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Diagnostic Accuracy of the Passive Straight Leg Raise Test in Detecting Compression of the Lower Lumbar Nerve Roots

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Abstract

Background: Lumbar nerve root compression is a pathological condition that occurs commonly in the low back pain population. Passive straight leg raise (SLR) is a clinical test widely used to confirm this pathological condition. Yet, its diagnostic accuracy needs further investigation. Objective: To assess the sensitivity and specificity of the passive SLR test in detecting compression of the lower lumbar nerve roots using magnetic resonance imaging as a reference standard. Design: This study is a prospective diagnostic-accuracy study. Methods: One hundred-and-twelve participants (82 males and 30 females) met the inclusion criteria and joined the study. Participants were recruited through direct communication and poster announcement and allocated into positive and negative MRI groups. A standardized passive SLR test was applied to all participants; then 2 X 2 cross-tabulation statistics were conducted to determine the sensitivity and specificity. Results: The passive SLR test was considered positive in 62 (56.36%) participants while it was negative in 50 (45.45%) participants. Sensitivity, specificity, positive and negative likelihood ratios were found to be 77.1%, 81.0%, 6.75, and 0.47 respectively. The diagnostic accuracy was found to be 80.95%. ROC curve revealed positive fair sensitivity and specificity of the test with the area under the curve equal to 0.775. Conclusion: The passive SLR test is a useful tool for the diagnosis of lower lumbar nerve root compression.

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ABSTRACT

Background: Lumbar nerve root compression is a pathological condition that occurs commonly in the low back pain population. Passive straight leg raise (SLR) is a clinical test widely used to confirm this pathological condition. Yet, its diagnostic accuracy needs further investigation. Objective: To assess the sensitivity and specificity of the passive SLR test in detecting compression of the lower lumbar nerve roots using magnetic resonance imaging as a reference standard. Design: This study is a prospective diagnostic-accuracy study. Methods: One hundred-and-twelve participants (82 males and 30 females) met the inclusion criteria and joined the study. Participants were recruited through direct communication and poster announcement and allocated into positive and negative MRI groups. A standardized passive SLR test was applied to all participants; then 2 X 2 cross-tabulation statistics were conducted to determine the sensitivity and specificity. Results: The passive SLR test was considered positive in 62 (56.36%) participants while it was negative in 50 (45.45%) participants. Sensitivity, specificity, positive and negative likelihood ratios were found to be 77.1%, 81.0%, 6.75, and 0.47 respectively. The diagnostic accuracy was found to be 80.95%. ROC curve revealed positive fair sensitivity and specificity of the test with the area under the curve equal to 0.775. Conclusion: The passive SLR test is a useful tool for the diagnosis of lower lumbar nerve root compression.

Keywords: Lasègue's test; sensitivity; specificity; lumbar disc; herniation
INTRODUCTION
Low back pain (LBP) is a common condition affecting many individuals at some point in their lives.\(^1\) It encompasses three types of presentations; axial pain at the lumbosacral area, radicular pain traveling along the course of a nerve, and referred pain which has a non-dermatomal pattern of spreading.\(^2\) LBP could be presented clinically in several pathological forms such as herniated disc, lumbar radicular pain, and sciatica.\(^3\)

A lumbar disc herniation is defined as the localized displacement of disc material beyond the margins of the intervertebral disc space involving less than 25% of the circumference of the disc margin as viewed in the axial plane.\(^4\) Pain radiating into the leg or sciatica could be the result of mechanical compression of a herniated disc that in turn compresses the nearby nerve roots and cause leg pain. These pathological changes affect up to 60% of LBP patients.\(^5\)

Magnetic Resonance Imaging (MRI) is one of the investigations commonly used to diagnose lumbar disc herniation.\(^6\) MRI is advantageous because it provides excellent imaging capabilities for detecting spinal pathology, disc abnormalities, and nerve root compression without exposing the patient to ionizing radiation as occurs with plain X-rays.\(^7\) Due to the previously mentioned advantages, MRI has been used as a reference standard test for determining the validity, reliability, sensitivity, and specificity of common clinical tests such as SLUMP and straight leg raise (SLR) tests in several previous studies.\(^3,8–10\)

In addition to the imaging methods, clinical tests are important tools used by clinicians to indicate the type and location of pathology: the passive straight leg raise (SLR) test is one of these clinical tests where it has been used frequently in primary care examination as well as physical therapy outpatient settings.\(^3,10,11\) SLR test aims to determine whether there is a lumbar disc herniation or compression on sciatic nerve roots at lower lumber levels. Additionally, this test has been designed to recognize nerve root irritation which is the major cause of sciatica.\(^12\)

