

Diagnostic Accuracy of Bilateral Lower Limb Traction Test in Discogenic Low Back Pain

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Abstract

Background: Low back pain (LBP) is a common reason for pain and disability. Mechanical back pain is considered a common form of LBP, and intervertebral disc pathology is one form of mechanical LBP. Though imaging identifies disc pathology, the image findings must be correlated with the physical examination. Physical examination tests like the SLUMP test and Straight leg raise test are widely used. This study evaluate a new test called the bilateral lower limb traction test (BLTT) as a form of lumbar distraction test to help in diagnosing discogenic low back pain.

Objective: To identify the sensitivity and specificity of the bilateral lower limb traction test with straight leg raise test and slump test.

Design: This is a Cross-Sectional Observational Study that included seventy patients who had LBP for more than two months with an MRI diagnosis of lumbar disc pathology. Clinically, all patients experienced central or unilateral low back pain symptoms with or without radiating pain down to their lower limbs. SLRT, SLUMP test, and BLTT were performed on the patients. BLTT is a new test in which the examiner exerts a longitudinal traction force while the patient is positioned in prone lying.

Result: BLTT was positive on 71.4% of the patients and negative on 28.6% of the patients. Sensitivity, BLTT and SLR showed 70.83% and BLTT and SLUMP was 67.86%. The result demonstrated that BLTT test results correlated significantly with SLR and SLUMP test results.

Conclusion: In this study, BLTT had a good sensitivity with tests like SLR and SLUMP tests. As part of their physical examination, physical therapists must start using BLTT to explore its diagnostic utility.

Keywords: Discogenic Back pain, Bilateral Lower limb traction test, Straight leg raise test, SLUMP test.

1. Introduction

INTRODUCTION

Low-back pain is defined as “pain, muscle tension or stiffness in the region below the costal margin and above the inferior gluteal folds, with or without radiates leg pain”¹. Low-back pain can be classified into two main categories: 1) Nonspecific mechanical low-back pain, which does not have a recognizable known specific cause or pathology, including cases considered to be of mechanical origin²; and 2) Specific non-mechanical low-back pain, associated with a recognizable known specific cause or pathology, such as infection, tumor, fracture, inflammatory process, or radicular syndrome³. Non-specific low back pain is usually categorized as acute, sub-acute and chronic based on duration: less than 6 weeks, 6–12 weeks, and 12 weeks or more, respectively⁴. Common causes of mechanical back pain include spinal stenosis, herniated discs, zygapophysial joint pain, discogenic pain, SI joint pain, and myofascial pain⁵

Low back pain (LBP) is one of the most common reasons for visits to a physician and is the leading cause of disability worldwide^{6,7}. The lifetime prevalence of LBP is 60–80% in adults, with an annual prevalence of 42.5%^{8,9}. The majority of back pain is non-specific or mechanical back pain, representing 97% of overall patients¹². Amongst all the mechanical causes, discogenic pain source is estimated to account for 40–45% of mechanical back pain cases^{13,14}.

The intervertebral disc serves as a main joint between two vertebrae and comprises the nucleus pulposus, annulus fibrosus, and two cartilage endplates¹⁵. Degeneration of the intervertebral disc in the lumbar spine can lead to functional impairment and instability. In response to degeneration, the body initiates a compensatory mechanism aimed at stabilizing the lumbar spine through formation of osteophytes, which may also lead to nerve compression and reduced flexibility¹⁶.

Discogenic pain describes mechanical pain that originates from the intervertebral disc due to desiccation, degradation, radial and circumferential tears¹⁷. Clinical features include pain, acute or recurrent muscle spasm, restricted mobility, functional limitations, and radiating pain with sensory symptoms such as tingling, numbness, and paraesthesia¹⁸.

