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ORIGINAL ARTICLE

Effect of Upper Limb Nerve Mobilization on Sleep Pattern in Cervical Radiculopathy Patients

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ABSTRACT
The effects of neural mobilization on the patients' sleep quality are still poorly understood, despite the fact that it is known to increase pain. The purpose of this study was to examine how well two upper limb neurodynamic mobilization strategies (ULTT-1 and ULTT-2) worked in conjunction with isometric exercises to improve sleep quality and pain intensity in patients with cervical radiculopathy. Ninety individuals with a diagnosis of cervical radiculopathy were divided into two groups at random (n = 45 each). Over a predetermined treatment period, Group 1 received ULTT-1 with isometric exercises, while Group 2 received ULTT-2 with isometric exercises. The Insomnia Severity Index (ISI) and the Numeric Pain Rating Scale (NPRS) were used to measure the results both before and after the intervention. Correlation analyses and paired t-tests were used in the statistical analyses. Following treatment, NPRS and ISI scores decreased statistically significantly in both groups (p < 0.001). Group 1 showed that their NPRS decreased from 7.47±1.16 to 3.16±1.64 and their ISI decreased from 14.24±4.98 to 6.49±3.65. NPRS (7.27±1.21 to 2.78±1.48) and ISI (14.38±3.12 to 5.29±2.75) decreased more in Group 2. There was no discernible gender-based variation in treatment response. Patients with cervical radiculopathy can have pain reduction and improved sleep when using both ULTT-1 and ULTT-2 procedures in conjunction with isometric exercises. In contrast, ULTT-2 has shown a marginally better effect on the intensity of sleeplessness.
Keywords: *Cervical, Nerve mobilization, Neurodynamic, Radiculopathy, Sleep.*

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INTRODUCTION

Compression or irritation of the cervical nerve roots results in cervical radiculopathy (CR), a disorder that causes numbness, tingling, and motor weakness in addition to pain that radiates from the neck into the upper extremities. Disc herniation and degenerative spondylotic alterations, which shorten the intervertebral foramina and press against the exiting nerve roots, are the most frequent causes. (1). At about 83 cases per 100,000 people annually, the illness is somewhat widespread and most common in those between the ages of 40 and 50. (2). The predisposing factors of CR encompass a combination of cervical spondylosis, disc herniation, decreased intervertebral height, facet joint osteoarthritis, and cervical vertebrae spondylolisthesis, which lead to nerve root irritation or compression. (3) The most common cervical nerve roots affected by cervical radiculopathy are the C6 and C7 nerve roots. Depending on the damaged nerve root, inflammation or impingement of these nerve roots causes sensory changes including tingling and motor loss in the dermatomal and myotomal distribution by activating pain receptors found in the cervical spine's soft tissues and joints. (4) Radiculopathy patients may also have weakness or numbness in their upper limbs. They have related socioeconomic and psychological repercussions that adversely affect employment, sleep, and leisure. (5) In addition to impairing physical function, CR has a substantial negative impact on quality of life by limiting movement and involvement in daily activities. Patients who suffer from neuropathic pain frequently endure persistent agony, which can result in psychological problems like worry and restless nights or poor sleep. (6) People with neuropathic and chronic musculoskeletal disorders, such as CR, are increasingly known to experience sleep difficulties. These disruptions include non-restorative sleep, trouble falling asleep, and frequent overnight awakenings. A recent cross-sectional study found that 56.5% of CR patients had poor sleep, which was linked to more postural imbalance, neck pain, and impairment. (7) It is commonly known that pain and sleep are correlated; chronic pain can affect sleep architecture, while inadequate sleep can increase the sense of pain. (8) Since restful sleep is essential for neuromuscular recovery and general wellbeing, it is imperative to recognize and address sleep disorders. As a specialized manual therapy approach, neural mobilization—also known as neurodynamic mobilization—aims to restore the normal mobility of nerves and the structures that surround them. Sensitized neural tissues are desensitized, intraneural edema is decreased, axoplasmic flow is improved, and certain nerves are mobilized by passive and active motions. (9). In CR instances, upper limb neurodynamic tests (ULNTs), such as those that target the ulnar, median, and radial nerves, are frequently employed for both diagnostic and therapeutic purposes. These methods, which are predicated on the idea of nerve gliding or sliding, have been demonstrated to be successful in lowering pain, enhancing nerve function, and regaining movement. (10). Neural mobilization is essential to regaining the suppleness and fluidity of the nervous system in order to facilitate a return to normal activities. The method reduces the intrinsic pressure of the brain tissue and can restore neural biomechanics, such as flexibility, by tensing and/or moving the nervous system. By improving CR patients' pain, hand grip strength, and axoplasmic flow, neurodynamic mobilization helps them endure the normal compressive, tensile, and friction forces associated with daily and athletic activities. Additionally, improved motor unit recruitment, which in turn improves muscular strength, is made possible by neural mobilization. Furthermore, it has long been known that nervous system mobilization reduces the intensity of pain and improves related symptoms in neurological diseases. (11) Additionally, neck pain can be effectively treated with isometric neck exercises. When a muscle contracts without observable joint motion or changes in length, this is known as static exercise. It is thought that isometric exercise training is a useful technique for treating acute soft tissue stress. (5) Neural mobilization of the upper limbs has been shown in numerous trials to be effective in lowering pain and enhancing function in CR. In comparison to controls, patients who received median nerve mobilization in conjunction with traditional physiotherapy demonstrated noticeably higher gains in handgrip strength, pain reduction (as measured by the Visual Analogue Scale), and functional ability. (12). According to a different study, cervical range of motion and neck disability index (NDI) ratings improved when neurodynamic treatments were added to cervical isometric workouts. (4). Although the majority of neural mobilization research focuses on pain and function, its impact on sleep quality is gaining attention. One tenable interpretation is that neuronal mobilization indirectly enhances sleep by lowering nocturnal arousals and improving comfort by reducing pain and discomfort. Significant improvements in the severity of insomnia and general quality of life were observed in a clinical trial examining the effects of cervical traction, a method frequently employed in conjunction with neural mobilization. (13) While there is currently little direct data on how neural mobilization affects sleep, its soothing and pain-relieving properties point to a potential use in treating CR patients' sleep difficulties. So, to find out the effect of upper limb nerve mobilization on sleep patterns in patients with cervical radiculopathy.

