Egyptian Journal of Physical Therapy [EJPT]

Original Article

Neural mobilization versus somatosensory motor control in treating lumbar disc herniation with unilateral sciatica

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Abstract:

Purpose: This research was done to compare the efficacy of neural mobilization and somatosensory motor control training on balance, nerve excitability, lumbar range of motion, pain, and functional disability in individuals with persistent low back pain and unilateral sciatica. **Methods**: Forty-five male and female patients with low 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 consisted of Transcutaneous Electrical Nerve Stimulation (TENS), hot pack, stretching exercises for back extensors, Hamstrings, illiopsoas, calves, and core strengthening exercises for multifidus and transversus abdominis. 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. Balance, nerve excitability, lumbar range of motion, pain, and function were assessed before and after treatment. **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 with respect to balance scores, lumbar range of motion, and pain ($p > 0.05$). Group B and C similarly improved and were higher than group A with respect to nerve excitability (H-latency). Group B improved significantly higher than groups A and C with respect to function ($P < 0.05$). **Conclusion**: Adding neural mobilization or somatosensory motor control training to traditional physiotherapy program is beneficial in management of individuals with persistent lower back discomfort and unilateral sciatica.

Keywords: Sciatic nerve mobilization; somatosensory motor control training; C-mill; H-latency; functional disability.

Academic Editor: Mohammed Ali Atya.
Received: June 2025, Revised: July 2025, Accepted: August 2025, Published: September 2025
Citation: To be added by editorial staff during production.

1. Introduction:

Chronic low back pain is identified as discomfort recognized in the lower part of lumbar region and lasts for more than three months **[1].** Seventy to eighty percent of the general population report having low back pain (LBP) at some point in their lives. LBP is one of the most prevalent causes of pain from musculoskeletal illnesses and a significant public health issue that affects the functional status and quality of life in elderly people. The prevalence rises linearly from the third decade of life to age sixty, with a higher incidence in women **[2].** When compared to people between the ages of eighteen and thirty, prevalence was around three to four times higher in people over the age of fifty. The prevalence was higher in females, those with lesser economic stress, people with less education, and smokers **[3].** The most commonly found risk factors for CLBP are increased pain severity, weight gain, carrying large loads at work, difficult working postures, and depression **[4].** Damage to the lumbar spine's neurological or musculoskeletal structures may cause lower limb irritation **[5].** Lumbar radiculopathy may be the diagnosis if the reason is neurological **[6].** According to the distribution of the symptoms in the lower limbs, the diagnostic characteristics include sensory and motor issues with a particular nerve root **[7].**

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 **[8].**

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 **[9].**

The mechanisms underlying improvements following neural mobilization are unclear, however, some possible theories include physiological effects (washing out of intraneural edema), central effects (decreasing sensitization of dorsal horn and supraspinal regions) and mechanical effects (increasing nerve excursion) **[10].**

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 **[11].** 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) **[12].** Patients with low back pain suffer with controlling both the superficial as well as deep muscles of the trunk, which are essential to maintain stability **[13].** In single-leg standing activities, chronic low back pain patients' balance was worse than that of healthy individuals **[14].** 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 thirty seconds, walking while moving the head, and performing oculomotor or joint position exercises during balance training **[15].**

The purpose of the work: This study was conducted to compare between the efficacy of neural mobilization and somatosensory motor control training on balance, nerve excitability, lumbar range of motion, pain, and function in patients with chronic low back pain and unilateral sciatica.

2. Materials and Methods:

Study design:

The study was approved by the Ethics Committee of Cairo University's Department of Physiotherapy at 12/4/2022 (P.T.REC/012/003703) considering that it was a single-blind, randomized clinical trial. Before receiving their consent form to participate in the current investigation, all participants received a thorough and understandable explanation of the study. The trial coordinator routinely checked the quality of screening, data management, and protocol adherence.

Study participants and recruitment criteria:

Referred by an orthopedic surgeon or rheumatologist, forty-five 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 thirty-fifty 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 three – six months; showed symptoms' propagation between forty and seventy degrees on a straight leg lift test. Equal numbers of patients **(15)** were split randomly into three groups (A, B, and C). The three groups were homogenous in terms of number of patients, age, and distribution of sexes.

