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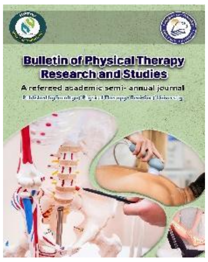

Effectiveness of Adding Slider Neurodynamic Mobilization Technique to a Conventional Physical Therapy Program in Cervical Radiculopathy: A Randomized Control Trial

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Running Title: Adding Slider Neurodynamic Mobilization To Conventional Program In Cervical Radiculopathy

Abstract

Background Cervical radiculopathy (CR) is caused by impingement or irritation of the cervical nerve roots. Neurodynamic mobilization (NDM) involves targeted combined movements to improve nerve mobility and sensitivity. **[Purpose]** This study investigated the effectiveness of adding the sliding NDM technique into a conventional physical therapy program on neck pain, disability, cervical range of motion (ROM), and electrophysiological function of the median nerve in patients with CR. [**Methods]** A double-blind randomized controlled trial was employed with 21 CR patients (19 females, 2 males; aged 30–50 years). Patients were randomly allocated either to the conventional group (n = 10), which received the conventional program (TENS, stretching, and isometric exercises), or the slider group (n = 11), which received the same program plus the sliding NDM of the median nerve for 12 sessions over four weeks. The visual analogue scale (VAS), the Arabic version of the neck disability index (NDI), the cervical range of motion (CROM) device, and the electromyogram (EMG) device were used to assess neck pain, disability, ROM, and EMG parameters, respectively. **[Results]** A significant within-group improvement in neck pain, disability, and cervical ROM was observed in both groups. However, group B showed greater percentage improvement in disability (52.69%) and extension ROM (19.16%). No significant differences were found in motor nerve conduction velocity or F-wave. Notably, the H-reflex revealed improvements in latency, amplitude, and H-ratio between groups. [**Conclusion]** Adding Sliding NDM technique to a conventional physical therapy program may enhance pain, functional recovery and nerve excitability in patients with CR.

Keywords: Cervical Radiculopathy, Neurodynamic Mobilization, Median Nerve Mobilization, EMG, Sliding.

Introduction

Cervical radiculopathy (CR) is a frequent spinal condition caused by nerve root irritation or compression, often due to degenerative changes, bone spurs, or disc herniation. This impingement causes nerve root inflammation, causing neck, shoulder, and scapular pain. It radiates unilateral or bilateral to the arms or hands, causing discomfort and impairments in the daily life of patients.[1] In addition to pain, neurological symptoms are the major chief complaint, such as altered sensation (numbness, paraesthesia), weakening of the muscles, and decreased deep tendon reflexes.[2] The most involved segments affected in the cervical region are the C6 and C7 nerve roots.[3] According to many epidemiological studies, CR affects around 83.2 individuals per 100,000 yearly, with a prevalence ranging from 1.21 to 5.8 per 1,000.[4] Conservative physical therapy is preferred as a first treatment option to enhance function in CR. Treatments include active and passive stretching,[5] strengthening,[6] manual therapy such as mobilization and manipulation,[7,8] electrophysiological modalities like transcutaneous electrical stimulation (TENS),[9] and other modalities including traction,[3] that improve soft tissue flexibility and mobility. Neurodynamic mobilization (NDM) is a therapeutic method that involves the movement of the nervous system and surrounding structures to manage neural tissue dysfunction. It increases the spread of inflammatory products, reduces intraneural swelling, limits fibroblastic activity, prevents adhesion formation, increases circulation, axonal transport, and enhances oxygen delivery to nerve tissues.[10, 11] It has two main types: slider and tensioner NDM techniques. [11] The slider NDM is the most commonly used method; it elongates the nerve at one end with simultaneous combined movements, counteracted by a movement at the other end in the same direction along its course. This promotes non-tensioned gliding of the nerve within its surrounding tissues that results in a larger longitudinal excursion with a minimal strain, facilitating optimal neural mobility and function.[11] While the tensioner NDM approach mimics a neurodynamic test, generating tension in the neural tissue without exceeding its elastic capacity. The slider NDM is often more tolerated and less provocative in acute cases; its function in treating patients with CR needs further investigation.[12] Current research on the effectiveness of NDM in CR remains limited. Most studies [3, 13- 16, 17] investigated the effects of various NDM techniques with the addition of other physical therapy modalities. These investigations have primarily focused on outcomes such as neck or arm pain, functional disability, grip strength, and cervical range of motion (ROM). Neurophysiological studies consist of nerve conduction velocity (NCS) and electromyography (EMG). These tests can confirm nerve root impingement, distinguish the level, rule out different diagnosis, and track changes in nerve function over time, enabling effective monitoring of the applied treatment.[18] However, limited studies have examined how NDM affects nerve function in CR. Notably,[19] was the only study to examine the electrophysiological outcomes for tensioning NDM, reporting changes in H-reflex latency. Therefore, this study aimed to investigate the potential benefits of adding the sliding NDM technique to a conventional physical therapy program for patients with cervical CR, examining its effects on neck pain, functional disability, cervical ROM, and the electrophysiological function of the median nerve. Understanding its effectiveness may help enhance evidence-based conservative treatment methods for this frequent and functionally limiting disorder.

