an accurate and noninvasive diagnostic tool [8, 11].

Although the diagnostic accuracy of history taking and physical examination is often questioned by physicians, Boden et al. [3] demonstrated that when a clinical examination supports the diagnosis of meniscus damage, MRI will not change treatment decisions. Ruwe et al. [18] reported that preoperative MRI can prevent unnecessary

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arthroscopy in 50% of the patients and is of great value in the preoperative period. In contrast, Bridgman et al. [6] reported that MRI did not reduce arthroscopy rates. Although arthroscopy is a highly sensitive and specific procedure with both diagnostic and therapeutic implications, it is an invasive procedure and potential complications must be weighed against its benefits.

Although the diagnostic importance of a physical examination by an experienced clinician has been described in many studies [16, 20], it has not been investigated in depth. The aim of this study was to correlate the history, clinical examination, MRI, and arthroscopic findings in the diagnosis of meniscal tears and to determine the reliability and value of an experienced knee surgeon in clinical decision making.

Materials and methods

In a prospective study, 270 patients with symptoms relating to the knee joint were admitted to our clinic. All adults with a knee injury and an initial diagnosis of a meniscal tear made on the basis of history were included in this study. All patients with pain over the joint line during weight-bearing and/or mechanical symptoms (a history of locking episodes or complain of "pop" or "clunk" sensation) were included. Only patients who had an injury (regardless of severity) within the 12 months prior to clinic review were included. Patients with degenerative changes, evidence of loose bodies in plain radiographs, or prior knee arthroscopy were excluded, as were patients treated non-operatively.

A total of 30 patients, 18 men and 12 women, met these inclusion criteria. All 30 patients underwent both MRI and arthroscopy. The median age was 38 years (range: 19–63 years). Of the meniscal tears treated, 17 were left knees and 13 were right knees. At the time of arthroscopy, 18 medial meniscus tears, 4 lateral meniscus tears, and 2 bilateral menisci tears were documented.

All patients had a clinical examination performed by an experienced knee surgeon, a specialist in general orthopedics, a senior resident, and a fourth-year resident. These examiners recorded and evaluated the results of seven tests: the medial and lateral joint line tenderness test, the McMurray test, the Apley test, the Stienmann I test, the Payr's test, Childress' sign (Squat test), and the Ege's test (Table 1). The injury was classified as a meniscal tear if there were two positive tests.

After clinical examination, plain radiographs (AP and lateral) and MRI were performed. All MRI studies were performed by using a standard knee protocol. An experienced radiology consultant reported on all the MRI scans. A meniscal tear was diagnosed if there was a linear intrameniscal signal extending to either the superior or inferior surface of the meniscus. All arthroscopies were performed by same surgeons in our clinic. Records of the clinical examinations, MRIs, and arthroscopic findings were kept and compared. Arthroscopic findings were regarded as the standard for diagnosis of a meniscal tear.

Statistical analysis

Statistical analysis was used to calculate sensitivity, specificity, PPV, NPV, and overall accuracy of the clinical diagnosis and MRIs. The accuracy is the percentage of patients in whom the clinical examination or the MRI is correct (both true positive and true negatives). The sensitivity measures the proportion of actual positives that are correctly identified, whereas the specificity measures the proportion of negatives that are correctly identified. The PPV is the proportion of patients with positive test results who are correctly diagnosed. The NPV is the proportion of patients with negative test results who are correctly diagnosed.

Results

The results demonstrated that the specificity, PPV, and NPV of the clinical examination for experienced knee surgeon and specialist in general orthopedics in medial meniscus tears are considerably higher than the same parameters for MRI results. The accuracy of the clinical examination in detecting medial meniscus injuries was >93% for experienced knee surgeons and 83, 77, and 73% for specialists in general orthopedics, senior residents, and fourth-year residents, respectively. Also, the specificity, sensitivity, positive predictive values, and negative predictive values were found to be higher for the knee surgeon in comparison with other examiners. Our results are listed in Tables 2 and 3.