Outcome measures:

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 **[16].** Nicolet Viking Quest was used to record H-latency. H-reflexes were helpful and valid techniques for testing S1 involvement **[17].** Lumbar ROM (lumbar flexion and extension) was measured with a measuring tape using a standardized approach of the Modified-Modified Schober Test. The degree of discomfort was measured using the VAS. It has high validity and reliability **[18].** 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 **[19].**

Procedures:

Patients in group (A) (traditional): received TENS (one hundred Hz fixed-frequency pulse was delivered for fifteen minutes), Hot pack (for ten minutes), Passive stretch (for back extensors, Hamstring, illiopsoas, and calf muscles) **[20],** 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 **[21]).**

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 grasped the heel with one hand and mobilizing the knee with the other hand. The therapist mechanically alternated simultaneous hip and knee flexion and ankle dorsiflexion with simultaneous hip and knee extension and ankle planter flexion from this posture **[22] (figure 1).** The slider intervention was applied as three sets of ten repetitions during each treatment session for five minutes. Three sessions per week were applied for four weeks **[23].**

Figure (1): Neural mobilization

Patients in group (C): received the traditional program followed by somatosensory motor control training in the form of PNF exercises: during the first week, the patient was instructed on how to correctly alternate isometric contractions of the trunk flexor and extensor muscles against manual resistance while seated for ten seconds **(figure 2A).** During the second week, training exercises included a five-second resisted concentric trunk flexion, a five-second resisted isometric contraction in flexion, and a five-second resisted eccentric trunk flexion **[24] (figure 2B).** During the third and fourth weeks, training consisted of trunk rotation and diagonal upper limb motions in both directions, with the physical therapist providing the greatest amount of manual resistance **[25] (figure 2C).**

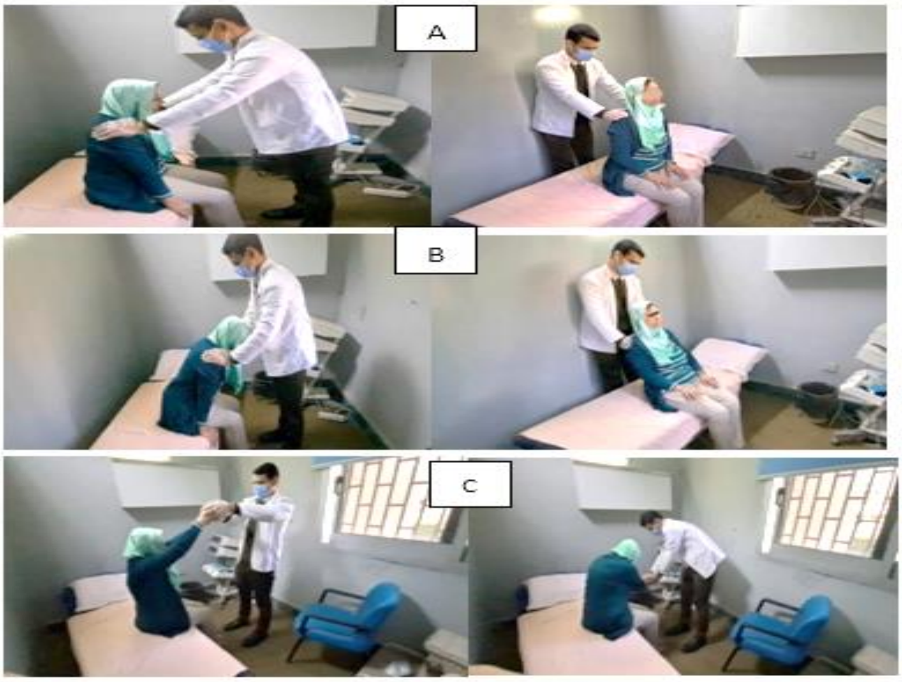

Figure (2): PNF phases: Isometric contraction (A), the combination of isotonic (B), and twisting (C).

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 **[26].**

Exercises for enhancing eye movements (head rotations **(figure 3A, B),** head-trunk rotations **(figure 3C),** and head rotations during gait), Exercises involving trunk rotation may be helpful for people who suffer from persistent low back pain (CLBP) **[27].** Exercises for improving postural stability, and exercises to enhance daily activities.

