The Sensitivity and Specificity of the Slump and the Straight Leg Raising Tests in Patients With Lumbar Disc Herniation

Javid Majlesi, MD, Halit Togay, MD,† Halil Ünalan, MD,‡ and Sadık Toprak, MD§*

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Background: An accurate and specific diagnosis prevents the recurrences of low back pain and chronic spinal pain. The physical examination is the most useful tool to diagnosis. The examiner must aim to determine the exact tissue that pain arises from to make the specific diagnosis. Lumbar disc herniation is 1 disease that physical examination, symptoms, and findings on imaging technique do not always correlate with each other. The Straight Leg Raising (SLR) test has been used as the primary test to diagnosis lumbar disc herniations and found to have high correlation with findings on operation since its sensitivity is high in only disc herniations leading to root compression that may eventually need operation. More sensitive test, like the Slump, might be used in herniations in which the SLR is negative. The Slump test is really a variant of the SLR and the Lasègue's tests performed in the seated position and is a progressive series of maneuvers designed to place the sciatic nerve roots under increasing tension. At each step in the procedure, the patient informs the examiner what is being felt and whether radicular pain is produced. As a result, the Slump test applies traction to the nerve roots by incorporating spinal and hip joint flexion into the leg raising and would warn the examiner of the presence of nerve root compression when there is a negative SLR test.

Objectives: This study measured the sensitivity and specificity of the Slump test and compare it with the SLR test in patients with and without lumbar disc herniations.

Methods: A prospective case control study of 75 patients with complaints suggestive of lumbar disc herniation was carried out in the outpatient clinics of the neurosurgery department of a state teaching hospital. Seventy-five referred or self-admitted patients with low back, leg, or low back and leg pain who had results of magnetic resonance imaging (MRI) of the lumbar spine were included in the study. Thirty-eight patients had signs of herniation demonstrated by MRI. Control patients (n = 37) had no disc bulges or herniations on MRI. Both the Slump and SLR tests were performed during the assessment of all the patients by the second author. The MRI results were assessed and recorded by the first author.

Results: The Slump test was found to be more sensitive (0.84) than the SLR (0.52) in the patients with lumbar disc herniations. However, the SLR was found to be a slightly more specific test (0.89) than the Slump test (0.83).

Conclusion: The Slump test might be used more frequently as a sensitive physical examination tool in patients with symptoms of lumbar disc herniations. In contrast, owing to its higher specificity, the SLR test may especially help identify patients who have herniations with root compression requiring surgery.

Key Words: lumbar disc herniation, Slump test, Straight Leg Raising test, low back pain, physical examination

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Regardless of the diagnosis and cause, low back pain occurs commonly. Multiple authors note extremely high rates of lifetime prevalence, ranging up to 75% to 85%, and a 5% annual incidence. Low back pain has been reported as the most frequent cause of disability for individuals less than 45 years old. Low back pain is among the most common reasons for visiting a primary care physician, and about 7% of the patients in a primary care practice will consult their physician due to low back pain in a single year. The lumbar spine is also a frequent site of injury in many sports, including gymnastics, football, weightlifting, wrestling, tennis, golf, and dance.[1]

For what is often thought of as a benign problem, the variability in the rates of health care utilization among different practitioners, regions, and even countries is sobering.[1]

The reference to "nonspecific" spinal pain is commonly encountered in the literature. The ambiguity of this term is apparent. Does it imply that there is no easily identifiable source of pain or is the implication that there is no pathology? The interpretation and correlation of advanced imaging test results also must be made carefully because a relatively large proportion of disc abnormalities, including degenerative changes and disc protrusions, have been demonstrated in asymptomatic people.[1]

Algorithms have been developed to assist with diagnosis. These approaches to spinal pain are particularly useful in establishing a diagnosis of a nonmechanical etiology (e.g.,

From the *Formed PM&R Center, İstanbul, Turkey; †SSK İstanbul Education Hospital, İstanbul, Turkey; ‡Istanbul University, Cerrahpaçsa Medical Faculty, Physical Medicine and Rehabilitation Department, İstanbul, Turkey; and §Gazi Osman Paçsa University, Forensic Pathology Department, Tokat, Turkey.