Discussion

The most important finding of the present study was that the accuracy of the clinical examination performed by an experienced surgeon was higher than either MRI findings or the clinical examination findings of other examiners. The differential diagnosis of knee pain is extensive but can be narrowed with a detailed history. A thorough subjective history can help the examiner to choose the appropriate clinical tests. Surgeons decide whether to proceed with further laboratory tests based on the history and clinical examination. Regardless of the cost, the number of MRIs performed increases annually. Chang et al. [8] studied findings of 148 patients and demonstrated 92% sensitivity

Table 1 Clinical tests used to detect meniscal lesions

1. Joint line tenderness: The patient lies supine on the bed while bending the knee and hip. The examiner grasps around the knee with one hand while pressing on the joint line with his thumb. In a positive test, the patient will feel pain along the joint line [10]
2. McMurray test: The patient lies supine on the bed while bending the knee and hip. Keeping the heel close to the hip as much as possible, the examiner holds the knee joint with one hand by placing his index finger and thumbs along the joint line and then uses the other hand to hold and twist the foot in external rotation or internal rotation and stretch the knee. The patient will feel pain and hear a noise from the knee joint held by the examiner if the test is positive [19]
3. Apley test: The patient is in the prone position, the hip is extended, and the knee flexed 90°. The examiner applies axial pressure onto the foot and rotates the tibia. The resulting knee joint pain is regarded as a positive test [19]
4. Stienmann I test: The patient is supine. The examiner immobilizes the patient's flexed knee with the left hand and grasps the lower leg with the other hand. The examiner then forcefully rotates the lower leg in various degrees of knee flexion. Pain in the medial joint cavity in forced external rotation suggests damage to the medial meniscus; pain in the lateral joint cavity in internal rotation suggests damage to the lateral meniscus [16]
5. Payr's test: Knees are flexed beyond 90° and legs crossed. Downward force on the knee leads to pain in the medial knee compartment because of compression (Fig. 1). A positive test is associated with a lesion of the medial posterior horn [16]
6. Childress' sign (Squat test): The patient squats and walks like a duck (Fig. 2). With a positive test, the patient will feel pain and cannot squat all the way down and will feel a snap or click from the knee joint [4]
7. Ege's Test: The test is performed with the patient in a standing position. The knees are in extension and the feet are held 30–40 cm away from each other at the beginning of the test. To detect a medial meniscal tear, the patient squats with both lower legs in maximum external rotation and then stands up slowly. For lateral meniscal tears, both lower extremities are held in maximum internal rotation while the patient squats and stands up (Fig. 3). The test is positive when pain and/or a click are felt by the patient (sometimes audible to the physician) at the related site of the joint line [1]

Fig. 1 Illustration of Payr's test: Downward force on the knee leads to pain in the medial knee compartment because of compression in posterior medial meniscus lesions

Fig. 2 Illustration of Childress' sign (Squat test): Patients with meniscal lesions will usually be unable to assume the squatting position

and 87% specificity for meniscal tears. The group concluded that MRI is a reliable diagnostic tool for displaced meniscal tears. Crotty et al. [9] proposed MRI as a screening tool prior to arthroscopy because of its high sensitivity. Brooks et al. [7] demonstrated a 79% agreement between clinical diagnosis and arthroscopic findings but a 77% agreement between MRI and arthroscopic findings. Their negative arthroscopy rate was 4%, and this was not reduced by MRI scanning before arthroscopy. Lundberg et al. [13] found a sensitivity and specificity of 74 and 66%, respectively, for medial meniscus tears and 50 and 84%, respectively, for lateral meniscus tears. They found that MRI could not replace arthroscopy in diagnosis of acute knee injuries. Alioto et al. [2] determined that MRI beneficially altered the treatment plan in only 18% of their patients. They recommended an MRI scan only when the diagnosis was unclear.