Materials and Methods

Study design

The study was a double-blind, randomized controlled trial. It was conducted at the Faculty of Physical Therapy, Cairo University's outpatient clinics from November 2024 to April 2025.

Ethical approval

The study followed the Declaration of Helsinki, and all participants signed an informed consent after fully explaining study procedures. The study received ethical approval from the review board of the Faculty of Physical Therapy, Cairo University **(No. P.T.REC/012/005270)**.

Patients

A total of 70 patients were screened by an orthopaedic surgeon for eligibility, and only twenty-two patients with CR (20 females and 2 males) participated in the study (Figure 1). Their ages ranged from 30 to 50 years. Patients were randomly assigned to the conventional group (control, n = 10), which received a conventional program (TENS, stretching of neck muscles and cervical isometrics), or the slider group (experimental, n = 11), which received the same conventional program in addition to sliding NDM of the median nerve. If patients had bilateral CR, the more affected side received the slider NDM. The included patients had a history of persisted pain for more than 3 months,[2] having motor/sensory changes, diminished deep tendon reflexes, or combination of both in the affected upper limb,[1] and also who met the wainner's criteria (Spurling's test, less than 60° cervical rotation towards the symptomatic side, Valsalva manoeuvre, neck distraction test, and upper limb tension test 1 (Median nerve)).[20] Patients were excluded if they had a history of surgery or fractures, carpal tunnel syndrome,[2] red flag symptoms (e.g., infection, cardiac issues),[21] systemic or severe conditions such as rheumatism, tuberculosis, arterial insufficiency,[7] upper motor neuron disease,[22] diabetes-related peripheral neuropathy,[23] upper limb compression syndrome,[2] pregnancy,[7] or prior cervical physical therapy within the past 3 months.[24] the patients