Reprints: Dr. Javid Majlesi, Fromed PM&R Center, Vali Konaðı Cad., Bina Pasaj Ap, 73/2, Nişantaşı, İstanbul 34365, Turkey. E-mail: javidmajlesi@yahoo.co.uk.

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tumor or infection) or in identifying surgical emergencies (e.g., cauda equina syndrome) but unfortunately fall short in evaluating disorders of the spinal motion segment.[1]

There are many arbitrary ways of categorizing disorders of the spine (e.g., biomechanical and biochemical, surgical and nonsurgical, acquired and congenital), and clearly ruling out serious medical problems is of paramount importance. Whether an absolute diagnosis for mechanical spinal pain is required is debatable and may not even be obtainable despite the expertise of the medical provider.[1]

Medical frustration with this commonly transient yet occasionally chronic entity is illustrated by up to a 9-fold variation in use of evaluation and treatment modalities in different regions of the United States (up to a 10-fold variation in different counties in the state of Washington).[2]

There are some examination tests that are universally used to distinguish pain originating from compression of neural tissues from other types of pain regardless of the discipline. The Straight Leg Raising test (SLR) is widely used as 1 of the primary diagnostic physical examination tests, in patients who have low back or low back and leg pain. The test is performed with the patient lying in a comfortable position with the head and pelvis flat. While full knee extension is maintained, 1 of the patient's feet is slowly lifted off the table. The limb is progressively elevated until maximal hip flexion is reached or the patient asks the examiner to stop owing to pain. The angle formed by the lower limb and the examination table at the point of maximal elevation is noted, and the procedure is repeated with the opposite limb.[3]

In a normal patient, straight-leg-raising of 70° to 90° should be possible and may be accompanied by a feeling of tightness in the posterior thigh. In the presence of sciatica, the angle of hip flexion is reduced and the patient reports shooting pain radiating down the posterior thigh and often into the lower leg along the distribution of the sciatic nerve. Straight-leg-raising stretches the L5 and S1 nerve roots 2 mm to 6 mm, but it puts little tension on the more proximal (L2, L3, and L4) nerve roots. An abnormal straight-leg-raising test, therefore, suggests a lesion of either the L5 or the S1 nerve root. Beyond 70° of hip flexion, deformation of the sciatic nerve—not all the nerve roots occurs beyond the spine. Sciatic pain that is reproduced only with hip flexion beyond 70°, therefore, suggests the possibility of sciatic nerve compression outside the spinal canal.[3]

The Slump test is really a variant of the SLR and the Lasègue's tests performed in the seated position. The Slump test is a progressive series of maneuvers designed to place the sciatic nerve roots under increasing tension. The patient begins the Slump test sitting on the side of the examination table with the back straight, looking straight ahead. The patient is then encouraged to slump, allowing the thoracic and lumbar spines to collapse into flexion while still looking straight ahead. The next step is to fully flex the cervical spine. The patient is then instructed to extend 1 knee, thus performing a straight-leg raise. The patient then dorsiflexes the foot on the same side, thus duplicating the Lasègue test. At each step in the procedure, the patient informs the examiner what is being felt and whether radicular pain is produced. Many normal individuals feel tightness in the lower back and the thigh with this series of maneuvers. Reproduction of familiar radicular pain, as in the SLR, Lasègue, and crossed SLR tests, is highly suggestive of sciatic nerve root tension. Subsequent extension of the neck relaxes the spinal cord and may thus relieve nerve tension. The process is then repeated with the opposite lower extremity.[3,4]

