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Novel Therapeutic Approach to Enhancing Sleep Quality and Alleviating Pain in Subjects with Cervical Neuralgia

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ABSTRACT

Background: Cervical neuralgia is a chronic medical condition characterized by persistent neck pain, sleeping difficulties, and reduced cervical movement. The purpose of this study was to evaluate the effectiveness of the Two-Ended Slider Neurodynamic Technique (NM) and the combined use of cognitive behavioral therapy (CBT) and NM in improving sleep quality, pain, and cervical range of motion in subjects with cervical neuralgia.

Methods: This study was a single-blind, randomized controlled study. A total of 322 subjects with cervical neuralgia aged 45 to 54 years were included in the study based on inclusion and exclusion criteria. Subjects were randomly assigned to two groups (Group A and Group B), with 161 in each group. Group A was treated with NM, while Group B was treated with CBT & NM. The intervention period was 4 weeks. Pretest and post-test measures were taken using the Pittsburgh Sleep Quality Index (PSQI), Numerical Pain Rating Scale (NPRS), and the Sense Coordination 3D Cervical Trainer (SCT).

Results: Significant differences were observed in the paired t-test values of both groups. Group B demonstrated more improvement than Group A across all metrics in NPRS (65.92 vs. 58.11, $p < 0.0001$), PSQI (39.12 vs. 27.65, $p < 0.0001$), ROM {Flexion – 55.13 vs. 12.65, Extension – 63.29 vs. 9.41, Lateral Flexion (R) – 171.54 vs. 76.82 ($p < 0.0001$), Lateral Flexion (L) – 161.23 vs. 69.45 ($p < 0.0001$), Rotation (R) – 140.11 vs. 36.71 ($p < 0.0001$) & Rotation (L) – 147.21 vs. 39.86 ($p < 0.0001$)}.

Conclusion: A comprehensive approach combining CBT with NM in subjects with cervical neuralgia was more effective in reducing pain, improving sleep quality, and increasing cervical mobility in Group B subjects than in Group A subjects, who received NM alone.

Keywords: Cervical neuralgia, cognitive behavioral therapy, two-ended slider neurodynamic technique, Pittsburgh Sleep Quality Index, Numerical Pain Rating Scale, Sense Coordination 3D cervical trainer.

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INTRODUCTION

Cervical neuralgia is a chronic disorder characterized by neck pain and sensitivity in the surrounding tissues, as well as difficulty sleeping, recurrent exhaustion, and a range of other functional issues. There remains a need for more effective pharmacological treatments for cervical neuralgia, as many therapeutic techniques, both pharmacological and non-pharmacological, have focused on altering central nervous system pain perception, given that cervical neuralgia is considered a condition involving heightened pain within the CNS [1].

Persistent pain is largely mediated by neuroinflammation, as astrocytes and spinal microglia are activated in response to neuronal damage, producing proinflammatory cytokines that exacerbate central sensitization. In chronic pain, astrocyte activation becomes prolonged, resulting in impaired synaptic plasticity [2]. Preclinical studies and human trials provide evidence correlating neuroinflammation with dysfunctions such as depression, insomnia, and neurological pain [3].

Neurodynamic therapies are designed to establish equilibrium within and outside the neural system. Intending to alleviate constraints and promote maximum efficiency, this approach strategically mobilizes the adjacent connective structures and nerve tissues. Neurodynamic techniques aim to improve physiological and functional outcomes by restoring equilibrium and harmony, which may have been disrupted by impairment, through targeted work on the nerves and surrounding structures [4].

Comorbid illnesses like sleep difficulties, depression, and anxiety can complicate the diagnosis and treatment of neuropathic pain [5, 6]. The link between the index neuropathic pain state and various comorbidities is complicated. Comorbidities should be considered as part of the diagnostic work-up, and management techniques should aim to treat the whole patient rather than just the pain [7].

Despite taking pain medication, many individuals with persistent neck pain continue to experience sleep disturbances. Approximately 19.88% of these individuals had serious sleep issues, meaning they slept for less than 4 hours every night. The degree of sleep deprivation was strongly associated with pain severity, failed back surgery syndrome, and having a migration history, but it was not associated with age or gender [8, 9].

Numerous studies have demonstrated that pain intensity and sleep quality are clearly correlated. The fundamental premise is that insufficient or interrupted sleep can worsen pain, which could lead to a vicious cycle in which discomfort makes it harder to sleep. This bilateral relationship suggests that enhancing sleep quality may play a significant role in reducing these individual pain levels [10].

