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Accuracy of Straight Leg Raising Test in the Clinical Diagnosis of Lumbar Disc Herniation

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ABSTRACT

Background: Low back pain is a common reason for medical consultation, though only 1–3% of cases result from lumbar disc herniation. Despite MRI being the diagnostic gold standard, its high cost and limited availability in Bangladesh restrict routine use. The straight leg raising (SLR) test is a simple clinical tool for suspected lumbar disc herniation, but its diagnostic accuracy varies widely across studies. Therefore, this study aimed to evaluate the diagnostic accuracy of the SLR test in the clinical diagnosis of lumbar disc herniation. **Methods & Materials:** This cross-sectional observational study was carried out in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, from October 2016 to April 2018. Ninety patients with low back pain and unilateral or bilateral sciatica were included. Following clinical evaluation, the straight leg raising (SLR) test was performed in the supine position, with pain below 70° considered positive. MRI of the lumbosacral spine served as the reference standard. Data were analyzed using SPSS version 23, and sensitivity, specificity, predictive values, accuracy, Fisher's exact test, and ROC analysis were calculated, with $p < 0.05$ considered statistically significant. **Results:** The mean age was 40 ± 11.1 years, with male predominance (2.2:1). Disc herniation most commonly involved the L4–L5 level (54.9%). The SLR test demonstrated sensitivity 87.8%, specificity 75.0%, positive predictive value 97.3%, negative predictive value 37.5%, and overall accuracy 86.7%. A significant association was found between SLR results and MRI findings ($p < 0.05$). **Conclusion**: The SLR test is a reliable clinical tool for diagnosing lumbar disc herniation, while MRI may be reserved for confirmation, especially when surgery is planned.

Keywords: *Low back pain; Lumbar disc herniation; Straight leg raising (SLR) test; Magnetic resonance imaging (MRI); Diagnostic accuracy; Sensitivity and specificity; Sciatica*

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Introduction

Low back pain is the second most common reason for people to seek medical attention. Of them only 1–3% of patients have lumbar disc herniation. Work activities including bending and twisting that are frequently used in daily life, inappropriate weight lifting, awkward static posture and psychological stress are the causal factors in development of herniated lumbar disc [1]. The most common symptom associated with herniated lumbar disc (HLD) is low back pain and second most common symptom is sciatica. Features suggestive of sciatica are unilateral or bilateral leg pain radiating along the posterolateral aspect of thigh and leg down to the heel and toes. Sciatic pain aggravates on standing, walking, bending, straining and coughing [2]. Other symptoms of herniated lumbar disc are sensory disturbances in legs, claudication and lower limb weakness [3]. Large lumbar disc herniation may also cause bladder-bowel involvement i.e. cauda equina syndrome [4]. A key physical sign in the diagnosis of lumbar disc herniation is the demonstration of nerve root tension signs. These include straight leg raising test (Lasègue's sign or Lasègue test), crossed straight leg raising test, femoral stretch test (reverse straight leg raising test), sitting knee extension test, cram test, slump test etc. The straight leg raising (SLR) test is frequently used by the physicians for evaluation of patients with low back pain & for making decisions about diagnostic imaging or hospital referral [5]. Straight leg raising test is performed with the patient lying in a comfortable position with the head and pelvis flat. While full knee extension is maintained, one of the patient's legs 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. If the patient experiences sciatic pain when the straight leg raises at an angle of below 70 degrees, the test is considered positive and a herniated lumbar disc is a possible cause of the pain [6,7]. Among the various imaging modalities used in clinical practice, MRI provides excellent soft tissue images and is particularly helpful for imaging of the brain and spinal cord. MRI has a higher sensitivity and is more specific than X-ray imaging, CT scans and myelography for diagnosing a disc herniation. MRI helps to establish disc herniation as the anatomical basis for sciatica [8]. Sagittal views clearly demonstrate the cord, thecal sac indentation & the level of disc herniation. Axial views show the nature of disc herniation and the degree of nerve root compression. MRI is 94.28% sensitive, 60% specific and shows an accuracy of 90% for lumbar disc herniation [9]. The sensitivity & specificity

of straight leg raising test remains controversial. In 1999, Vroomen et al. reported the sensitivity and specificity of SLR test as 85% and 52% respectively [10]. Devillé et al. also found that sensitivity of SLR test was 91% and specificity was 26% [11]. On the other hand, Majlesi et al. found that the sensitivity and specificity of this test was 52% and 89% respectively [6]. Capra et al. also reported that sensitivity of SLR test was 36%, whereas specificity was 74% [12]. Omar et al. found sensitivity, specificity & accuracy of SLR test were 82.8%, 87.4% and 84.9% respectively and concluded that SLR test is accurate enough to diagnose disc herniation with reference to MRI [13]. Capra et al. showed low accuracy of the SLR test in diagnosing disc herniation [12]. Thelander et al. found no correlation between disc protrusion size, shape, or location and degree of SLR restriction [14]. Considering these studies and as there was no previous study in our country regarding this issue, it is necessary to re-evaluate the accuracy of this test in clinical diagnosis of lumbar disc herniation.

