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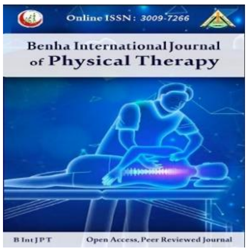

Original research

Neural mobilization versus somatosensory motor control in treatment of chronic low back pain with unilateral sciatica: a randomized controlled study.

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Abstract

Background: Low back pain is one of the most prevalent musculoskeletal illnesses in contemporary culture. The greater demand for orthopedic physical therapy identifies the need for more evidence-based techniques. **Purpose:** This research compared the efficacy of neural mobilization and somatosensory motor control training on balance, nerve excitability, and lumbar range of motion in individuals with persistent low back pain and unilateral sciatica. **Methods:** Forty-five male and female patients with persistent lower back pain and unilateral sciatica were included in this investigation. They were between thirty and fifty years old. They were randomly divided into three treatment groups (groups A, B, and C) of equal size. Group A received a traditional physiotherapy program (Transcutaneous Electrical Nerve Stimulation (TENS), hot pack, passive stretching, and core strengthening). Group B received the same traditional program, followed by sciatic neural slider mobilization. Group C received the traditional program followed by somatosensory motor control training, which consisted of proprioceptive neuromuscular facilitation (PNF), somatosensory exercises, and vestibular exercises. **Results:** All groups had statistically significant improvements in all outcome measures ($p < 0.05$) post treatment. No significant variations were recorded among the three groups in respect to balance scores, lumbar range of motion, and pain ($p > 0.05$) post treatment. Group B and C similarly improved and higher than group A in respect to nerve excitability (H-latency). Group B improved significantly higher than group A and C in respect to function ($P < 0.05$). **Conclusion:** Adding the neural mobilization and/or somatosensory motor control training to traditional physiotherapy program is beneficial in management of individuals with persistent lower back discomfort and unilateral sciatica.

Keywords: C-mill, Functional disability, H-latency, Sciatic nerve mobilization; Somatosensory motor control training.

Introduction

Low back pain is one of the most prevalent musculoskeletal illnesses in contemporary culture. Chronic low back pain is identified as discomfort recognized in the lower part of lumbar region and lasts for more than three months[1]. When compared to people between the ages of 18 and 30, prevalence was around 3 to 4 times higher in people over the age of 50. The prevalence was higher in females, those with lesser economic stress, people with less education, and smokers [2]. Damage to the lumbar spine's neurological or musculoskeletal structures may cause lower limb irritation. Lumbar radiculopathy may be the diagnosis if the reason is neurological. According to the distribution of the symptoms in the lower limbs, the diagnostic characteristics include

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sensory and motor issues with a particular nerve root[3].

In the first six to twelve weeks (acute and sub-acute phase), the majority of patients are managed conservatively with the main goal of reducing pain, either with analgesics or by decompressing the nerve root with physical therapy. First, conservative treatment is recommended, which includes counseling, exercise, manual therapy, psychiatric treatments, and medication. Mobilization, electrotherapy, traction, taping, and exercise have all been used as additional physiotherapy techniques[4].

In order to increase nerve gliding and reduce neural mechanosensitivity, neural mobilizations are treatments that involve a specific series of joint movements to mobilize the afflicted peripheral nerve. Those who experience lumbar disc herniation and consequent unilateral sciatica benefit from the use of neural tissue mobilization because it reduces functional impairment and enhances radiculopathy[5].

The sensorimotor function of low back pain patients has been studied using MRI, and it has been found that lower use of proprioceptive signals from the back (lower motor control) for maintaining upright posture is associated with lower white matter integrity of the upper peduncle of the cerebellum, which is a crucial area for proprioceptive input to reach higher centers[6].

To reestablish control of the trunk muscles, posture, and movement patterns and to lessen pain and functional impairment, motor control exercises apply the principles of motor learning (cognitive, associative, and automatic stages)[7]. Proprioceptive, oculomotor (Eye follow, gaze stability, and eye-head coordination), and vestibular training are all included in the somatosensory motor control program. Examples of vestibular activities include standing still for 30 seconds, walking while moving the head, and performing oculomotor or joint position exercises during balance training[8].

The purpose of the work: is to evaluate the efficacy of neural mobilization and somatosensory motor control training on balance, nerve excitability, lumbar mobility, pain, and function in cases with persistent low backache and subsequent unilateral sciatica**.**

The greater demand for orthopedic physical therapy identifies the need for more effective, safer, and more evidence-based techniques. The findings of the study will assist orthopedic physical therapists to conserve time and effort during their work. Patients also will benefit from the results obtained from this study by being treated with the best modalities and techniques which will relieve their symptoms and help them return to their work and life as soon as possible.