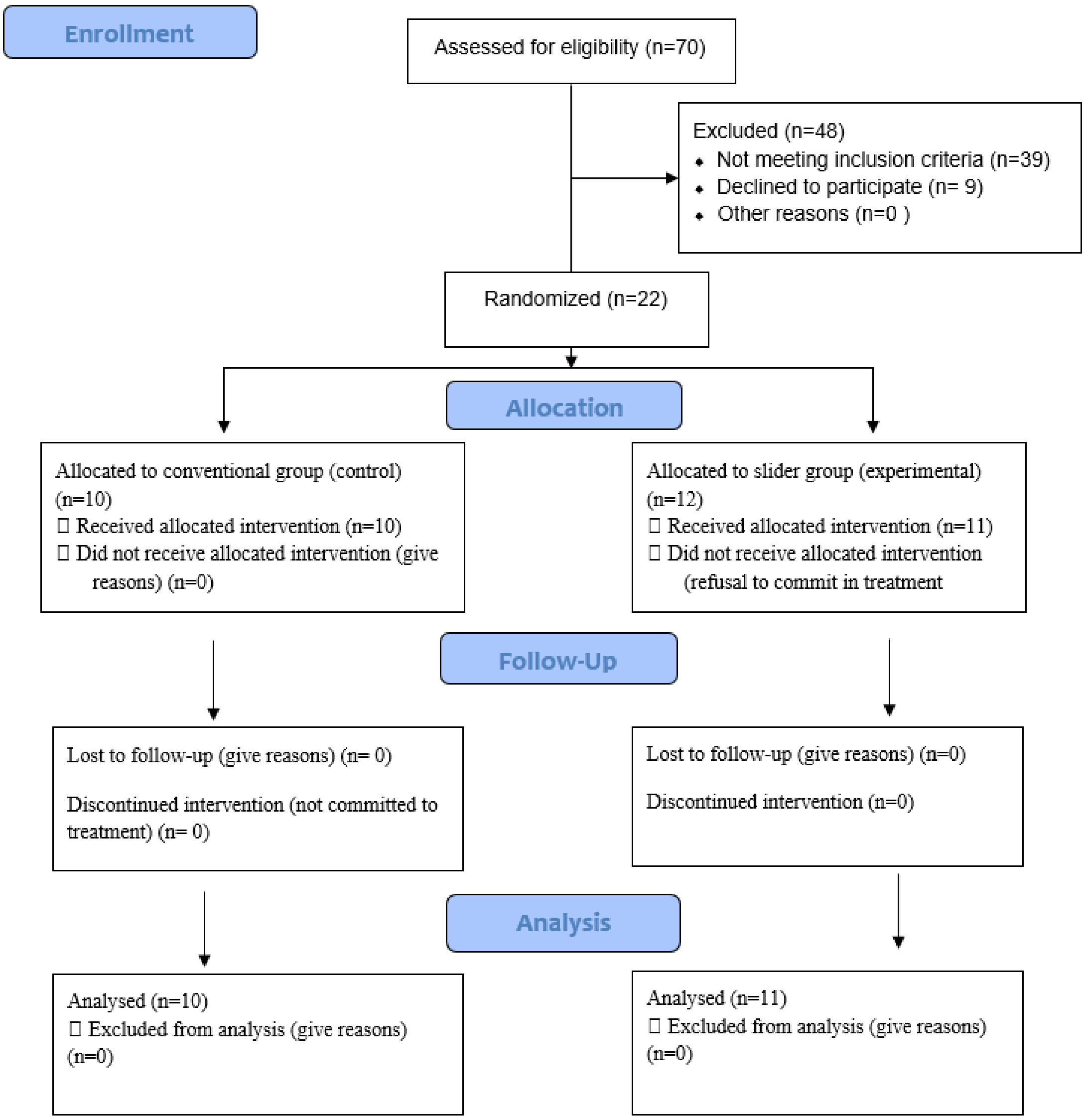

Figure 1: Flowchart of the study

Randomization and blinding

After the initial evaluation, participants were randomly assigned to their group utilizing sequentially numbered, opaque, sealed envelopes. Every patient selected an envelope before the first treatment session. The outcome assessors and the patients were blinded to treatment allocation throughout the treatment period.

Sample Size Calculation

A total of 22 patients were included in this study using convenience sampling. After data analysis, a power analysis was calculated using (G*Power software, version 3.1.9.7) to assess the statistical power for detecting differences in the primary functional outcome. With a two-tailed test, an alpha level of 0.05, and an effect size of (e.g., Cohen's d = 1.2, based on observed data), the analysis showed that the study had 100% power to detect a statistically significant effect.

Assessment procedures

A single investigator and an EMG technician were responsible for the before-and-after intervention assessment of the study outcomes. Outcome assessments were employed at baseline and after four weeks of treatment for both groups.

1. **Assessment of pain intensity**

Pain intensity was measured using the VAS, which is a 10-centimeter horizontal line, ranging from 0 (no pain) to 10 (worst imaginable pain). VAS demonstrates high reliability and strong validity, with an intraclass correlation coefficient (ICC) of 0.97.[25-26] Patients were asked to rate their neck pain intensity during the last 24 hours by instructing them to place a mark on a 10-cm line, then the researcher measured it in centimetres and recorded.[25]

2. **Assessment of neck functional disability**

Neck disability index is a self-administered questionnaire comprising 10 items that assesses neck pain's intensity on daily functional activities. Each item is scored on a scale from 0 to 5, giving a total score between 0 and 50; greater levels of disability are indicated by higher scores. The Ar-NDI demonstrates strong internal consistency, excellent test–retest reliability (ICC = 0.96), and robust validity. [27] After patients received a complete explanation, they answered each item. The assessor then evaluated its completeness and generated the final score by adding the item scores and expressing them as a percentage.