Methods & Materials

This cross-sectional observational study was conducted from October 2016 to April 2018 in the outpatient department of the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka. A total of 90 patients of any age and sex presenting with low back pain associated with unilateral or bilateral sciatica were enrolled in this study using purposive sampling technique based on predefined inclusion and exclusion criteria. Patients with prior lumbar surgery, spinal trauma, infection, tumor, spondylolisthesis, active spondyloarthritis, hip pathology, upper lumbar disc herniation (L1–L3), isolated back pain and without MRI of the lumbosacral spine were excluded. After obtaining informed written consent, demographic and clinical data were collected through structured data sheets. Clinical evaluation comprised standard history taking, physical examination, and straight leg raising (SLR) and crossed SLR tests. The SLR test was conducted in the supine position using a goniometer, and pain radiating distal to the knee at an angle <70° was regarded as a positive result. The collected data were analyzed using Statistical Package for Social Sciences (SPSS) version 23.0. Descriptive statistics were expressed as mean ± SD or frequencies and percentages; Fisher's exact test was applied where appropriate, and sensitivity, specificity, predictive values, accuracy, and area under the ROC curve of the SLR test were calculated, considering a p-value <0.05 as statistically significant.The ethical clearance of this study was obtained from Instituitional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, Bangladesh.

Results

A total of 90 patients were included in the study.

Table I shows the majority of patients belonged to the 31–40 years age group (35, 38.9%), followed by 41–50 years (22, 24.4%), 51–60 years (14, 15.6%), and 21–30 years (13, 14.4%). Patients aged 10–20 years and above 60 years constituted 4 (4.4%) and 2 (2.2%) cases respectively. Regarding gender distribution, 62 (68.9%) patients were male and 28 (31.1%) were female, with a male-to-female ratio of approximately 2.2:1.

Table I
Demographic characteristics of the study population (*n* = 90).

Age group (years)	Frequency	Percentage (%)
10–20	4	4.4
21–30	13	14.4
31–40	35	38.9
41–50	22	24.4
51–60	14	15.6
>60	2	2.2
Gender		
Male	62	68.9
Female	28	31.1

Table II shows service holders constituted the largest group (30, 33.3%), followed by housewives (26, 28.9%) and businesspersons (14, 15.6%). Farmers and laborers accounted for 8 (8.9%) patients each, while students comprised 4 (4.4%). BMI assessment showed that half of the patients were overweight (45, 50.0%). Normal BMI was observed in 38 (42.2%) patients, while 6 (6.7%) were obese and only 1 (1.1%) patient was underweight.

Table II
Occupational and BMI distribution of patients (*n* = 90).

Occupation	Frequency	Percentage (%)
Service	30	33.3
Housewife	26	28.9
Business	14	15.6
Farmer	8	8.9
Laborer	8	8.9
Student	4	4.4
BMI category		
Underweight (<18.5)	1	1.1
Normal (18.5–24.9)	38	42.2
Overweight (25.0–29.9)	45	50
Obese (≥30)	6	6.7

Table III shows clinical features of the patients; Lumbago was present in 88 (97.8%) patients. Sciatica was observed on the right side in 39 (43.3%), on the left side in 40 (44.4%), and bilaterally in 10 (11.1%) patients. Tingling or numbness was present

in the right lower limb in 29 (32.2%), left lower limb in 32 (35.6%), and bilaterally in 5 (5.6%) patients. Lower limb weakness was noted in 14 (15.6%) cases, and urinary symptoms were reported by 2 (2.2%) patients. Pain was aggravated by standing or walking in 87 (96.7%) patients, bending forward in 80 (88.9%), coughing or straining in 73 (81.1%), and sitting in 67 (74.4%). Pain relief on lying flat was reported by 72 (80.0%) patients.

Table III
Clinical presentation and pain characteristics (n = 90).