Methods

Study design

The study was approved by the Ethics Committee of Cairo University's Department of Physiotherapy considering that it was a single-blind, randomized clinical experiment. The study's quality was approved by a Research Ethics Committee that reviewed and approved it at 12/4/2022 (P.T.REC/012/003703). Before receiving their written agreement to participate in the current investigation, all participants received a thorough and understandable explanation of the study **.**

Participants:

Referred by an orthopedic surgeon or rheumatologist, patients with unilateral sciatica and chronic lower back discomfort were carefully selected from the Agouza Rheumatology Rehabilitation Centre (ARRC) outpatient clinic. All participants were between 30-50 years of both sexes; Diagnosed with herniation of lumbar discs between L4-L5 / L5-S1 levels (verified by MRI or CT); Pain radiated to one lower limb; The existence of pain was for 3 – 6 months; showed symptoms' propagation between forty and seventy degrees on a straight leg lift test; When answering the Oswestry disability index (ODI) and visual analogue scale (VAS) surveys, they were totally honest.

Allocation and randomization:

Equal numbers of patients (15) were split randomly into 3 groups (A, B, and C). Allocation concealment was secured by employing sealed, opaque envelopes **.**

Assessment procedure:

All patients underwent the same evaluation and recording of all parameters at the beginning and the end of the study (four weeks): C-Mill with virtual reality (VR+): was used to evaluate balance. It assessed limits of stability (LOS) for dynamic balance and postural stability for static balance in a valid, objective, and highly reliable manner[9]. Nicolet Viking Quest was used to record H-latency. H-reflexes were helpful and valid techniques for testing S1 involvement[10]. Lumbar ROM (lumbar flexion and extension) was measured with a measuring tape using a standardized approach of the Modified-Modified Schober Test[11]. The degree of discomfort was measured using the VAS. It has high validity and reliability[12]. The ODI Arabic version measured particular back functions. ODI has an elevated degree of reliability and has been certified for use with patients who have low back pain[13].

Treatment procedure:

Patients in group (A) (traditional): received TENS (a 100 Hz fixed-frequency pulse was delivered for 15 minutes), hot pack (for 10 minutes), Passive stretch (for back extensors, Hamstring, illiopsoas, and calf muscles), and Core strengthening of back muscles (a progression from independent transversus abdominis contraction and multifidus contraction to combined contraction of both in various postures, such as supine or prone or bridging).

Patients in group (B): received the traditional program followed by slider neural mobilization of the sciatic nerve which involved passive ankle dorsiflexion, knee extension, and hip flexion, adduction, and internal rotation (if applicable). The therapist mechanically alternated simultaneous hip and knee flexion with simultaneous hip and knee extension from this posture **(Figure 1)**. Three groups of ten movements were applied in every session (3 sessions / week) **.**

Figure 1: Neural mobilization

Patients in group (C): received the traditional program followed by somatosensory motor control training in the form of: PNF exercises (Each patient alternately contracted trunk extensors and flexors isometrically for 10 seconds against maximum resistance while seated, then contracted trunk agonists alternately in a concentric and eccentric manner against manual resistance without relaxing, then moved his or her trunk in a twisting and diagonal orientation against maximum resistance) **(Figure 2)**, Somatosensory exercises in which a wobbling board was used and six types of exercises were performed including hallowing, one lower limb elevation, opposite upper and lower limb elevation from a four-limb supported position (quadriped), abdominal reinforcement, maintaining a bridging posture, and one lower limb elevation from the bridging posture, **(Figure 3 & 4)** and finally Vestibular training which involved exercises to improve gaze focus, exercises for enhancing eye movements (head rotations, head-trunk rotations **(Figure 5)**, and head rotations during gait), exercises for improving postural stability, and exercises to enhance daily activities.

Figure 2: PNF phases: Isometric contraction and (A), the combination of isotonic (B) twisting (C).