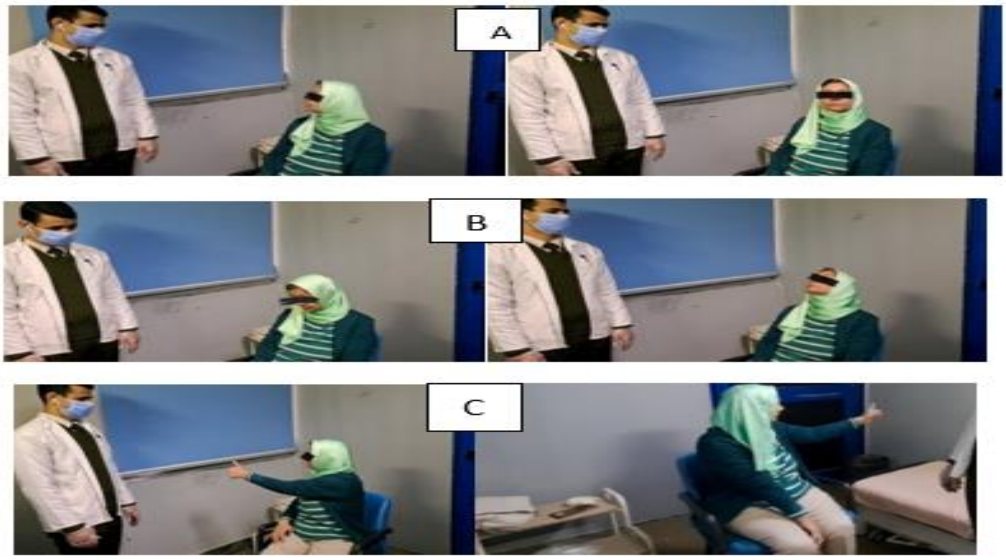

Figure (3): Head rotations horizontal (A) – vertical (B) – Head-trunk rotations (C)

Data Analysis:

Calculation of sample size:

Samples size was calculated using G* poer3.1.1 software and as based on detecting effect size F of 0.53 or partial eta squared of 0.22 on mechanical pain sensitivity or neuropathic symptomatology, based on work of Plaza et al. **[22],** assuming alpha level of 0.05 and a desired power of 0.8. This revealed a sample size of 38 (for 3 groups), 45 patients (15 patients per group) were included to account for 15% drop-outs. Six patients dropped out (thirty-nine analyzed) as shown in the flowchart **(figure 4).**

