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ORIGINAL ARTICLE

Joint Line Tenderness and McMurray Tests for the Detection of Meniscal Lesions: What Is Their Real Diagnostic Value?

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Abstract

Objectives: To assess the interobserver concordance of the joint line tenderness (JLT) and McMurray tests, and to determine their diagnostic efficiency for the detection of meniscal lesions.
Design: Prospective observational study.
Setting: Orthopedics outpatient clinic, university hospital.
Participants: Patients (N=60) with suspected nonacute meniscal lesions who underwent knee arthroscopy.
Interventions: Not applicable.
Main Outcome Measures: Patients were examined by 3 independent observers with graded levels of experience (>10y, 3y, and 4mo of practice). The interobserver concordance was assessed by Cohen-Fleiss κ statistics. Accuracy, negative and positive predictive values for prevalence 10% to 90%, positive (LR+) and negative (LR−) likelihood ratios, and the Bayesian posttest probability with a positive or negative result were also determined. The diagnostic value of the 2 tests combined was assessed by logistic regression. Arthroscopy was used as the reference test.
Results: No interobserver concordance was determined for the JLT. The McMurray test showed higher interobserver concordance, which improved when judgments by the less experienced examiner were discarded. The whole series studied by the "best" examiner (experienced orthopedist) provided the following values: (1) JLT: sensitivity, 62.9%; specificity, 50%; LR+, 1.26; LR−, .74; (2) McMurray: sensitivity, 34.3%; specificity, 86.4%; LR+, 2.52; LR−, .76. The combination of the 2 tests did not offer advantages over the McMurray alone.
Conclusions: The JLT alone is of little clinical usefulness. A negative McMurray test does not modify the pretest probability of a meniscal lesion, while a positive result has a fair predictive value. Hence, in a patient with a suspected meniscal lesion, a positive McMurray test indicates that arthroscopy should be performed. In case of a negative result, further examinations, including imaging, are needed.
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Knee pain is a common reason for patient referral to physiatric and orthopedic specialists. Persistent knee pain resistant to physical or pharmacologic treatment may be indicative of an overlooked meniscal lesion even in patients with negative imaging findings. Hence, obtaining a detailed medical history and performing a thorough physical examination are of the utmost importance to reach a correct diagnosis and define the appropriate treatment.

A wide variety of physical maneuvers are described for the detection of meniscal lesions; however, their diagnostic value has yet to be clearly established.[1] Even for the commonly used joint line tenderness (JLT) and McMurray tests, diagnostic efficiency is still a matter of debate.[2] Large prospective clinical studies have provided conflicting findings regarding the value of the JLT test. For instance, Fowler and Lubliner[3] reported a sensitivity of 85% but a specificity of only 29.4%. In contrast, Kurosaka et al[4] found that the JLT test was more specific (67%) than sensitive (55%). More recently, in a case series of 104 knees, the JLT test was accurate (96%), sensitive (89%), and specific (97%) in the presence of lateral meniscal tears, with lower values in the case of

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medial lesions.[5] Regarding the McMurray test, general agreement exists that this maneuver is more specific than sensitive.[6] However, a remarkable variability in both sensitivity (16%−58%)[7,8] and specificity (77%−98%) has been reported.[4,7] These discrepancies have mainly been attributed to methodological flaws of the studies.[9,10] Indeed, the reproducibility of the physical examination is rarely reported, and the interobserver concordance of the JLT and McMurray tests has yet to be evaluated. In addition, the examiner's experience is generally not adequately taken into account, although skillfulness is an important determinant of accuracy.[9,10]

The availability of reliable examination maneuvers for the identification of meniscal lesions would significantly reduce the rate of misdiagnosis as well as the need for expensive imaging examinations. To this aim, we performed a prospective study to assess the interobserver concordance of the JLT and McMurray tests, and the degree to which the results of the 2 tests are dependent on the examiner's experience. The study also sought to determine the diagnostic value of the 2 tests when applied by an experienced examiner, and the advantage, if any, of the combination of the 2 tests.

