

# Validity of squatting test versus magnetic resonance and arthroscopy for meniscus injuries of the knee

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## ABSTRACT

**Aims:** Squatting clinical tests used for the detection of meniscal tears in the knee do not present acceptable diagnostic validity values. Diagnostic accuracy is improved by arthroscopic evaluation or magnetic resonance imaging studies. The objective of this study was to evaluate the validity of squatting clinical examination test for detection of meniscal tears. **Methods:** This case series study was conducted in Aljumhoori teaching hospital, Mosul city, Iraq during the period from January 2010 through December 2011, the study sample consisted of a series of 159 patients (127 males and 32 females), age between 15–56 years. Sensitivity of squatting test (as a screening test) was measured versus MRI and knee arthroscopy (as the gold standards). **Results:** The results revealed that the sensitivity of the squatting test versus MRI scan was 87% and 55% respectively for the medial meniscus, and (57% and 90%) for the lateral meniscus. The

positive and negative predictive values for the medial and lateral menisci were (78%, 63%, and 55%, 90%) respectively with an accuracy of 74% for the medial and 84% for the lateral meniscus. Using arthroscopy as a gold standard gave a sensitivity of 84% and specificity of 54% for the medial meniscus with a positive and negative predictive value of the screening test of 76% and 66% respectively, while the lateral meniscus showed a sensitivity and specificity of 63% and 87%, and positive and negative predictive values of 41% and 94% respectively. The accuracy was 63% for the medial and 85% for the lateral meniscus. **Conclusion:** squatting test is helpful (but not sufficient) in diagnosing meniscus injure, while MRI and knee arthroscopy increase the validity of the test and are necessary for confirming the diagnosis.

**Keywords:** Arthroscopy, Iraq, Knee joint, Meniscus injure, Squatting test

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## INTRODUCTION

The menisci increase the stability of the knee. It is usually torn by a rotational force on partially flexed knee with the meniscus being trapped between femur and tibia in the flexed knee position and getting torn as the knee is extended. Although history is very important is diagnosing menisci, still it is not always enough, that is why many tests are used to confirm the diagnosis like: Mc Murrays test, Apley's test, Ege's test, Thessaly's test and joint line tenderness [1, 2]. The introduction of MRI scan led to a revolutionary change in medical diagnosis. Magnetic resonance imaging scan is non-invasive, gives much better soft tissue contrast and has shorter imaging time with reduced artifacts [3, 4]. It has been suggested that routine MRI scan before therapeutic arthroscopy for clinically diagnosed meniscus tears reduces the number and cost of unnecessary invasive procedure [5–7]. The objective of this study was to determine the accuracy of the preoperative diagnosis via comparing the clinical diagnosis with MRI scan and arthroscopic findings.

## MATERIALS AND METHODS

This study was conducted in Aljumhoori Teaching Hospital (the main hospital in Mosul city) during the period from January 1, 2010 through December 2011. The study sample included all the patients that were admitted to the orthopedic ward during the two year study period, and who fulfilled the inclusion criteria, those were 159 patients (127 males, 32 females), age between 15–56 years. A team of three orthopedic specialist surgeons did conduct this study starting from diagnosing the patients, (by taking full history and doing medical examination) to performing MRI scan and arthroscopy. The examination was usually started with inspection, palpation, and movement, then dynamic squatting test was done (for all patients) to confirm the presence of pain by asking the patient to duck walk, that is to walk in a deep squat, as the patient lifts the uninvolved limb to step forward, all the body weight momentarily compresses the symptomatic knee (Figures 1 and 2). If a meniscus tear is present, this maneuver usually causes pain localized to the joint line of the involved meniscus, making the movement extremely difficult [8]. The observed agreement in the clinical diagnosis between the three orthopedic surgeons was 100%.

A verbal consent was taken from each patient after explaining to them the objective of the study and giving them the complete unconditioned choice to participate (or not) in the trial without any reward or penalty. The research was approved by the Ethical Committee of the College of Medicine, University of Mosul.

## Inclusion criteria

Patients age between 15 and 56 years who had experienced symptoms that included pain, swelling, instability, and/or locking of the knee for at least four weeks to make sure that the injury is not a simple trivial one and to increase the yield of positivity.

