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Comparison of Ipsilateral Versus Contralateral Lower Limb Neural Mobilization in Unilateral Lumbar Radiculopathy- A Randomized Clinical Trial

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ABSTRACT

Background: Neural tissue mobilization is a movement-based intervention aimed at restoring homeostasis in and around the nervous system. However, there are limited studies on the effects of contralateral lower extremity neural mobilization in lumbar radiculopathy.

Aim/Objective: To compare and evaluate the immediate effect of neural slider mobilization on contralateral versus ipsilateral lower extremity pain and hip range of motion (ROM) during straight leg raise (SLR) in unilateral lumbar radiculopathy.

Methods: Thirty-six individuals with subacute and chronic back pain during SLR, resulting from unilateral lumbar radiculopathy in the sciatic nerve and its branches, were randomized to two groups: ipsilateral and contralateral. They received a single session of neural slider mobilization in the ipsilateral and contralateral lower extremity, respectively. The numeric pain rating scale was used to measure pain, and for hip flexion ROM during straight leg raise digital goniometer was used for assessment.

Results: Pre- and post-treatment values showed a statistically significant difference within the groups in terms of pain (P=0.00001 for both ipsilateral and contralateral group). However, there was no significant difference between the groups (P=0.00001). For hip ROM during SLR, a significant difference was found within as well as between the groups (P=0.00088 for the ipsilateral group and P=0.3476 for the contralateral group; and between-group comparison P=0.00047).

Conclusions: Both the ipsilateral and contralateral slider neural mobilization technique was effective in reducing lower extremity pain. However, the ipsilateral neural mobilization technique was superior to the contralateral technique in reducing pain. Ipsilateral slider neural mobilization alone showed improvement in hip ROM during SLR.

Keywords: neural mobilization, lumbar radiculopathy, pain, and straight leg raise.

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INTRODUCTION

Lumbar radiculopathy can be defined as low back pain radiating to one or both the extremities with spinal nerve root involvement, depending on the affected dermatome. The lifetime prevalence of radiculopathy ranges from 2.2% to 34%. A herniated disk and lateral canal stenosis are the two most common causes of radiculopathy, with the other causes being lumbar spinal stenosis, spondylolisthesis, and tumors [1]. Direct compression of the nerve roots and the inflammatory and ischemic mechanisms involving the roots and dorsal root ganglia cause intervertebral disc herniation symptoms. The intervertebral discs affected mostly are L4-5 and L5-S1, leading to L5 or S1 radiculopathies [2].

Various physical therapy forms such as traction, stretching, strengthening exercises, warm water fomentation, modalities like interferential therapy with varying degrees of success [3, 4]. Neurodynamics is an effective method for assessing and treating pain syndromes. It aims to restore the dynamic balance between the relative movements of neural tissue and the surrounding mechanical interfaces, reducing pressure on neural tissue and improving the nervous system's functioning [5]. The nervous system performs three primary mechanical functions to aid normal movement: withstand tension, slide in its container, and be compressible. Failure of this protective mechanism leads to neural edema, fibrosis, ischemia, and hypoxia, which may cause altered neurodynamics [5].

A nerve's ability to stretch and slide may be disrupted due to nerve compression. Further prolonged compression gives rise to sequel of intraneural events that may ultimately lead to impaired nerve sliding [6,7]. Neurodynamic sliders and tensioners cause excursion and tension of neural tissues, respectively, which can be used to resolve abnormal mechanosensitivity caused by nerve compression [8,9]. A slider is used to produce significant movement in the nerves without generating much tension or compression by applying longitudinal force at one end of the nerve while tension at the other. A tensioner activates viscoelastic, movement-related, and physiological functions in the nervous system. It is applied to neural tissues by increasing the distance between each end of the nerve tract [8,9]. Previous studies performed on hamstring flexibility, carpal tunnel syndrome, and cervical radiculopathy have shown that applying the contralateral neural mobilization technique helps reduce tension in the ipsilateral nerve root [4,10,11,12].

However, contralateral neural mobilization on the ipsilateral lower extremity in lumbar radiculopathy is unknown. Hence, this study was undertaken to analyze the efficacy of contralateral versus ipsilateral neural mobilization in patients with lumbar radiculopathy. It was hypothesized that ipsilateral neural mobilization, which is painful in lumbar radiculopathy patients, may benefit from contralateral neural mobilization.

Materials and Methods

Study Design

This was a single-blinded, randomized clinical trial. The Institutional Research and Ethics Committee approved the study. It is registered under Clinical Trial Registry - India with trial number CTRI/2019/02/017515.

Setting and timescale

This study was conducted at tertiary care Hospital, Belagavi, Karnataka, India, from September 2018 to February 2019.