The Slump test might be preferred over the better known SLR test for several reasons. First, the Slump test is more sensitive because it adds cephalad gliding of the spinal cord, while the SLR maneuver only offers caudal gliding of the nerve roots. Second, the Slump test adds specificity because neck flexion and extension help distinguish motion restrictions in neural tissue from other soft tissue inflexibilities. Using the Standard SLR test, it is often difficult to distinguish between adverse neural tension and hamstring or gastrocnemius tightness.[5]

Both the Slump and the SLR tests elicit pain in the presence of lumbar disc herniation due to the traction of the involved nerve root. The SLR applies traction primarily to L5 and S1 roots. The Slump test in contrast, may apply further traction to all the lumbar roots. The examiner applies traction during the SLR test by hip flexion and knee extension. During the Slump test, further traction is applied by additional hip flexion and spinal flexion.[6]

On magnetic resonance imaging (MRI) disc herniations may be suspected on sagittal images but must be confirmed on axial sequences. These may range from a focal bulge in the disc contour resulting in compression of epidural fat and mass effect to disc protrusions where significant herniation of the nucleus pulposus is still confined to the outermost layers of the annulus pulposus. Once the nucleus has ruptured completely through the annulus (disc extrusions) it is free to extend above or more frequently below the level of the interspace.[7]

There are not many studies done on the sensitivity and specificity of the Slump test. The main reason could be the fact that the SLR is the test taught and performed as the primary tool,[8] and is routinely and by itself applied. This may also have been originated from intrarater and interrater reliability issues related to both the Slump and SLR tests.

Furthermore, the SLR bears characteristics such as inevitable pelvic and hip joint motion, and hamstrings tightness that are the factors not clarified enough and may limit the usefulness of the SLR. There is no standard procedure and also no consensus on the interpretation of the results.[9]

We have been doing the Slump test during our routine physical examinations since 1995. In this study, we investigated the sensitivity and the specificity of both the Slump and the SLR tests in a prospective study and also tried to test the hypothesis that the Slump test is a more sensitive test.

METHODS

Participants

Seventy-five patients with complaints of acute or recurrent low back, leg, or low back and leg pain of no more than 12 weeks duration who had undergone MRI of the

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lumbar spine were included in the study. The exclusion criteria were detection of pain originating from the hip or sacroiliac joints during examination, radiologic evidence of spondylolisis and/or spondylolisthesis, coexistence of diabetes, cardiac, and/or pulmonary disease, and being on medications during the first visit.

The group with abnormal MRIs consisted of 38 referred or self-admitted patients seen at the outpatient clinic of the Department of Neurosurgery of Istanbul SSK Education Hospital during first half of 2005. All the patients were examined by the second author.

The control group with no disc bulges or herniations consisted of 37 referred or self-admitted patients seen at the outpatient clinic of the Department of Neurosurgery of Istanbul SSK Education Hospital during first half of 2005. All the patients were seen by the second author.

Procedure

An informed consent was signed by all the participants. The study was approved by the ethics committee of the institution. All the patients' detailed histories encompassing the information on the complaints, systems, and prior medical history were recorded. A physical examination that included assessment of the spine, hip and sacroiliac joints, and also Slump and SLR tests were done. Both the tests were done on both sides according to the methods described above. During the SLR, the angle between the examination table and the patient's leg was measured by a goniometer and recorded. MRI of the lumbar spine was ordered for the patients who had not already undertaken the procedure. The MRI results were assessed by the first author. Thus, the second author who did the physical examinations was blind to the imaging techniques results.

Data Analysis

The data was entered and analyzed in Epi Info 2000. Continuous data has been shown as mean and standard deviation.