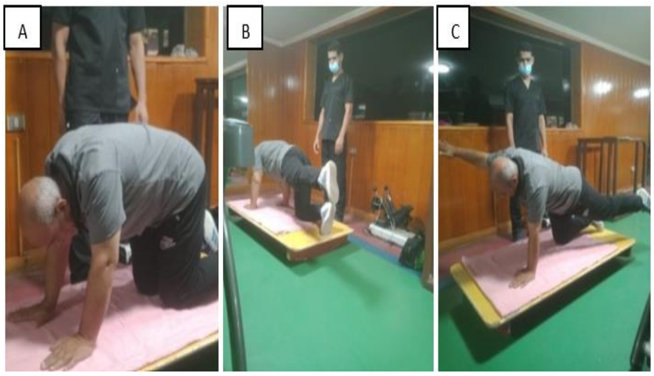


Figure 3: Somatosensory training: (A) hollowing, (B) one lower limb elevation, (C) opposite arm and leg elevation.

Figure 4: Somatosensory training: (A) abdominal reinforcement, (B) Bridging position (C) Holding a bridging on one leg.

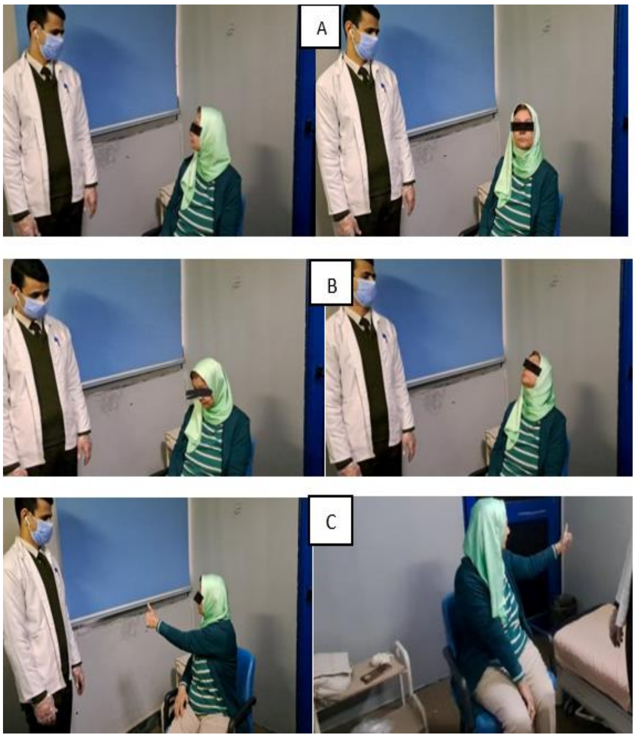


Figure 5: Head rotations horizontal (A) – vertical (B) – Head-trunk rotations (C)

Statistical analysis

The findings were presented as a percentage (%) or as mean ± standard deviation. The baseline characteristics were compared using ANOVA (analysis of variance) (except sex). A chi-squared test was employed to examine the distribution of genders. A mixed ANOVA was used to compare the outcomes of the three groups (together with Tukey's post hoc test). The significance limit was set at p-value < 0.05. SPSS, a statistical program for social sciences, was used to analyze the data (version 24 windows). A P-value of 0.05 or lower was considered significant **.**

Results

This research, which followed the concept of a randomized clinical trial, involved 45 individuals between the ages of 30 and 50 who were randomized to three groups. Six patients dropped out (39 analyzed) as shown in the flowchart **(Figure 6)**. The groups' baseline characteristics did not significantly differ from one another (p-value > 0.9) **(Table 1)**. In terms of the number of patients, age, sex distribution, the three groups were homogeneous.

Group (A): consisted of 13 patients (7 males and 6 females) with about 54% (7 patients) being right affected **(Table 1)** and **(Figure 7)**. Group (B): consisted of 13 patients (7 males and 6 females) with about 54% (7 patients) being right affected (Table 1) and (Figure 7). Group (C): consisted of 13 patients (7 males and 6 females) with about 54% (7 patients) being right affected (Table 1) and (Figure 7). There were no significant differences between groups in baseline characteristics (p-value > 0.9).

Table 1: Comparison of baseline characteristics (affected side and sex distribution) between groups.