Methods

Participants and setting

Participants were enrolled among patients referred by their general practitioners to the outpatient clinic of the Department of Orthopaedics and Traumatology, University Hospital "Agostino Gemelli" (Rome, Italy) because of knee pain caused by a suspected traumatic meniscal lesion. Patients with acute lesions were excluded. Analyses were performed in 60 participants (mean age ± SD, 29.0±11.7y; 65% men) who underwent knee arthroscopy based on the indication of an orthopedic surgeon not involved in the study. All patients provided their informed consent to participate in the study. The study protocol was approved by the Catholic University's ethics committee.

Examination procedures

All patients were examined by 3 independent observers with graded levels of experience: observer A (orthopedic specialist with >10y of practice); observer B (third-year orthopedic resident); and observer C (a medical student rotating in the orthopedic ward with 4mo of experience). Observers A and B separately trained observer C to correctly perform the JLT and McMurray tests. Both tests were applied as described by Malanga et al.[6] Briefly, the JLT consists in the evocation of pain by the palpation of the anterior half of each meniscus with the knee in midflexion. The medial meniscus becomes more prominent with internal rotation of the tibia, whereas external rotation facilitates lateral meniscus palpation. The McMurray test is performed with the patient lying flat, the knee fully flexed, and the foot held by grasping the heel. Subsequently, the leg is rotated on the thigh with the knee in full flexion. During the extension of the knee, the posterior aspect of the meniscus is rotated together with the tibial epiphysis. In the presence of a meniscal tear, this movement can produce a snap perceivable at the joint line by the fingertip of the examiner. By externally rotating the leg, the medial meniscus is tested, whereas internal rotation is used to evaluate the lateral meniscus.

Examiners were required to apply the 2 tests in a random sequence, so that the second test would not be systematically influenced by the result of the first maneuver. For the randomization, the JLT was coded as "test 1" and the McMurray as "test 2." For each patient, diagnostic test concealment was performed using closed envelopes that were opened by the examiner only at the time of physical examination. Each observer examined the patient separately and recorded the results according to 1 of 5 possibilities: positive, probably positive, uncertain, probably negative, and negative. The performance of the 3 observers was assessed using a first cohort of 30 patients, and the most accurate examiner was selected for the evaluation of a second group of 30 patients.

> ***List of abbreviations:***
>
> **JLT** joint line tenderness
> **LR−** negative likelihood ratio
> **LR+** positive likelihood ratio
> **MRI** magnetic resonance imaging
> **ROC** receiver operating characteristic

Statistical analysis

Sample size was calculated based on judgments by the most efficient examiner (observer A), according to the method described by Armitage and Berry.[11] The equation was computed for a 1-sided alternative, based on the assumption that the study should be powered to detect a 25% difference, from 50% to 75%, in sensitivity or specificity between the 2 tests, being lower values of no clinical usefulness. It was therefore estimated that a sample of 45 patients would provide a power (1 − β) of .80 with an $\alpha = .05$. The sample size increased to 53 cases after applying the Fleiss continuity correction. Hence, our 2 groups of 30 patients each were sufficient for the planned analyses.

Proportions or means and SDs were calculated for all variables. The interobserver concordance on the JLT and McMurray tests was determined via Cohen-Fleiss κ statistics. The computation of receiver operating characteristic (ROC) curves was not possible because judgments were in most cases dichotomous (ie, positive/negative). Indeed, of 60 cases, only 5 were classified as "probably positive," 3 as "probably negative," and 1 as "uncertain." Therefore, it was decided to assess observer ability in terms of sensitivity and specificity, which required the aggregation of the "probably" results with the correspondent positive or negative judgments. The 1 case categorized as "uncertain" was excluded from the analysis. Accuracy, sensitivity, and specificity of the JLT and McMurray tests were determined using arthroscopy as the reference test.

