Research Article

Effect of neurodynamic techniques on radiating symptoms and mechanosensitivity of neural tissue in subjects with lumbosacral radiculopathy: A double-blind randomized controlled trial

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ABSTRACT

Background: Lumbosacral radiculopathy has a prevalence ranging from 1.2% to 43%. It is associated with altered mechanosensitivity of the neural tissue and symptoms of pain and paresthesia radiating to the lower extremity. Neurodynamic techniques described by Shacklock have shown beneficial results clinically in subjects with radiculopathy. However, there is lack of research on systematic protocol of neurodynamic techniques in lower limb radiculopathy. **Objectives:** The objectives of the present study were to evaluate the effect of neurodynamic techniques including treatment of neural tissues and interface dysfunctions as advocated by Michael Shacklock. **Materials and Methods:** A double-blind randomized controlled trial on 108 subjects with lumbosacral radiculopathy was conducted using computer generated block randomization after taking ethics approval. They were divided into two equal groups of 54. The treatment for both groups was given in six sessions, thrice a week for 2 weeks. Interventional group received neurodynamic techniques based on diagnosis of neural and interface dysfunctions and control group received sham neurodynamic techniques. Both groups additionally received hydrocollator packs for 20 min and 10 repetitions of isometric back exercises. The outcome measures were Sciatica Bothersomeness Index and Sciatica Frequency Index for Bothersomeness and frequency of radiating symptoms, pain site codes on overlay template for centralization of radiating symptoms and active knee extension range of motion in slump posture using universal goniometer for mechanosensitivity of neural tissue. The outcome assessor and the subjects were blinded to the treatment allocation. **Results:** Wilcoxon signed-ranks test showed a statistically significant difference in all the outcome measures in both groups ($P < 0.05$). Mann–Whitney U-test showed that the interventional group had better improvement compared to the control group ($P < 0.05$). **Conclusion:** Neurodynamic techniques are effective in reducing the Bothersomeness and frequency of radiating symptoms, producing centralization, and reducing mechanosensitivity of the neural tissue in subjects with lumbosacral radiculopathy.

KEY WORDS: Neurodynamic Techniques; Radiculopathy; Centralization

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INTRODUCTION

Low back pain with radiculopathy is a common entity encountered in the clinical practice of orthopedic surgeons, neurophysicians, and physical therapists. It accounts for billions of dollars of health-care costs annually and a cause of work absenteeism and economic burden to the family, society, industry, and government.[1,2]

The prevalence of low back pain with or without radiculopathy is reported to be 3–5%.[3] The prevalence of lumbosacral radiculopathy ranges from 1.2% to 43%.[4] In the Indian population, the incidence of low back pain with or without radiculopathy has been reported to be 23.09% and a lifetime prevalence of 60–85%.[5,6] Lumbosacral radiculopathy is characterized by a constellation of symptoms ranging from radiating pain, tingling and numbness to muscular weakness, reflex changes, and gait abnormalities across a spectrum of severity.[1] The treatment of lumbosacral radiculopathy can be categorically put under two headings: Conservative and surgical. Most commonly, the first line of treatment is conservative, which consists of rest, medication, and physical therapy. Physical therapy interventions include electrotherapy, heat therapy, decompression therapy, and exercise therapy.[7]

Commonly used exercise therapy interventions are core stabilization exercises, isometric abdominal muscles and back extensor muscle exercises, flexibility exercises, and manual therapy techniques which include gentle passive stretching, Maitland mobilization, Mulligan mobilization, and Neural mobilization.[2]

Neural tissue mobilization techniques or "Neurodynamic techniques" are passive or active movements that focus on restoring the ability of the nervous system to tolerate the normal compressive, friction, and tensile forces associated with activities of daily living. It is hypothesized that these neurodynamic techniques can have a positive impact on symptoms by improving intraneural circulation, axoplasmic flow, neural connective tissue viscoelasticity, and by reducing the sensitivity of abnormal impulse generating sites in dorsal root ganglion.[8,9]