RESULTS

The abnormal MRI group consisted of 38 patients. The subjects included 8 females and 30 males. The mean age was 38.08 ± 9.63 years. The presenting complaints were low back, leg, or low back and leg pain. The time of the onset of the present complaints was less than 6 weeks before the admissions. However, the mean symptom duration was 5.40 ± 3.62 days. All the patients had positive MRI findings but at different levels: 12 (31.5%) herniations at the L5–S1 level, 23 (60.5%) herniations at the L4–L5 level. Herniation types were as follows: 1 (2.6%) bulging, 12 (31.5%) protrusions, 4 (10.4%) extrusions, 1 (2.6%) bulging and extrusion, 13 (34.2%) protrusions and root compressions, and 7 (18.4%) extrusions and root compressions. One (2.6%) patient had low back, 6 (15.8%) had low back and leg pain, and 31 (81.6%) had leg pain. Upon examination, 27 (71.05%) patients in the study group displayed spinal flexion as the most painful range of motion direction. Among these 27 patients 21 (77.7%) had positive Slump and SLR results.

The control group consisted of 37 patients. The subjects included 12 females and 25 males. The mean age was 40 ± 9.14 years. The presenting complaints were low back, leg, or low back and leg pain. The time of the onset of the present complaints was less than 6 weeks before the admission. However, the mean duration since the onset of symptoms was 5.48 ± 3.37 days. All the patients had no disc bulges or herniations on MRI.

When all the patients were considered, the sensitivity of the Slump test was 0.84 in a confidence interval between 0.74 and 0.90, and its specificity was 0.83 in a confidence interval between 0.73 and 0.90. The sensitivity of the SLR test was 0.52 in a confidence interval between 0.42 and 0.58, and its specificity was 0.89 in a confidence interval between 0.79 and 0.95.

These make the positive predictive values of the Slump and the SLR 0.84 (confidence interval: 0.74–0.90), and 0.83 (confidence interval: 0.0.67–0.92), respectively. And the negative predictive values will be 0.83 (confidence interval: 0.73–0.90) and 0.64 (confidence interval: 0.57–0.69), respectively.

When the patients with herniations at the L5–S1 level were considered, the sensitivity of the Slump test was 0.91 with a positive predictive value of 0.64, and its specificity was 0.90 with a negative predictive value of 0.98; the sensitivity of the SLR test was 0.75 with a positive predictive value of 0.56, and its specificity was 0.95 with a negative predictive value of 0.94.

When the patients with herniations at the L4–L5 level were considered, the sensitivity of the Slump test was 0.78 with a positive predictive value of 0.75, and its specificity was 0.88 with a negative predictive value of 0.90; the sensitivity of the SLR test was 0.78 with a positive predictive value of 0.72, and its specificity was 0.86 with a negative predictive value of 0.90.

Comparing the patients with protrusions leading to root compression, we also found different sensitivity levels. The sensitivity of the Slump test was 0.84 with a positive predictive value of 0.64 in the patients with root compressions, and its specificity was 0.90 with a negative predictive value of 0.96; the sensitivity of the SLR test was 0.84 with a positive predictive value of 0.61, and its specificity was 0.88 with a negative predictive value of 0.96.

DISCUSSION

Our results show that both the Slump and the SLR tests had similar rates of specificity, but Slump was found to be more sensitive in the study group and also in its subgroups.

When the subgroups were considered, the Slump test was found more sensitive, comparing to SLR, in the L5–S1 disc herniations than in the L4–L5 herniations. But both tests were found equally specific in these subgroups. This may support the idea that the Slump test applies more traction to more neuromeningeal tissues[6]; but may degrade the fact that the SLR applies traction primarily to the L5 and S1 roots.[6]

The SLR test has been found highly correlated with findings on lumbar disc operations.[10,11] But is the correlation also as high in patients with disc herniations not requiring

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surgery? The answer may be negative, as we found the Slump to be more sensitive in herniations not leading to root compressions. SLR is more sensitive in patients with protrusions leading to root compression comparing to its sensitivity in the patients with solely protrusions. These findings also may imply, again, that the Slump test applies more traction to the neuromeningeal tissues.[6]