Variable	Groups	Count (Percentage)	p-value
Affected side (right)	Group (A)	7 (54%)	1
	Group (B)	7 (54%)	
	Group (C)	7 (54%)	
Sex distribution (male)	Group (A)	7 (54%)	0.9
	Group (B)	7 (54%)	
	Group (C)	6 (46%)	

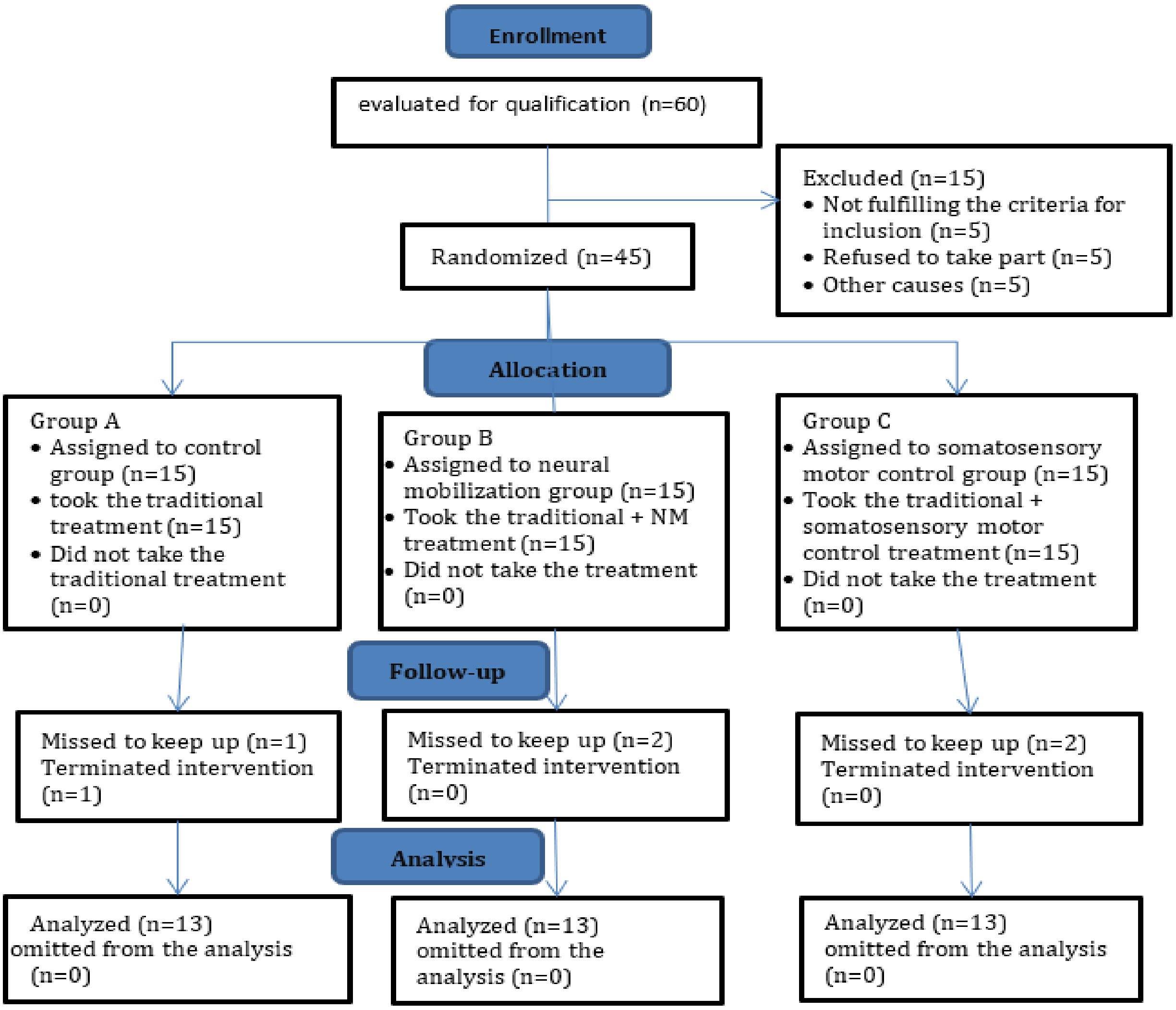


Figure 6: Flow Chart

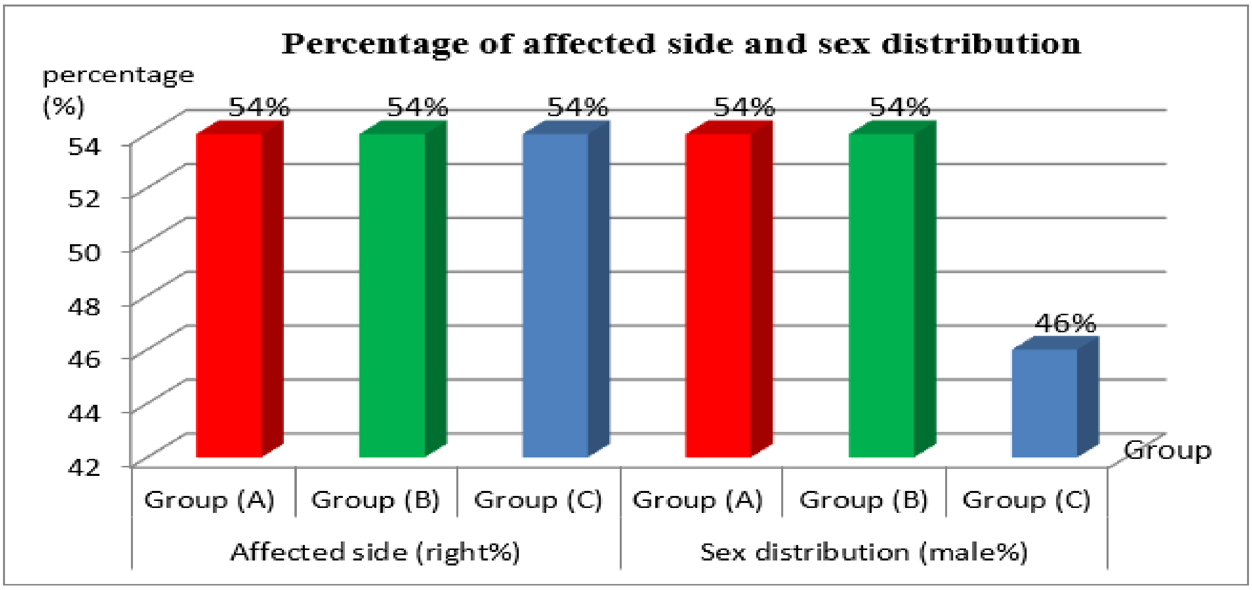
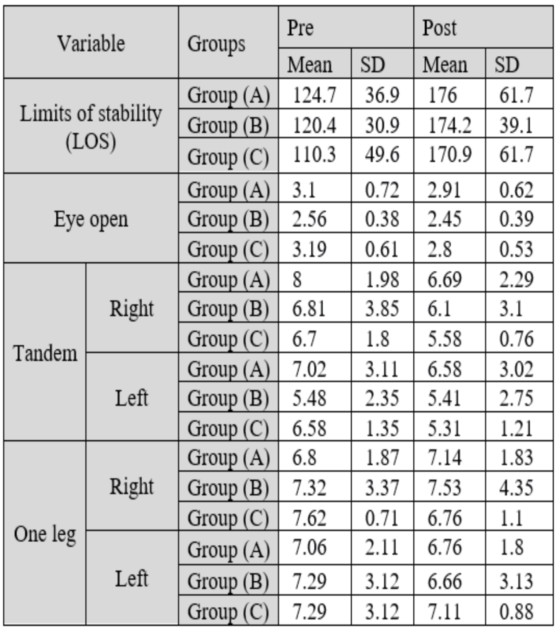


Figure 7: Chart showing sex distribution (male percentage %) and affected side in the three groups (group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group).

Descriptive statistics (means and standard deviations) of balance scores (limits of stability (LOS), eye open, tandem, one leg) for the three groups pre and post treatment were presented in **(Table 2)** and **(Figure 8)**.

Table 2: Balance scores in the three groups pre and post treatment.



Variable		Groups	Pre		Post	
			Mean	SD	Mean	SD
Limits of stability (LOS)		Group (A)	124.7	36.9	176	61.7
		Group (B)	120.4	30.9	174.2	39.1
		Group (C)	110.3	49.6	170.9	61.7
Eye open		Group (A)	3.1	0.72	2.91	0.62
		Group (B)	2.56	0.38	2.45	0.39
		Group (C)	3.19	0.61	2.8	0.53
Tandem	Right	Group (A)	8	1.98	6.69	2.29
		Group (B)	6.81	3.85	6.1	3.1
		Group (C)	6.7	1.8	5.58	0.76
	Left	Group (A)	7.02	3.11	6.58	3.02
		Group (B)	5.48	2.35	5.41	2.75
		Group (C)	6.58	1.35	5.31	1.21
One leg	Right	Group (A)	6.8	1.87	7.14	1.83
		Group (B)	7.32	3.37	7.53	4.35
		Group (C)	7.62	0.71	6.76	1.1
	Left	Group (A)	7.06	2.11	6.76	1.8
		Group (B)	7.29	3.12	6.66	3.13
		Group (C)	7.29	3.12	7.11	0.88

SD: Standard deviation, group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group.