## Exclusion criteria

Locked knee at presentation, previous knee surgery, presence of a radiographically confirmed fracture, severe osteoarthritis of the knee. Severe osteoarthritis was diagnosed by clinical examination and X-ray as this proved a high sensitivity in our practice. Patients with lesions in arthroscopies like chondral lesions, ACL tears, or both meniscus tears were also excluded.

X-ray was done as a part of evaluation of the knee to exclude any fracture or osteoarthritic changes, but was not included in the analysis.

The MRI machine (Philips 1.5 tesla Achieva) proton sequence (PDW) in sagittal section, its data TE 60, TR 4800 ms, matrix 240x168 slice thickness 3 mm, other



Figure 1: Patient both limbs ready to start step forward



Figure 2: Patient lifts the uninvolved limb to step forward, all the body weight momentarily compresses the symptomatic knee.

section coronal T2-weighted sequence its data TR 5668, TE 160, matrix 240x168 (Figure 3).

All arthroscopic procedures were performed under general or spinal anesthesia by one of the three orthopedic surgeons. The decision of using general or otherwise spinal anesthesia is related to the anesthesiologist depending on the availability of the materials and experience. Operative findings were documented in the operation theatre (Figure 4). The waiting time for the MRI investigation from the point of definite clinical diagnosis was two to three weeks.

The composite data was tabulated on Microsoft Excel spread sheet. Correlation of clinical examination and MRI with arthroscopy from the pooled data was expressed as a percentage. Validity of squatting test was calculated as follows: sensitivity, specificity, positive predictive value (PV+), negative predictive value (PV-), positive likelihood ratio (LR+), and negative likelihood ratio (LR-) [9].

Chi-square test with yate's continuity correction was used for statistical analysis of associations between categorical variables. Continuous data were compared by using t-test, p-value <0.05 was considered significant.

## RESULTS

Table 1 describes the distribution of the study sample by age and gender, males form 80% versus 20% females, 41% of the cases are in the age group of 20–29 years. Table 2 gives the distribution of the cases by duration of symptoms and laterality of the injury; the duration of symptoms was less than 10 months in 70% of the cases that are distributed almost equally between the right and left knees (48% versus 52%).

The results revealed that the sensitivity and specificity of the squatting test versus MRI scan was 87% and 55% respectively for the medial meniscus, while it was 57% and 90% for the lateral meniscus. The positive and negative predictive values for the medial and lateral menisci were 78%, 63%, and 55%, 90% respectively with an accuracy of 74% for the medial meniscus and 84% for the lateral meniscus (Table 3).

In respect to the validity of squatting test using arthroscopy the results showed a sensitivity of 84% and specificity of 54% for the medial meniscus with a positive and negative predictive value of the screening test of 76% and 66% respectively, while the lateral meniscus showed a sensitivity and specificity of 63% and 87%, and positive and negative predictive values of 41% and 94% respectively. The accuracy proved to be 63% for the medial and 85% for the lateral meniscus as given in Table 4.

Using MRI scans screening test versus knee arthroscopy revealed a sensitivity and specificity of the medial meniscus of 89% and 75% while it was 89% and 92% respectively for the lateral meniscus. The positive and negative predictive values were 86% and 79% for the medial and 60%, 98% for the lateral meniscus respectively.

The accuracy was seen to be 84% and 92% for the medial and lateral menisci respectively. The positive likelihood ratio was 3.63, 11.31 compared to 0.14–0.11 of not having this injury, as demonstrated in Table 5.

## DISCUSSION

Although patients with meniscus injuries are usually reluctant to squatting test because of their fear of pain, still, it is considered to be of great importance for its



Figure 3: Magnetic resonance imaging sagittal view of the knee with an evidence of torn of the medial meniscus.