The neurodynamic techniques can be classified into slider techniques and tensioner techniques. Slider techniques produce a sliding movement between neural structures and adjacent non-neural tissues, in a non-provocative manner. Tensioner techniques restore the physical capabilities of neural tissues to tolerate movements that lengthen the corresponding nerve bed. The decision to give sliders or tensioners is taken based on the type of neural dysfunctions: Sliding dysfunction and tensioning dysfunction.[8,9]

Shacklock's Neurodynamic techniques are effective in reducing the radiating symptoms, however, there is limited evidence evaluating its ability to produce centralization and reducing the radiating symptoms in lumbosacral radiculopathy. The present study was conducted to evaluate the effectiveness of neurodynamic techniques in reducing Bothersomeness and frequency of radiating symptoms, producing centralization of radiating symptoms, and reducing the mechanosensitivity of neural tissue.

MATERIALS AND METHODS

A randomized controlled trial was conducted at a private physiotherapy clinic, Ahmedabad, India. Ethics approval was obtained from Medilink Ethics Committee. After a detailed musculoskeletal and neurological assessment, male and female subjects having lumbosacral radiculopathy were recruited in the study. The diagnosis of sliding and tensioning dysfunction was done using the slump test. If the radiating symptoms were reproduced on doing cervical flexion alone, it was diagnosed as cephalad sliding dysfunction. If the radiating symptoms were reproduced on knee extension with ankle dorsiflexion, it was diagnosed as caudal sliding dysfunction and if the radiating symptoms were reproduced with combined cervical flexion and knee extension with ankle dorsiflexion and relieved by either cervical extension or knee flexion, it was diagnosed as tensioning dysfunction. To diagnose the interface dysfunctions, the subject was given ipsilateral and contralateral side flexion while doing SLR test. If the patient demonstrated reproduction of symptoms with ipsilateral side flexion, the interface dysfunction was diagnosed as closing dysfunction and if the symptoms were reproduced with contralateral side flexion, it was diagnosed as opening dysfunction.[9] Inclusion criteria were subjects with unilateral lumbosacral radiculopathy, aged 18–60 years, with neurodynamic tests straight leg raise test and slump test positive, with ability to read and understand English and Gujarati languages. Subjects having restricted range of motion of spine, hip or knee, previous history of spinal surgery, neuropathy, red flags such as spinal tumors, infection, and fractures, muscle weakness, hyporeflexia or areflexia in lower limb, pregnancy, history of taking steroids in the past 6 months, and femoral nerve tension test positive were excluded from the study.

The sample size (n = 48) was calculated on the basis of a pilot study. After screening 132 subjects, 108 (N) subjects were recruited, taking into account an attrition rate of around 10%.[10] They were randomly allocated to one of the two groups (n = 54) by computer generated block randomization using Random Allocation Software 2.0. After taking verbal and written informed consent, the outcome measures were recorded. English[11] and Gujarati[12] versions of Sciatica Bothersomeness Index (SBI) and Sciatica Frequency Index (SFI) were used for the radiating symptoms which are both comprised four radiating symptoms scored for Bothersomeness and frequency of the radiating symptoms, (1) leg pain, (2) numbness or tingling in the leg, foot or groin, (3) weakness in the leg/foot, and (4) back or leg pain while sitting with each symptom having a range of scores from 0 to 6. The SBI categories have labels at the categories 0 (not bothersome), 3 (somewhat bothersome), and 6 (extremely bothersome). For SFI, the categories are labeled 0 (not at all), 1 (very rarely), 2 (a few times), 3 (about half the time), 4 (usually), 5 (almost always), and 6 (always). The total score ranges from 0 to 24, with higher scores indicating worse condition. Pain site codes (PSCs) were used for location of symptoms to quantify centralization phenomenon using the overlay template [Figure 1], where 0=no pain, 1=central low back pain, 2=spinal symptoms referred to low back