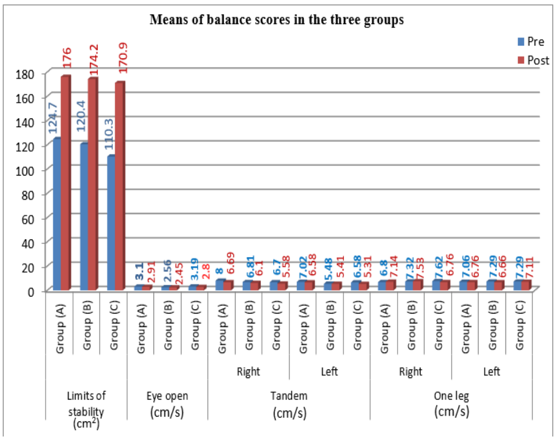
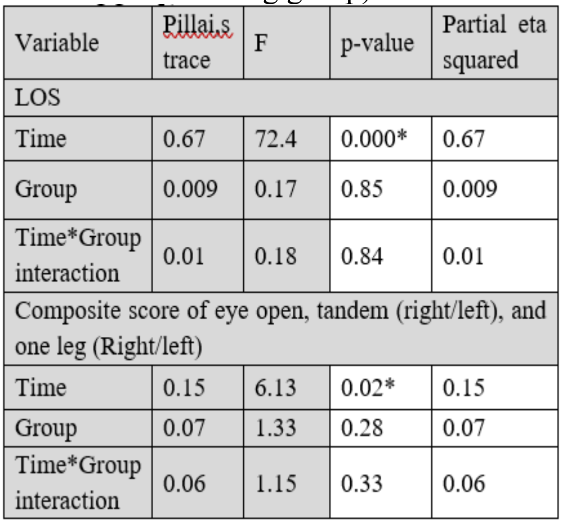


Figure 8: Chart showing means of balance score in the three groups (group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group) pre and post treatment.

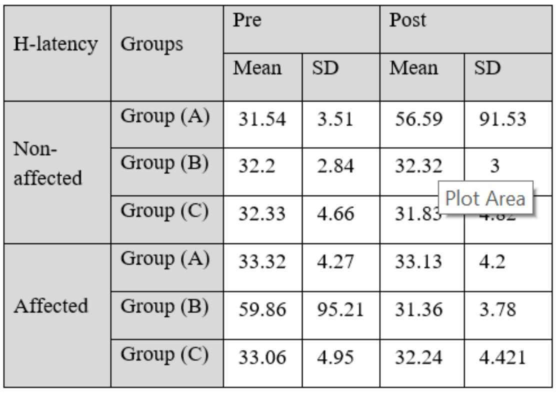
Only time (pretreatment and posttreatment) had a significant principal influence on balance (LOS: Pillai's trace =0.67, F=72.4, p-value=0.000) and the Composite Score of eye open, tandem, and one Leg (Pillai,s trace =0.15, F=6.13, p-value=0.02) in the Mixed ANOVA results. Both the major impact of group and the time-group interaction influence were not of statistical significance. All groups improved significantly post-treatment in balance with no difference between groups **(Table 3)**.

Table 3: Mixed ANOVA for balance scores in the three groups (group (A): traditional group, group (B): neural mobilization group, and group (C): Somatosensory motor control training group).



Variable	Pillai,s trace	F	p-value	Partial eta squared
LOS				
Time	0.67	72.4	0.000*	0.67
Group	0.009	0.17	0.85	0.009
Time*Group interaction	0.01	0.18	0.84	0.01
Composite score of eye open, tandem (right/left), and one leg (Right/left)				
Time	0.15	6.13	0.02*	0.15
Group	0.07	1.33	0.28	0.07
Time*Group interaction	0.06	1.15	0.33	0.06

P-value: Probability value, LOS: limits of stability



H-latency	Groups	Pre		Post	
		Mean	SD	Mean	SD
Non-affected	Group (A)	31.54	3.51	56.59	91.53
	Group (B)	32.2	2.84	32.32	3
	Group (C)	32.33	4.66	31.83	4.82
Affected	Group (A)	33.32	4.27	33.13	4.2
	Group (B)	59.86	95.21	31.36	3.78
	Group (C)	33.06	4.95	32.24	4.421

SD: Standard deviation, group (A): Traditional group (B): Neural mobilization group, group (C): Somatosensory motor control training.