According to a recent systematic review, the SLR test has variable degrees of reliability. This review reported that the errors in the measurement procedures and the lack of structural differentiation could affect the reliability of the test. The authors recommend applying the test using standardized procedures to improve the reliability of the test.\(^11\)

Literature demonstrated a lack of reporting on important issues such as well-defined test procedures, consensus regarding the interpretation of test results,\(^13\) valid study designs,\(^14\) the correlation between the test and demographic characteristics such as patients’ age and sex, and finally considering the different contexts in which the test might be used.\(^15\) Failure to consider these important issues raise doubts about the findings of previous literature and necessitate the conduction of new well-designed research. The use of standardized testing procedures allows practitioners to easily apply the test and obtain consistent results.

Investigating the sensitivity and specificity of the passive SLR test is necessary to justify its use in clinical practice. The sensitivity of the SLR test was low in Capra et al and Majlesi et al where the values were 0.36 and 0.52 respectively.\(^8,9\) The sensitivity of the test in these studies was high (0.74 and 0.89) respectively. On the other hand, high sensitivity was reported on two occasions: in the study by M’kumbuzi’s it was 0.87 while it was 0.82 in the study by Omar et al. These studies reported variable levels of specificity ranging from 0.42 to 78.4.\(^4,10,16\) Additionally, using standardized procedures is paramount as the variations in testing procedures could be a potential reason for the variability in sensitivity and specificity reported in previous work.\(^11\)

The current study aimed to assess the sensitivity and specificity of the passive SLR test (index test) in detecting lower lumbar nerve root compression secondary to disc herniation using MRI as a reference standard (reference test).

METHODS
Participants
The participants were recruited from attendees of two physical therapy outpatient clinics, the first was a private physical therapy clinic in Cairo, Egypt. The second facility was a rehabilitation center in Al Qassim, Saudi Arabia. The recruitment process was conducted between November 2018 to May 2021. The number of participants was limited to those who were referred to the rehabilitation facilities during the period of the study. Ethical approval was obtained.
from the local ethical committee board (PT-2018/17). Participants signed a paper-based consent form before the start of the study.

Patients diagnosed, by their physicians, as having low back dysfunction were invited to join the study if they met the following inclusion criteria: 1) adults above 17 years of age; 2) having persistent pain [three months or more] in the low back and/or lower extremity, 3) pain intensity of at least 2 on the VAS scale of lower extremity pain intensity, and 4) agreed to sign the consent form. Patients with bone tumors, vascular disorders, bone deformity or osteomyelitis, pain originating from the hip or sacroiliac joints, spondylolisthesis, and uncontrolled diabetes were excluded from the study.

Data Collection
Two of the authors (HH and MR) interviewed all the potential participants, discussed all procedures, and answered all questions related to the study. A clinical assessment consisting of demographic data, history taking, and a detailed pain profile (intensity, site, duration, aggravating and calming factors) was conducted to assess the eligibility of the participants according to the inclusion and exclusion criteria. The passive SLR test was performed on those who met the inclusion criteria. The author who performed the passive SLR test was blind to the results of the MRI. All participants were instructed to stop their analgesic and muscle relaxant medications 24 hours before applying the SLR test.

Instruments
Index Test
Procedures
The passive SLR test was performed by asking the participant to assume supine position, then the assessor instructed the participant to remain relaxed while the tested limb was raised passively, through the sagittal plane, till the recognized symptoms were experienced or the range stopped by the tightness of the hamstring muscles. The recognized symptoms were the symptoms that were usually experienced by the participant due to his or her pathological condition. Using the patient's typical symptoms as a sign of a positive test result was recommended in previous work. 8

If the participant reported symptoms, a detailed explanation of these symptoms (type, severity, location, whether similar to the pain usually experienced or not) was recorded, then the assessor lowered the tested limb a few degrees till the symptoms disappeared. The second step of the test was to apply passive dorsiflexion and then active neck flexion and observe the participant's response. The passive SLR test was conducted on the symptomatic lower extremity.

Interpretation of Test Results
The test was considered positive if the elicited symptoms were predominantly below the gluteal region, and well-recognized by the participant, and/or the same symptoms were elicited during the elevation of the tested lower limb (with knee extension) and re-elicited during passive dorsiflexion and/or neck flexion.