MATERIAL AND METHODS

The study design is a pre and post experimental type. A total of 100 participants were recruited using the convenient non-probability sampling method. The duration of study was 4 weeks, which was recruited from the TMU Hospital, TMU Physiotherapy OPD. Participants included were individuals' 20-40 years of age both male and female; who gave consent to participate in the study, cervical radiculopathy diagnosed patients confirmed on MRI & Spurling's test and sleep related disturbances due to radiculopathy (confirmed by history/ questionnaire). Subjects excluded from the study were as following - any history of cervical fracture, cognitive impairment, pregnant females, vertebral instability, spinal cord or vertebral surgery, neoplasm or tumour & severe cervical disc prolapsed (requiring surgery). Outcome measures used were Insomnia Severity index (ISI), Numeric pain rating scale (NPRS) & Spurling's test.

Procedure: The data collection procedure began with obtaining written consent from the patient after thoroughly explaining the study procedure and its potential outcomes. Following consent, a pre-treatment assessment was conducted using the NPRS (numeric pain rating scale) and ISI (insomnia severity index) to establish baseline scores. The 90 subjects meeting the inclusion criteria were then randomly divided into two equal groups of 45 each; experimental group A and the experimental group B. The Experiment Group A had received ULTT 1 with neck isometrics exercises. Experimental Group B received ULTT2 with neck isometrics exercises. Duration of the intervention was of 4 weeks, 3 days in a week. After completion of the 4-week intervention period, all participants were reassessed to evaluate the outcomes of upper limb nerve mobilization therapy. The post-intervention assessment was conducted under similar conditions as the baseline evaluation.

Intervention Protocol-Hot pack application for 10 minutes on cervical area for the muscle relaxation & improvement of tissue extensibility before neural mobilization (Common to both groups)

Group 1: ULTT 1 + neck isometrics exercises

ULTT 1- Median nerve mobilization (slider techniques by Butler).