area, 3=spinal symptoms referred to buttock area, 4=spinal symptoms referred to thigh area, 5=spinal symptoms referred to calf area, and 6=spinal symptoms referred to foot area.[13-15] Active knee extension (AKE) range of motion in slump posture[16] was used for testing the mechanosensitivity of the neural tissue. The subject was instructed to sag the trunk while the cervical spine was kept in a neutral position. A universal 180° goniometer was positioned with the stationary arm aligned along the imaginary line joining lateral condyle of the knee and the greater trochanter, and the moving arm aligned along the imaginary line joining the lateral condyle of the knee and the lateral malleolus of the ankle. 0° was taken as the range of full knee extension. The subject was asked to move cervical spine into flexion with the instruction of touching the chin to the chest with mouth closed and the upper and lower jaw approximated against each other. In this position, another physical therapist applied comfortable overpressure. Once the correct neck position had been achieved, the subject was asked to slowly extend the knee keeping the ankle fully dorsiflexed stopping immediately at the onset of radiating symptoms. The range of knee flexion at this point was measured relative to the operationally defined zero position. The outcomes were assessed by a physiotherapist with an experience of 11 years in musculoskeletal physiotherapy outpatient department.

Subjects in the interventional group received six sessions of neurodynamic techniques (thrice a week for 2 weeks), based on the type of interface (closing or opening) dysfunctions and neural (sliding or tensioning) dysfunctions. The diagnosis of dysfunctions, the neurodynamic techniques, and treatment of interface which included static and dynamic openers and closers were given as per the guidelines given by Michael Shacklock. (9) Subjects in the control group received sham neurodynamic techniques, in which pendular exercises in small range with cervical rotation were given in high sitting position so that no significant sliding or tensioning of the neural structures could occur. The treatment common to both groups was moist heat in the form of hydrocollator packs to the back for 20 min and isometric back exercises and isometric abdominal exercises, five sets of 10 repetitions with 10 s hold for each repetition. The treatment was given by a physiotherapist certified in neurodynamic techniques and with an experience of 7.5 years in treating patients with low back pain with or without radiculopathy. The post-intervention outcome measures were taken after every session. The subjects and the outcome assessor were blinded to the allocation of treatment. Flowchart shown in Figure 2 describes the process of the study.

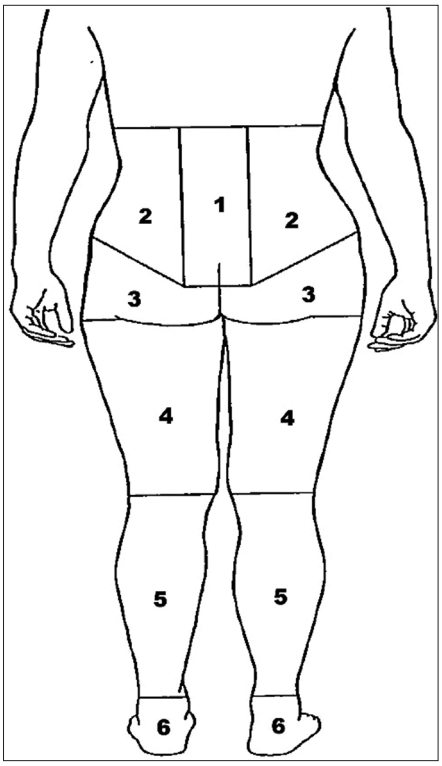

Figure 1: Pain site codes

RESULTS

The statistical analysis was done using SPSSv21, for those subjects who had taken all the six sessions of the protocol. The power of the study was kept 80% and the significance level was 5%. There were two dropouts in the interventional group and four dropouts in the control group [Figure 2]. Hence, data of 102 subjects were considered for the analysis.

The demographic details and comparison of baseline characteristics using Mann–Whitney U-test between both groups are shown in Table 1. Both groups were similar in the baseline characteristics.

All the subjects demonstrated neural tensioning dysfunction. There was no subject with neural sliding dysfunction. In the dysfunctions of the interface, 10 patients had reduced closing dysfunction, 13 patients had reduced opening dysfunction, and the remaining had no dysfunction related to the interface in the interventional group. In the control group, there were eight patients with reduced closing dysfunction, 12 patients with reduced opening dysfunction, and the remaining had no dysfunction related to the interface.