3. **Cervical range of motion (CROM)**

Patients sat upright while the CROM device was secured on their heads. They received instructions to perform three repetitions of head flexion, extension, rotation, and lateral side-bending. The assessor recorded inclinometer readings for each movement during every trial and calculated the average across three trials for analysis.[28] The CROM device demonstrates excellent reliability and is a valid instrument with ICC values ranging from 0.93 to 0.98 across all cervical movements.[28]

4. Electrodiagnostic study (EMG)

Median nerve EMG testing on the most affected side confirmed CR. Following established guidelines, it ruled out other conditions using the Neurosoft EMG system with standard EMG/NCS equipment and surface electrodes.[29] Electrodiagnostic methods (EMG, H-reflex, NCS) demonstrate moderate-to-high diagnostic accuracy in CR, with intra-rater reliability up to ICC = 0.61 and inter-rater reliability around ICC = 0.53, supporting their clinical utility.[30] The motor conduction velocity assessment recorded amplitude (mV), distal latency (ms), and conduction velocity (m/s) using active and reference electrodes placed over the abductor pollicis brevis muscle and tendon, respectively. A ground electrode was placed proximally. Stimulation was applied at the wrist, approximately 8 cm proximal to the active electrode.[29] F-wave latency (ms) was recorded using the same setup, which primarily assessed proximal motor nerve segments, which were often not tested directly in standard motor nerve conduction studies.[31] For the H reflex testing, the flexor carpi radialis motor point was identified by applying a low-threshold stimulus to locate the site with the strongest response. The active electrode was placed at this point, the reference electrode on the lateral forearm, and the ground electrode proximally between the active and the reference on the forearm. A surface stimulator was positioned over the median nerve at the antecubital fossa. Latency (ms), amplitude (mV), and H ratio (%) were obtained. [19]

Interventions

Conventional physical therapy program

Patients were instructed to sit upright on a standard chair throughout the intervention procedures. The program began with applying TENS, followed by stretching exercises for the neck and pectoral region, and finally with cervical isometric exercises. First, TENS was applied with self-adhesive electrodes over the site of maximum pain intensity. A 40–70 Hz frequency, with pulse duration between 10 and 50 microseconds, was utilized for 20 minutes. The intensity was adjusted according to each patient's tolerance.[9] Immediately following TENS, a series of stretching exercises was performed. Each targeted muscle was stretched for 30 seconds and repeated three times. The muscles included the anterior, middle, and posterior scalene, upper fibers of the trapezius, levator scapulae, and both the pectoralis major and minor muscles.[32,33] Then, patients performed cervical isometric exercise in directions of head flexion, extension, right and left lateral bending, and rotation by contracting neck muscles against submaximal resistance without movement. The exercise was conducted for three sets of 10 repetitions, each held for 5 seconds against the researcher's applied resistance, with 30 seconds rest between sets. All exercises were done with the neck in a neutral position. [14]

Slider neurodynamic mobilization

Patients were supine with the shoulder abducted approximately 90°, the elbow flexed at 90°, with the wrist, head, and neck in a neutral position. The researcher then extended the elbow to 45° while the patient actively side-bent the neck ipsilaterally to about 45°. In the alternating movement, the neck returned to neutral as the therapist flexed the elbow back to 90° (Figure 2).[11; 34] This sliding NDM cycle was repeated 10 times at a pace of approximately 6 seconds per cycle, performed over 4 sets with 1-minute rest intervals. After 10 repetitions, the final position was held for 10 seconds. [35]

Figure 2: Slider neurodynamic mobilization. (A) Starting position, (B) Shoulder abduction, lateral rotation, wrist extension, (C) End position (elbow extension, ipsilateral neck flexion).

Statistical Analysis

Statistical analysis was conducted using SPSS for Windows, version 26 (SPSS, Inc., Chicago, IL). The data were screened for normality, variance homogeneity, and extreme scores before final analysis. The p-value was set at < 0.05. Shapiro-Wilk and Levene tests were used to check for normal distributions and variance homogeneity in the data. Descriptive statistics and independent sample t-tests were used to compare subject characteristics between groups, while a Chi-squared test was used to compare sex and affected side distribution. MANOVA was conducted to compare the effect of time (pre versus post) and the effect of treatment (between groups), as well as the interaction between time and treatment on the mean values of all variables.