Imaging of the Lumbar Spine
The majority of the referred participants already had a recent MRI. MRI Imaging was ordered for the participant who had not or had an old imaging report (more than 6 months). All MRI images were obtained using an open, low-field 0.2 T MRI unit (Magnetom Open Viva, Siemens AG, Germany). In the current study, the MRI was used as a reference test.8,9

MRI findings were considered positive if there are morphological changes in the disc shape, height, and color or if there was posterior or postero-lateral bulging.17 The MRI imaging report was assessed by two authors (EK and HH) who were not involved in applying the passive SLR test. Data was extracted using an Excel spreadsheet and special coding referring to each participant. The interpretation of the coding system was kept with another independent author (AE) and was revealed after the end of the study.
Data Analysis
Data was entered and analyzed through SPSS version 23. Descriptive statistics were used to describe the results. Mean and standard deviation (SD) were calculated for numerical variables. Frequency and percentages were reported for categorical variables. Diagnostic measures were calculated for passive SLR test using MRI as a gold standard by conducting a 2X2 contingency table to assess 1) the sensitivity which was described as the ability of a diagnostic test to correctly recognize cases with the medical condition (true positive), 2) the specificity, which means the ability of a given test to correctly recognize those without the medical condition (true negative), 3) a positive likelihood ratio which was obtained by dividing the true positivity rate by the false positivity rate, 4) a negative likelihood ratio which is "the probability of a patient testing negative who has a medical condition divided by the probability of a patient testing negative who does not have a medical condition." The ROC curve was constructed to assess the area under the curve and to determine the degree of sensitivity and specificity of the test. Statistical significance was set as p< 0.05.

RESULTS
From a total of 177 subjects invited to participate in this study, 112 participants (82 males and 30 females) met the inclusion criteria and consented to participate in the study. Participants were allocated into a positive MRI group and a negative MRI group (Figure 1).

The positive MRI group consisted of 70 participants representing 62.5% of the total sample. Their mean age, weight, height, and BMI were 43.7±11.2 years, 82.3±10.8 Kilograms, 1.73±9.0 meters, and 31.5±5.0 respectively. All the participants in the positive MRI group (n=70; 13 females and 57 males) demonstrated single or multi-level discogenic lesions with nerve root compression in the lower lumbar spine.

Figure 1. Distribution of Subjects
The longest duration of symptoms was 17 months while the shortest was 3 months with the mean duration equal to 8.47 months. Fifty-six (81.1%) of the participants with a positive MRI were able to recognize symptoms while receiving the passive SLR test. LBP with sciatica distal to the knee joint was observed in 24 (34.8%) participants, symptoms proximal to the knee were 21 (30.4%) participants while 11 (15.9%) participants reported localized LBP symptoms.

The negative MRI group consisted of 42 participants. Their mean age, weight, height, and BMI were 44.1±9.5 years, 79.3±12.0 kilograms, 1.70±0.1 meters, and 32.2±6.1 respectively. They demonstrated either discogenic lesions in the upper lumbar vertebrae n= 8(19.5%) or other pathologies such as degenerative changes or facet joint arthropathy n=17(41.4%). The rest of the participants in this group had normal MRI findings n=17(41.4%).

Both groups were similar at baseline in terms of age, weight, height, and BMI. P-values were 0.072, 0.751, 0.118, and 0.504 respectively.

Considering the entire sample, the sensitivity of the passive SLR test was 0.77 (95% CI 66.55-86.33), and its specificity was 0.81 (95% CI 65.88-91.40). The positive and negative likelihood ratios were 6.75 and 0.47 respectively (Table 1).

### Table 1. 2X2 Cross Tabulation Table and Diagnostic Analysis for the Passive SLR Test

<table>
<thead>
<tr>
<th></th>
<th>+ve MRI</th>
<th>-ve MRI</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ve passive SLR</td>
<td>A = 54</td>
<td>B = 8</td>
<td>A+B= 62</td>
</tr>
<tr>
<td>-ve passive SLR</td>
<td>C = 16</td>
<td>D = 34</td>
<td>C+D= 50</td>
</tr>
<tr>
<td>Total</td>
<td>A+C= 70</td>
<td>B+D= 42</td>
<td>A+B+C+D= 112</td>
</tr>
</tbody>
</table>

Diagnostic analysis:
- Sensitivity: 54/70 (77.1%), CI (66.55-86.33)
- Specificity: 34/42 (81.0%), CI (65.88-91.40)
- Accuracy: 80.95 CI (72.45-87.76)
- Positive likelihood ratio: 54/8 (6.75)
- Negative likelihood ratio: 16/34 (0.47)
- Z statistics= 5.48 % p<0.0001

The ROC curve demonstrated significant fair sensitivity and specificity of the passive SLR test in detecting compression of the lower lumbar nerve roots where the curve was shifted toward the upper-left corner, the area under the curve was 0.775, p< 0.001, and 95% CI between 0.684 and 0.867 (Figure 2).
DISCUSSION
This study was conducted to assess the specificity, sensitivity, and accuracy of the passive SLR test in the diagnosis of lower lumbar nerve root compression with radicular pain. The results suggest that the passive SLR test has a high level of sensitivity, specificity, likelihood ratios, and accuracy.