Clinical features	Frequency	Percentage (%)
Lumbago	88	97.8
Sciatica – Right	39	43.3
Sciatica – Left	40	44.4
Sciatica – Bilateral	10	11.1
Tingling/numbness – Right LL	29	32.2
Tingling/numbness – Left LL	32	35.6
Tingling/numbness – Bilateral	5	5.6
Lower limb weakness	14	15.6
Urinary symptoms	2	2.2
Pain aggravated by standing/walking	87	96.7
Pain aggravated by bending forward	80	88.9
Pain aggravated by coughing/straining	73	81.1
Pain relieved by lying flat	72	80

Table IV shows gait assessment revealed that most patients had an antalgic gait (72, 80.0%), while normal gait was observed in 14 (15.6%) and high-stepping gait in 4 (4.4%) patients. Motor system examination showed right lower limb weakness in 35 (38.9%) patients and left lower limb weakness in 53 (58.9%). Muscle wasting was present in 4 (4.4%) patients, and foot drop was observed in 4 (4.4%) cases.

Table IV
Gait and neurological motor examination findings (n = 90).

Finding	Frequency	Percentage (%)
Gait		
Antalgic	72	80
Normal	14	15.6
High stepping	4	4.4
Motor deficit (any muscle group)		
Right lower limb weakness	35	38.9
Left lower limb weakness	53	58.9
Muscle wasting	4	4.4
Foot drop	4	4.4

Table V shows sensory loss was most frequently observed in the S1 dermatome (52, 57.8%), followed by the L5 dermatome (49, 54.4%). Saddle area sensory loss was present in 2 (2.2%) patients. Regarding deep tendon reflexes, reduced or absent ankle jerk was observed in 29 (32.2%) patients, while reduced or absent knee jerk was found in 5 (5.6%) cases.

Table V
Sensory and deep tendon reflex findings (n = 90).

Neurological finding	Abnormal n (%)
Sensory loss (L5 dermatome)	49 (54.4)
Sensory loss (S1 dermatome)	52 (57.8)
Saddle area sensory loss	2 (2.2)
Reduced/absent knee jerk	5 (5.6)
Reduced/absent ankle jerk	29 (32.2)

Table VI shows MRI of the lumbosacral spine was performed in 82 patients. Disc herniation was most commonly observed at the L4–L5 level in 45 (54.9%) patients, followed by L5–S1 in 28 (34.2%). Herniation at the L3–L4 level was found in 2 (2.4%) patients, while 7 (8.5%) patients had multilevel disc herniation.

Table VI
MRI findings and level of disc herniation (n = 82).

MRI level	Frequency	Percentage (%)
L3–L4	2	2.4
L4–L5	45	54.9
L5–S1	28	34.2
Multiple levels	7	8.5

Table VII shows the diagnostic performance of the straight leg raising (SLR) and crossed SLR tests, the SLR test demonstrated a sensitivity of 87.8%, specificity of 75.0%, positive predictive value of 97.3%, negative predictive value of 37.5%, and an overall diagnostic accuracy of 86.7%. In contrast, the crossed SLR test showed lower sensitivity (22.0%) but higher specificity (87.5%), with a positive predictive value of 94.7%, negative predictive value of 9.9%, and overall accuracy of 27.8%. The SLR test showed a statistically significant association with MRI-confirmed lumbar disc herniation (Fisher's exact test, p = 0.0003), whereas no significant association was observed for the crossed SLR test (p = 1.000).

Table VII
Diagnostic performance of SLR and crossed SLR tests.

Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Straight leg raising (SLR)	87.8	75	97.3	37.5	86.7
Crossed SLR	22	87.5	94.7	9.9	27.8

SLR test showed significant association with MRI-confirmed lumbar disc herniation (Fisher's exact test, p = 0.0003). AUROC for SLR = 0.806.

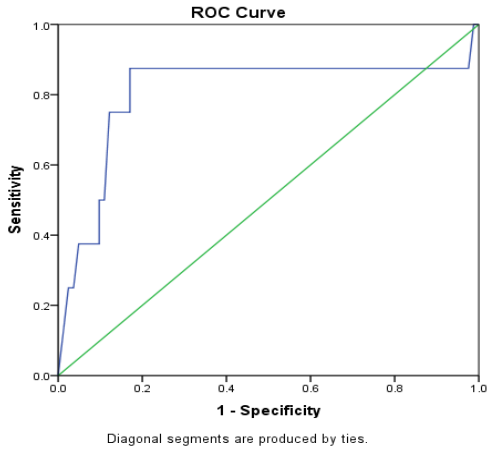

Figure 1 Receiver Operating Characteristic (ROC) curve of SLR test for diagnosis of lumbar disc herniation.

Figure 1 shows receiver operating characteristic (ROC) curve analysis of the SLR test.

Table VIII shows the area under the ROC curve (AUROC) was 0.806 with a standard error of 0.109 and a 95% confidence interval ranging from 0.593 to 1.000. This result was statistically significant (p = 0.004), demonstrating good diagnostic discrimination of the SLR test when compared with MRI findings.

Table VIII
Area under the ROC Curve (AUROC).