The diagnosis of discogenic pain remains ambiguous. Provocative discography is considered a diagnostic reference standard, but its invasive nature, cost, need for expertise, and possibility of false-positive results limit its use^{19–21}. Hence, there is a need to rely upon physical examination to diagnose discogenic pain. To date, there are no standard accepted guidelines on physical examination for discogenic pain. Physical examination tests like straight leg raise test (SLR), SLUMP, and prone knee bent test (PKBT) are widely used in mechanical low back pain, lumbar disc pathology, and radiculopathy. Hence, we propose a form of distraction test called bilateral lower limb traction test (BLTT) to find the presence of lumbar disc pathology. The aim of this study is to evaluate BLTT as a form of lumbar distraction test to help in diagnosing discogenic low back pain.

2 Materials and Methods

2.1 Study design

This study was a Cross-Sectional Diagnostic Accuracy Study

2.2 Participants and eligibility criteria

The study was conducted among patients with discogenic low back pain and the data were collected from APTER Physiotherapy Center, RMV Hospital- Bengaluru, Sanjay Gandhi Institute of Trauma & Orthopaedics, Manipal Hospital, Actilife Physiotherapy & Chiropractic Clinic in Bangalore. Ethical approval was obtained from the Ethical Committee team of Rajiv Gandhi University of Health and Sciences (RGUHS), Karnataka before commencement of the study.

The required sample size was calculated using the $2SD^2 (Z_{\alpha/2} + Z_{\beta})^2 / d^2$, where n = Sample Size, $Z_{\alpha/2}$ = Alpha Value (Probability of falsely rejecting a true null hypothesis); 1.96, Z_{β} = Beta Value (power of the test); 0.84, SD = Standard deviation of the outcome: 4.2, d = Size of the effect that is clinically worthwhile to detect; 1.97. Based on these parameters, the required sample size was calculated to be 70 participants. Eligible participants were recruited following screening according to the predefined inclusion and exclusion criteria.

Before enrolment, all participants were informed about the purpose and procedures of the study, including its potential benefits and possible risks. Written informed consent was obtained from each participant before data collection.

2.3 Inclusion criteria

Participants were included if they were diagnosed with discogenic low back pain by a physician/orthopaedist and confirmed by MRI, were male or female, aged 20–60 years, had experienced low back pain for more than two months, and were willing to provide informed consent.

2.4 Exclusion criteria

Participants were excluded if they had massive herniation with cauda equina symptoms; a history of fracture, surgery, steroid injection, spinal infection, fibromyalgia, or other inflammatory spondyloarthropathies; difficulty in understanding commands; or were unwilling to participate in the study.

2.5 Procedure

The study procedure was submitted to the Ethical Committee for approval, and the study was initiated only after obtaining ethical clearance. Prior permission was obtained from the selected institutions where the study was conducted. Participants were selected from the study centres based on the predefined inclusion and exclusion criteria. The investigator introduced themselves to the participants and explained the purpose and procedures of the study. The participants were informed about the study, and written informed consent was obtained from those willing to participate. Following consent, the evaluation was initiated using the Bilateral Lower Limb Traction Test (BLTT), Straight Leg Raise Test (SLRT), and Slump Test.

2.6 Outcome measures

2.6.1 Bilateral Lower Limb Traction Test (BLTT)

The Bilateral Lower Limb Traction Test (BLTT) was performed as a lumbar distraction test to assess discogenic low back pain. The participant was positioned prone with a pillow under the chest, and the intensity and locality of pain were recorded before the test. The participant held the head end of the table with the elbows flexed to 90° for stabilization. The examiner grasped both lower legs just above the ankle joints and applied gentle longitudinal traction by pulling the lower limbs towards the examiner. The traction force was gradually increased according to the participant's body stature and tolerance, with the lower back maintained in a neutral position. The traction was maintained for 3–5 seconds, and the participant's pain response was recorded. The test was considered positive when the pre-existing back, hip, buttock, thigh, or leg pain disappeared or reduced, indicating relief with traction. The test was considered negative when there was no reduction or there was an increase in pain.