Shapiro–Wilk test was used to analyze the distribution of data. The data were not normally distributed. Hence, Mann–Whitney U-test was used for comparison of baseline data of age, which revealed that there was no statistically significant difference between the two groups [Table 1]. Wilcoxon test was used to compare the values of SBI, SFI, PSC, and AKE before and after the intervention, which showed statistically significant difference in all outcome measures in both groups ($P < 0.05$) [Table 2]. Mann–Whitney U-test was used to compare the differences in the outcome measure between the two groups which showed that the interventional group had

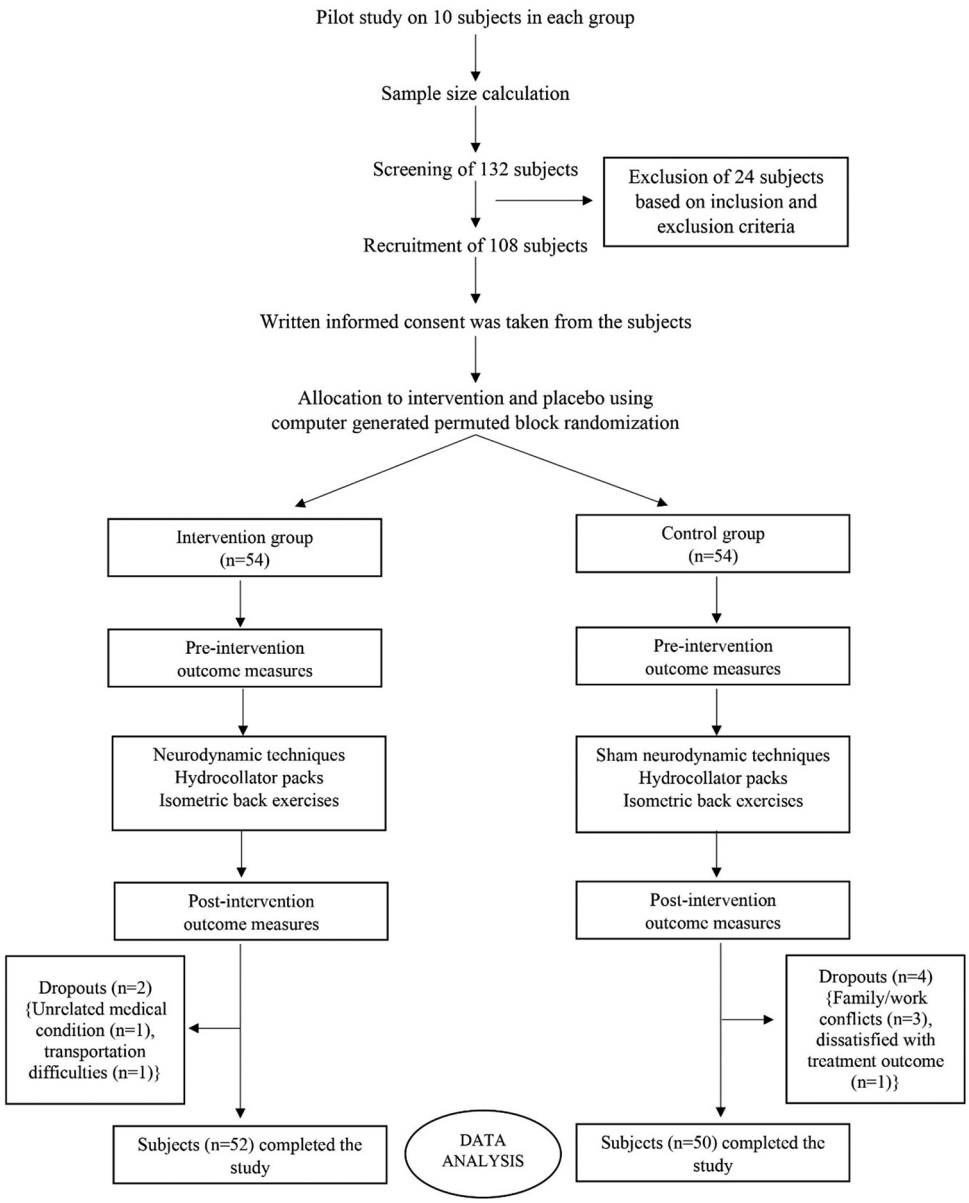

Figure 2: Study flowchart

Table 1: Comparison of demographic details and baseline characteristics of subjects using Mann–Whitney U-test