Area Under the ROC Curve (AUROC)				
Test Result Variable(s): SLR test				
Area	**Std. Error**	**p value**	**95% CI**	
			Lower Bound	**Upper Bound**
0.806	0.109	0.004	0.593	1

Discussion

The present study evaluated the demographic characteristics, clinical and neurological features, MRI findings, and diagnostic accuracy of the straight leg raising (SLR) and crossed SLR tests in patients with lumbar disc herniation. The findings reinforce the continued clinical relevance of the SLR test as a reliable diagnostic tool when correlated with imaging. Lumbar disc herniation in this study found predominantly affected patients in the 31–50-year age group, with a peak in the fourth decade. This age distribution is consistent with previous reports indicating that disc herniation commonly occurs during the most physically and occupationally active period of life [15, 16]. The marked male predominance (male–female ratio 2.2:1) observed in this study is comparable to findings reported by Kilic and others, suggesting that occupational exposure and mechanical stress may play a significant role in disease development [17]. A large proportion of patients were service holders and businesspersons, reflecting a predominance of sedentary occupations. Prolonged sitting and reduced physical activity have been associated with weakening of paraspinal musculature and increased susceptibility to lumbar disc pathology [18]. Additionally, half of the patients were overweight and a further proportion were obese, supporting existing evidence that increased body weight contributes to lumbar disc herniation by increasing axial spinal load and impairing normal biomechanics [19]. Clinically, almost all patients presented with lumbago, and sciatica was present in the majority, either unilaterally or bilaterally. These findings are consistent with the classical presentation of lumbar disc herniation described in earlier studies [20]. Neurological deficits such as motor weakness, sensory loss in L5 and S1 dermatomes, and diminished ankle reflexes were common, reflecting nerve root compression at commonly affected levels. The small proportion of patients with saddle anesthesia and urinary symptoms likely represents cauda equina syndrome, which

has been reported to occur in approximately 1–2% of lumbar disc herniation cases [21]. MRI findings demonstrated that disc herniation most frequently involved the L4–L5 level, followed by L5–S1, which is in agreement with earlier regional and international studies [22, 23]. These levels are biomechanically more vulnerable due to greater mobility and load-bearing demands. The SLR test in this study showed high sensitivity (87.8%) and good overall diagnostic accuracy (86.7%), with a statistically significant association with MRI-confirmed lumbar disc herniation. These results are comparable to those reported by Vroomen et al. and Rebain et al., who also found high sensitivity of the SLR test, although with variable specificity [24, 25]. Differences in specificity across studies may be explained by variations in patient selection, disease severity, and SLR testing technique. In contrast to some earlier studies reporting low specificity of the SLR test, the present study demonstrated a specificity of 75.0%, which is closer to the findings of Omar et al., who reported balanced sensitivity and specificity when standardized testing methods were applied [26]. The high positive predictive value observed suggests that a positive SLR test strongly indicates the presence of lumbar disc herniation in clinically suspected cases. ROC curve analysis further supported the diagnostic utility of the SLR test, with an AUROC of 0.806, indicating good discriminatory ability. This finding highlights the usefulness of the SLR test as a screening and diagnostic aid, particularly in settings where MRI availability is limited [27]. The crossed SLR test demonstrated high specificity but very low sensitivity and overall accuracy. Similar findings have been reported by Vroomen et al. and Deville et al., who noted that while the crossed SLR test is not suitable for screening, a positive result is highly suggestive of central or large disc herniation [28]. Therefore, crossed SLR should be considered a confirmatory rather than a primary diagnostic test. Overall, the findings of this study support the continued use of the SLR test as a simple, cost-effective, and clinically valuable diagnostic tool for lumbar disc herniation. When interpreted alongside clinical findings and supported by imaging, when necessary, it can significantly aid early diagnosis and appropriate management.

Conclusion

In this study positive straight leg raising (SLR) test associated well with the MRI findings consistent with the lumbar disc herniation but all the negative straight leg raising test didn't exclude presence of lumbar disc herniation on MRI. The accuracy of SLR test was calculated as 86.7%, so it may be concluded that SLR test is accurate enough to diagnose lumbar disc herniation as MRI for the set-ups where MRI is not easily available. The presence of positive straight leg raising test act as a valuable diagnostic tool clinically but other clinical signs and symptoms must be taken into considerations. MRI may not be essential for clinical diagnosis but MRI is indicated for confirmation of diagnosis of lumbar disc herniation when surgery is planned.

Limitations

The study was conducted in a tertiary-level hospital, which may limit the generalize ability of the findings, as the actual incidence and distribution of cases according to age, sex, and occupation in the general population may not be fully represented. Additionally, radiological data were obtained from different sources, and variability among MRI systems and imaging protocols may have influenced the study results.

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