- **Patients position: supine lying.**
- Sequence - Shoulder depression, Shoulder abduction (90-110 degree), Forearm supination, Wrist and finger extension, Shoulder external rotation, Elbow extension, Contralateral neck side flexion; Repetition: 10 rep.; Hold: 3 sec.

Neck isometrics exercises - Directions: flexion, extension, right and left side bending.

- Procedure: Patient in sitting position, pushes head into the hand without visible neck movement; Hold: 5 second; Repetition: 3 sets of 10 reps in each direction.

Group 2: ULTT 2 + neck isometrics exercises

ULTT 2 – Radial nerve mobilization (slider techniques by Bulter).

- Patients position: supine lying.
- Sequence - Shoulder depression and internal rotation, Elbow extension, Forearm pronation, Wrist flexion and ulnar deviation, Finger and thumb flexion, Neck side flexion away; Repetition: 10 repetitions; Hold: 3 second.
- Neck isometrics exercises: Same as group 1

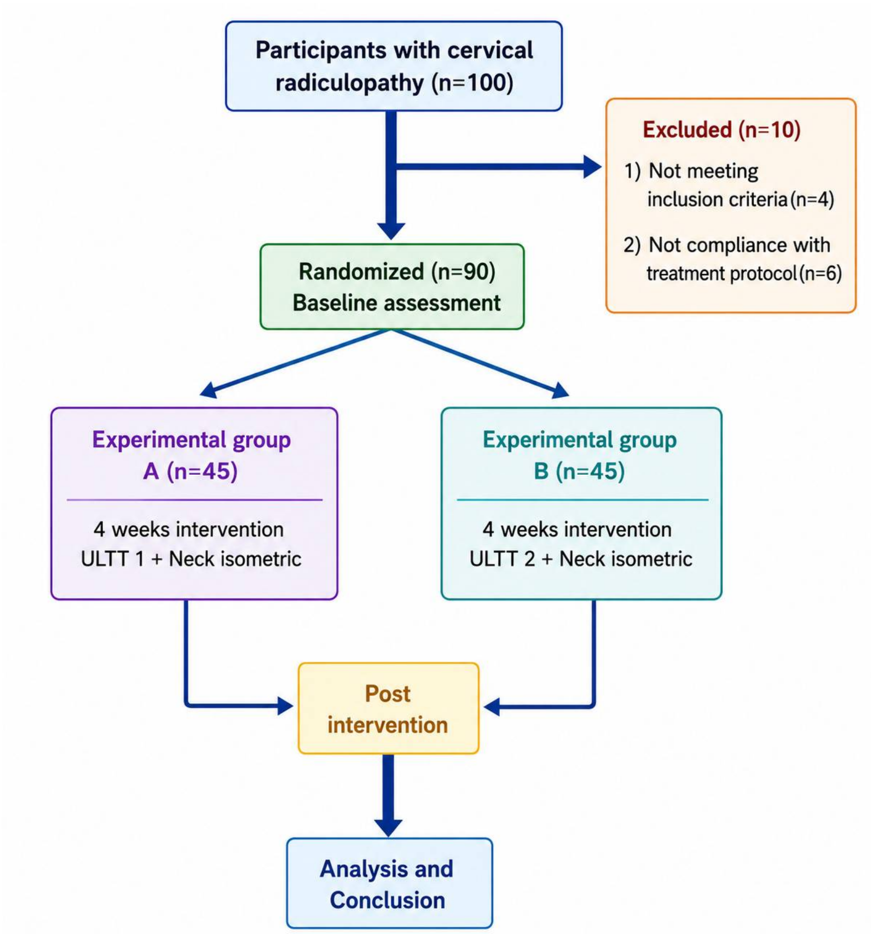

Figure 1: CONSORT Flow Diagram of the Study

RESULTS

The research compared the impact of two intervention protocols on pain intensity (NPRS) and insomnia severity (ISI) in two groups of participants (Group 1 and Group 2), both having 45 participants. Descriptive statistics (Table 1) indicated similar baseline characteristics with mean ages of 31.78±4.95 and 30.42±4.81 for Groups 1 and 2, respectively.