2.6.2 Straight Leg Raise Test (SLRT)

The Straight Leg Raise Test (SLRT) was performed as a passive test to assess disc pathology or nerve root irritation. The participant was positioned supine, and each lower limb was tested individually, with the unaffected side tested first. The examiner maintained the knee in full extension and passively elevated the leg by supporting the heel. The test was continued until pain or tightness was reported. Reproduction of the participant's familiar radiating pain between 30° and 70° of hip flexion was considered a positive test, suggestive of lumbar disc pathology.

2.6.3 Slump Test

The Slump Test was performed to assess neural involvement associated with lumbar disc pathology or irritation of the spinal dura. The participant sat on the edge of the examination table with the hands held behind the back. The participant was instructed to slump the spine, followed by cervical flexion and knee extension. If knee extension reproduced the participant's symptoms, the cervical spine was returned to a

neutral position. Reproduction of the participant's symptoms with the sequence of movements was considered a positive test.

3 Statistical analysis

Data collected from 70 participants with discogenic low back pain were analysed to evaluate the diagnostic efficacy of the Bilateral Lower Limb Traction Test (BLTT). The variables included age, gender, and the results of the Straight Leg Raise Test (SLRT), Slump Test, and BLTT. The test results were recorded as positive or negative.

The collected data were checked for missing values, inconsistencies, and errors and were appropriately cleaned before analysis. Descriptive statistics were performed using SPSS to summarize the demographic characteristics of the participants. Age was presented using descriptive statistics, while gender and the SLRT, Slump Test, and BLTT results were presented using frequency and percentage distributions. Bar graphs were generated using Microsoft Excel for graphical representation of the results.

The diagnostic accuracy of BLTT was assessed by calculating sensitivity and specificity using the values of true positive, false positive, true negative, and false negative results. SPSS was used for data entry and statistical analysis, while Microsoft Excel was used for graphical representation of the findings.

4 Results

In order to assess the performance and accuracy of our diagnostic test BLTT (Bilateral Lower Limb Traction Test) in discogenic low back pain, two most important variables, i.e. the sensitivity and specificity of our test, were assessed.

In order to calculate the Sensitivity and Specificity of the BLTT test, the Contingency Table or Cross Tab for BLTT test and the existing tests was prepared and analysed. A contingency table (also known as a cross-tabulation or crosstab) is an arrangement in which data is classified according to two categorical variables. Each cell reflected the total count of cases for a specific pair of categories.

70 (32 male and 38 females) patients with a mean age of 45 years were studied (Table 1). Radiologically, all patients had varying degrees of disc pathology in L3-L4, L4-L5, and L5-S1. After demographic data collection, as a part of physical examination, all patients were tested for SLR, SLUMP, and BLTT. The results were recorded as either positive or negative. This study showed 71.43% of patients tested BLTT positive, and 28.57% tested negative (Table 2). For SLR, 68.57% tested positive, and 31.43% tested negative (Table 3). In the SLUMP test, 40% tested positive, and 60% tested negative (Table 4).

Table 1: Age- Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	70	20	60	45.00	10.812
Valid N (listwise)	70				

From the above Descriptive Statistics, the Minimum Value, Maximum Value, Mean, and Standard Deviation for the 'Age' variable were assessed.

Some of the findings from the above analysis were listed below:

- The total sample size assessed was 70, and there were no missing values in the data.
- The Age of the respondents ranged from 20 to 60, and the Mean Age of the respondents was 45 years.

Table 2: BLTT test – Frequency Table

	Frequency	Percent	Valid Percent	Cumulative Percent
Negative	20	28.6	28.6	28.6
Valid Positive	50	71.4	71.4	100.0
Total	70	100.0	100.0	