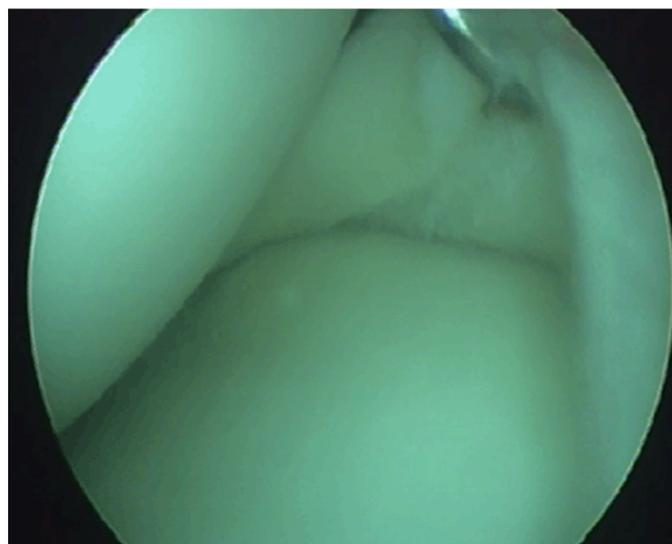


Figure 4: Arthroscopic findings with an evidence of tear of the medial meniscus.

practicality (quick and easily applied). Our results revealed that this physical examination is a very useful diagnostic tool with a relatively good sensitivity and specificity. It is proved by some studies to be reliable with a sensitivity of 91%, specificity (93%), and an accuracy of 92% for tears of the lateral meniscus (LM), and 98%, 65%, and 88% respectively for the medial meniscus (MM) [10]. Thessaly test demonstrated high sensitivity and specificity rates and a diagnostic accuracy of 94% for tears of the MM and 96% for tears of the LM. This makes it suitable to be used safely as a first-line screening test for the diagnosis of both medial and lateral meniscus tears [2, 11].

An MRI scan is considered by some as the gold standard for accurate, non-invasive evaluation of meniscus tears, but it is expensive, not always available, has inter-observer errors, and can only confirm the clinical diagnosis adding a little more information about the injury pattern. Negative clinical examination eliminates the need for MRI scan as a screening tool as it has a high degree of sensitivity and specificity [7].

Sensitivity reported in literature varies; generally, it is about 90% in MM injuries, and 75% in LM lesions. It can be said that MRI is currently not as important for the diagnosis of knee injuries as expected by both medical and lay communities [12].

The current study depicted that MRI scan had a very good sensitivity (89%) for both menisci, a high specificity, PV+, PV- and accuracy for both medial and lateral menisci. Magnetic resonance imaging was introduced to our unit early in 1990, but till the present, MRI machines are not sufficient to meet our needs, this leads to a very long waiting list of more than one month not speaking about

its high cost and the obstacles in reading the films because of shortage of expertise. With all these limitations; there is still, an urge to use this non-invasive, non-radiological technique to help reach a diagnosis prior to embarking upon arthroscopy as MRI scan helps a lot for determining the presence of menisci injuries.

There are several explanations for the misleading results of MRI regarding the menisci. First; meniscus tears and degenerative changes give the same appearance in MRI, second; one of the most frequent causes for false positive MRI scan for the lateral meniscus is the miss interpretation of the signal coming from the inferior knee artery, and third; MRI scan can be subjected to “observation bias”, that is why (and to dilute this problem, we have recruited two MRI specialists to diagnose the cases and included only cases that showed “observed agreement”. Often, the popliteal bursa or Humphrey’s ligament may mimic posterior lateral meniscus tears as well [13]. Magnetic resonance imaging scan should be used in connection with clinical findings and history to provide a more complete picture, especially in complex injuries, it is clear that the diagnostic performance results of MRI scan differ for the medial and lateral meniscus [14], this goes with our findings.

Although arthroscopy is a highly sensitive and specific (diagnostic and therapeutic) procedure, it is invasive, requires hospitalization and anesthesia with all its surgical complications, and the results vary according to the surgeons’ experience, an accurately performed clinical examination by an experienced examiner with positive signs alone will be justified for arthroscopy [7, 13]. When comparing the results of MRI with arthroscopic findings;

Table 1: Distributions of cases by age and gender

Age (years)	Males	%	Females	%
10----	25	16	5	3
20----	52	33	13	8
30----	34	21	7	4
40----	15	9	3	2
50----	1	1	4	3
Total	127	80	32	20