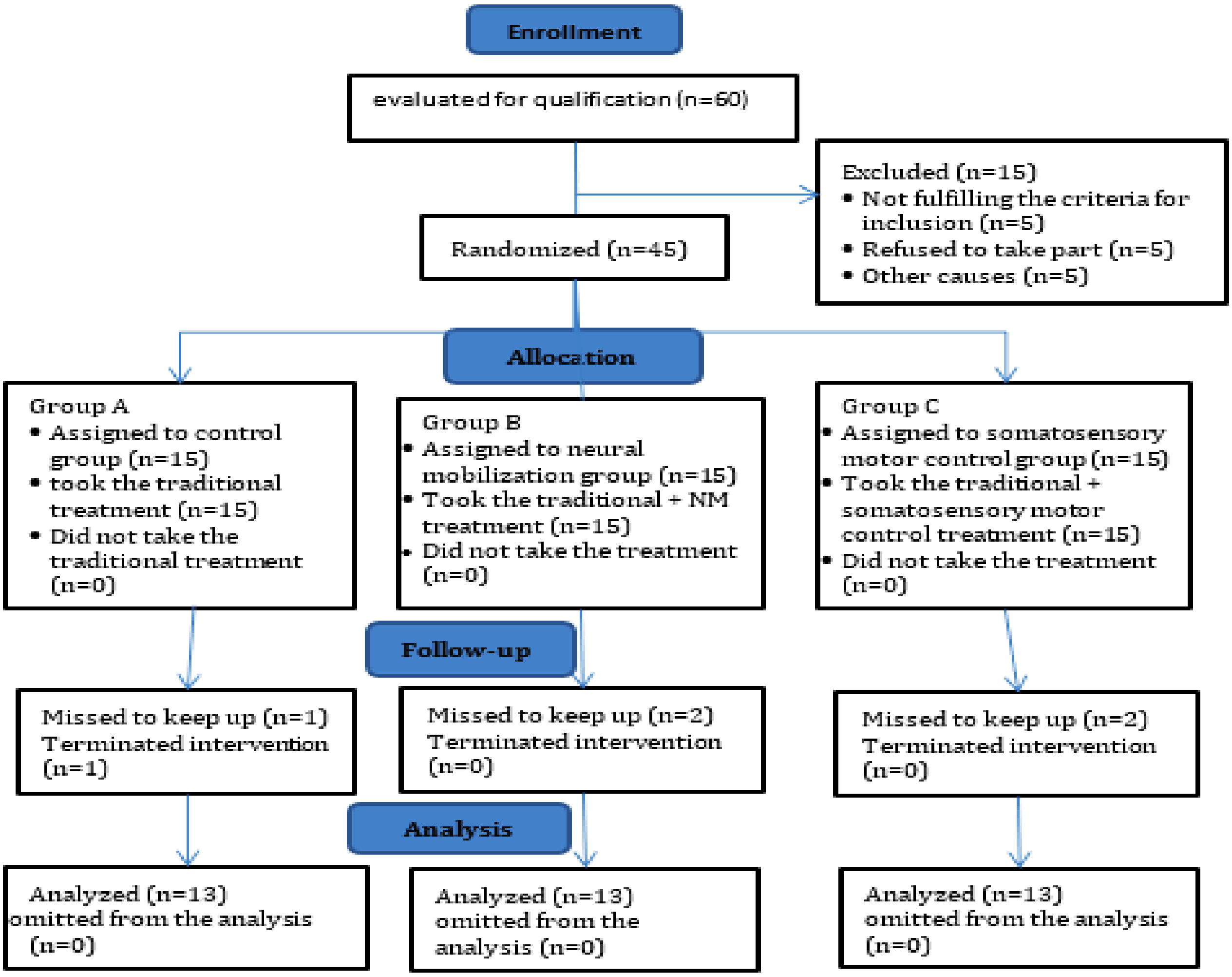

Figure (4). Flow Chart

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). A two-way MANOVA test was utilized to examine the impact of intervention in two groups for the measures of balance, nerve excitability (H-reflex), lumbar ROM, pain (VAS), and function (ODI) and to test the difference between the three groups. 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.

3. Results:

The groups' baseline characteristics did not significantly differ from one another (p-value > 0.9) **(Table 1).**

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%)	

P-value: Probability value, group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group.

Balance:

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 (Fig. 5).**

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.