Graph 1: BLTT test- Bar chart

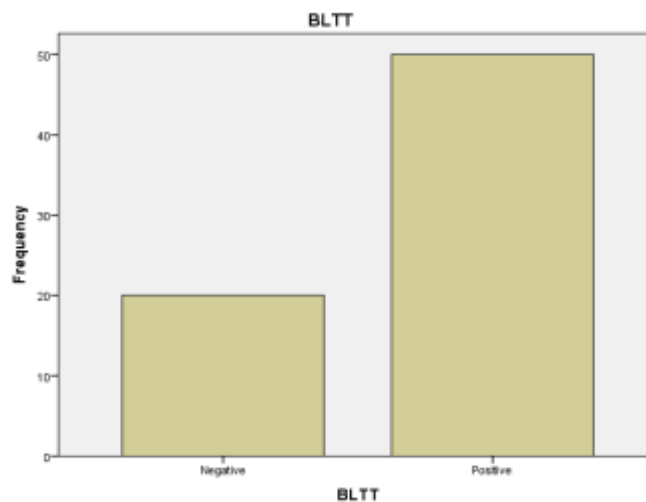


Table 3: SLRT test – Frequency Table

	Frequency	Percent	Valid Percent	Cumulative Percent
Negative	22	31.4	31.4	31.4
Valid Positive	48	68.6	68.6	100.0
Total	70	100.0	100.0	

Graph 2: SLRT test- Bar chart

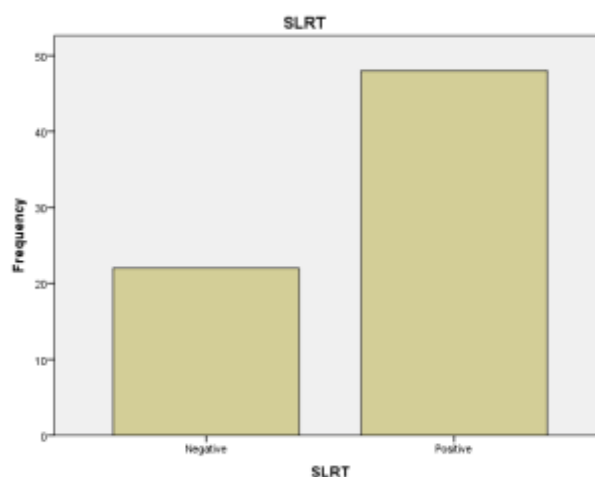


Table 3: SLUMP test – Frequency Table

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Negative	42	60.0	60.0	60.0
	Positive	28	40.0	40.0	100.0
	Total	70	100.0	100.0	

Graph 2: SLUMP test- Bar chart

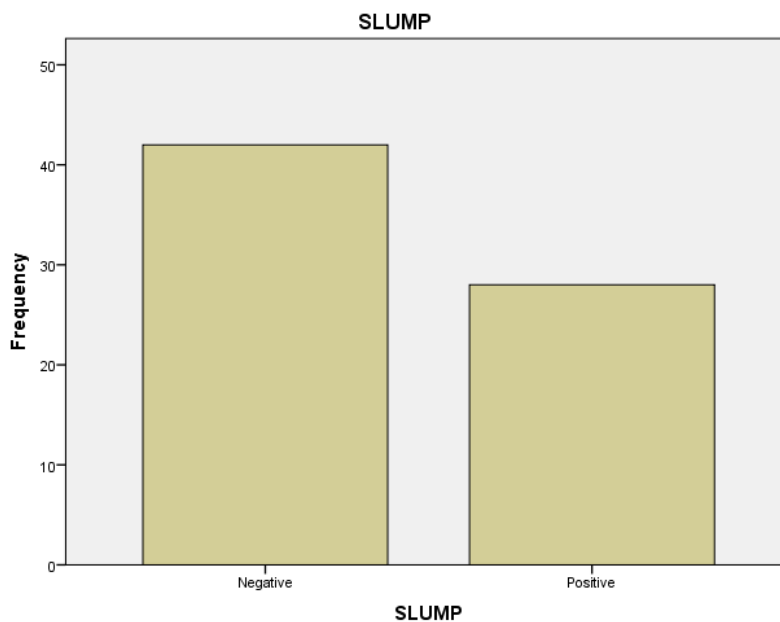


Table 5: SENSITIVITY & SPECIFICITY OF THE TEST- BLTT & SLRT test

BLTT * SLRT Crosstabulation					
			SLRT		Total
			Negative	Positive	
BLTT	Negative	Count	6	14	20
		% within SLRT	27.3%	29.2%	28.6%
	Positive	Count	16	34	50
		% within SLRT	72.7%	70.8%	71.4%
Total		Count	22	48	70
		% within SLRT	100.0%	100.0%	100.0%

BLTT and SLRT Test

From the above table, the values obtained were TP (True Positive) = 34, FN (False Negative) = 14, TN (True Negative) = 6, and FP (False Positive) = 16.