Determination of sample size

The sample size calculation was done based on the study done by Mahmoud S. Asal et al. [10] and determined as a minimum of 18 subjects in each group using the single mean sample size formula with α set at 5% and β at 95%.

Study Participants

A total of 36 subjects who were aged between 25-60 years, diagnosed with subacute or chronic-stage low back pain with unilateral radiculopathy involving the sciatic nerve and its branches with positive SLR, with a minimum pain intensity of 4 as shown on the Numeric Pain Rating Scale (NPRS), and those willing to participate in the study were included in the study. Patients diagnosed with rapidly progressing neurological symptoms; extruded disc; dementia or other cognitive impairment; inflammatory or other specific disorders of the spine such as ankylosing spondylitis, Paget's disease, vertebral collapse, rheumatoid arthritis, spondylolisthesis, severe osteoporosis, spine spinal tuberculosis; intermittent claudication; diabetic neuropathy; stenosis; sacroiliac joint pathology; previous spinal surgery; previous spinal injury causing radiculopathy; pathology of the hip, knee, and ankle; severe pain (NPRS>7); more than one nerve root involvement; muscular involvement such as Piriformis syndrome; red flags such as trauma, cancer, and infection; and pregnant women were excluded from the study; All the study participants read and signed the informed consent form before the start of the study.

The subjects who met the inclusion criteria were randomly assigned to two groups by lottery method. Subjects in group-1 (ipsilateral group) received ipsilateral slider neural mobilization with conventional treatment, whereas group-2 (contralateral group) received contralateral slider neural mobilization with conventional treatment (Figure 1).

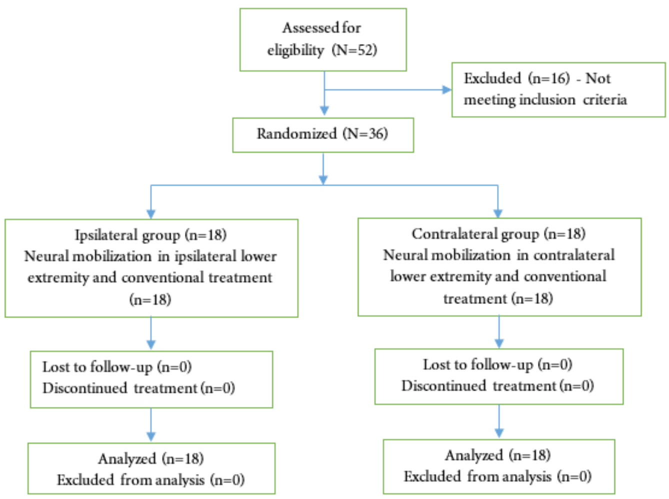

Figure 1: CONSORT diagram

Outcome measures

All the selected subjects underwent a pretreatment and post-treatment assessment for pain using NPRS [13,14] and hip ROM during SLR using a goniometer [15]. For the ipsilateral group, both intervention and assessment were done on the affected side. In contrast, for the contralateral group, an assessment was done of the affected side, but treatment was given to the unaffected side.

Intervention

Subjects in both groups received conventional treatment, which consisted of transcutaneous electrical nerve stimulation (TENS) and hydro-collator pack application. Conventional TENS with two channels was applied for 20 min. The patient lied down in the prone position, and one electrode was placed on the involved nerve root and other electrodes along the course of the nerve [16]. After that, moist heat was applied for 15 min [17]. Following conventional treatment, both groups received one session of neural slider mobilization each: the ipsilateral group received neural mobilization on the affected side, and the contralateral group received neural mobilization on the unaffected side.

Slider neural mobilization [8] was given for three sets of 1 session following structural differentiation as performed by the SLR test. The first set consisted of 5 repetitions, the second set of 10 repetitions, and the third set of 15 repetitions with a break of 2 minutes / 120 seconds between sets [8]. The distal slider for the sciatic nerve incorporated the foot into dorsiflexion when the hip was in neutral. The knee was kept in an extended position with the patient lying supine on a bed, head resting on a pillow. The therapist stood on the side where the lower extremity was mobilized and placed one hand over the posterior aspect of the patient's leg, and the other hand held the patient's foot under its plantar surface [8].

For the peroneal nerve, the patient was placed supine on a bed with their head resting on a pillow, and the therapist stood on the side where the lower extremity was mobilized. The distal slider incorporated the movements of knee flexion and plantar flexion/inversion. The therapist held the limb at its hip and flexed the knee to 90°, where he placed the medial aspect of his near arm around the medial and/or posterior aspects of the patient's leg (almost using his armpit to grip the leg). His other hand held the dorsum of the patient's forefoot [8].