Results

A total of twenty-two patients with CR completed the current study. The study found no significant differences in age, weight, height, or BMI between patients in both groups using the unpaired t-test, indicating no significant differences in demographic data (p >0.05). On the other hand, the Chi-square test revealed significant differences between both groups in terms of gender, most affected side, and bilateral distribution among patients (p ≤ 0.05) **(Table 1).**

Table 1: Descriptive statistics and independent sample test

Variable		Mean ± SD		t-value	*P*-value	Sig.
		Conventional group N = 10	Slider group N = 11			
Age (years)		38.3 ± 5.79	39.45 ± 6.517	-0.427	0.674	**NS**
Weight (kg)		67.75 ± 8.99	74.64 ± 9.18	-1.734	0.099	**NS**
Height (cm)		164 ± 10.6	165 ± 7.55	-0.251	0.805	**NS**
BMI (kg/m²)		25.2 ± 2.7	27.23 ± 2.23	-1.88	0.075	**NS**
		Conventional group N=10	**Slider group N=11**	**Chi-square (X2)**	***P*-value**	**Sig**
Sex distribution	**Females**	9 (90 %)	10 (90.9 %)	13.762	<0.001	S
	Males	1 (10 %)	1 (9.1%)			
Most affected Side distribution	**Right**	2 (20 %)	3 (27.3%)	0.280	0.016	S
	Left	8 (80 %)	8 (72.7%)			
Unilateral		1 (10%)	11 (100%)	1.176	<0.001	S
Bilateral		9 (90%)	0 (0%)			

*SD= Standard deviation, *t-value=t-statistic, *P-value=probability, *Sig. =Significance, *NS=non-significant, BMI=Body mass index

The Shapiro-Wilk test revealed that most dependent variables were normally distributed, and parametric tests can be safely used. The MANOVA test reported a statistical significance difference within subjects (main effect of time) (Wilks' Lambda= 0.015, F= 11.523, *p* = 0.034, Partial Eta Squared= 0.985). On the other hand, there were no statistically significant differences between the subjects' effect (group) (Wilks' Lambda= 0.083, F= 1.951, *p* = 0.321, Partial Eta Squared= 0.917). As well as there was no statistically significant interaction effect between time and groups (Wilks' Lambda= 0.353, F= 323, *p* = 0.945, Partial Eta Squared= 0.647) (Table 2).

Table 2: The multivariate analysis of variance test for the between and within-subject effects

Effect	Wilks' Lambda	F-value	p-value	Partial Eta Squared
Between-subject (Group)	0.083	1.951	0.321	0.917
Within subjects (main effect of time)	0.015	11.523	0.034	0.985
Interaction effect (time and groups)	0.353	0.323	0.945	0.647

1. The effect of neurodynamic mobilization on cervical pain and functional disability

The study found significant differences in neck pain and functional disability within both groups, with group B showing a higher percentage of change in functional disability (52.69%). However, pain intensity improved similarly across both groups. No significant differences were observed between groups in the post-treatment (Table 3).

Table 3: Mean, Within, and between-group comparisons for pain and function

Variables/Test		Within-group pairwise comparisons		Between-group pairwise comparisons				
		Conventional Group N = 10	**Slider NDM Group N = 11**	**MD**	**p-value**	**Sig**	**95% Confidence Interval for Difference**	
		Mean ± SD					**Lower Bound**	**Upper Bound**
VAS (cm)	**Pre**	6.88±1.40	7.24±1.64	-0.365	0.591	NS	-1.764	-1.764
	Post	2.92±1.03	3.07±0.88	-0.153	0.718	NS	1.033	1.033
	MD	3.96	4.173					
	% of change	57.56%	57.60%					
	***p*-value (CI)**	**<0.001*** (2.923:4.997)	**<0.001*** 3.184:5.161)					
	Sig.	**S**	**S**					
NDI (%)	**Pre**	38.60±11.12	47.58±14.39	-8.98	0.129	NS	-1.764	-1.764
	Post	21.48±7.16	22.51±9.89	-1.03	0.790	NS	1.033	1.033
	MD	17.12	25.07					
	% of change	44.35%	52,69%					
	***p*-value**	**<0.001*** (10.87:23.37)	**<0.001*** (19.12:31.028)					
	Sig.	**S**	**S**					

SD= Standard deviation, p-value= Probability, Sig.= Significance, *= Statistically significant, NS= Non-significant, S= Significant, MD= Mean difference, %= Percentage of change, VAS=Visual analogue scale ,NDI =Neck disability index

2. The effect of neurodynamic mobilization on cervical range of motion

There were significant improvements within-group for cervical extension ROM in the slider group and Left side bending ROM in the conventional group, with no significant differences observed in other ROM directions. However, there was no significant difference between groups in all ROM directions pre- and post-treatment (Table 4).

