

# A New Weight-Bearing Meniscal Test and a Comparison With McMurray's Test and Joint Line Tenderness

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**Purpose:** The purpose of this study was to describe a new weight-bearing McMurray's test (Ege's test) and to compare its diagnostic value with McMurray's test and joint line tenderness (JLT). We also aimed to determine if associated lesions had any effect on the diagnostic values of the 3 tests. **Type of Study:** Prospective controlled trial, clinical study. **Methods:** The study group consisted of 150 consecutive patients who had had symptoms related to intra-articular knee pathology, and arthroscopic diagnoses were used as the gold standard. **Results:** There were a total of 211 diagnoses on arthroscopy. A meniscus tear was found in 127 of the 150 patients; 90 had medial, 28 had lateral, and 9 had tears of both menisci. There were no statistically significant differences between the 3 tests in detecting a meniscal tear ( $P > .05$ ). However, better accuracy, sensitivity, and specificity rates were obtained with Ege's test for medial meniscal lesions (71%, 67%, and 81%, respectively). JLT also gave superior accuracy rates (71%), but the specificity of Ege's test was apparently higher than JLT (81% v 44%). The highest positive predictive value was also obtained with Ege's test (86%), whereas a superior negative predictive value was obtained with JLT (67%) in medial meniscal tears. Lateral meniscal tears were diagnosed more accurately than medial meniscal tears, and Ege's test gave results superior to the others (84%, 64%, 90% for accuracy, sensitivity, and specificity, respectively). Higher positive predictive values were obtained with McMurray's and Ege's tests than with JLT, but similar negative predictive values were achieved in all. A torn anterior cruciate ligament did not decrease the diagnostic values of the 3 tests, whereas the number of associated lesions in the knee negatively affected the diagnostic capabilities of the tests. **Conclusions:** Accuracies of traditional clinical meniscus tests may be improved by including Ege's test in the clinical examination. **Level of Evidence:** Level II, diagnostic. **Key Words:** Meniscus tear—Clinical tests—McMurray's test.

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Clinical diagnosis of a meniscal tear may be difficult even for the experienced knee surgeon. Although some studies have stressed the high diagnostic value of magnetic resonance imaging (MRI),<sup>1,2</sup> others have reported that MRI is not superior to physical examination in the diagnosis of meniscal tears.<sup>3,4</sup>

The high cost of MRI also prevents its routine use for meniscal injuries. Physical examination and clinical meniscus tests in addition to a carefully taken history have still been the most important means of diagnosing a meniscal tear.

Many tests have been described and used over the years in diagnosing the tears of the meniscus.<sup>5-9</sup> Several investigators have shown that the accuracy rates of clinical tests range between 0%<sup>2</sup> and 95%.<sup>10</sup> All of these tests are performed in non-weight-bearing positions, whereas most of the symptoms of a torn meniscus occur during weight-bearing activities. Obviously, current meniscus tests can not mimic the activities that precipitate the symptoms of a torn meniscus.

The purpose of this study was to assess a new meniscus test performed under weight-bearing condi-

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TABLE 1. Definition of Statistical Parameters

Term	Definition	Formula
Accuracy	Ability of the test to correctly detect the presence or absence of lesion.	$\frac{\text{True POS} + \text{True NEG}}{\text{Total}}$
Sensitivity	Ability of the test to correctly detect the presence of lesion.	$\frac{\text{True POS}}{\text{True POS} + \text{False NEG}}$
Specificity	Ability of the test to correctly detect the absence of lesion.	$\frac{\text{True NEG}}{\text{True NEG} + \text{False POS}}$
PPV	Frequency of a positive initial diagnosis confirmed postoperatively.	$\frac{\text{True POS}}{\text{True POS} + \text{False NEG}}$
NPV	Frequency of a negative initial diagnosis confirmed postoperatively.	$\frac{\text{True NEG}}{\text{True NEG} + \text{False POS}}$

tions, Ege's test, and to compare its diagnostic value with the 2 commonly used tests—McMurray's test and joint line tenderness (JLT). We also aimed to determine if associated lesions had any effect on the diagnostic values of the 3 tests.