A major and significant impact for time (Pillai,s trace =0.11, F=4.4, p-value = 0.044, partial eta squared = 0.11) and (Pillai,s trace = 0.27, F = 6.66, p-value = 0.003, partial eta squared = 0.27) group on H-latency (affected/non-affected) was found using mixed ANOVA. The interaction effect of time and group was non-significant. All groups improved significantly post-treatment in H-latency with neural mobilization and motor control groups similarly improved higher than the traditional group **(Table 5, 6**).

Table 5: Mixed ANOVA for H-latency scores in the three groups (group (A): traditional group, group (B): neural mobilization group, and group (C): Somatosensory motor control training group).

H-latency	Pillai,s trace	F	p-value	Partial eta squared
Time	0.11	4.4	0.044*	0.11
Group	0.27	06.66	0.003*	0.27
Time*Group interaction	0.106	2.14	0.13	0.106

P-value: Probability value.

Table 6: Pairwise comparisons (Post hoc test) between groups (group (A): traditional group, group (B): neural mobilization group, and group (C): Somatosensory motor control training group) in H-latency scores.

H-latency	MD	p-value
Neural mobilization vs. traditional	-0.06	0.001*
Motor control vs. traditional	-0.035	0.046*
Neural mobilization vs. Motor control	-0.026	0.124

MD: Mean difference, p-value: Probability value.

Descriptive statistics (means and standard deviations) of lumbar ROM (flexion and extension) scores for the three groups were presented in **(Table 7)**.

Table 7: Lumbar ROM scores in the three groups pre and post treatment.

Lumbar ROM	Groups	Pre		Post	
		Mean	SD	Mean	SD
Flexion	Group (A)	3.31	0.69	4.19	1.32
	Group (B)	4.19	0.93	5.23	1.05
	Group (C)	4.04	1.39	5.27	1.47
Extension	Group (A)	1.27	0.48	2.08	0.53
	Group (B)	1.08	0.4	1.69	0.43
	Group (C)	1.31	0.38	2	0.65

SD: Standard deviation, group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group.

The entire lumbar ROM (flexion + extension) showed a significant major impact of time (Pillai,s trace =0.8, F=142.5, p-value < 0.001, partial eta squared = 0.8), according to mixed ANOVA results. Both the major impact of group and the time-group interaction influence were not of statistical significance. All groups improved significantly post-treatment in lumbar ROM with no differences between groups **(Table 8)**.

Table 8: Mixed ANOVA for lumbar ROM scores in the three groups (group (A): traditional group, group (B): neural mobilization group, and group (C): Somatosensory motor control training.

Lumbar ROM	Pillai,s trace	F	p-value	Partial eta squared
Time	0.8	142.5	0.000*	0.8
Group	0.095	1.9	0.17	0.095
Time*Group interaction	0.018	0.33	0.72	0.018

P-value: Probability value.

Table 13: Pairwise comparisons (Post hoc test) between groups (Group (A): traditional group, Group (B): Neural mobilization group and Group (C): Somatosensory motor control training group) in ODI scores.

Disability	MD	p-value
Neural mobilization vs. traditional	-6.4	0.019*
Motor control vs. traditional	-4.46	0.13
Neural mobilization vs. Motor control	-1.96	0.66

MD: Mean difference, P-value: probability value

Discussion

This research study is a randomized clinical trial that compare between effect of neural mobilization and somatosensory motor control training on balance, nerve excitability, lumbar ROM, pain severity, and functional disability in patients who have CLBP with unilateral sciatica.

The results of these studies showed that the three groups improved significantly in balance, lumbar ROM, and pain with no significant difference between groups. The three groups improved significantly in h-latency with the neural mobilization and motor control groups similarly improved higher than the traditional group. The three groups improved significantly in functional disability with neural mobilization improved higher than motor control and traditional groups.

According to Yu et al.[14], Patients with low back pain suffer with controlling both the superficial as well as deep muscles (such as multifidus and transversus abdominis) of the trunk, which are essential to maintain trunk stability. In single-leg standing activities, chronic low back pain patients' balance was worse than that of healthy individuals[15].

Maximizing sensory input to various portions of the body and improving muscle adjustment ability through sensorimotor training and proprioceptive sense retraining both contribute to improving motor flexibility. When compared to other therapies, sensorimotor training is more effective at enhancing motor function and coordination[16].

In support of our results, Marchand et al.[16] depicted that improved muscular coordination and improve ability to react to sensory input are two benefits of sensorimotor training. Additionally, development occurs as a result of adjustments to various postures, the basis of support, and hurdles to the center of gravity. The influence of a core strengthening program on balance in patients with persistent low back pain was investigated by Choi et al.[17], who found that it enhanced balance.

