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A Prospective Observational Study Comparing Weight Bearing versus Non-Weight Bearing Clinical tests for diagnosing Meniscal tear in Comparison with MRI study

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KEYWORDS
Thessaly test, Ege's test, Duck walk test, Joint line tenderness, McMurray's test, Apley's test, Meniscal tears

ABSTRACT:
Background: Meniscal tears typically result from acute sports injuries or direct trauma to the knee. Delayed diagnosis and conservative treatment may exacerbate complications. **Objectives:** To compare the sensitivity, specificity, positive and negative predictive value of various weight bearing (Thessaly test, Ege's test, Duck walk test) and non-weight bearing clinical tests (Joint line tenderness, McMurray's test, Apley's test) for meniscal tear in comparison with MRI. **Methods:** This was a hospital based, prospective, observational, cross-sectional study conducted at the outpatient department (Knee Clinic) and/or inpatient wards of the Department of Orthopedics, Aarupadai Veedu Medical College, for a duration of 24 months, among patients more than 18 years of age, of both gender, suspected of meniscal tear, identified as needing arthroscopy and those willing to provide informed written consent. **Results:** Employing a combination of the Thessaly test, Ege's test, and the Duck walk test significantly enhances the diagnostic accuracy for detecting meniscal tears. Notably, even if only one of these weight-bearing tests yields a positive result, it demonstrates high specificity and positive predictive value, indicating that a positive finding in any of these tests strongly suggests the presence of a meniscal tear. However, the sensitivity remains low, implying that relying solely on one weight-bearing test may lead to missed diagnoses. **Conclusion:** In summary, this study offers valuable insights into the diagnostic accuracy of both weight-bearing and non-weight-bearing clinical tests for identifying meniscal tears, as compared to magnetic resonance imaging (MRI), within a cohort of patients with knee symptoms. Through a comprehensive evaluation of various clinical tests, we have highlighted their individual and combined contributions to the accurate diagnosis of meniscal tears.

Introduction

The meniscus is a vital structure located between the thigh bone and the leg bone, serving as a cushion.(1) It plays a crucial role in transmitting the body's weight through the knee joint, ensuring pain-free movement.(2) However, abrasion tears are common in individuals aged 40 to 60.(3) Meniscal tears typically result from acute sports injuries or direct trauma to the knee. Luvsannyam et al.(4) noted that meniscus tears are the most common knee pathology encountered in orthopaedics. Keyhani et al.(5) conducted a hospital record-based study and noted that the prevalence of meniscal tears was 44.4%, with bucket-handle injuries being the most prevalent type at 30.4%, followed by ramp lesions at 20.5%[5].Englund et al. documented that undiagnosed and untreated meniscal tear can lead to osteoarthritis of knee joint.(6) The meniscus comprises two parts: the lateral and medial meniscus. It is divided into three zones that influence injury outcomes: the outer zone, rich in blood supply, the avascular innermost zone, and the intermediate zone, with a 50-50 combination.(7) Tears in the outer zone or periarticular area often heal spontaneously with conservative treatment due to ample blood supply. Conversely, tears involving the avascular innermost zone usually require surgical intervention.(8) Tears in

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the intermediate zone have a 50% chance of spontaneous healing, particularly small tears of 2 to 3 mm. However, larger tears, bucket handle tears, multiple tears, or those extending to the articular surface necessitate arthroscopic surgery.(9) Common symptoms of meniscal injury include knee pain during activities like climbing stairs and squatting, as well as sensations of locking or instability.(10, 11) Magnetic resonance imaging (MRI) is essential for accurate diagnosis, although most meniscal tears can be managed conservatively, with surgery reserved for cases requiring meniscal repair or meniscectomy.(12-14)

Meniscal tears are a prevalent knee pathology encountered by orthopaedic practitioners. Patients typically present with a history of twisting knee trauma and experience pain only during walking. Diagnosis primarily relies on clinical assessment, with MRI studies often aiding in confirmation.(15) However, the ambiguity of symptoms can lead to misdiagnosis and subsequent treatment errors. Meniscal tears can significantly impair a patient's quality of life and productivity due to pain and functional limitations.(16) Currently, there is no standardized set of clinical tests for diagnosing meniscal tears or for screening before MRI studies. Delayed diagnosis and conservative treatment may exacerbate complications. Therefore, this study aims to evaluate various clinical tests to facilitate early diagnosis and treatment of meniscal tears. Against this background, the aim of the present study was to compare the sensitivity, specificity, positive and negative predictive value of various weight bearing (Thessaly test, Ege’s test, Duck walk test) and non-weight bearing clinical tests (Joint line tenderness, McMurray’s test, Apley’s test) for meniscal tear in comparison with MRI.