Recently, more precise cervical neuromuscular movement has been assessed using an objective tool, the Sense Coordination 3D Cervical Trainer (SCT), a validated device that provides real-time data on neuromuscular function, joint position errors, and dynamic cervical range of motion through guided tasks that analyze head-neck movements. It is a sensor-based, head-mounted device that records 3D cervical movements in real time and provides instant feedback on movement accuracy and control. It has been used in research and clinical settings to monitor the rehabilitation progress of subjects with neck discomfort and to identify sensorimotor disabilities. It demonstrates concurrent validity and strong inter-rater reliability compared with the cervical range-of-motion device. It is therefore the appropriate tool for evaluating cognitive and neurodynamic techniques [11].

The purpose of the study was to evaluate the effectiveness of the Two-ended slider neurodynamic technique and the combined effectiveness of cognitive behavioral therapy and the Two-ended slider neurodynamic technique in subjects with cervical neuralgia. This study aimed to ascertain whether adding CBT would result in greater improvements in pain intensity, sleep quality, and cervical range of motion, as assessed using validated measures such as the Numerical Pain Rating Scale (NPRS), the Pittsburgh Sleep Quality Index (PSQI), and the Sense Coordination 3D Cervical Trainer (SCT).

METHODOLOGY

A prospective, single-blind, randomized controlled trial was conducted in which subjects were blinded to group allocation and assigned using a computer-generated random sequence placed in sealed opaque envelopes. This study was conducted at Nandha College of Physiotherapy over 3 years from January 2022 to January 2025, followed by a 4-week intervention phase. A total of 322 subjects with cervical neuralgia were selected based on inclusion and exclusion criteria. The sample consisted of 162 males and 160 females. Subjects were divided into 2 groups (Group A and Group B) with 161 subjects in each group. Cervical neuralgia subjects, aged between 45 and 54, with a history of >3 months of persistent neck pain accompanied by sleep disturbances, were included in the study. Subjects were excluded if they had neural involvement (including tingling, numbness, or radiating pain), recent cervical surgery, uncontrolled diabetes, cardiovascular disease, cervical inflammatory disorders, mental illness (such as schizophrenia or depression), or significant neurological disorders. Outcome measures included the NPRS, the Pittsburgh Sleep Quality Index (PSQI), and the Sense Coordination 3D Cervical Trainer (SCT). Ethical approval was obtained prior to the study (Ref. No.: NCPT/IHEC/215/2022).

Procedure

Group A (two-ended slider neurodynamic technique): Subjects were placed in a supine position with the upper limb positioned with a shoulder abduction of 90° and elbow extension adjusted for optimal neural mobilization. The therapist performed neural mobilization by directing the head and neck ipsilaterally and contralaterally while the patient performed elbow extension and flexion, respectively. The intervention was conducted over four weeks, with 3 sessions per week, each consisting of 3 sets of 10 minutes, with a 10-second interval between sets [12,13].

Group B (cognitive behavioral therapy & two-ended slider neurodynamic technique): Group B was treated with cognitive behavioral therapy (CBT) and the two-ended slider neurodynamic technique (NM). CBT was conducted in two stages over 18 sessions over 4 weeks, with each session lasting approximately 45 minutes and held twice weekly by a physiotherapist under the supervision and guidance of a clinical psychologist [14,15].

Stage 1: Cognitive education (6 sessions) focused on using PowerPoint presentations to address subjects' preconceptions about pain, fear-avoidance attitudes, and disability, accompanied by interactive discussions with the therapist to encourage active participation and challenge maladaptive thoughts.

Stage 2: Training in behavioral and coping strategies (12 sessions) involved instructing subjects in self-management techniques, including active neck range-of-motion exercises, relaxation techniques, diaphragmatic breathing, attention redirection, and mindfulness-based coping methods.

The effectiveness of the intervention in both groups was evaluated using outcome measures: the Numerical Pain Rating Scale (NPRS), the Pittsburgh Sleep Quality Index (PSQI), and the Sense Coordination 3D Cervical Trainer (SCT), which were used to quantify pain intensity, sleep quality, and cervical range of motion, respectively. The outcome measures were recorded at baseline (pre-test) and after the 4-week intervention (post-test) to assess changes in pain, sleep quality, and cervical range of motion.