Care must be taken not to consider pain originating from the hamstrings, the hip, or the sacroiliac joint as the pain originating from neural tissues. The problem of false positive results inherent to SLR can be reduced by presuming the tissue that the pain has been originated from. Mc Combe et al. reported that signs of root tension showed better agreement upon, when qualified with a description of where the pain was experienced.[12] The fact that "the patient's response to the pain evoked by the SLR test is not uniform, and that muscle action potentials recorded during SLR and intentional resistance during the SLR test are different"[8] makes interpretation difficult in many patients. But findings in a study done by Kostelijanets et al. showed that there were considerable interobserver variation among 3 observers concerning the measured angle at which pain was elicited during application of SLR. Some discordance also was found in the classification of the type of pain that was elicited.[13] As it is true for most of the examination tests, this requires constant communication between the physician and the patient. Hamstrings tightness and/or pain also can limit the usefulness of the Slump test. However, this can be verified by the cervical component of the test.[6] Johnson and Chiarello reported that hamstrings tightness and pain, and limitation in the terminal extension range of the knee can be considered normal, during the Slump test, in the population without LDH.[14] This limitation was found to be confounded by cervical flexion and ankle dorsiflexion.[15]

The limitations in the usefulness of the SLR have been the topic of many investigations over the years. The most sophisticated of them may be using "instrumental leg raising test to determine the extensibility and elasticity of the hamstring and the back muscles, and pelvic rotation in patients with LDH and in the normal population"[16,17] to determine the degree of movement in these tissues during the SLR, and provide a better basis for the interpretation of the test results.

The hamstrings are a limiting factor during the application of the SLR test, but there is no certain way to verify this. Medial hip rotation is another limiting factor during SLR. If uncontrolled, medial hip rotation reduces the value of SLR and increases tension and neurologic signs.[18] Bohannan et al. used cinematography during application of SLR and found that pelvic rotation accompanies hamstrings tightness and should be taken into account.[19] Hamstrings tightness was reported, by Yamada and Yashizawa, to be found more frequently in the L5–S1 herniations, and gluteus maximus tightness to be found more frequently in the L4–L5 herniations. Positive SLR results, in lower degrees, due to hamstrings tightness can be resolved after reapplication under general anesthesia.[8] The role of hip flexion and rotation during the SLR test is unclear but can be detrimental.[18] The same applies to hamstrings tension limiting the degree to which the leg can be raised.[8]

Rebain et al in their review article reported SLR to be highly specific, and viewed it as a test to be more reliable as a tool for differential diagnosis. They also reported that little recognition is present upon the fact that a negative SLR may be of greater diagnostic value.[9] In another review article, Vroomen et al. reported the pooled sensitivity of SLR to be 85%, and specificity was found to be 52%. The authors concluded that SLR sensitivity has been overestimated and its specificity underestimated.[20] Both these review articles' findings are parallel to ours.

The above-mentioned factors may, to some degree, limit the usefulness of the SLR test in patients with hip and hamstrings pain accompanying lumbar disc herniation. The positioning of the patient during application of the Slump may prevent unwanted hip joint and pelvis motion; but however similar to SLR, some degree of hamstring tightness may also be inevitable during the Slump. However, the Slump test incorporates total spinal flexion in the traction of the involved root. This may be valuable in patients with positive SLR tests at higher degrees, and also in patients with negative SLR results.

The cervical component of the Slump test, as reported by Stankovic et al., affects the hamstring muscles and can confound the differential diagnosis,[21] and may be useful in eliminating the causal link between the hamstring tightness and a positive Slump result.

Overall, the results of this study show that the Slump test, by being more sensitive, may be a valuable tool for suggesting a diagnosis, may have been overlooked over the years, and could be used extensively. The results of extensive researches done on SLR, in contrast, may imply that it may have been overestimated over the years and may be a tool more useful in differential diagnosis, and in the diagnosis of the larger herniations requiring operation.

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