## METHODS

A prospective and controlled study was undertaken on 150 knees of 150 patients. There were 110 male and 40 female patients aged between 17 and 73 years (average, 35.7 years). All patients had had symptoms related to an intra-articular knee pathology for an average of 32.4 months (range, 4 weeks to 180 months). There was a history of trauma in 89 of the patients. The patients in the acute period of trauma (within 6 weeks of injury) were not included in the study. Because Ege's test<sup>11</sup> is performed in a weight-bearing position and a squat is requested, the patients who were unable to bear weight and unable to squat because of loss of motion, pain, obesity, or weakness due to age, were also excluded from the study. After a detailed history, physical examination, and standard radiographic evaluation, patients underwent arthroscopic surgery. The average preoperative Lysholm score was  $65.9 \pm 15.01$  (range, 25 to 98). The surgical indications were based on history and clinical examination. Additional diagnostic aids such as MRI were not taken into consideration. To detect a meniscal tear clinically, McMurray's test, JLT, and a new test as described by Ridvan Ege, M.D.,<sup>11</sup> were performed. The study was based on the results of the last clinical examination just prior to surgery. The arthroscopic findings were accepted as the gold standard and final diagnoses were correlated with the results of the me-

niscus tests. The diagnostic values of the 3 tests were then calculated and compared.

When a meniscal tear was suspected by clinical tests and was found on arthroscopy, the result was defined as a true-positive result. A negative arthroscopy following a negative clinical test was defined as a true-negative result. A positive clinical test but a negative arthroscopy was defined as false-positive. A false-negative result meant that a meniscus tear was not suspected on clinical tests, but was found on arthroscopy. Statistical analyses were performed using SPSS (v. 10.0, SPSS Inc, Chicago, IL), McNemar's  $\chi$ -square test was used to compare the 3 tests, and correlation of test results with arthroscopic findings were measured by calculating kappa scores. Additionally, 5 statistical parameters were calculated: accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Definitions and importance of these parameters are summarized in Table 1.

## 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 to 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 (Fig 1A and B). The distance between the knees increases and each knee becomes externally rotated as the squatting proceeds (Fig 1B). For lateral meniscal tears, both lower extremities are held in maximum internal rotation while the patient squats and stands up (Fig 1C and D). A full squat in internal rotation is almost impossible even in healthy individuals. So a



**FIGURE 1.** Illustration of Ege's test. (A) To detect a medial meniscal tear, both lower extremities are held in maximum external rotation. (B) The patient then squats in this position. (C) For lateral meniscal tears, both lower extremities are held in maximum internal rotation. (D) Maximum internal rotations of both lower extremities are preserved during squatting.

slightly less than full squat is required in internal rotation, and the patient is allowed to use an object nearby as a support. In contrast to the medial meniscal test, the distance between the knees decreases and each knee becomes internally rotated as the squatting proceeds (Fig 1D). The test is positive when pain and/or a click is felt by the patient (sometimes audible to the physician) at the related site of the joint line.<sup>11</sup> Further squatting is stopped as soon as the pain and/or click is felt; hereby a full squat is not needed in all of the patients. Sometimes pain and/or click may not be felt until maximum squat, but may be felt as the patient comes out of the squat. This finding is also accepted as a positive sign of the test. Pain and/or click are felt at around 90° of knee flexion. Anteriorly located tears produce the symptoms in earlier knee flexion, whereas tears located on posterior horn of the menisci produce the symptoms in more knee

flexion, as in other meniscal tests. Flexion-extension, and internal-external rotation components of the test are similar to that of McMurray's test.<sup>5</sup> However, the most important difference is the weight-bearing position of the patient. The test may also be called the weight-bearing McMurray's test. Varus and valgus stresses are also produced during internal and external rotation positions, respectively.

## RESULTS

There were a total of 211 diagnoses on arthroscopy. Only 1 lesion was found in 75 knees. Two lesions were found at arthroscopy in 37 knees and the remaining 38 knees had at least 3 or more lesions. At least 1 meniscus was torn in 127 of the 150 patients. Medial and lateral tears were found in 90 and 28 patients,

**TABLE 2.** *Diagnostic Values of 3 Tests in Medial and Lateral Meniscal Tears*

	JLT Medial/Lateral	McMurray's Medial/Lateral	Ege's Medial/Lateral
Accuracy (%)	71/77	66/82	71/84
Sensitivity (%)	88/67	67/53	67/64
Specificity (%)	44/80	69/88	81/90
PPV (%)	74/47	80/59	86/58
NPV (%)	67/90	53/88	57/90

respectively, and 9 patients had tears of both menisci. The posterior horns of both menisci were the most common tear sites.