3. The effect of the neurodynamic mobilization on the nerve conduction velocity:

There were no significant within-group comparisons for all measures of EMG/NCS on both groups. On the other hand, there is a significant difference between groups for the post-treatment for H-reflex Latency, H-reflex Amplitude, and H/M ratio (Table 5).

Table 4: Mean, Within, and between-group comparisons for cervical Range of Motion

Variables/Test		Within-group pairwise comparisons		Between-group pairwise comparisons				
		Conventional Group N = 10	Slider NDM Group N = 11	MD	p-value	Sig	95% Confidence Interval for Difference	
		Mean ± SD					Lower Bound	Upper Bound
Flexion ROM (deg)	Pre	45.26±10.33	39.63±8.42	5.63	0.185	NS	-2.943	-2.943
	Post	48.28±9.86	40.99±7.60	7.29	0.072	NS	14.209	14.209
	MD	-3.02	-1.36					
	% of change	-6.67%	-3,43%					
	p-value (CI)	0.267 (-8.548: 2.508)	0.594 (-6.635: 3.908)					
	Sig.	NS	NS					
Extension ROM (deg)	Pre	43.03±10.77	48.85±7.84	-5.825	0.170	NS	-14.368	-14.368
	Post	44.77±11.78	39.49±11.06	5.28	0.303	NS	2.719	2.719
	MD	-1.74	9.364					
	% of change	-4.04%	19.16%					
	p-value (CI)	0.693 (-10.833: 7.353)	**0.036*** (0.694: -18.033)					
	Sig.	NS	**S**					
Rt rotation ROM (deg)	Pre	44.3±8.83	46.54±13.26	-2.24	0.66	NS	-12.655	-12.655
	Post	47.8±12.14	47.46±11.63	0.336	0.949	NS	8.164	8.164
	MD	-3.5	-0.918					
	% of change	-7.9%	-1.98%					
	p-value (CI)	0.325 (-10.753: 3.753)	0.784 (-7.834: 5.997)					
	Sig.	NS	NS					
Lt rotation ROM (deg)	Pre	40.27±9.33	41.13±10.67	-0.857	0.847	NS	-10.058	-10.058
	Post	42.47±9.85	43.83±10.51	-1.36	0.764	NS	8.343	8.343
	MD	-2.2	-2.7					
	% of change	-5.5%	-6.6%					
	p-value (CI)	0.555 (-9.866:5.466)	0.449 (-10.009: 4.609)					
	Sig.	NS	NS					
Rt side bending ROM (deg)	Pre	32.63±9.10	28.78±7.71	3.848	0.308	NS	-3.834	-3.834
	Post	34.27±5.47	31.84±2.95	2.434	0.214	NS	11.531	11.531
	MD	-1.64	-3.055					
	% of change	-5.03%	-10.06%					
	p-value (CI)	0.515 (-6.813: 3.533)	0.210 (-7.987: 1.878)					
	Sig.	NS	NS					
Lt side bending ROM (deg)	Pre	37.63±11.68	38.38±5.82	-0.752	0.852	NS	-9.054	-9.054
	Post	43.67±10.82	39.69±5.75	3.979	0.299	NS	7.550	7.550
	MD	-6.04	-1.309					
	% of change	-16.1%	-3.41%					
	p-value (CI)	**0.039*** (-11.735: -0.345)	0.620 (-6.739: -4.121)					
	Sig.	**S**	NS					

SD= Standard deviation, p-value= Probability, Sig.= Significance, *= Statistically significant, NS= Non-significant, S= Significant, MD= Mean difference, %= Percentage of change, Lt left, Rt: Right