The current study's findings were contrasted with those of Shamsi et al.[18], who found that in patients with persistent nonspecific low back pain, there was no discernible difference in stability between the two therapy groups. Hlaing et al.[19] discovered that in patients with sub-acute nonspecific low back pain, core stabilization exercises were superior to general strengthening activities for enhancing balance, proprioception, and percentage difference in muscle thickness and a decrease in both motion phobia and functional impairment.

According to Sharaf et al.[20], both the neural mobilization group and the traditionally treated groups in low back pain patients with sciatica caused by S1 nerve involvement experienced reduced pain levels, functional impairment, latency, enhanced amplitude, and H/M ratio improvements after 6 weeks of treatment. However, the effectiveness of the neural mobilization approach group exceeded that of the control group. The findings were further strengthened by Katke and Anthikat [21], who discovered that neural mobilization

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According to De Faria et al.[22], neural mobilization is a practical approach for treating individuals with persistent low back pain since it increases ROM, and tissue extensibility, while reduces stiffness, as well as pain severity. Kumar [23] concluded that in cases suffering from low back pain of nonspecific type, the motor control group exceeded the placebo group in terms of increasing flexion range of lumbar spine, reducing pain severity, and enhancing the functional impairment primarily brought on by painful sensation experienced.

Alshami et al.[24] treated individuals with persistent low back pain exclusively using the neural mobilization technique. According to the results of the goniometry tests and the Wells bench, neural mobilization increased flexion movement of lumbar region but had no impact on pain. Malik et al.[25] concluded that after receiving neural mobilization treatment, patients experienced an average reduction in pain of 70% while also experiencing improved lumbar mobility. This demonstrates that neural mobilization optimizes patients' return to their normal activities of daily living by relieving pain and encouraging the functional recovery process.

Borges et al.[26] demonstrated that although neural mobilization and segmental stabilization were successful in lowering pain severity and enhancing functional ability, they could not guarantee that these treatments used alone would introduce the same results. Paeslandim and De Matos [27] were able to evaluate the severity of pain and degree of muscular power and correlated NM with many therapeutic modalities. Both revealed distinct findings regarding the improvement in the strength pattern, but both showed a decrease in discomfort levels

Our findings are consistent with those of Garg et al.[28], who discovered that participants with persistent nonspecific low back pain benefit similarly from both sensory motor training and core stabilization training in aspects of reducing pain, disability, and enhancing function. However, when means were taken into account, sensory motor training had a stronger impact. Therefore, we could draw the conclusion that sensory motor training is a viable therapy option.

In cases suffering from sciatica due to herniated disc in lumbar spine, França et al.[29] found that motor control training was more effective than TENS at pain reduction, functional impairment limitation, and transversus abdominis muscle activation.

According to Plaza et al.[30], individuals with lower back discomfort and radiculopathy did not benefit more from the incorporation of neural mobilization technique to the motor control training program regarding pain relief, functional impairment limitation, or pressure pain threshold enhancement. Although straight leg raise and the Self-Administered Leeds Assessment of Neuropathic signs and symptoms (S-LANSS) revealed larger changes in brain mechanosensitivity in individuals who received neural mobilizations, these variations were small and most likely not clinically relevant

Limitations:

The long duration of each treatment session and too many exercises that made some patients exhausted mainly those in the somatosensory motor control training group.

Conclusion:

Based on the results supported by relevant studies, it could be concluded that there was no difference of statistical significance between both neural mobilization and somatosensory motor control training on balance, lumbar ROM, and pain post-treatment, while neural mobilization and somatosensory motor control training added to traditional treatment were more effective significantly than traditional treatment alone in enhancing nerve excitability (H-latency),

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furthermore, neural mobilization added to traditional treatment was the most significantly effective in improving functional disability.

The findings of this study and the findings of other researchers working in the same field shows that including somatosensory motor control training or neural mobilization in addition to traditional treatment may be beneficial, but there was no significant difference between them except on function in favor of neural mobilization group and both groups were significantly better than the traditional group in improving nerve excitability.

Scientific Responsibility Statement:

The writers affirm that they are in charge of the study structure, gathering, analyzing, and interpreting the data, writing, part or all of the major body of the work, preparation, and approval of the article's final draught.

Human rights statement:

Every procedure used in this study complied with the 1964 Helsinki Declaration and its subsequent modifications, as well as similar ethical norms, and the guidelines of the organisational and/or national research committee.

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No conflicts of interest are disclosed by the writers.

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