Demographics and baseline characteristics	Interventional group	Control group	Z-value	*P*-value
Mean age (years)	38.92±11.59	39.94±9.61	−0.757	0.449
Gender				
Males	25	22	-	-
Females	27	28	-	-
SBI	13.81±2.26	13.64±2.59	−0.115	0.908
SFI	14.02±2.72	13.44±2.35	−0.796	0.426
PSC	4.44±0.75	4.30±0.88	−0.935	0.350
AKE	53.59±9.62	55.04±10.53	−0.603	0.546

SBI: Sciatica Bothersomeness Index, SFI: Sciatica Frequency Index, PSC: Pain site codes and AKE: Active knee extension

better improvement in all four outcome measures compared to the control group ($P < 0.05$) [Table 3]. There were five subjects with complete disappearance of radiating symptoms (PSC = 0) and 24 subjects with the symptoms localized to central area of low back (PSC = 1) after six sessions in the interventional group. There was no subject in the control

Table 2: Comparison of pre- and post-intervention outcome measures within the group using Wilcoxon test

Outcome measures	Interventional group		Z-value	*P*-value	Control group		Z-value	*P*-value
	Pre-intervention	Post-intervention			Pre-intervention	Post-intervention		
SBI	13.81±2.26	3.40±1.59	−6.304	<0.05	13.64±2.59	12.66±2.56	−4.566	<0.05
SFI	14.02±2.72	3.15±1.53	−6.293	<0.05	13.44±2.35	12.44±2.19	−4.911	<0.05
PSC	4.44±0.75	1.42±1.42	−6.523	<0.05	4.30±0.88	3.92±1.01	−3.416	<0.05
AKE	53.59±9.62	28.35±8.26	−6.279	<0.05	55.04±10.53	52.44±10.53	−4.832	<0.05

SBI: Sciatica Bothersomeness Index, SFI: Sciatica Frequency Index, PSC: Pain site codes and AKE: Active knee extension

Table 3: Comparison of the difference in outcome measures between the groups using Mann–Whitney U-test

Outcome measures	Interventional group	Control group	Z-value	*P*-value
SBI	10.40±1.74	0.98±1.33	−8.797	<0.05
SFI	10.87±2.42	1.00±1.14	−8.770	<0.05
PSC	3.02±0.85	0.38±0.67	−8.853	<0.05
AKE	25.25±4.61	2.60±3.23	−8.714	<0.05

SBI: Sciatica Bothersomeness Index, SFI: Sciatica Frequency Index, PSC: Pain site codes and AKE:Active knee extension

group who demonstrated either complete disappearance or central localization of the symptoms after six sessions.

DISCUSSION

The present study was conducted to evaluate the effectiveness of neurodynamic technique along with treatment of interface in reducing the radiating symptoms and improve the ability of the neural tissue to undergo tension associated with lower extremity movements. Neurodynamic techniques are effective in producing centralization and reducing the Bothersomeness and frequency of radiating symptoms and improving knee extension range of motion in slump position. The sample size calculation was done assuming 10% attrition rate. There were six dropouts, that is, 5.56% attrition rate. Hence, the results of the study can be considered as valid and acceptable.