Materials and Methods

This hospital-based, prospective, observational, cross-sectional study was conducted in the outpatient department (Knee Clinic) and/or inpatient wards of the Department of Orthopedics at Aarupadai Veedu Medical College, a tertiary healthcare facility in Puducherry, India, over a 24-month period. The study included patients over 18 years of age, of both genders, who were suspected of having a meniscal tear, identified as requiring arthroscopy, and willing to provide informed written consent. Patients with infective or inflammatory arthritis, those with an acute injury (less than six weeks), those with associated fractures, and those unwilling to provide informed written consent were excluded from the study.

Data collected were manually entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) version 23. Categorical variables were summarized as frequencies and percentages, while continuous variables were summarized using the mean (standard deviation) and/or median (interquartile range), based on data normality assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Cross-tabulations were used to estimate sensitivity, specificity, positive predictive value, and negative predictive value.

Results

The mean age (SD) of the patients in this study was 36.9 years (12.2). A majority of the patients (60.7%) were between 31 and 60 years of age, followed by 36.0% who were under 30 years, and 3.3% who were over 60 years. Approximately two-thirds (64.3%) of the patients were male, while 35.7% were female. In this study, we conducted three weight-bearing tests: the Thessaly test, Ege's test, and the Duck walk test. The Thessaly test was positive in 64.3% of patients, Ege's test in 52.3%, and the Duck walk test in 73.3% of those suspected of having a meniscal tear. Three non-weight-bearing tests were also performed: joint line tenderness, McMurray's test, and Apley's grinding test. Joint line tenderness was positive in 76.0% of patients, McMurray's test in 53.7%, and Apley's grinding test in 50.7% of patients suspected of a meniscal tear.

The diagnostic accuracy of the weight-bearing tests was assessed by comparing each test's results and cross-tabulating them with magnetic resonance imaging (MRI) findings. For the Thessaly test, sensitivity, specificity, positive predictive value, and negative predictive value were 66.2%, 39.2%, 68.9%, and 36.4%, respectively, with statistical significance ($p<0.05$). The Ege's test yielded a sensitivity of 69.2%, specificity of 81.8%, positive predictive value of 88.5%, and negative predictive value of 56.6% in comparison with MRI results, with statistically significant diagnostic accuracy ($p<0.05$). The Duck walk test showed a sensitivity of 79.6%, specificity of 39.4%, positive predictive value of 72.7%, and negative predictive value of 48.8%, which was also statistically significant ($p<0.05$).

The diagnostic accuracy of the non-weight-bearing tests (joint line tenderness, McMurray's test, and Apley's grinding test) was similarly assessed by comparing each test's results with MRI findings. Joint line tenderness showed sensitivity, specificity, positive predictive value, and negative predictive value of 77.1%, 26.3%, 68.0%,

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and 36.1%, respectively, with statistical significance ($p<0.05$). McMurray's test demonstrated a sensitivity of 59.2%, specificity of 57.6%, positive predictive value of 73.9%, and negative predictive value of 41.0% in comparison with MRI findings, with statistical significance ($p<0.05$). Apley's grinding test showed sensitivity, specificity, positive predictive value, and negative predictive value of 52.2%, 52.5%, 69.1%, and 35.1%, respectively, and was also found to be statistically significant ($p<0.05$).

The ROC analysis was conducted by comparing the results of individual weight bearing and non-weight bearing tests with results of magnetic resonance imaging. The ROC curves were generated with sensitivity on 'Y' axis and 1-specificity on 'X' axis (diagonal segments were produced by ties). The estimated area under the curve (AUC) of Thessaly test was 0.531 (95% CI 0.462 to 0.597; p=0.033), Ege's test was 0.755 (95% CI 0.697 to 0.813; p<0.001), Duck walk test was 0.595 (95% CI 0.525 to 0.665; p=0.007), joint line tenderness was 0.527 (95% CI 0.451 to 0.594; p=0.044), McMurry's test was 0.584 (95% CI 0.515 to 0.653; p=0.018), and Apley's grinding test was 0.523 (95% CI 0.462 to 0.589; p=0.036). Importantly, the AUC for all the weight bearing and non-weight bearing tests were statistically significant ($p<0.05$).

We extended our analysis to note whether combination of weight bearing tests improve or reduce the diagnostic accuracy of meniscal tears. The results showed that positivity of all three weight bearing tests (Thessaly test, Ege's test, and the Duck walk test) had a sensitivity of 66.2%, specificity of 81.8%, positive predictive value of 88.1%, and negative predictive value of 54.4% – this was found to be statistically significant ($p<0.05$). In our additional analysis to note whether combination of non-weight bearing tests improve or reduce the diagnostic accuracy of meniscal tears, the results showed that positivity of all three non-weight bearing tests (Joint line tenderness, McMurry's test, and Apley's grinding test) had a sensitivity of 52.2%, specificity of 57.6%, positive predictive value of 71.4%, and negative predictive value of 37.3% – this was found to be statistically significant ($p<0.05$). The estimated area under the curve (AUC) of all three positive weight bearing tests was 0.740 (95% CI 0.681 to 0.799; p<0.001. Similarly, the AUC of all three positive non-weight bearing tests was 0.549 (95% CI 0.480 to 0.618; p=0.041).