Although MRI and arthroscopy have become increasingly important in the treatment for meniscal disorders, a carefully performed physical examination and a detailed history taking remains essential to proper diagnosis. History alone is insufficient as a diagnostic tool [4, 12, 14]. Miller [14] found the overall clinical diagnosis accuracy of

Fig. 3 Illustration of Ege's test: Lower extremities are held in maximum external rotation. The patient then squats in this position to detect a medial meniscal tear (**a**, **b**). Lower extremities are held in maximum internal rotation. The patient then squats in this position to detect a lateral meniscal tear (**c**, **d**)

Table 2 Diagnostic values of MRI

Sensitivity (%)		Specificity (%)		PPV (%)		NPV (%)		Accuracy (%)	
Medial meniscus tears	Lateral meniscus tears	Medial meniscus tears	Lateral meniscus tears	Medial meniscus tears	Lateral meniscus tears	Medial meniscus tears	Lateral meniscus tears	Medial meniscus tears	Lateral meniscus tears
95	67	60	88	83	57	86	91	83	83

Sensitivity, specificity, positive predictive value (PPV), Negative predictive value (NPV), and accuracy for medial meniscus tears and lateral meniscus tears

meniscal tears to be 80%, and the corresponding accuracy for MRI was 73%. Rose and Gold [17] found the clinical examination to be correct more often than the MRI diagnosis. Our study shows that the accuracy, specificity, and the PPV are significantly higher for a clinical examination performed by an experienced surgeon for medial meniscus tears.

Depending on the results of the history and clinical examination, the surgeon decides whether an MRI examination is necessary or whether the patient can be admitted for surgery solely relying on the clinical examination. Various examiners do not have the same level of experience, leading to variable accuracy. Bohnsack et al. [5] concluded that an experienced examiner can diagnose adequately by clinical examination alone. A clinical examination performed by an experienced surgeon was 93% accurate for diagnosing medial meniscal tears and 80% accurate for diagnosing lateral meniscal tears. This

Table 3 Diagnostic values of clinical examination

	Sensitivity (%)		Specificity (%)		PPV (%)		NPV (%)		Accuracy (%)	
	Medial meniscus tears	Lateral meniscus tears	Medial meniscus tears	Lateral meniscus tears	Medial meniscus tears	Lateral meniscus tears	Medial meniscus tears	Lateral meniscus tears	Medial meniscus tears	Lateral meniscus tears
Experienced knee surgeon	95	33	90	92	95	50	90	85	93	80
Specialist in general orthopedics	95	60	70	92	86	60	88	92	83	83
Senior resident	85	50	60	92	81	60	67	88	77	83
Fourth-year resident	84	50	60	88	80	50	67	88	73	80

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy for medial meniscus tears and lateral meniscus tears

corresponded to an MRI accuracy of 83% for both medial and lateral meniscal tears. For the least experienced examiner in our study (a fourth-year resident), the clinical examination was 73% accurate for diagnosing medial meniscal tears and 80% accurate for diagnosing lateral meniscal tears. These results indicate that a clinical examination performed by an experienced surgeon is more valuable than an MRI scan in diagnosing meniscal injury.

Eren [10] reported on the accuracy of joint line tenderness in meniscal tears in 104 knees, demonstrated 74% accuracy for medial meniscal tears and 96% accuracy for lateral meniscal tears. Mohen et al. [15] reported on the accuracy of the clinical examination using joint line tenderness and the McMurray test in 130 patients, with 88% diagnostic accuracy for medial meniscus tears and 92% diagnostic accuracy for lateral meniscus tears. Our study demonstrated improved diagnostic accuracy by using seven tests in the clinical examination for medial meniscal tear evaluation, but this did not improve the lateral meniscus diagnostic accuracy.

We recognize the limitations of this study in terms of the small numbers but believe that the group studied is representative of the population normally attending orthopedic clinics.

Conclusion

These results highlight the importance of history and clinical examination in the diagnosis of meniscal lesions of the knee. The strength of correlation between MRI and arthroscopic findings indicates the value of MRI in the diagnostic evaluation. Using MRI as a routine diagnostic supplement to the clinical examination is unnecessary. A thorough clinical assessment can provide sufficient information for the surgeon to make a definitive primary preoperative diagnosis.

Conflict of interest The authors declare that they have no conflict of interest.

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