The Sensitivity of the BLTT test was calculated as:

Sensitivity = True Positive / (True Positive + False Negative)

$$= 34 / (34 + 14) \approx 0.7083 \text{ (or 70.83\%)}$$

This showed that the BLTT test had a Sensitivity of approximately 70.83%. In other words, the test successfully identified about 70.83% of individuals who actually had discogenic low back pain (Table 5).

The Specificity of the BLTT test was calculated as:

Specificity = True Negative / (True Negative + False Positive)

$$= 6 / (6 + 16) \approx 0.2727 \text{ (or 27.27\%)}$$

This showed that the BLTT test had a Specificity of approximately 27.27% (Table 5).

The Positive Predictive Value (PPV) was calculated as:

PPV = True Positive (TP) / (True Positive (TP) + False Positive (FP))

$$PPV = 34 / (34 + 16) \approx 0.68 \text{ (or 68\%)}$$

The Negative Predictive Value (NPV) was calculated as:

NPV = True Negative (TN) / (True Negative (TN) + False Negative (FN))

$$NPV = 6 / (6 + 14) \approx 0.3 \text{ (or 30\%)}$$

Thus, the Positive Predictive Value (PPV) of the BLTT test was approximately 68%, while the Negative Predictive Value (NPV) was approximately 30% (Table 6).

Table 6: Positive and negative predictive value

Metric	Calculation	Value
Positive Predictive Value (PPV)	TP / (TP + FP)	68%
Negative Predictive Value (NPV)	TN / (TN + FN)	30%

Table7: BLTT * SLUMP Crosstabulation

		SLUMP		Total
		Negative	Positive	
BLTT	Count	11	9	20
	Negative % within SLUMP	26.2%	32.1%	28.6%
	Count	31	19	50
	Positive % within SLUMP	73.8%	67.9%	71.4%
Total	Count	42	28	70
	% within SLUMP	100.0%	100.0%	100.0%

From the above table, the values obtained were TP (True Positive) = 19, FN (False Negative) = 9, TN (True Negative) = 11, and FP (False Positive) = 31.

The Sensitivity of the BLTT test was calculated as:

$$\text{Sensitivity} = \text{True Positive} / (\text{True Positive} + \text{False Negative})$$

$$= 19 / (19 + 9) \approx 0.6786 \text{ (or 67.86\%)}$$

This showed that the BLTT test had a Sensitivity of approximately 67.86% (Table 7).

The Specificity of the BLTT test was calculated as:

$$\text{Specificity} = \text{True Negative} / (\text{True Negative} + \text{False Positive})$$

$$= 11 / (11 + 31) \approx 0.2619 \text{ (or 26.19\%)}$$

This showed that the BLTT test had a Specificity of approximately 26.19% (Table 7).

The Positive Predictive Value (PPV) was calculated as:

$$\text{PPV} = \text{True Positive (TP)} / (\text{True Positive (TP)} + \text{False Positive (FP)})$$

$$\text{PPV} = 19 / (19 + 31) \approx 0.38 \text{ (or 38\%)}$$

The Negative Predictive Value (NPV) was calculated as:

$$\text{NPV} = \text{True Negative (TN)} / (\text{True Negative (TN)} + \text{False Negative (FN)})$$

$$\text{NPV} = 11 / (11 + 9) \approx 0.55 \text{ (or 55\%)}$$

Thus, the Positive Predictive Value (PPV) of the BLTT test was approximately 38%, while the Negative Predictive Value (NPV) was approximately 55% (Table 8).