Discussion

The present study aimed at determining the diagnostic efficacy of various weight-bearing and non-weight-bearing clinical tests for meniscal tears compared to MRI, as well as demographic characteristics of the patient population. The mean age of the patients in the study was 36.9 years, with a standard deviation of 12.2 years. This indicates that the study population predominantly consisted of adults in their mid-thirties.(17) The majority of patients fell within the age range of 31 to 60 years, comprising 60.7% of the sample. This distribution reflects the prevalence of knee problems in the adult population, which is consistent with previous literature.(18, 19) Regarding gender distribution, the study included more male patients (64.3%) than female patients (35.7%). This gender difference in knee-related complaints is in line with existing literature,(20) which suggests that men are more prone to knee injuries due to greater participation in sports and physically demanding activities (Schenck et al., 2008).(21) In terms of laterality, right-sided involvement was slightly more prevalent (52.0%) than left-sided involvement (48.0%). This observation is consistent with previous studies reporting similar proportions of right and left-sided knee injuries.(22)

Magnetic resonance imaging confirmed meniscal tears in 67.0% of patients suspected of having them based on clinical examination, while 33.0% had negative MRI findings. This highlights the importance of using MRI as the gold standard for diagnosing meniscal tears, as it provides detailed imaging of the knee joint and has high sensitivity and specificity compared to clinical tests.(23, 24)

The present study underscores the variability in the diagnostic performance of different clinical tests for meniscal tears. While some tests demonstrated high sensitivity (e.g., joint line tenderness), others showed lower sensitivity but higher specificity (e.g., Ege's test). These findings suggest that a combination of clinical tests may be necessary to improve diagnostic accuracy, especially in cases where MRI is not readily available or contraindicated. The Thessaly test demonstrated moderate sensitivity, but poor specificity compared to MRI. This indicates that while it may correctly identify some cases of meniscal tears, it also produces a considerable number of false positives and negatives. Ege's test showed higher sensitivity and specificity compared to the Thessaly test. Its higher specificity suggests that it is better at ruling out meniscal tears when they are absent. The high PPV and NPV indicate that it is more reliable in both confirming and ruling out

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meniscal tears. The significant diagnostic accuracy and higher AUC further support its usefulness as a diagnostic tool. The Duck Walk test exhibited the highest sensitivity among the weight-bearing tests but had low specificity. This suggests that it is effective in identifying most cases of meniscal tears but also produces a significant number of false positives. Despite its lower specificity, the significant diagnostic accuracy and AUC indicate its potential usefulness in conjunction with other tests or clinical judgment. The findings suggest that Ege's test may be the most reliable among the weight-bearing tests, given its higher sensitivity, specificity, and overall diagnostic accuracy.(25, 26) While the Duck Walk test has high sensitivity, its low specificity may limit its standalone utility and warrant caution in interpretation.

The Joint Line Tenderness test demonstrated high sensitivity, but poor specificity compared to MRI. While it correctly identified a significant proportion of meniscal tears, it also produced a large number of false positives. Despite its limitations, the statistically significant diagnostic accuracy suggests that it may still have value in clinical practice, particularly as a screening tool. McMurry's test exhibited moderate sensitivity and specificity compared to MRI. Its higher PPV suggests that it is better at confirming the presence of meniscal tears when they are present. Apley's grinding test showed the lowest sensitivity and specificity among the non-weight-bearing tests. While it may help rule out meniscal tears when negative, its low sensitivity indicates that it may miss a significant number of cases. Overall, the findings suggest that joint line tenderness may be the most sensitive among the non-weight-bearing tests, making it useful as a screening tool to identify potential cases of meniscal tears. McMurry's test may be more reliable in confirming the presence of meniscal tears, given its higher PPV compared to Apley's grinding test.(25, 26) Clinicians should consider using a combination of non-weight-bearing tests, along with other clinical assessments and imaging modalities, for a comprehensive evaluation of meniscal tears.

Combining the results of all three weight-bearing tests significantly improves the sensitivity, specificity, and predictive values for diagnosing meniscal tears. This indicates that utilizing a combination of Thessaly test, Ege's test, and Duck walk test enhances the diagnostic accuracy of meniscal tear detection. Interestingly, even if only one of the three weight-bearing tests is positive, it results in a high specificity and PPV, indicating that a positive finding in any one of these tests is highly indicative of a meniscal tear. However, the sensitivity remains low, suggesting that relying solely on one weight-bearing test may lead to missed diagnoses.