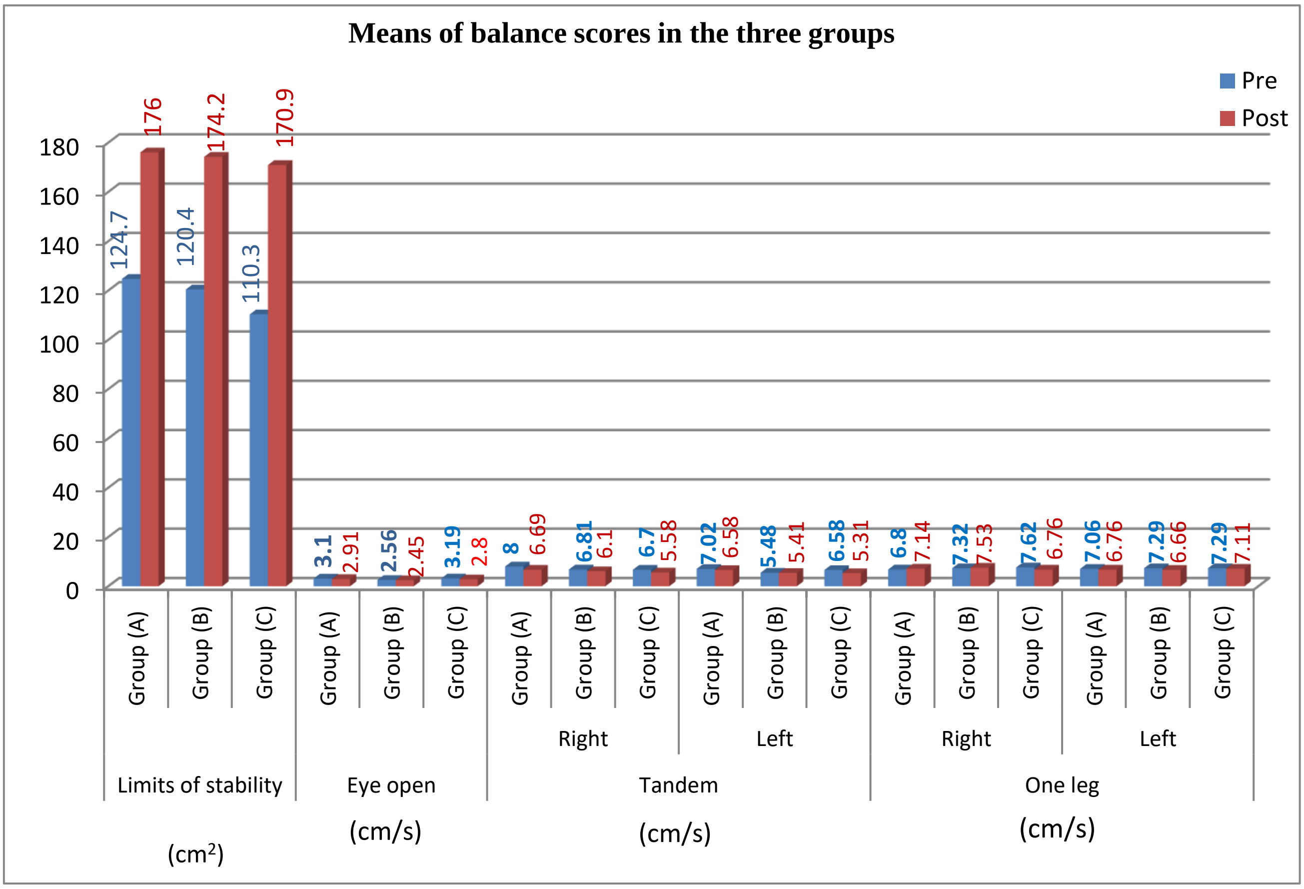

Figure (5): Chart showing means of balance score in the three groups (group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group) pre and post treatment.

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.

H-latency:

Descriptive statistics (means and standard deviations) of H-latency scores for the three groups were presented in **(Table 3)** and **(Figure 6).**

Table (3): H-latency scores in the three groups pre and post treatment.

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, group (B): neural mobilization group, group (C): Somatosensory motor control training group.

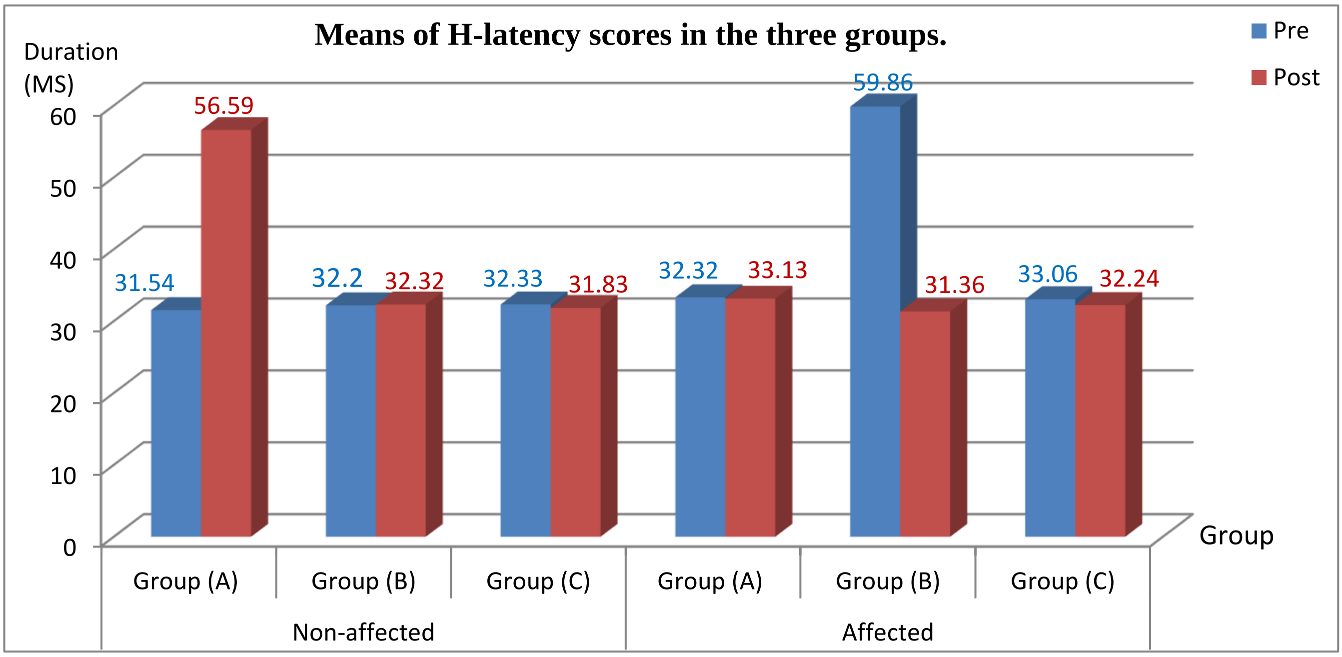

Figure (6). Chart showing means of H-latency in the three groups (group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group) pre and post treatment - MS: millisecond.