Statistical Analysis

Data analysis was performed using SPSS version 20. Descriptive statistics summarized outcome variables. An intention-to-treat analysis was employed. All subjects completed the trial without attrition.

RESULTS

All 322 subjects completed the study. Significant improvements were observed in sleep quality (PSQI), pain intensity (NPRS), and cervical mobility (SCT) within both groups, with Group B showing superior outcomes compared to Group A.

Table 1: Demographic Characteristics of Participants

Variable	Group A (NM) n=161	Group B (CBT+NM) n=161
Age (years), Mean ± SD	49.4 ± 2.6	49.3 ± 3.1
Gender		
• Male	82 (50.6%)	80 (49.6%)
• Female	79 (49.2%)	81 (50.4%)
Duration of Neck Pain (months)	7.7 ± 2.2	7.8 ± 2.5
Dominant Hand		
• Right	139 (86.3%)	142 (88.2%)
• Left	23 (13.7%)	19 (11.8%)

Table 1 presents the demographic characteristics of all 322subjects, including age, gender, duration of neck pain, and dominant hand. Both groups were similar at baseline. Participants in Group A (49.4 ± 2.6 years) and Group B (49.3 ± 3.1 years) had comparable mean ages. In Group A, there were 82 (50.6%) males and 79 (49.2%) females, and in Group B, 80 (49.6%) males and 81 (50.4%) females; the gender distribution was nearly identical in both groups. Group A reported an average of 7.7 + 2.2 months, and Group B reported an average of 7.8 ± 2.5 months for the duration of neck pain. Randomization was efficient since there were no statistically significant baseline differences between the groups.

Table 2: Pre-test, Post-test, and Paired t-test results

Outcome	Variables	Group	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Diff	t-value	p-value
NPRS	Pain	A	8.00 ± 0.80	5.00 ± 0.78	3.00	58.11	p < 0.0001
		B	7.00 ± 0.70	3.00 ± 0.65	4.00	65.92	p < 0.0001
PSQI	Sleep Quality	A	17.61 ± 6.9	5.30 ± 5.4	12.31	27.65	p < 0.0001
		B	23.43 ± 7.8	3.20 ± 6.3	20.23	39.12	p < 0.0001
SCT	Flexion	A	36 ± 14.8	52 ± 14.6	16.0	12.65	p < 0.0001
		B	29 ± 6.2	55 ± 6.0	26.0	55.13	p < 0.0001
	Extension	A	21 ± 15.8	32 ± 15.6	11.0	9.41	p < 0.0001
		B	19 ± 4.2	39 ± 4.1	20.0	63.29	p < 0.0001
	Lateral Flexion Right	A	21 ± 2.3	34 ± 2.2	13.0	76.82	p < 0.0001
		B	23 ± 1.8	46 ± 1.7	23.0	171.54	p < 0.0001
	Lateral Flexion Left	A	18 ± 2.2	30 ± 2.1	12.0	69.45	p < 0.0001
		B	21 ± 1.8	44 ± 1.7	23.0	161.23	p < 0.0001
	Rotation Right	A	26 ± 4.2	38 ± 4.1	12.0	36.71	p < 0.0001
		B	23 ± 1.7	45 ± 1.6	22.0	140.11	p < 0.0001
	Rotation Left	A	25 ± 4.4	38 ± 4.3	13.0	39.86	p < 0.0001
		B	26 ± 2.2	49 ± 2.0	23.0	147.21	p < 0.0001

Table 2 presents pre-test and post-test means (Mean + SD) and paired t-test results (mean difference, t-value, and p-value) for pain intensity (NPRS), sleep quality (PSQI), and cervical range of motion (ROM). All outcomes improved significantly from baseline in both groups post-intervention (all $p < 0.0001$). Group B (CBT + NM) exhibited consistently larger improvements than Group A (NM).

Pain scores (NPRS) significantly improved in both groups, Group A's mean reduced from 8.00 ± 0.80 to 5.00 ± 0.78, with a mean difference of 3.00 (t= 58.11, $p < 0.0001$), and Group B's mean reduced from 7.00 ± 0.70 to 3.00 ± 0.65, with a mean difference of 4.00 (t= 65.92, $p < 0.0001$). Thus, Group B achieved a greater reduction in pain intensity compared to Group A.