For each clinical test, the following parameters were determined: sensitivity, specificity, and positive (LR+ = sensitivity/[1 − specificity]) and negative (LR− = [1 − sensitivity]/specificity) likelihood ratios. Accuracy was calculated for prevalence rates ranging from 10% to 90% according to the following formula:

$$\text{Accuracy} = \text{Prevalence} \times \text{Sensitivity} + (1 - \text{Prevalence}) \times \text{Specificity}$$

This equation requires values of diagnostic parameters to be input in unit fractions, instead of percentages.

The Bayesian "a posteriori" (posttest) probability of the lesion for "a priori" (pretest) probability varying from 10% to 90% was assessed according to the procedure described by Altman.[12]

Finally, the diagnostic value of the combination of the 2 tests was evaluated by logistic regression.

All tests, except for sample size calculation, were 2-sided, with significance set at $P<.05$.

Results

Characteristics of the study sample

Descriptive characteristics of the study sample are depicted in table 1. Analyses were performed in 56 patients. Four cases were excluded because of inconclusive arthroscopic findings (n=3) or judged as "uncertain" at the physical examination (n=1). At arthroscopy, meniscal tears were found in 35 patients, while in 21 cases no lesions were evident (lesion prevalence, 62.5%). Meniscal injuries were medial in 93% of cases and lateral in the remaining 7%.

Efficiency of the observers

Table 2 reports sensitivity and specificity values of the 2 tests calculated on the basis of judgments by the 3 observers in the first 30-patient group. With the JLT test, observers B and C showed higher sensitivity than observer A, but very low specificity. As a whole, judgments by observer A appeared more balanced than those by the other examiners. With the McMurray test, all 3 observers displayed higher specificity than sensitivity, with identical specificity values for observers A and B.

Figure 1A depicts the accuracy of the 3 observers with the JLT test for prevalence rates ranging from 10% to 90%. For a prevalence rate of <50%, which is commonly observed in general practice, examiner A performed better than B and C. The diagnostic performance of observers B and C improved for prevalence rates >50%, with B being more accurate than C.

Figure 1B shows the accuracy values for the McMurray test. The performance of observer A was far better than examiner C at any prevalence rate. The accuracy of observer B was similar to that of examiner A at low prevalence rates, but decreased markedly at high prevalence rates, although remaining higher than C. Taken as a whole, observer A was the most efficient examiner.

Concordance among observers

No interobserver concordance was detected for the JLT test either among all 3 observers ($\kappa=.11$) or between any pair of them. A better concordance was found with the McMurray test, although the result was not statistically significant ($\kappa=.205$, $z=1.55$, $P=.012$). The coefficient of concordance was higher for observations in patients with no lesions ($\kappa=.252$) than in those with meniscal tears ($\kappa=.126$). When judgments by the least experienced examiner (observer C) were excluded, the concordance between A and B improved ($\kappa=.365$), although remaining statistically nonsignificant.

Table 1 Descriptive characteristics of the cohort analyzed (n=56)

Characteristic	Value
Age (y)	29.7±11.6
Sex (men)	39 (70)
Symptom duration (d)	52±15
Affected knee (left)	24 (43)

NOTE. Values are mean ± SD or n (%).

Table 2 Sensitivity and specificity of the JLT and McMurray tests based on judgments by 3 independent examiners in a cohort of 30 patients

Test	Observer A	Observer B	Observer C
JLT			
Sensitivity	40	80	67
Specificity	60	20	20
McMurray			
Sensitivity	45	29	14
Specificity	80	80	70

NOTE. Values are percentages.

Diagnostic value of the JLT and McMurray tests

Table 3 reports prevalence-independent values of diagnostic efficiency of the 2 tests determined in the 56 cases judged by observer A. The McMurray test displayed lower sensitivity and higher specificity than the JLT. The LR+ of the McMurray was more than 2-fold higher than the JLT, indicating a better confirmatory value of the first test in the case of a suspected meniscal tear. In contrast, the LR− was not substantially different between the 2 tests.