All 3 tests were well correlated to arthroscopic findings with the following kappa scores: Ege, 0.341; McMurray's, 0.321; and JLT, 0.443 ( $P < .05$ ). When compared with each other, there were no statistically significant differences between the 3 tests in detecting a meniscal tear ( $P > .05$ ). However, some differences were found between the tests in terms of accuracy, sensitivity, specificity, PPV, and NPV (Table 2). JLT and Ege's test were the most accurate tests for medial meniscus tears, but the specificity of Ege's test was apparently higher than JLT (81% v 44%). This means that when a lesion is not present in the knee, Ege's test determines it more correctly than others. The highest PPV was also obtained with Ege's test (86%) in medial meniscal tears. This means that when a positive diagnosis was made preoperatively with Ege's test, the probability of a torn medial meniscus on arthroscopy was higher than with the other tests. JLT was observed to give a higher number of false-negative results, and as a result, the lowest PPV was obtained with JLT (74%). The number of true-negative results was higher with Ege's test than with JLT (42 v 23). However, more false-positive results were obtained with Ege's test than with JLT (31 v 11). Because of the high number of false-positive results with Ege's test, a lower NPV was obtained than for JLT (Table 2). In summary, although the true-negative cases were better detected using Ege's test than with JLT, Ege's test did have a high number of false-positive results.

For lateral meniscal lesions, Ege's test was again the most accurate and specific test, but similar results were obtained in sensitivity and PPV with other tests. Overall results, however, showed that Ege's test was the most accurate and specific test for both medial and lateral meniscal tears.

When analyzed separately, the number of true-positive results was equal in Ege's and McMurray's tests

( $n = 64$  for both tests) for medial meniscal lesions. However, differences were noted in the number of true-negative results between the 2 tests. A true-negative result was obtained in 42 cases with Ege's test and in 36 cases with McMurray's test. This means that by using Ege's test, an additional 6 cases were diagnosed correctly. Ege and McMurray's tests were positive together in 52 of the 90 medial meniscus tears (58%). At least 1 of these tests was positive in 84 of medial meniscal tears (93%). In 51 knees in which a medial meniscus tear was absent, both tests were negative in 32 knees (63%). For medial meniscus tears, Ege's and McMurray's tests gave similar results in 111 of the 150 knees (74%).

When lateral meniscal lesions were analyzed, the number of true-positive results were similar with Ege's test and JLT ( $n = 20$  and  $n = 21$ , respectively). The differences occurred between the numbers of true-negative cases ( $n = 106$  for Ege, and  $n = 95$  for JLT). Although they were diagnosed as having a meniscal lesion with JLT, an additional 11 patients without a meniscal lesion on arthroscopy were diagnosed correctly with Ege's test. When compared with McMurray's test, 4 additional patients with torn menisci on arthroscopy were diagnosed correctly with Ege's test. At least 1 of Ege's and McMurray's tests was positive in 19 of the 28 lateral meniscus tears (68%). Both tests were positive in 15 lateral meniscus tears (54%). In 113 knees in which the lateral meniscus was normal, both tests were negative in 102 (90%). When compared for lateral meniscus lesions, Ege's and McMurray's tests gave similar results in 139 of the 150 knees (93%).

Results of the tests in relation to the types of tears are listed in Table 3. According to these results, degenerative tears of the medial menisci were the most commonly missed types with Ege's test; 8 of 12 (66%) degenerative tears were missed. McMurray's test was positive in 10 of these 12 tears (83%). In contrast, radial tears of medial menisci were diagnosed correctly with Ege's test in 84% of cases, whereas only 61% were diagnosed with McMurray's test. Similarly, Ege's test was better at diagnosing longitudinal and bucket-handle medial meniscal tears; more than 50% of such tears were missed with McMurray's test. As for lateral meniscal lesions, McMurray's test failed to diagnose all of 4 bucket-handle tears. JLT was highly positive in all types of meniscal tears, but generally lower accuracies were obtained in degenerative tears of the medial and flap tears of the lateral meniscus.