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.

Lumbar ROM:

Descriptive statistics (means and standard deviations) of lumbar ROM (flexion and extension) scores for the three groups were presented in **(Table 4)** and **(Figure 7).**

Table (4): 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.

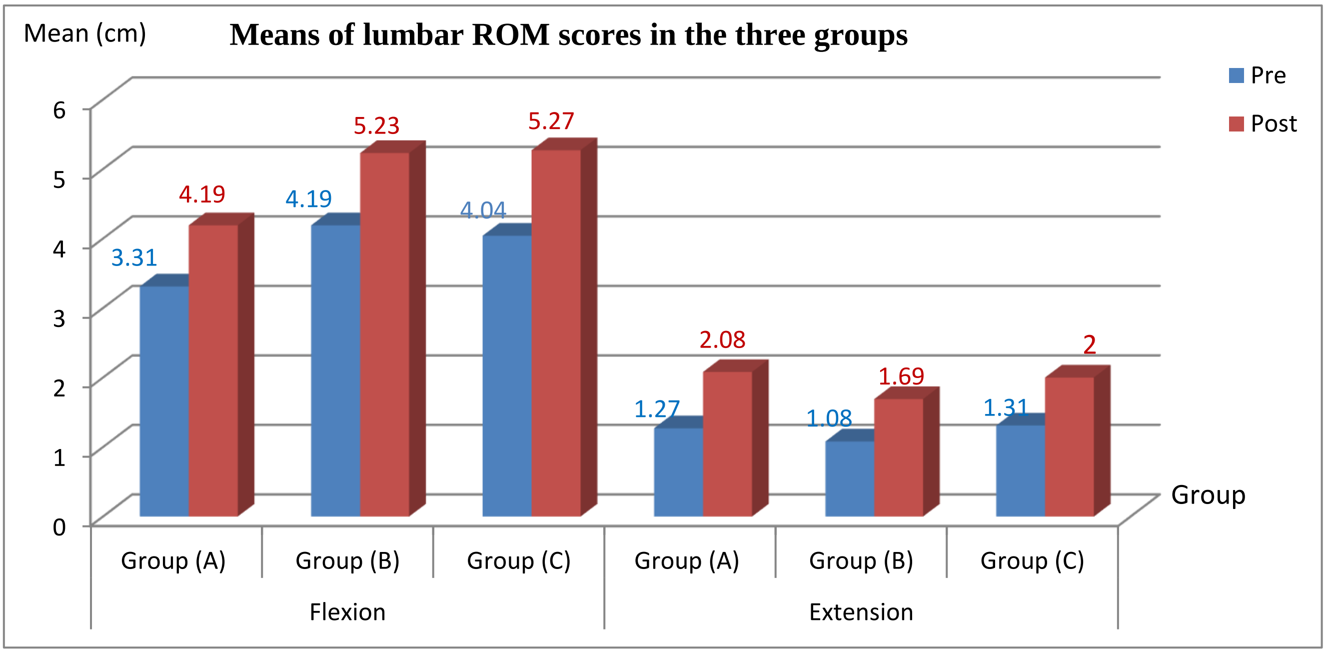

Figure (7): Chart showing means of lumbar ROM scores in the three groups (group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group) pre and post treatment.

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.

Pain:

Descriptive statistics (means and standard deviations) of VAS scores for the three groups were presented in **(Table 5)** and **(Figure 8).**

Table (5): Pain scores in the three groups pre and post treatment.

Variable	Groups	Pre		Post	
		Mean	SD	Mean	SD
Pain	Group (A)	8.15	1.52	2.69	1.32
	Group (B)	7.38	1.2	2.92	1.98
	Group (C)	8.42	1.1	3.08	1.61

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

Mixed ANOVA result showed a significant principal impact for time (Pillai,s trace =0.87, F=245, p-value<0.001, partial eta squared=0.87) on pain. The main impact of group and interaction impact of time and group was non-significant. All groups improved significantly post-treatment in pain with no differences between groups.