Table 4 shows prevalence-dependent diagnostic parameters of the 2 tests. As a whole, the McMurray test displayed a higher diagnostic value than the JLT. Specifically, the accuracy of the

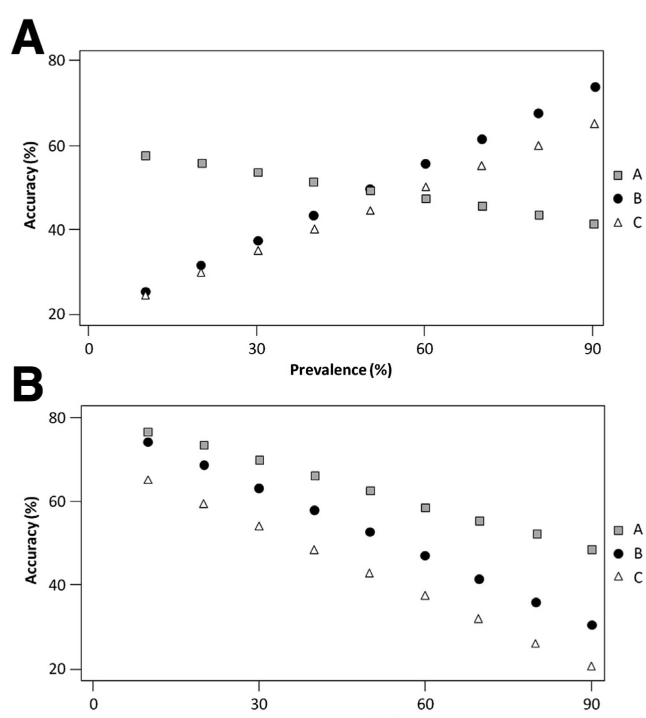

Fig 1 Accuracy of the 3 examiners at the JLT (A) and the McMurray (B) tests for prevalence rates from 10% to 90%.

Table 3 Values of diagnostic efficiency of the JLT and McMurray tests determined on the basis of judgments by observer A (56 patients)

Measure	JLT Value (95% CI)	McMurray Value (95% CI)
Sensitivity (%)	62.9 (44.9–78.5)	34.3 (19.1–52.2)
Specificity (%)	50 (28.2–71.8)	86.4 (65.3–97.2)
LR+	1.26	2.53
LR−	0.74	0.76

Abbreviation: CI, confidence interval.

McMurray test was far better at low prevalence, with a positive predictive value higher at any prevalence rate. Conversely, the negative predictive value was not substantially different between the 2 tests.

The most important results from a clinical perspective are depicted in figure 2. In both panels, the upper curve represents the Bayesian posttest probability of the presence of a lesion if the result of the test is positive, for different values of a priori probability. The lower curve indicates the posttest probability of a lesion if the result is negative. For the JLT, a positive test does not modify the probability of the presence of a lesion, whereas a negative result involves only a minor, nonsignificant reduction of the probability (see fig 2A). In contrast, for the McMurray, a positive result has a significant predictive value, mainly for a priori probabilities between 20% and 60% (see fig 2B). Similar to the JLT, a negative result does not significantly reduce the probability of a lesion.

Diagnostic value of the combination of JLT and McMurray tests

Cases with meniscal lesions at arthroscopy were classified as "category 1," whereas those with no meniscal tears were defined as "category 0." Positive physical tests were designated as "test 1," with "test 0" assigned to negative tests. The regression of arthroscopic categories toward physical tests yielded a model described by the following equation: Logit $= -.109 + .53$ JLT $+$ 1.198 McMurray, with a deviance of 71.98. According to the equation, 74.3% of "category 1" and 41% of "category 0" cases could be correctly classified by physical tests. However, correct classifications appeared to be dependent on the McMurray test only ($P=.096$), while the JLT test did not increase the probability of formulating a correct diagnosis ($P=.35$). According to the regression coefficient of the McMurray test, in the case of a positive result, the relative risk (in terms of odds ratio) of a true lesion was 3.31. In summary, the combined application of the 2 tests does not offer advantages over the McMurray alone.