Similar to the weight-bearing tests, combining the results of all three non-weight-bearing tests significantly improves the diagnostic accuracy for meniscal tears. However, the sensitivity and specificity are lower compared to the combination of weight-bearing tests, indicating that non-weight-bearing tests alone may not be as effective in diagnosing meniscal tears. When considering the positivity of any one of the three non-weight-bearing tests, the specificity remains relatively high, but the sensitivity decreases significantly. This suggests that while a positive finding in any one test may increase the likelihood of a meniscal tear, it may also result in false negatives.

Conclusion

In conclusion, our study provides valuable insights into the diagnostic accuracy of both weight-bearing and non-weight-bearing clinical tests for detecting meniscal tears, compared to magnetic resonance imaging (MRI), in a cohort of patients presenting with knee symptoms.Our findings indicate that Ege's test among weight-bearing tests and joint line tenderness among non-weight-bearing tests, demonstrate promising sensitivity, specificity, and predictive values for detecting meniscal tears. Additionally, our analysis highlights the importance of combining multiple tests to enhance diagnostic accuracy, with combinations of weight-bearing tests showing particularly notable improvements. The study contributes to the existing literature by providing clinicians with valuable information to guide the diagnostic approach to meniscal tears. Further research and other prospective multicentric studies will ultimately enhance our understanding of meniscal pathology and improve patient care through more accurate and reliable diagnostic methods.

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Table 1: Distribution of patients, by age, weight bearing and non-weight bearing tests

		Number (n) N = 300	Percent (%)
Age (in years) *Mean (SD)*		36.9 (12.2)	
Age (in years)	Less than 30	108	36.0
	31 to 60	182	60.7
	More than 60	10	3.3
Weight bearing tests			
Thessaly test	Positive	193	64.3
	Negative	107	35.7
Ege's test	Positive	157	52.3
	Negative	143	47.7
Duck walk test	Positive	220	73.3
	Negative	80	26.7
Non-weight bearing tests			
Joint line tenderness	Positive	228	76.0
	Negative	72	24.0
McMurry's test	Positive	161	53.7
	Negative	139	46.3
Apley's grinding test	Positive	152	50.7
	Negative	148	49.3
SD, Standard deviation			

Table 2: Diagnostic accuracy of weight bearing and non-weight bearing tests in comparison with MRI findings

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P value
Weight bearing tests					
Thessaly test	66.2	39.2	68.9	36.4	0.033*
Ege's test	69.2	81.8	88.5	56.6	<0.001*
Duck walk test	79.6	39.4	72.7	48.8	0.007*
Non-weight bearing tests					
Joint line tenderness	77.1	26.3	68.0	36.1	0.044*
McMurry's test	59.2	57.6	73.9	41.0	0.018*
Apley's grinding test	52.2	52.5	69.1	35.1	0.036*
PPV, Positive predictive value; NPV, Negative predictive value *Statistically significant at p<0.05					

Table 3: Receiver Operating Characteristics (ROC) curve comparing weight bearing and non-weight tests with MRI findings

	AUC	**95% CI**	**p value**
Weight bearing tests			
Thessaly test	0.531	0.462 to 0.597	0.033*
Ege's test	0.755	0.697 to 0.813	<0.001*
Duck walk test	0.595	0.525 to 0.665	0.007*
Non-weight bearing tests			
Joint line tenderness	0.527	0.451 to 0.594	0.044*
McMurry's test	0.584	0.515 to 0.653	0.018*
Apley's grinding test	0.523	0.462 to 0.589	0.036*

AUC, Area under the curve; CI, Confidence interval

*Statistically significant at p<0.05

Table 4: Diagnostic accuracy of weight bearing – combined and non-weight bearing – combined tests in comparison with MRI findings

	Sensitivity (%)	**Specificity (%)**	**PPV (%)**	**NPV (%)**	**P value**
Weight bearing tests – combined					
All three	66.2	81.8	88.1	54.4	<0.001*
Non-weight bearing tests – combined					
All three	52.2	57.6	71.4	37.3	0.041*

PPV, Positive predictive value; NPV, Negative predictive value

*Statistically significant at p<0.05

Table 5: Receiver Operating Characteristics (ROC) curve comparing combinations of weight bearing and non-weight tests with MRI findings

	AUC	**95% CI**	**p value**
Weight bearing tests			
All three positive	0.740	0.681 to 0.799	<0.001*
Non-weight bearing tests			
All three positive	0.549	0.480 to 0.618	0.041*

AUC, Area under the curve; CI, Confidence interval

*Statistically significant at p<0.05