Table 1: Descriptive Statistics of Age, Gender, ISI and NPRS Scores in Group 1 And Group 2

	N	Minimum	Maximum	Mean	Std. Deviation
AGE_G1	45	23	40	31.78	4.945
GENDER_G1	45	1	2	1.27	.447
ISI_PRE_G1	45	3	23	14.24	4.982
ISI_POST_G1	45	1	15	6.49	3.653
NPRS_PRE_G1	45	5	10	7.47	1.160
NPRS_POST_G1	45	0	6	3.16	1.637
AGE_G2	45	21	40	30.42	4.812
GENDER_G2	45	1	2	1.38	.490
ISI_PRE_G2	45	8	24	14.38	3.121
ISI_POST_G2	45	0	15	5.29	2.752
NPRS_PRE_G2	45	5	10	7.27	1.214
NPRS_POST_G2	45	0	6	2.78	1.475
Valid N (listwise)	45				

Paired samples test (Table 2) revealed significant reductions in ISI and NPRS scores after intervention in both groups. Group 1 decreased in ISI from 14.24±4.98 to 6.49±3.65, and NPRS from 7.47±1.16 to 3.16±1.64. Group 2 also improved, with ISI reducing from 14.38±3.12 to 5.29±2.75, and NPRS from 7.27±1.21 to 2.78±1.48.

Table 2: Paired Sample Statistics for ISI And NPRS Scores (Pre and Post Intervention)

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	ISI_PRE_G1	14.24	45	4.982	.743
	ISI_POST_G1	6.49	45	3.653	.545
Pair 2	NPRS_PRE_G1	7.47	45	1.160	.173
	NPRS_POST_G1	3.16	45	1.637	.244
Pair 3	ISI_PRE_G2	14.38	45	3.121	.465
	ISI_POST_G2	5.29	45	2.752	.410
Pair 4	NPRS_PRE_G2	7.27	45	1.214	.181
	NPRS_POST_G2	2.78	45	1.475	.220

Correlation analysis (Table 3) indicated strong and statistically significant correlation between pre and post scores for all measurements ($p<0.05$), most significantly for ISI of Group 1 ($r = 0.856$).

Table 3: Paired Sample Correlation Between Pre And Post Intervention Scores

		N	Correlation	Sig.
Pair 1	ISI_PRE_G1 & ISI_POST_G1	45	.856	.000
Pair 2	NPRS_PRE_G1 & NPRS_POST_G1	45	.523	.000
Pair 3	ISI_PRE_G2 & ISI_POST_G2	45	.294	.050
Pair 4	NPRS_PRE_G2 & NPRS_POST_G2	45	.630	.000

Paired t-test findings (Table 4) established the significance of the improvements with all comparisons having p-values < 0.001. The largest mean difference was found in ISI for Group 2 (mean difference = 9.09, t = 17.41).

Table 4: Paired t-test results for ISI and NPRS in Group 1 and Group 2

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	ISI_PRE_G1 - ISI_POST_G1	7.756	2.647	.395	6.960	8.551	19.654	44	.000
Pair 2	NPRS_PRE_G1 - NPRS_POST_G1	4.311	1.427	.213	3.882	4.740	20.261	44	.000
Pair 3	ISI_PRE_G2 - ISI_POST_G2	9.089	3.502	.522	8.037	10.141	17.410	44	.000
Pair 4	NPRS_PRE_G2 - NPRS_POST_G2	4.489	1.180	.176	4.134	4.843	25.523	44	.000

Gender-by-treatment comparisons (Tables 5–8) also did not show any significant differences in ISI and NPRS outcomes between male and female members of each group ($p>0.05$), implying that the treatments worked equally well across genders.