Table 5: Mean, Within, and between-group comparisons for electrodiagnostic study

Variables/Test		Within-group pairwise comparisons		Between-group pairwise comparisons				
		Conventional Group N = 10	Slider NDM Group N = 11	MD	p-value	Sig	95% Confidence Interval for Difference	
		Mean ± SD					Lower Bound	Upper Bound
MCV Onset latency (ms)	Pre	3.39±0.48	3.42±0.44	-0.028	0.889	NS	-.446	-.446
	Post	3.36±0.41	3.39±0.40	-0.031	0.862	NS	.390	.390
	MD	0.030	0.027					
	% of change	0.9%	0.9%					
	p-value (CI)	0.681 (-0.121: 0.181)	0.695 (-0.116-0.171)					
	Sig.	NS	NS					
MCV Amplitude (mV)	Pre	7.82±2.29	7.66±2.48	0.165	0.876	NS	-2.023	-2.023
	Post	6.81±2.03	7.35±2.25	-0.545	0.568	NS	2.353	2.353
	MD	1.01	0.30					
	% of change	12.9%	4.04%					
	p-value (CI)	0.217 (-0.646: 2.67)	0.695 (-1.279: 1.879)					
	Sig.	NS	NS					
MCV Velocity (m/s)	Pre	68.17±5.69	68.95±8.64	-0.785	0.811	NS	-7.542	-7.542
	Post	64.55±7.55	66.55±8.64	-2.005	0.580	NS	5.973	5.973
	MD	3.62	2.4					
	% of change	5.3%	3.5%					
	p-value (CI)	0.061 (-0.179: -7.419)	0.182 (-1.222: -6.022)					
	Sig.	NS	NS					
F-wave latency (ms)	Pre	25.62±2.19	25.34±1.33	0.275	0.730	NS	-1.365	-1.365
	Post	25.75±2.31	25.39±2.01	0.359	0.708	NS	1.914	1.914
	MD	-0.13	-0.045					
	% of change	-0.5%	-0.2%					
	p-value (CI)	0.785 (-1.114:0.854)	0.920 (-0.983: 0.892)					
	Sig.	NS	NS					
H- Reflex Latency (ms)	Pre	16.54±3.52	15.48±6.39	4.058	0.092	NS	-.727	-.727
	Post	20.2±4.4	12.36±4.75	**7.836**	**0.001***	**S**	8.843	8.843
	MD	-3.66	3.118					
	% of change	-22%	20.2%					
	p-value (CI)	0.744 (-4.835: 3.515)	0.118 (-0.862:7.099)					
	Sig.	NS	NS					
H- Reflex Amplitude (mV)	Pre	0.94±1.08	3.92±5.47	-2.981	0.108	NS	-6.674	-6.674
	Post	1.3±1.02	5.45±5.75	**-4.150**	**0.037***	**S**	.713	.713
	MD	-0.361	-1.531					
	% of change	-38.3%	-39%					
	p-value (CI)	0.744 (-2.642:1.919)	0.157 (-3.705:0.644)					
	Sig.	NS	NS					
H/M (%)	Pre	7.18±7.13	30.23±41.47	-23.048	0.10	NS	-50.927	-50.927
	Post	8.27±5.59	37.94±39.81	**-29.666**	**0.031**	**S**	4.830	4.830
	MD	-1.091	-7.709					
	% of change	-15.2%	-25.5					
	p-value (CI)	0.897 (-18.307:18.489)	0.343 (-24.298:8.88)					
	Sig.	NS	NS					

SD= Standard deviation, p-value= Probability, Sig. = Significance, *= Statistically significant, NS= Non-significant, S= Significant, MD= Mean difference, %= Percentage of change, MCV =Motor Conduction Velocity

Discussion

This study evaluated the effects of adding sliding NDM of the median nerve to a conventional program on neck pain, functional disability, cervical ROM, and electrophysiological function of the median nerve (EMG, H-reflex, and NCS) in patients with CR. The present study results revealed an improvement in neck pain intensity and functional disability in both groups. However, the slider NDM group demonstrated a greater percentage of change (52.69%), which indicates a significant improvement in functional disability. This may be due to the added effect of the slider NDM. At the same time, both groups showed similar reductions in pain intensity. Despite these improvements, no significant differences were observed between the groups at either pre- or post-intervention for pain or disability. The results may be due to the conventional physical therapy program being successful as the primary treatment option. The slider NDM enhances functional recovery in the slider group by improving nerve mobility, decreasing mechanical sensitivity, promoting nerve gliding, reducing intraneural pressure, and enhancing blood flow, which lowers inflammation and restores normal nerve function.[11] These findings are consistent with previous research, [13,14] which found that adding NDM to cervical stabilization or isometric exercises resulted in greater pain and disability reduction in CR patients than exercises alone. Besides that, various studies reported improved neck pain and functional disability when NDM was combined with cervical traction. [3, 15, 17, 19, 36-37] This emphasizes the benefits of adding the NDM approach to conventional physical therapy treatment. The findings of this study showed significant within-group improvements in cervical ROM, specifically the extension movement in the slider NDM group, with a 19.16% increase. These gains may be due to nerve gliding that allows non-aggressive, large-range of movements to be constructed in a novel way in the brain, which decreases fear of pain.[10] Consistent with these findings, recent systematic reviews revealed that NDM substantially enhances cervical ROM, either in flexion, extension, or rotation, when compared to no treatment approach or control, signifying the rationale that NDM facilitates the reduction of neural tension and mechanical limitations in specific movement directions.[38,39] Furthermore, within-group improvements seen in the left side bending direction in the control group (conventional program alone), these could be attributed to the potential effects of therapeutic interventions such as stretching,[5] strengthening,[6] and TENS [9] which enhanced soft tissue mobility and flexibility on the affected side. Despite within-group improvements, no significant differences were reported between groups across all ROM directions after treatment. This concludes that incorporating the slider NDM had no superior benefits in improving cervical mobility. Research reported similar findings, showing no significant difference between the slider NDM and a conservative program in patients with CR [14].