Additional lesions were seen at arthroscopy in 75 knees: 32 anterior cruciate ligament (ACL) tears, 17

**TABLE 3.** Results of the Tests According to the Types of Tears on Medial and Lateral Menisci

Types of Tears	Medial Meniscus				Lateral Meniscus			
	Total	Ege's CD	McMurray's CD	JLT CD	Total	Ege's CD	McMurray's CD	JLT CD
Longitudinal	10	6	4	8	8	5	4	7
Bucket-handle	19	10	9	16	4	3	0	2
Flap	12	10	10	12	4	3	2	1
Radial	13	11	8	11	7	5	5	6
Degenerated	12	4	10	11	4	4	4	4
Horizontal	12	8	9	11	6	6	6	6
Complex	21	15	14	15	4	3	4	4
Total	99	64	64	84	37	29	25	30

Abbreviation: CD, correct diagnosis.

patellar cartilage lesions, 22 tibiofemoral arthrosis, 2 generalized synovitis, and 2 loose bodies. A meniscus tear was found in 84% (27 of 32) of the patients with an ACL tear. Seventeen tears were located on the medial meniscus and 3 tears were located on the lateral meniscus, and both medial and lateral menisci were found to be torn in 7 ACL-deficient knees.

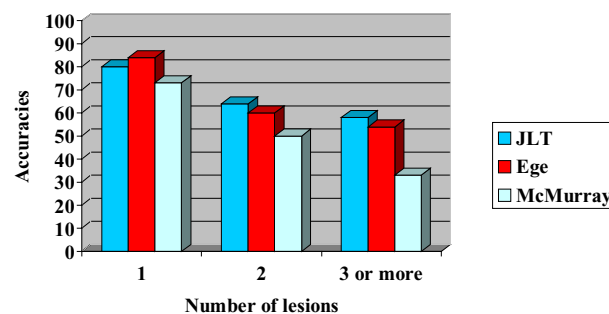
Detailed analyses of false-positive and false-negative results for the 3 tests showed that additional lesions of the knee were associated in these cases. However, Ege's test showed lower rates of false-positive and false-negative results compared with McMurray's test and JLT. Figure 2 presents the diagnostic values of the 3 tests according to the number of lesions in the knee. The highest accuracies were obtained when only 1 lesion was found at arthroscopy. The percentage of correct diagnoses of the 3 tests decreased as the number of lesions increased (Fig 2). The most common additional lesions accompanied with false-positive and false-negative results were chondral lesions (patellar and/or tibiofemoral). When the patients with chondral lesions were omitted from the study, higher accuracy rates were obtained (83%, 75%, and 85%, for JLT, McMurray's, and Ege's, respectively). Accuracy, sensitivity, and specificity rates were lower in patients with degenerative arthritis and patellofemoral disease (fibrillation to exposed bone) (Table 4). In contrast, a torn ACL did not decrease the diagnostic values of the 3 tests. When ACL-deficient knees were investigated separately, even higher accuracy rates were obtained (75%, 70%, and 76%, for JLT, McMurray's, and Ege's, respectively). In other words ACL deficiency did not have a negative effect on the diagnostic capability of the meniscus tests used in the present study.

There were 27 cases with an effusion in the knee. A meniscus tear was found in 17 of them. The accuracy,

sensitivity, and specificity of the 3 tests in these cases is shown in Table 4. Ege's test was the most accurate and most specific test in cases with effusion. The diagnostic accuracies of McMurray's test and JLT were negatively affected by effusion. Although there was a higher sensitivity with JLT (82%), there was low specificity (10%) obtained with the test.

## DISCUSSION

JLT has been reported as the most accurate but the least specific meniscus test in almost all of the previous studies.<sup>7,8,12-14</sup> The accuracy of Ege's test was equal to that of JLT in the present study and was superior to that of McMurray's test. It was also the most specific test for both medial and lateral meniscal tears. By using Ege's test, we were able to diagnose the meniscal lesions as accurately as with JLT, but more specifically. The philosophy of the test may explain the superior results; the test mimics the activities precipitating the symptoms of a torn meniscus more accurately and more specifically than the tests



**FIGURE 2.** Accuracies of the 3 tests according to number of lesions diagnosed at arthroscopy.

**TABLE 4.** Accuracy, Sensitivity, and Specificity of the 3 Tests in Gonarthrosis, Patellofemoral Chondromalacia, and Torn ACL