Table 5: Gender-wise Comparison of ISI and NPRS Scores in Group 1

GENDER_G1		N	Mean	Std. Deviation	Std. Error Mean
ISI_PRE_G1	FEMALE	33	14.70	5.102	.888
	MALE	12	13.00	4.612	1.331
ISI_POST_G1	FEMALE	33	6.70	3.729	.649
	MALE	12	5.92	3.528	1.018
NPRS_PRE_G1	FEMALE	33	7.55	1.227	.214
	MALE	12	7.25	.965	.279
NPRS_POST_G1	FEMALE	33	3.36	1.617	.281
	MALE	12	2.58	1.621	.468

Table 6: Independent t-test for Gender Differences in Group 1

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error	95% Confidence Interval of the Difference	
									Lower	Upper
ISI_PRE_G1	Equal variances assumed	.006	.941	1.011	43	.318	1.697	1.679	-1.689	5.083
	Equal variances not assumed			1.060	21.504	.301	1.697	1.600	-1.627	5.021
ISI_POST_G1	Equal variances assumed	.012	.915	.629	43	.533	.780	1.240	-1.721	3.281
	Equal variances not assumed			.646	20.585	.525	.780	1.208	-1.734	3.295
NPRS_PRE_G1	Equal variances assumed	1.098	.300	.752	43	.456	.295	.393	-.497	1.088
	Equal variances not assumed			.841	24.783	.408	.295	.351	-.428	1.019
NPRS_POST_G1	Equal variances assumed	.218	.643	1.431	43	.160	.780	.545	-.320	1.880
	Equal variances not assumed			1.429	19.515	.169	.780	.546	-.361	1.921

Table 7: Gender Wise Comparison of ISI and NPRS Scores in group 2

GENDER_G2		N	Mean	Std. Deviation	Std. Error Mean
ISI_PRE_G2	FEMALE	28	14.93	3.589	.678
	MALE	17	13.47	1.908	.463
ISI_POST_G2	FEMALE	28	5.61	3.131	.592
	MALE	17	4.76	1.954	.474
NPRS_PRE_G2	FEMALE	28	7.32	1.307	.247
	MALE	17	7.18	1.074	.261
NPRS_POST_G2	FEMALE	28	2.79	1.548	.293
	MALE	17	2.76	1.393	.338

Table 8: Independent t-test for Gender Differences in Group 2

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ISI_PRE_G2	Equal variances assumed	3.563	.066	1.543	43	.130	1.458	.945	-.448	3.364
	Equal variances not assumed			1.776	42.459	.083	1.458	.821	-.199	3.115
ISI_POST_G2	Equal variances assumed	3.395	.072	.995	43	.325	.842	.846	-.864	2.549
	Equal variances not assumed			1.111	42.936	.273	.842	.758	-.686	2.371
NPRS_PRE_G2	Equal variances assumed	1.765	.191	.385	43	.702	.145	.377	-.615	.905
	Equal variances not assumed			.404	39.003	.689	.145	.359	-.581	.871
NPRS_POST_G2	Equal variances assumed	.039	.845	.046	43	.964	.021	.459	-.904	.946
	Equal variances not assumed			.047	36.744	.963	.021	.447	-.885	.927