Although some researchers argue that a specific sample size should be studied in order to obtain accurate results in diagnostic studies, the literature varied widely in terms of sample size; a large number of participants (n=2352) were investigated in Capra study, while a small number (n=33 and 75) was included in two other studies. A medium number of participants (n> 200) were included in two previous studies as well as the current study.

The current study supports the high sensitivity value (82.8%) reported by Omar and colleagues. Another study reported a high association between the positive SLR test and the reference test (MRI findings) where the degree of sensitivity of the SLR test demonstrated a significant decline with the increase in age. Of 269 patients with positive MRI findings, a positive passive SLR test was evident in 100% of patients aged 10 -19, and 87% of patients aged 20-29, while in patients aged 30-39, the test was positive in only 82%. One of the reasons for this decline was because of the difference in age-related changes in bones and nerve tissues: while bones decrease in length, the nerve tissue remains the same. This put less tension on the sciatic nerve while applying the passive SLR test for older people.

On the other hand, a low sensitivity value was reported by Capra and colleagues where a retrospective study was conducted to assess the validity, sensitivity, and specificity of the SLR test in a group of patients having lumbar disc herniation with sciatica. Additionally, two studies tested the sensitivity of the SLR test in comparison to the slump test. Majlesi and colleagues found that the sensitivity of the SLR test was lower than the slump test, while M’Kumbuzi and colleagues reported higher sensitivity of the SLR test compared to the Slump test. These differences might be attributed to the variation in the sample size used in both studies. Additionally, the participants in Majlesi study were conducted on acute or sub-acute stages of lumbar disc herniation (< 3 months) while the stage of pathology was not clearly stated in M’kumbuzi study.

There was a consensus regarding the specificity of the SLR test when MRI was used as a reference test. The current study as well as two previous studies reported high specificity values between 74 and 87%. On the other hand, inconsistent results were reported when the specificity of the SLR test was compared to the Slump test: Majlesi and
colleagues\textsuperscript{8} reported slightly high specificity in favor of the passive SLR test while M’Kumbuzi and colleagues reported low specificity.\textsuperscript{16}

The positive likelihood ratio of the passive SLR test in the current study was high, which agreed with that reported by Capra et al.\textsuperscript{8} Meanwhile, the high value of the negative likelihood ratio reported by Capra et al contradicts the value reported in the current study.\textsuperscript{8} The likelihood ratios were not considered in the other studies.\textsuperscript{16,20}

The results of the current study could be attributed to the standardized method and clear steps used to conduct the SLR test. According to Pesonen and colleagues, the need to increase the diagnostic accuracy of the passive SLR test necessitates applying consistent procedures with well-known steps such as ankle dorsi flexion and neck flexion. Without these steps, the results of the test could be hyperinflated due to symptoms related to muscular tightness.\textsuperscript{3}

The study conducted by Capra et al did not consider steps such as dorsiflexion or head flexion,\textsuperscript{8} and another study did not explain the exact procedures of the SLR test.\textsuperscript{20} Biomechanically, the passive SLR test places tensile force mainly on the lower lumbar spine [L5, S1 nerve roots] compared to much less stress on the upper lumbar segments, so the procedure might be considered selective to lesions in this area.\textsuperscript{9}

Due to the complexity of the presentation of low back dysfunction, most of the patients came with a unique pattern of symptoms. We advise the health care professionals to use the patient recognition of elicited symptoms along with the MRI findings to diagnose the lower lumbar nerve root compression. This decision should also depend on other information obtained from history and other clinical examinations.

Limitations
The sample size for this study was small, which might affect the accuracy of the results. Another limitation is that most of the participants seen in clinical practice rarely experience single spinal-level involvement; cases usually demonstrate complex presentations such as soft tissue limitation, joint stiffness, and degenerative disc disease. All these presentations might affect the lumbar spine mechanics and affect the results of the SLR test. The current study used MRI reports as a reference test against which the results of the passive SLR test were evaluated. However, an MRI can sometimes give false-positive findings.\textsuperscript{8}

CONCLUSION
The passive SLR test, as performed in this study, is a useful clinical test that can be used to determine lower lumbar nerve root compression.
DIAGNOSTIC ACCURACY OF THE PASSIVE STRAIGHT LEG RAISE TEST

References


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