	Gonarthrosis			PF Chondromalacia			Torn ACL			Effusion		
	Ege	MM	JLT	Ege	MM	JLT	Ege	MM	JLT	Ege	MM	JLT
Accuracy (%)	54	59	45	64	59	58	76	70	75	74	59	51
Sensitivity (%)	40	63	80	62	66	78	68	65	83	68	63	82
Specificity (%)	66	60	16	66	50	37	83	73	47	88	50	10

Abbreviation: MM, McMurray's test.

performed by the physician under non-weight-bearing conditions.

The axially loaded pivot shift test described by Kurosaka et al.<sup>8</sup> is performed by applying an axial force to the knee during the test. Having found its diagnostic value to be superior to McMurray's test, the authors concluded that an axial compression was critical in reproducing the pain originating from the meniscal lesion. They found the sensitivity of McMurray's test to be 37% and the accuracy 45%, whereas an axially loaded pivot-shift test had 71% sensitivity and 73% accuracy. Our rates with McMurray's test (67% sensitivity and 66% accuracy for medial meniscal lesions) are higher than that of their study. They had performed the test as in its original description, and only the patients with click had been accepted as having meniscal lesion. However, we have modified the test by adding varus and valgus components, and pain and/or click was accepted as a positive result. Their overall accuracy rate with the axially loaded pivot-shift test (73%) is similar to that described in the present study (71% for medial meniscal tears, and 84% for lateral meniscal tears). This supports the importance of axial loading as we have previously stressed. Although axial loading may improve the reliability of McMurray's test, the amount of the axially applied force and the results of the test may be affected by the experience of the physician. However, in Ege's test, the applied axial force is more under weight-bearing conditions, and the results of the test are not affected by the experience of the physician because the test is performed by the patient.

The accuracy of McMurray's test has ranged from 0%<sup>2</sup> to 95%<sup>10</sup> in previous reports. There may be 2 main factors leading to this wide variability: (1) Patient selection and (2) differences in applying the test and interpretation of the results; in other words, experience of the tester. The number of studies testing McMurray's test in consecutive patients seems to be quite low. In most of the previous reports, the study groups included patients with suspected meniscal in-

jury; patients with ligamentous injuries or arthrosis were excluded.<sup>2,7,8,14,15</sup> We believe that, to be realistic, studies should include consecutive patients with different pathologies.

In the original description of McMurray's test,<sup>5</sup> no varus or valgus forces were applied to the knee, but some investigators have modified the test by adding varus or valgus components.<sup>16,17</sup> During the interpretation of the test, some accepted the test as positive with a painful click, as in the original description,<sup>2,8,12</sup> some with a click in the presence or absence of pain,<sup>16,18</sup> and some with pain in the presence or absence of a click.<sup>17</sup> As a result, confusing results appeared in the literature. Thus, comparisons are not feasible between different studies. In the present study, McMurray's test was performed by adding varus or valgus components, and pain and/or click at the corresponding joint line was accepted as positive. In Ege's test, the knees are also forced to varus (internal rotation) and valgus (external rotation) as the patient squats.

Although it is believed that the differences in tear types may influence the results of clinical tests, no detailed investigation of this issue exists in previous reports. Separate analysis of the results according to the types of tear revealed some differences between the tests. McMurray's test was superior to Ege's in diagnosing degenerative tears of the medial meniscus, whereas radial tears were diagnosed more accurately with Ege's test (Table 3). McMurray's test also failed to diagnose the bucket-handle tears of the lateral meniscus. We are unable to explain these differences. This finding stresses the complementary feature of both tests.