DISCUSSION

This study examined the effects of two upper limb neurodynamic mobilization strategies on pain intensity and sleep disruptions in patients with cervical radiculopathy: ULTT-1 with isometric exercises (Group 1) and ULTT-2 with isometric exercises (Group 2). The findings supported the effectiveness of neural mobilization in treating cervical radiculopathy symptoms by showing that both intervention techniques produced statistically significant improvements in pain reduction (NPRS) and insomnia severity (ISI). These results are in line with earlier research indicating that neural mobilization methods successfully lessen the symptoms of cervical radiculopathy. When compared to conservative therapy alone, Rafiq et al. (2022) discovered that median nerve mobilization in conjunction with traditional exercises dramatically reduced pain and impairment (4). In a similar, Anwar et al. [14] found that adding neuromobilization to regular physiotherapy significantly improved both function and discomfort. But by assessing how these methods affect sleep patterns—a frequently disregarded component of cervical radiculopathy—this study offers a fresh perspective. This is corroborated by a recent study by Lee and Shin (2024), which demonstrates that treatments like traction or mobilization that target the irritation of the cervical nerve roots can help improve the mood and insomnia of those who are impacted (15). The current study supports these results and emphasizes how nociceptive input and sleep disturbance interact, with increased sleep quality probably resulting from pain reduction through neural mobilization. There are intriguing theoretical and clinical questions raised by the radial nerve group's (ULTT2) somewhat larger ISI reduction. Targeting the radial nerve route, which involves the posterior part of the upper limb, may have a more effective effect on central pain modulation because it may be more sensitive in some cases of cervical radiculopathy. Few studies have examined radial nerve mobilization in this setting, despite the majority of literature focusing on the median nerve because of its frequent involvement and better diagnostic accuracy in upper limb tension tests (16). Thus, these results point to the necessity for more study comparing particular nerve biasing techniques and their impacts on pain as well as quality-of-life elements like sleep. Neural mobility treatments are thought to diminish nociceptive drive by improving axoplasmic flow, reducing intraneural edema, and decreasing mechanosensitive (17). Given the reciprocal association between chronic pain and sleeplessness, this decrease in peripheral sensitivity may aid in regulating central sleep mechanisms. The numerous effects of neural mobilization in neuromusculoskeletal illnesses are supported by other recent research, which demonstrate that therapies that reduce cervical compression and improve nerve mobility aid in both pain alleviation and sleep restoration (15). Clinically, this study supports the effectiveness of upper limb neurodynamic approaches as a non-pharmacologic intervention for patients with cervical radiculopathy who have both pain and sleep issues. Non-invasive options like neural mobilization offer a safer and more sustainable strategy, especially in light of the global concern about the abuse of pain and sleep medicines, especially in chronic musculoskeletal disorders. Both groups' usage of isometric neck exercises lends more credence to multimodal approaches that combine muscular and neurological therapies for comprehensive results. This study's gender-neutral response increases its practical value by indicating that these combined treatments may be equally beneficial for men and women with cervical radiculopathy. It is important to recognize a number of limitations in spite of these encouraging results. The ability to solely ascribe changes to the therapies employed is limited by the lack of a control or placebo group. Furthermore, knowledge of the long-term sustainability of the noted changes is limited by the short-term follow-up. Actigraphy and polysomnography, two objective sleep measurements that could improve future research, were not used. Lastly, neurophysiological tests like musculoskeletal ultrasonography or nerve conduction investigations may provide more information about the anatomical and functional alterations of the nerves after mobilization. In conclusion, individuals with cervical radiculopathy experienced much less discomfort and insomnia when using both ULTT1 and ULTT2 approaches in conjunction with neck isometric exercises. Although both approaches were successful, ULTT2 targeting the radial nerve improved sleep outcomes somewhat more, indicating that it would be a better strategy when sleep disturbance is the main complaint. With further advantages for sleep and general health, these results lend credence to the use of nerve mobilization procedures as a fundamental part of conservative treatment for cervical radiculopathy. To validate and build on these findings, more studies involving control groups, longer follow-ups, and objective sleep evaluations are required.

CONCLUSION

This study shows that when combined with isometric exercises, upper limb nerve mobilization—whether using ULTT-1 or ULTT-2 techniques—significantly reduces pain intensity and enhances sleep quality in individuals with cervical radiculopathy. The noted benefits highlight how neurodynamic approaches can be used to treat nerve root compression's wider effects beyond pain, such as sleep disturbance, a crucial but frequently disregarded aspect of patient care. Significantly, ULTT-2, which primarily acts on the median nerve, demonstrated slightly higher effectiveness in lessening the intensity of insomnia, indicating that people with sleep disturbance may prefer it. Furthermore, the absence of gender-related variations in results supports the intervention's generalizability.

STUDY LIMITATIONS & RECOMMENDATIONS

To improve the overall functional recovery and quality of life for patients with cervical radiculopathy, these findings emphasize the necessity for clinicians to think about neurodynamic mobilization not just as a pain management technique but also as a way to re-establish regular sleep patterns. It is advised that future studies use objective sleep measurements and long-term follow-up to confirm and build on these findings. Despite the encouraging results, the study was constrained by a comparatively little follow-up time. Unstudied are the long-term impacts on pain recurrence and sleep quality. Future research might include additional aspects of quality of life and include objective sleep measurement methods (such actigraphy or polysomnography).

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