Table 4 Diagnostic values of the JLT and McMurray tests as a function of disease prevalence

Test	Prevalence (%) 10	20	30	40	50	60	70	80	90
JLT									
Accuracy	51.3	52.6	53.8	55.1	56.4	57.7	58.9	60.2	61.5
PP	12.2	23.9	35.0	45.6	55.7	65.3	74.6	83.4	91.9
NP	92.4	84.3	75.8	66.8	57.3	47.2	36.6	25.1	13.0
McMurray									
Accuracy	81.1	79.9	70.7	65.5	60.3	55.1	49.9	44.7	39.5
PP	21.8	38.6	51.9	62.6	71.5	79.0	85.4	91.0	95.8
NP	92.2	84.0	75.4	66.3	56.8	46.7	36.0	24.7	12.7

Abbreviations: NP, negative predictive value; PP, positive predictive value.

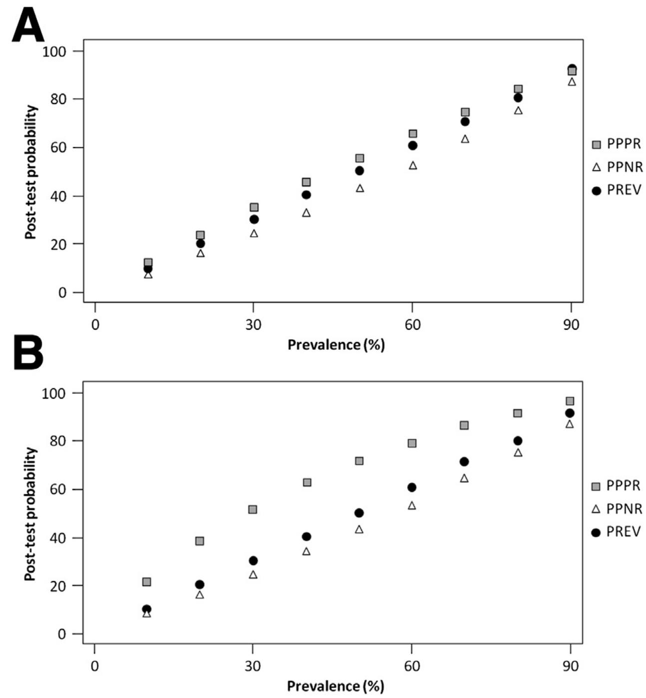

Fig 2 Values of diagnostic efficiency of the JLT (A) and the McMurray (B) tests as a function of disease prevalence on the basis of judgments by observer A. Abbreviations: PPNR, posttest probability with negative result; PPPR, posttest probability with positive result; PREV, prevalence.

Discussion

The aim of the present study was to determine the diagnostic value of 2 physical tests commonly used in clinical practice for the ascertainment of meniscal lesions: the JLT and the McMurray tests. Our results indicate that the JLT test has 2 significant flaws: (1) lack of interobserver concordance, with high reliance on the examiner's experience; and (2) very low specificity (20%–50%). The latter is consistent with previous studies reporting specificity rates ranging from 5% to 43% in case of medial meniscal tears,[13] with higher values in the presence of lateral lesions.[8,10,14] Noticeably, the JLT test specificity would have been higher if participants with no suspected meniscal lesion or no knee pathology at all had been included in our case series, as recommended by some authors.[9] However, the inclusion of such patients may not provide any clinically meaningful information about the diagnostic efficiency of the test. Indeed, the JLT test is virtually never applied to asymptomatic persons. Furthermore, in our case series, all patients with a positive JLT test had other knee pathologies at arthroscopy, such as cartilage lesions or ligament tears. Therefore, positivity of the JLT test was common to other diagnoses and was not pathognomonic for meniscal injuries, as previously highlighted by Malanga et al.[6]