An interesting result of the present study was that the lateral meniscal tears were diagnosed more accurately with all 3 tests. The diagnoses of lateral meniscus tears have been believed to be more difficult than that of medial meniscus tears.<sup>7,19,29</sup> The diagnostic value of clinical tests, however, was not separately

investigated for medial and lateral menisci in most of the previous studies.<sup>12,13,15</sup> In a prospective study, Evans et al.<sup>18</sup> found McMurray's test ineffective in detecting lateral meniscus tears; the sensitivity of McMurray's test for lateral meniscus tears was 16% in that study. In our study, the sensitivity of McMurray's test was 53% for lateral meniscus tears. The accuracy of the test was not reported in the aforementioned study, but it was 82% in our study. In contrast to the results of Evans et al.,<sup>18</sup> distinct evaluation of the medial and lateral meniscal tears revealed superior results, as in the present study, in detecting lateral tears in 2 previous studies.<sup>8,21</sup> Terry et al.<sup>21</sup> found the clinical examination to be more accurate and more specific for lateral meniscus tears than for medial tears (accuracy, 92% v 89%; specificity, 92% v 72%, respectively). However, the methodology of clinical diagnosis was not described in their report. Kurosaka et al.<sup>8</sup> also diagnosed lateral meniscus lesions more accurately than medial meniscus lesions using the axially loaded pivot-shift test. A possible explanation for these differences between these studies may be that Evans et al.<sup>18</sup> did not consider the test as being positive with pain alone but rather a medial thud was accepted as positive in their study.

The reliability of clinical meniscus tests has been found to be negatively affected by accompanied intra-articular lesions.<sup>12,22</sup> Oberlander et al.<sup>22</sup> found that the percentage of correct diagnoses decreased as the number of lesions increased. A negative effect of accompanying lesions on the clinical diagnosis of a meniscal tear was also suggested in the present study. However, types of accompanying lesions that interfere with the results of clinical meniscus tests have not been studied descriptively in most of the previous reports. Fowler et al.<sup>12</sup> found a negative correlation with McMurray's test and accompanying patellar chondromalacia. They indicated that, although 25% of their patients with chondromalacia had a meniscal tear, these patients were not as likely to give a positive result for McMurray's test.<sup>12</sup> Pain and crepitation caused by a patellofemoral disease are usually felt at the anterior part of the knee. But the pain and/or crepitation elicited by Ege's test is felt at the related joint line of the knee (medial or lateral). However, patellofemoral disorders may interfere with the diagnosis of meniscal lesions as in other meniscal tests. This fact is reflected in the lower accuracy rates of the tests. Interestingly, the diagnostic values of clinical meniscus tests were not affected by ACL deficiency. When ACL-deficient knees were omitted from the study, similar accuracy rates were observed with Ege and McMurray's tests.<sup>12</sup> However, Fowler et al.<sup>12</sup> suggested

that the presence of ACL deficiency would render the meniscus tests less effective. Results of the study of Kurosaka et al.<sup>8</sup> are in contrast to those of Fowler et al., but are in accordance to those of the present study. Accuracy rates of the axially loaded pivot-shift test were equal in patients with and without ACL deficiency.<sup>8</sup> We are unable to explain this difference between our results and those of Fowler et al. They reported 42 ACL-deficient knees and 13 knees with an intact but pathologic ACL. However, the types of pathology in these intact ACLs were not defined by the authors. The effusion generally had a negative effect on the diagnostic accuracy of McMurray's test and JLT, whereas better results were obtained with Ege's test. It may be concluded that advantages of weight bearing during the test may disqualify the negative effect of effusion on diagnostic accuracy.

Acute injuries were not included in this study for several reasons. First, we do not perform arthroscopy in cases of acute trauma unless the knee is locked. Arthroscopic findings were accepted as the gold standard to compare the results of clinical meniscus tests used in the present study. Second, we do not recommend using Ege's test in acute injuries because squatting is already a painful act no matter what the cause might be. It may lead to a high number of false-positive results in acute cases. This is also true for other clinical meniscus tests. For this reason, only cases with a history of trauma more than 6 weeks previously were included in the study. Other than acute injuries, patients who were unable to bear weight or squat because of loss of motion, and patients with pain, obesity, or weakness due to age, were also excluded from the study.

Statistical analysis showed no significant difference between the 3 tests in detecting a meniscal tear. However, Ege's test seems to be more specific and more accurate than McMurray's test and JLT in detecting medial and lateral meniscus tears. The accuracy of traditional clinical meniscus tests may be improved by including Ege's test in clinical examination. The combination of different clinical meniscus tests may improve our diagnostic ability. According to our results, we believe that the new test reflects the symptoms of a torn meniscus more accurately than the tests performed with the patient supine, because it is performed in a functional position. As the patient performs the test himself, misinterpretations due to the experience of the examiner are also eliminated.

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