Sleep quality (PSQI) scores significantly improved in both groups. Group A's mean reduced from 17.61 ± 6.9 to 5.30 ± 5.4, with a mean difference of 12.31 (t= 27.65, $p < 0.0001$) and Group B's mean reduced from 23.43 ± 7.8 to 3.20 ± 6.3, with a mean difference of 20.23 (t= 39.12, $p < 0.0001$). Thus, Group B experienced a greater reduction in sleep quality than Group A.

Cervical range-of-motion (SCT) scores improved significantly across all cervical motion planes in both groups. Flexion: Group A's mean increased from 36 ± 14.8 to 52 ± 14.6, with a mean difference of 16.0 (t= 12.65, $p < 0.0001$), and Group B's mean increased from 29 ± 6.2 to 55 ± 6.0, with a mean difference of 26.0 (t= 39.12, $p < 0.0001$). Extension: Group A's mean increased from 17.61 ± 6.9 to 5.30 ± 5.4, with a mean difference of 12.31 (t= 27.65, $p < 0.0001$), and Group B's mean increased from 23.43 ± 7.8 to 3.20 ± 6.3, with a mean difference of 20.23 (t= 55.13, $p < 0.0001$). Lateral Flexion Right ROM: Group A's mean increased from 21 ± 2.3 to 34 ± 2.2, with a mean difference of 13.0 (t= 76.82, $p < 0.0001$), and Group B's mean increased from 23 ± 1.8 to 46 ± 1.7, with a mean difference of 26.0 (t= 39.12, $p < 0.0001$). Lateral Flexion left ROM: Group A's mean increased from 18 ± 2.2 to 30 ± 2.1, with a mean difference of 12.0 (t= 69.45, $p < 0.0001$), and Group B's mean increased from 21 ± 1.8 to 44 ± 1.7, with a mean difference of 23.0 (t= 161.23, $p < 0.0001$). Rotation right ROM: Group A's mean increased from 26 ± 4.2 to 38 ± 4.1, with a mean difference of 12.0 (t= 36.71, $p < 0.0001$), and Group B's mean increased from 23 ± 1.7 to 45 ± 1.6, with a mean difference of 22.0 (t= 140.11, $p < 0.0001$). Rotation left ROM: Group A's mean increased from 25 ± 4.4 to 38 ± 4.3, with a mean difference of 13.0 (t= 39.86, $p < 0.0001$), and Group B's mean increased from 26 ± 2.2 to 49 ± 2.0, with a mean difference of 23.0 (t= 147.21, $p < 0.0001$). Thus, the magnitude of improvement was greater in Group B compared to Group A.

Table 3: Unpaired 't' test value and table values of PSQI, goniometer & NPRS

Parameters	Variables	Mean Difference	SD	Calculated 't' value	P-Value
PSQI	Sleep Quality	7.92	± 2.54	11.31	$p < 0.0001$
NPRS	Pain	1.00	± 2.71	8.09	$p < 0.0001$
SCT	Flexion	10	± 3.38	14.09	$p < 0.0001$
	Extension	9	± 2.63	16.38	$p < 0.0001$
	Lateral Flexion Left	11	± 1.53	32.27	$p < 0.0001$
	Lateral Flexion Right	10	± 1.41	30.01	$p < 0.0001$
	Rotation Left	10	± 1.69	27.29	$p < 0.0001$
	Rotation Right	10	± 1.42	29.17	$p < 0.0001$

Table 3 presents the unpaired t-test comparison of post-intervention outcomes between Group A and Group B. Significant differences were observed across all metrics, suggesting that Group B had greater improvement. Pain intensity (NPRS) showed a mean difference of 1.00 (SD ± 2.71) with a statistically significant t-value (t = 8.09, $p < 0.0001$). Sleep quality (PSQI) showed a mean difference of 7.92 (SD = 2.54) with a highly significant t-value (t = 11.31, $p < 0.0001$).In the cervical range of motion, flexion and extension showed a mean difference of 10 (SD + 3.38) with a t-value (t= 14.09, $p < 0.0001$) and a mean difference of 9 (SD + 2.63) with a t-value of 16.38, respectively. Lateral flexion to left and right showed significant improvement with a mean difference of 11 (SD ± 1.53), t-value (t= 32.27, $p < 0.0001$), and a mean difference of 10 (SD + 1.41), t-value (t= 30.01, $p < 0.0001$), respectively. Similarly, significant variation was shown with a mean difference of 10 (SD + 1.69), t-value (t= 27.29, $p < 0.0001$) for rotation to left, and a mean difference of 10 (SD ± 1.42), t-value (t= 29.17) for rotation to right. Group B showed greater improvement than Group A across all unpaired t-test comparisons.