There was a statistically significant improvement in the Bothersomeness and frequency of radiating symptoms, location of symptoms (centralization), and active knee extension range of motion in slump posture in both the groups and a statistically significant difference between the groups, with the interventional group showing a better improvement compared to the control group. These findings are consistent with the previous studies conducted by Ahmed *et al*. and Adel *et al*. who showed that neural mobilization techniques can reducing the radiating symptoms.[17,18] Improvement in the Bothersomeness and frequency of radiating symptoms in the interventional group, as evident from the SBI and SFI scores, could be attributed to the effect of neurodynamic techniques in reducing the intraneural edema by dispersal of noxious intraneural fluid, thereby restoring the homeostasis around the neural tissue.[19-21] Compression over the neural structures has shown to accumulate fluid and increase intraneural edema.[20] Decompression caused in the intervertebral foramina by the static and dynamic openers could further disperse the fluid and reestablish the axoplasmic flow across the nerve roots.[17] Centralization occurred in the interventional group which is evident from a statistically significant improvement in the pain site codes. Centralization of radiating symptoms indicates favorable prognosis and it is one of the most important criteria to judge the efficacy of a treatment in conditions with radiating symptoms and a guiding tool to identify the patients who would respond favorably to conservative management.[22,23] There is conflicting evidence showing the effect of neurodynamic techniques on centralization with two studies reporting peripheralization in some subjects because the maneuvers used in these studies placed excessive tension on the neural tissue and they continued treatment despite an increase in the radiating symptoms.[18,24] Ahmed *et al*. reported centralization using neurodynamic techniques which are consistent with the present study. However, method of quantifying centralization was not mentioned by them.[17] The reason of centralization occurring in the present study which not seen in the previous studies could be the fact that as opposed to the treatment technique of Adel *et al*.[18] and George *et al*.,[24] we never allowed the symptoms to be provoked during the mobilization, as per the guidelines given by Shacklock.[9] This could be the reason of complete disappearance of symptoms in five subjects and pain centralized to central area of low back in 24 subjects in the interventional group. There was a statistically significant improvement in active knee extension range of motion in slump posture in the interventional group. These findings are consistent with a study conducted by Shah *et al*. in which one session of slider neurodynamic technique was effective in improving knee extension range of motion in slump posture.[25] This could be due to the effect of neurodynamic techniques, which are combinations of neural mobilization and openers of the intervertebral foramina may reverse the increased immune response and reduce mechanical hyperalgesia and mechanosensitivity in the neural tissue.[26,27] It can be surmised that reduction in mechanical hyperalgesia and mechanosensitivity allowed the subjects to take the knee further into extension in slump posture as the slump test is a "clinical" measure of the "physiological" phenomenon, mechanosensitivity.

There was a statistically significant difference in the outcome measures in control group. However, a difference of

0.98, 1, 0.38, and 2.6 in SBI, SFI, PSC, and AKE, respectively, cannot be considered as clinically significant. These small changes in the outcome measures can be attributed to the effect of isometric exercises, hot packs, and placebo. In a Cochrane review by French *et al*.,[28] it was concluded that heat therapy along with exercises is effective in reducing pain and improving function in patients with low back pain. The small magnitude of change in Bothersomeness and frequency of radiating symptoms, reported by the subjects, can be due to a perceived improvement in functional status because of the hydrocollator packs and isometric exercises. There was no subject who reported complete disappearance of symptoms or migration of symptoms to central area of low back as seen in the pain site codes on the overlay template.

This is one of the few studies consisting of a double-blind randomized controlled trial on the effectiveness of neurodynamic techniques on radiating symptoms, centralization, and mechanosensitivity in lumbosacral radiculopathy. This will serve as a guiding light to the physiotherapists aiming to treat the patients with lumbosacral radiculopathy by targeting the affected tissue and the mechanical interface. However, the subjects in the single-center trial were taken from different areas of a city in India. Looking at the economical, cultural, and social diversity of the Indian subcontinent, the study results may not be generalized to the entire population. Authors recommend conducting multicenter trials consisting of a stratified sample from different cities of the country.

CONCLUSION

Neurodynamic techniques, focusing on neural tissue and mechanical interface, can centralize the radiating symptoms, reduce their Bothersomeness and frequency, and normalize the mechanosensitivity of the nervous system, making them an important part of physiotherapy rehabilitation of the patients with lumbosacral radiculopathy.

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