Distal slider neural mobilization of the posterior tibial nerve was done in the hip and knee flexed to 90º, and toes extended with the patient in a supine position, head resting on a pillow. The therapist stood on the side where the lower extremity was mobilized. He held the limb at the hip and flexed the knee to 90°, where he placed the medial aspect of his arm around the medial and/or posterior aspects of the patient's leg and stabilized the calcaneus with his palm. His other hand held the patient's foot on its plantar surface, placing his hand under the forefoot with fingers spreading to the toes. The therapist's thumb then passed around the foot's medial surface toward the dorsum of the foot, taking a firm but comfortable hold [8].

Statistical analysis

Data were analyzed using statistical software R version 3.6.0 and Excel. Continuous variables were represented as mean ± standard deviation. Frequency tables represented categorical variables. A Chi-square test was used to analyze categorical data (age and gender). For the mean comparison of pain and hip ROM (SLR), an independent/paired *t*-test was used. The significance level was set at 5%.

RESULTS

Demographic data

The study included 36 subjects aged 41.28±10.02 years, with 18 subjects in each group (viz., ipsilateral and contralateral lower extremity group, respectively, as shown in Table 1.

Table 1: Distribution of age and gender in the study (N=36)

Variable	Sub-category	Number of subjects n (%)
Age (yrs.)	<30	6 (16.66)
	30-40	11 (30.56)
	41-50	12 (33.33)
	51-60	7 (19.44)
Gender	Male	20 (55.56)
	Female	16 (44.44)

The *t*-test showed no significant difference in the mean age between the two groups, as shown in Table 2 (P=0.8964). Also, the Chi-square test did not show any relationship between age and gender.

Table 2: Distribution of age and gender over the groups

Variable		Group		*P*-value
		Ipsilateral	Contralateral	
Age (yrs.)		41.5±10.58	41.06±9.73	0.8964
Gender	Male	9	11	0.5023
	Female	9	7	

Effect of treatment on HIP ROM (SLR) within groups:

Paired *t*-test was used to compare the mean of pre-and post-hip ROM (SLR). The mean of post-hip ROM (SLR) was significantly greater than pre-hip ROM (SLR) in the ipsilateral group. There was no significant increase in the hip ROM (SLR) score in the contralateral group. In the ipsilateral group, the hip ROM (SLR) increased by 10.98% after treatment, but in the contralateral group, the percentage increment was negligible (Table 3).

Table 3: Comparison of pre-and post-hip ROM (SLR)

Group	Hip ROM (SLR)		*P*-value	Mean of percentage increment
	Pre	Post		
Ipsilateral	34.67±4.01	39.33±5.36	0.00088[L]	10.98%
Contralateral	33.11±5.28	33.22±5.5	0.3476[L]	0.15%

ROM: Range of motion

SLR: Straight leg raise

Effect of treatment on the hip ROM (SLR) between groups

The Mann-Whitney test showed a significant difference (P=0.0004689) in hip ROM during SLR between the groups, with the difference in mean of post-hip ROM (SLR) being significantly more for the ipsilateral (4.67±5.35) group compared to the contralateral group (0.11±1.18) (Figure 2).

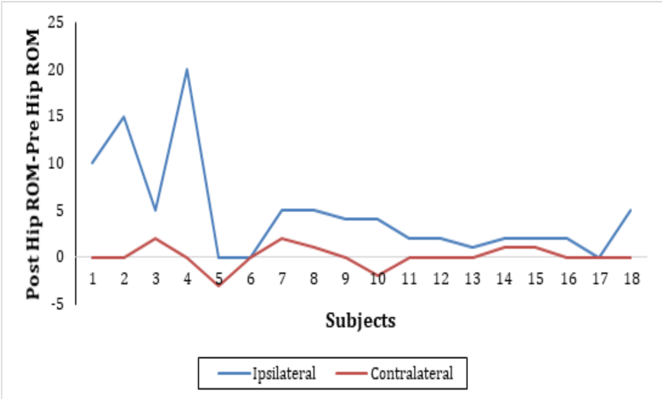

Figure 2: Comparison of pre-hip ROM (SLR) and post-hip ROM (SLR) between two groups.

Effect of treatment on the numeric pain rating score within groups:

The NPRS was comparatively small after treatment. The pre-test pain score was significantly greater than the post-test pain score (P<0.00001 was significant for the paired *t*-test). In the ipsilateral group, the pain score was reduced by 33.89% after treatment. In the contralateral group, the reduction was 17.43% after treatment (Table 4).

Table 4: Comparison of pre- and post-numeric pain rating score

Group	NPRS		*P*-value	Mean percentage reduction
	Pre	Post		
Ipsilateral	6.67±1.61	4.44±1.95	<0.00001^G	33.89%
Contralateral	6.72±1.6	5.44±1.1	<0.00001^G	17.43%

G: Greater

NPRS: Numeric pain rating score

Effect of treatment on the numeric pain rating scores between groups

A two-sample *t*-test was used to compare the mean difference between the post-pain score and pre-pain scores over the two groups. There was significantly (P=0.017) less pain in the ipsilateral group (-2.22±1.48) compared to the contralateral group (-1.28±1.1) (Figure 3).