In addition, systematic reviews concluded that while NDM may be preferable to no intervention, its effects are not significantly different from those of conventional therapeutic treatments on ROM, [38,39], supporting the present study's findings. This highlights the need for joint-based interventions (mobilization or manipulation) to be combined with NDM approaches to achieve more gains in neck ROM. On the other hand, **Agarwal et al.** [13] found that incorporating the specific movement NDM approach to cervical stabilization exercises led to larger ROM improvements in acute unilateral CR. In addition, **Kim et al.** [3] reported enhanced ROM when slider NDM was added to cervical traction over 8 weeks, compared to traction alone. Similarly, **Savva et al**[17] reported significant gains in most directions of cervical ROM after 4 weeks of slider NDM with intermittent traction versus no treatment. These contradictions may be attributed to different treatment durations that extended further than 4weeks, or the efficacy of combining cervical stabilization exercises and intermittent cervical traction with NDM, respectively. This emphasizes that multimodal comprehensive treatment may incorporate more cervical ROM directions enhancement than NDM alone, and each treatment approach should be individualized and tailored based on the patient's specific demands. Up to the author's knowledge, this is the first study that attempted to determine the specific impact of adding slider NDM to a conventional physical therapy program, regarding EMG function of the median nerve in patients with CR. The study's findings revealed no significant within-group changes in EMG measurements for either group, suggesting that the interventions did not elicit significant neuromuscular adaptations apparent over time when each group was analysed separately. However, the substantial between-group variations in H-reflex following treatment demonstrate that slider NDM had a greater impact on spinal cord excitability and reflex arc function than the conventional program alone. While pain scales and ROM are subjective, H-reflex provides quantitative evidence of nerve function. 40. Research suggests that neural function is linked to mechanical and physiological components, with alterations in nerve mechanics impacting blood flow, axonal transport, and nerve conduction. [40] This study's findings indicated a significant reduction in H-reflex latency (ms), which reflects the increased speed of conduction in the proximal portion of the peripheral nervous system, including nerve roots and spinal segments. These study findings are consistent with prior research by [19] reported that combining cervical traction with tensioner median nerve NDM significantly reduced H-reflex latency in unilateral CR. Moreover, this study demonstrated a significant increase in H-reflex amplitude (mV) following NDM reflects an increased number of motor units recruited in response to afferent input and indicates enhanced spinal motor neuron excitability. In addition, the increased H/M ratio following NDM, suggests a greater proportion of motor neuron pool activation and enhanced spinal reflex excitability, likely due to improved neural conduction and reduced inhibition at the spinal level.[41] Moreover, these electrophysiological changes support the effectiveness of NDM in restoring nerve function and enhancing neuromuscular performance in patients with cervical radiculopathy. This study had certain limitations, including short-term outcome measures with no long-term follow-up, which made it difficult to draw conclusions on long-term impacts. Pain assessment depended on self-reported methods that only assessed neck pain, not arm pain, which is relevant in CR. Furthermore, the EMG assessment was performed unilaterally; future research should incorporate bilateral comparisons to identify better neuromuscular alterations and possible asymmetries related to this condition and its treatment approaches.

Conclusion

Both conventional therapy and median nerve sliding NDM reduced pain, functional disability, and cervical ROM in patients with CR. However, slider NDM may have enhanced effects in functional disability and promote nerve excitability, supporting its use may be a valuable adjunct for enhancing recovery. A multimodal treatment approach, including NDM should be integrated in managing patients with CR.

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The authors declare that they have no conflicting interests.

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