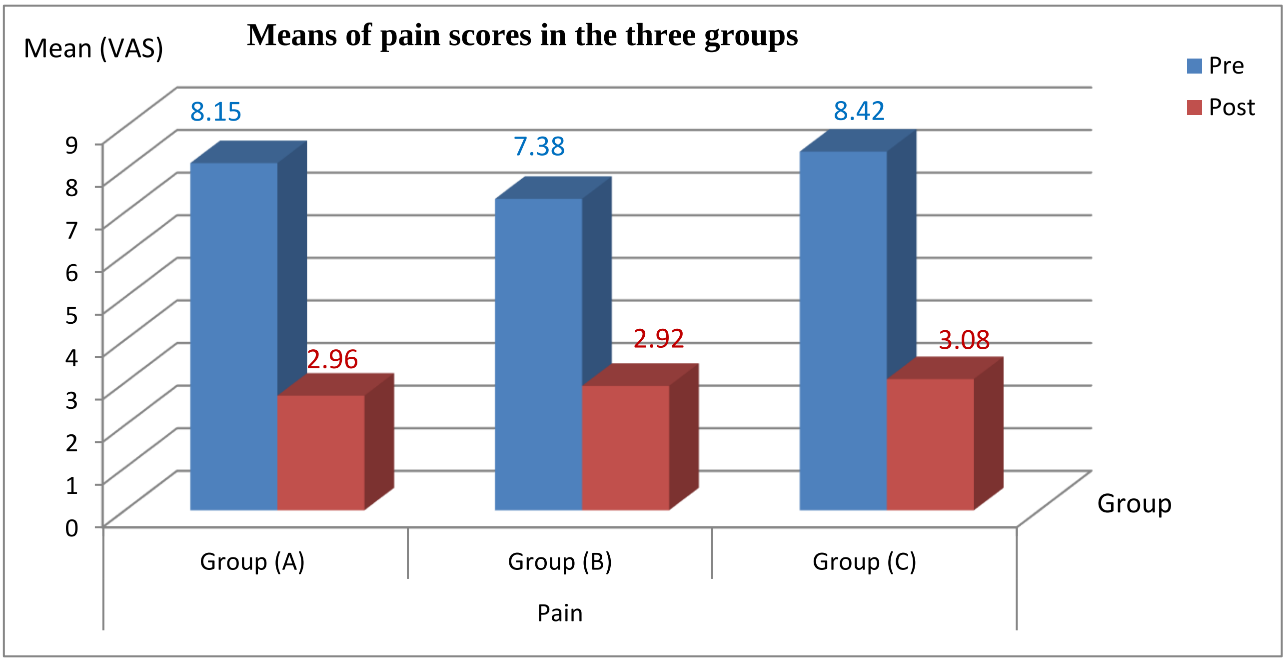

Figure (8): Chart showing means of pain scores in the three groups (group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group) pre and post treatment.

Disability:

Descriptive statistics (means and standard deviations) of ODI scores for the three groups were presented in **(Table 6)** and **(Figure 9).**

Table (6): Disability scores in the three groups pre and post treatment.

Variable	Groups	Pre		Post	
		Mean	SD	Mean	SD
	Group (A)	24.1	4.1	15	6.35
Disability	Group (B)	17.85	4.95	8.4	6.4
	Group (C)	18.1	6.86	12.1	7.2

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

The results of a mixed ANOVA showed that there was a significant principal impact for both time (Pillai,s trace =0.83, F=173.3, p-value<0.001, partial eta squared=0.83) and group (Pillai,s trace =0.19, F=4.3, p-value=0.022, partial eta squared=0.19), as well as an insignificant time*group interaction (Pillai's trace =0.15, F=3.1, p-value=0.06, partial eta squared =0.15) on disability. All groups improved significantly post-treatment in disability. Groups differed significantly post-treatment in favor of neural mobilization that was lower in disability than traditional group (MD = -6.4, p-value = 0.019).