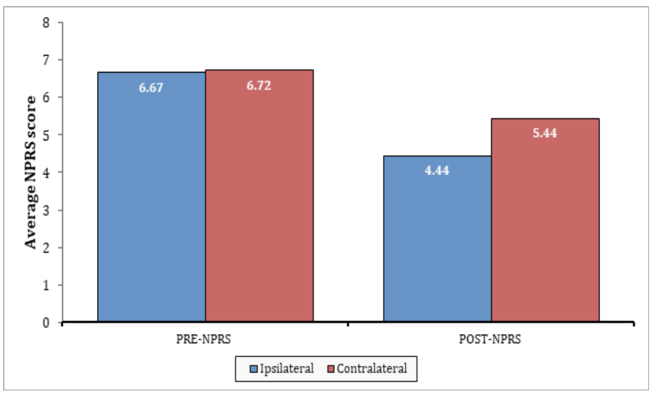

Figure 3: Comparison of NPRS between groups.

DISCUSSION

The purpose of this study was to compare and evaluate the immediate effect of distal slider neural mobilization on contralateral versus ipsilateral lower extremity hip range of motion and pain during SLR in unilateral lumbar radiculopathy. This study demonstrated that there was a significant difference in pain reduction within the groups, with no significant difference found between the groups in terms of pain intensity there was a significant difference in hip ROM improvement during SLR in favor of the ipsilateral neural mobilization technique.

The pain reduction following the ipsilateral neural mobilization technique could decrease intraneural edema and circulatory stasis as it decreases intraneural pressure [6,7]. The slider technique reduces the abnormal mechanical sensitivity caused by nerve compression in lumbar radiculopathy by producing excursion in the nerve without generating much tension [8,9]. In this study, the slider neural mobilization technique was performed in the supine position. Sitting in a slump position involves lumbar flexion, which would further worsen the pain symptoms due to a narrowing of the intervertebral foramen, leading to the nerve compression.

This study's results are consistent with those of previous studies using ipsilateral neural mobilization in subjects with sciatica. A study was conducted by Anikwe EE [16] on acute sciatica using nerve flossing technique, which was given for two weeks during six treatment sessions including conventional therapy in the study group while the control group received only conventional therapy like cryotherapy, soft tissue manipulation (stroking and effleurage) to the painful areas, four-channel TENS, and reverse SLR actively in a prone position. The study concluded that both groups improved the pain score and passive SLR value significantly [16]. Another study done by Haris Colakovic[17] in subjects with radicular low back pain concluded that subjects in the study group receiving neural mobilization and lumbar stabilization showed better visual analog scale scores and SLR scores than the control group who received active ROM exercises and lumbar stabilization [17].

The contralateral distal slider neural mobilization also helped reduce pain, which could be attributed to the relationships between the angles of nerve roots and spinal cord movement. The cervical and lumbar nerve roots diverge from the spinal cord at an angle. This angle contains two component vectors, horizontal and vertical. The vertical vector produces spinal cord movements necessary to reduce tension in the contralateral nerve root. As the contralateral neurodynamic test is performed, forces enter the spinal cord through the contralateral nerve roots. The vertical component force passing along the contralateral nerve roots causes the spinal cord to descend in the canal. The spinal cord's downward movement is most likely less but is sufficient to transmit a reduction of tension through the vertical component of the ipsilateral nerve root [8].

Previous studies that have used the contralateral neural mobilization technique in patients with cervical radiculopathy showed improvement in pain reduction and increased ROM in the cervical spine, and improved elbow ROM. Therefore, the study concluded that the contralateral slider neural mobilization technique is clinically efficacious in treating cervical radiculopathy patients [11]. However, our study's result is not in agreement with that study in terms of increasing ROM, which could be because of the study being conducted to find only the immediate effect of the neural mobilization technique. There may be an improvement in increasing the ROM with more sessions as in the previous study. It could also be because of the technique itself, as the assessment was done on the ipsilateral side, and treatment was given to the contralateral side. At this time, the reason for not obtaining the improvement in ROM is still not apparent.

Limitations: Follow-up assessment was not taken into consideration to know the carry-over effect. The sample size was small to extrapolate the result to a larger population.

CONCLUSIONS

This study's findings provide evidence that both ipsilateral and contralateral slider neural mobilization techniques resulted in pain reduction. Hence, they can be used in the treatment of patients with unilateral lumbar radiculopathy. However, concerning the hip ROM during SLR, only the ipsilateral neural mobilization technique was helpful.

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