Table 2: Distributions of cases by duration of symptoms and laterality

Duration (months)	Males	%	Females	%	Total	%
<10	90	57	20	13	110	70
10---	22	14	10	6	32	20
20---	7	4	2	1	9	5
30---	8	5	0	0	8	5
Laterality						
Right	57	36	19	44	76	48
Left	71	12	12	8	83	52
Total	127	80	32	20	159	100

Table 3: Validity of squatting test versus MRI scan

	Medial Meniscus	Lateral Meniscus
Sensitivity	87	57
Specificity	55	90
Positive predictive value (P V+)	78	55
Negative predictive value (P V-)	63	90
Positive likelihood ratio (P L +)	1.88	5.71
Negative likelihood ratio (N L -)	0.29	0.48
Accuracy	74%	84%

Table 4: Validity of squatting test versus knee arthroscopy

	Medial Meniscus	Lateral Meniscus
Sensitivity	84	63
Specificity	54	87
Positive predictive value (P V+)	76	41
Negative predictive value (P V-)	66	94
Positive likelihood ratio (P L+)	1.85	5.16
Negative likelihood ratio (N L-)	0.29	0.42
Accuracy	63%	85%

Table 5: Validity of MRI scan using knee arthroscopy

	Medial Meniscus	Lateral Meniscus
Sensitivity	89	89
Specificity	75	92
Positive predictive value (P V+)	86	60
Negative predictive value (P V-)	79	98
Positive likelihood ratio (L R+)	3.63	11.31
Negative likelihood ratio (L R-)	0.14	0.11
Accuracy	84%	92%

it is obvious that the accuracy, specificity, sensitivity, and the positive and negative predictive values are higher than in the group of clinical examination versus arthroscopic results [15].

The study showed that clinical diagnosis is as accurate as MRI with 79% agreement between the preoperative diagnosis and arthroscopy compared to 77% agreement between MRI scan and arthroscopy. This study also shows no evidence that a MRI scan can reduce the number of negative arthroscopies. MRI scan of the knee represents a useful adjunct to, but not a substitute for, careful clinical diagnosis [16].

Arthroscopic surgery is a commonly performed method of investigating and treating internal derangements of the knee, its accuracy of diagnosis has been reported in previous studies to be 95% [17], provided

that an experienced operator performs the arthroscopy, it is considered to be the 'gold standard' investigative method, its high diagnostic accuracy allows it to be used as a benchmark when assessing the usefulness and sensitivity of other diagnostic methods, especially when preoperative diagnoses done at a consultant-led knee clinic, by highly expert consultants who are experienced in arthroscopic knee surgery as this will increase the reliability of the results obtained and may account for higher rates of accuracy which suggest that clinical diagnosis is a reliable and effective method of identifying intra-articular pathologies of the knee [17].

Clinical examination performed by an experienced knee surgeon had better specificity (90% versus 60%), positive predictive value (95% versus 83%), negative predictive value (90% versus 86%), and diagnostic

accuracy (93% versus 83%) than MRI for medial meniscal tears. These parameters showed only a marginal difference in lateral meniscal tears. The experienced knee surgeon has usually better sensitivity, specificity, predictive values, and diagnostic accuracy parameters for medial meniscus tears [18].

In the present study; arthroscopy has been done by highly experienced arthroscopic surgeons. Most of the patients had the arthroscopy within two weeks after MRI scan, with a specificity of 87%, PV 94%, and 85% accuracy for LM, while for MM injuries, the diagnosis looks to be hard as it appears with low percentage (54%, 66%, 63% for specificity, PV+, and accuracy respectively). We experienced some difficulties regarding the acceptability most probably attributed to its invasiveness, all the patients were subjected to general or spinal anesthesia, with no complications encountered. We assessed the validity of MRI scan with arthroscopy, the specificity 92%, PV- 98%, and accuracy 92% for LM, while it was lower for MM (75%, 79%, and 84% respectively).

## CONCLUSION

It can be concluded from this study that Squatting test is helpful in diagnosing meniscus injury, while MRI scan and knee arthroscopy increase the validity of the test.

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## Author Contributions

Husham A. Salih – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

Ali K. Mohialdeen – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Laith K. Omar – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Bara H. Abdulkareem – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Riyadh K. Lafta – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

## Guarantor

The corresponding author is the guarantor of submission.

## Conflict of Interest

Authors declare no conflict of interest.

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