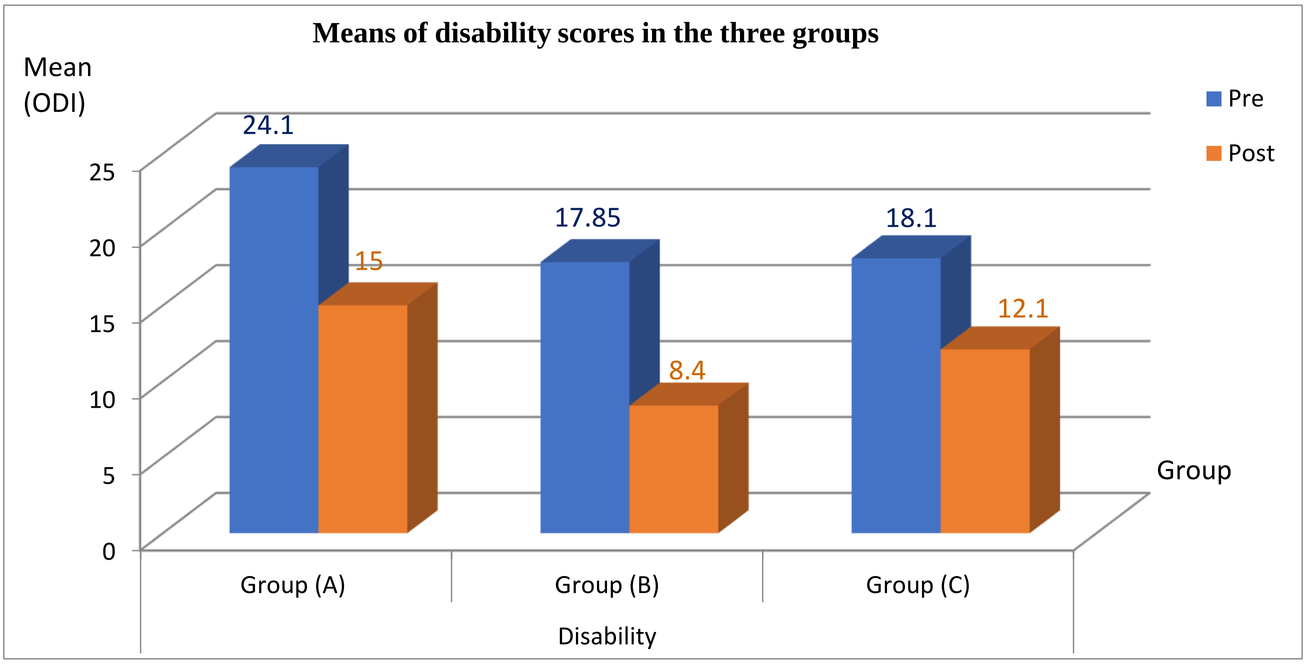

Figure (9) Chart showing means of disability scores in the three groups (group (A): traditional group, group (B): neural mobilization group, group (C): Somatosensory motor control training group) pre and post treatment.

4. 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.

The goal of neural mobilization techniques is to improve Neurodynamics and neural tissue mobility; on the other hand, somatosensory training aims to improve motor control and sensory processing. Neural mobilization strategies improved nerve transmission and reduced pain in sciatica patients, according to a study by Mecagni et al. **[28];** this implies that in people with unilateral sciatica who have CLBP, neural mobilization may positively affect nerve excitability and pain thresholds. On the other hand, it has been demonstrated that somatosensory training enhances proprioception and balance in those with low back pain. Somatosensory training significantly improved postural control and balance in individuals with chronic low back pain according to a study by Luoto et al. **[29].** 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 **[30].**

In support of our results, Marchand et al**. [30]** depicted that improved muscular coordination and improved 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. **[31],** who found that it enhanced balance. The current study's findings were contrasted with those of Shamsi et al. **[32],** 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. **[33]** 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.

In a study published by Paatelma et al. **[34]** examined the effects of somatosensory training and neural mobilization on lumbar flexibility in patients with persistent low back pain. The findings showed that lumbar range of motion improved with both therapies, indicating that somatosensory training and neural mobilization may be helpful in treating this part of CLBP.

The benefits of neural mobilization and somatosensory training on pain and functional results in patients with chronic low back pain were compared in a systematic review conducted by Nambi et al. **[35].** According to the review, there was no discernible difference in the two therapies' efficacy in lowering pain and enhancing functional status. This implies that in treating pain and function in people with CLBP who have unilateral sciatica, neural mobilization and somatosensory training may be equally beneficial.

According to Sharaf et al. **[36],** 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 six 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 **[37],** who discovered that neural mobilization increased the speed of median nerve conduction.

Our findings are consistent with those of Garg et al. **[38],** 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. According to Plaza et al. **[22],** 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 raises 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.

The similar improvement observed in all groups, despite the literature suggesting higher efficacy of sensorimotor training, could indeed be related to the dose of exercises used in the research. The specific characteristics of the exercise protocols, including the frequency, intensity, duration, and progression of the exercises, play a crucial role in determining their effectiveness. Additionally, the individual responsiveness of patients to different exercise regimens and the potential interaction effects between the interventions may have contributed to the observed outcomes **[39].**

5. Conclusion:

According to previous discussions of these results and reviews of academic research associated with the current study, it is possible to state 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 organizational and/or national research committee.

Funding: None

Conflict of interest:

No conflicts of interest are disclosed by the writers.

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