Contrary to the JLT test, our results indicate that the McMurray test possesses good specificity (86.4%) and fair interobserver concordance. These findings are in agreement with previous reports[13,15] by other groups and are linked to the principle of the test (ie, perception of a snap). In fact, it is unlikely, even for an examiner who is not well trained, to provide a false-positive result—that is, to perceive a snap when there is none. The main shortcoming of the McMurray test is its low sensitivity, which was already highlighted in other reports.[1,16] Indeed, not all meniscal tears give rise to a snap; moreover, a faint snap may be difficult to perceive. In such cases, the correct application of the McMurray test is highly dependent on the examiner's ability and training. This is reflected by the fact that in our case series, sensitivity values ranked exactly the same as the observer's experience (ie, 14% for C, 29% for B, and 45% for A).

Although examination maneuvers have some limitations for the detection of meniscal tears, they should not be discarded in favor of imaging-assisted approaches. In fact, in a recent study,[17] the combination of the JLT and McMurray tests offered higher sensitivity (86% vs 76%), specificity (73% vs 52%), and diagnostic accuracy (79% vs 63%) than magnetic resonance imaging (MRI) in cases with medial meniscal lesions, with marginal differences in patients with lateral tears. Based on these findings, the authors concluded that MRI should be used to rule out meniscal injuries rather than routinely applied to identify them.[17] Hence, in the presence of suspected meniscal lesions with positive clinical tests, performing an MRI scan before arthroscopy may not provide any meaningful information, while resulting in treatment delay and higher costs. Along these lines, Kocabey et al[18] found no statistically significant differences in terms of accuracy, sensitivity, specificity, and positive and negative predictive values between clinical examination (combining the JLT, McMurray, Steinmann, and a modified Apley test) and MRI in patients with lateral or medial meniscal tears. These findings are in agreement with several other reports[19-21] on the subject and indicate that, when performed by an experienced examiner, clinical examination alone is at least as accurate as MRI in cases of suspected meniscal lesions. Thus, MRI should only be obtained in patients with persisting symptoms in the absence of a definite diagnosis.

In summary, in our case series, the diagnostic accuracy of clinical tests was comparable to that found in other reports in the literature. Moreover, our study was powered to detect clinically meaningful differences in specificity and sensitivity between the physical tests applied, which makes our results highly reliable. In addition, to our knowledge, our study is the first that reports interobserver concordance for the JLT and McMurray tests in the physical examination of patients with suspected meniscal lesions.

Study limitations

Since arthroscopy is currently considered the criterion standard technique for detecting meniscal lesions, the main limitation of the study resides in the need of performing an invasive procedure in participants. This prevented us from enrolling asymptomatic subjects with no knee pathology. Because of this limitation and the dichotomous nature of most judgments, ROC computation was not possible. In addition, we could not determine eventual differences in the diagnostic value of the 2 tests for lateral or medial meniscal tears. Indeed, in our case series, only 7% of patients had lateral lesions, which did not allow a meaningful comparison between injury sites. Finally, the arthroscopic prevalence of meniscal lesions in our cohort was higher than that reported in primary care,[22] since the patients were referred by general practitioners and an orthopedic specialist.

Conclusions

Our findings indicate that the JLT test alone is of little clinical usefulness. The McMurray test, although having limited sensitivity, displays good specificity and accuracy especially at low prevalence rates, with fair interobserver concordance. Thus, based on our results, the McMurray test may be considered a reliable examination maneuver for the clinical confirmation of a suspected meniscal lesion.

In summary, if the medical history is suggestive of meniscal injury, a positive McMurray test applied by an experienced examiner indicates that arthroscopy should be performed. In such circumstance, imaging procedures do not add any significant diagnostic insights. The combination of the JLT and McMurray tests does not appear to offer any diagnostic advantage over the McMurray alone.

Keywords

Arthroscopy; Diagnostic accuracy; Interobserver concordance; Knee; Menisci; Rehabilitation; Sensitivity; Specificity

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