Table 8: Positive and negative predictive value

Metric	Calculation	Value
Positive Predictive Value (PPV)	TP / (TP + FP)	38%
Negative Predictive Value (NPV)	TN / (TN + FN)	55%

5 Discussion

DISCUSSION

In this study, we introduced a new form of physical examination called the Bilateral Lower Limb Traction Test (BLTT) in patients suffering from discogenic LBP with or without radicular pain. All patients showed disc pathology on MRI that ranged from mild bulge to moderate herniation with varied pain locality. MRI alone is insufficient to confirm or refute discogenic pain. The diagnostic criteria established in our study for classifying discogenic LBP were clinical symptoms indicative of discogenic back pain with positive MRI findings for disc pathology.

The objective of this study was to evaluate the diagnostic utility of BLTT by comparing the results of BLTT with other established tests like SLR and SLUMP tests, which are widely used by physical therapists in patients with discogenic LBP. A Cochrane meta-analysis showed high sensitivity of 0.92 with varying specificity of 0.28 for SLR³². SLUMP was reported to have a sensitivity of 0.84 and a specificity of 0.83 in patients with lumbar disc herniation²⁷.

BLTT, SLR, and SLUMP tests were performed on all patients, and the results of SLR and SLUMP were compared with BLTT results. BLTT is a form of distraction test, where the examiner pulls the patient's legs just above the ankle joint in order to give a traction force in the lumbar spine segments. Traction was in use for many decades in the treatment of low back pain and radicular pain. Traction increases disc height and reduces intradiscal pressure due to increased intervertebral space^{24,33}. Hence, BLTT was performed in prone lying because the spine would be unloaded in prone. The mean intradiscal pressure in

loaded standing is high compared to the unloaded prone position²⁶. Additionally, prone lying naturally assumes extension at the lumbar spine, which allows the disc to migrate anteriorly and may reduce nerve compression that occurs in posterior disc herniation^{36,37}.

The cervical distraction test is used to diagnose cervical discogenic and radicular pain, which has a good specificity (0.90)³⁰. Likewise, we proposed BLTT as a form of lumbar distraction test, which can be used similarly to a cervical distraction test. In the present study, 71.4% of the patients tested positive for BLTT, which indicated that those patients had an immediate reduction in pain during the test. The possible reasons behind the pain reduction during BLTT are pressure reduction in the disc itself that calms down the nerves that are innervating it or reduction of compression of the nervous tissue by the disc. Yet, this mechanism is to be validated further.

The available evidence indicates that in patients with low-back pain and radicular pain, a diagnosis of lumbar disc herniation should not be based on the results of one single physical examination test³². BLTT could be used along with SLRT and SLUMP tests to add to diagnostic accuracy. In our study, 14.28% of the patients showed positive results in all three tests. Instead of having one or two tests, a cluster of tests would have more diagnostic accuracy.

The primary objective of this study was to establish the sensitivity and specificity of the BLTT test in diagnosing discogenic low back pain. The sensitivity of BLTT was determined to be 70.83% when compared in relation to the SLRT test and 67.86% when compared in relation to the SLUMP test. The specificity was calculated at 27.27% when compared in relation to the SLRT test and 26.2% when compared in relation to the SLUMP test. These findings indicate that the BLTT test identified a proportion of patients who also tested positive on the comparison tests; however, the relatively low specificity indicates that further improvement and validation are needed. Further studies using an appropriate independent reference standard are required to establish the diagnostic accuracy of BLTT.

6 Conclusion

We used a novel test called BLTT in patients with discogenic back pain. When BLTT was compared with standard tests like SLR and SLUMP, it was found that BLTT has good sensitivity with those two tests (SLRT & SLUMP). Hence BLTT can be used as one of the clinical tests in the diagnosis of discogenic back pain. Future studies should be aimed at testing the validity and reliability of BLTT, and if it is proven so, BLTT can be used as one of the standard tests to diagnose discogenic LBA. Future studies also must aim to ascertain the utility of mechanical traction in patients with positive BLTT, which could reveal the prognostic value of BLTT. We recommend the clinicians start using BLTT in their patients to see how the test helps in the diagnostic process.

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