DISCUSSION

This study aimed to determine the effectiveness of the two-ended slider neurodynamic technique, with or without cognitive behavioral therapy, on sleep quality, pain, and cervical mobility. A total of 322 subjects who met the inclusion and exclusion criteria were randomly assigned into two groups of 161 each. Group B had received CBT and NM, while Group A had received NM. The outcomes suggested significant improvement in all measures, including PSQI, NPRS, and the Sense Coordination 3D Cervical Trainer (SCT). Compared with Group A, Group B exhibited greater effectiveness. Group B (CBT + NM) showed a greater reduction in pain intensity compared to Group A (NM), with a mean difference of 4.00 in group B and a mean difference of 3.00 in Group A on the NPRS. These findings have been supported by previous research cited in references [12,13]. The core concept of cognitive behavioral therapy is that negative patterns in any of these areas can exacerbate pain perception because thoughts, behaviors, and emotions are interconnected. Group B (CBT + NM) showed a significantly larger improvement in sleep quality than Group A, with mean differences of 20.23 and 12.31, respectively on PSQI. All evaluated planes, including flexion, extension, lateral flexion (right and left), and rotation (right and left), showed substantially higher improvements in cervical mobility in Group B (CBT + NM) compared to Group A (NM) with a mean difference of Group B (Flexion 26, Extension 20, Lateral flexion right and left 23, rotation to right 22, rotation to left 23) and

Group A (Flexion 3, Extension 12.31, Lateral flexion right 13 and lateral flexion left 12, rotation to right 12, rotation to left 13.

The better outcomes in Group B suggest that the therapeutic advantages of neurodynamic mobilization have been enhanced by the inclusion of CBT. Improved functional recovery may be facilitated by CBT through reduced catastrophizing and increased adherence to therapeutic intervention. The results also imply that physical therapies alone weren't successful in addressing the behavioral and psychological aspects of persistent neck pain. Hence, integrating CBT enhances the therapeutic intervention observed in neurodynamic therapy.

The present study's results align with previous research demonstrating that cognitive-behavioral interventions improve pain modulation and functional outcomes. This result is supported by Finan et al. (2013), who emphasized the reciprocal link between pain and sleep: chronic pain interferes with sleep, and poor sleep exacerbates pain [16]. Similarly, Vlaeyen and Linton (2000), reiterated that therapies that target maladaptive pain beliefs and anxiety result in increased participation with physical activities and improved rehabilitation compliance [18]. Psychological factors are recognized determinants of pain persistence, as emphasized by Woby et al. (2004), who demonstrated that reductions in catastrophizing and fear avoidance predict improvements in pain and disability in chronic musculoskeletal conditions [17]. Gatchel et al. (2007) and Kamper SJ et al. (2015) demonstrated that multimodal rehabilitation approaches that combine biomechanical and psychosocial strategies yield greater therapeutic benefits. In alignment with these findings, superior outcomes observed in Group B suggest that integrating CBT with the NM group provides additional benefits for pain reduction, sleep quality, and cervical mobility [19, 20].

STUDY LIMITATIONS

A sham group, or placebo control, was not included in the study.

Evaluators were not blinded, which may have introduced bias.

The quality of CBT sessions, including adherence and delivery consistency, was not assessed.

Integrity tests, longer follow-up, and blinding may be included in future research.

Practical Implications for Physiotherapists

Improve neural mobility by applying the two-ended slider neurodynamic technique.

Sessions can last for 10 minutes with rest periods.

Incorporate CBT techniques such as pain education, deep breathing, gradual exposure to movement, pacing, and goal setting. Integrating physical and cognitive methods may enhance outcomes.

CONCLUSION

In subjects with cervical neuralgia, the Two-Ended Slider Neurodynamic Technique (NM) showed significant improvements in cervical range of motion, pain reduction, and sleep quality when used alone in Group A, with greater benefits observed when NM was combined with Cognitive Behavioral Therapy (CBT) in Group B. The inclusion of CBT led to superior clinical outcomes in all measured parameters. Validating the findings and exploring long-term implications requires further investigation.

Ethical Permission: Nandha College of Physiotherapy, Erode. IHEC letter No. NCPT/IHEC/215/2022

Conflict of interest: The authors declare no conflict of interest.

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