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Neural Mobilization–Induced Changes in Cervicocephalic Kinesthetic Performance in Cervical Radiculopathy Patients With and Without Diabetes Mellitus

Divya Aggarwal[1*], Manoj Narain Shukla[2]

[1*]PhD Scholar, Sri Ganganagar College of Allied Health Sciences Physiotherapy, Tantia University, Sri Ganganagar, Rajasthan, India.
[2]Associate Professor, Sri Ganganagar College of Allied Health Sciences Physiotherapy, Tantia University, Sri Ganganagar, Rajasthan, India.

ABSTRACT

Background
Diabetes mellitus (DM) is a common metabolic disease that is often combined with chronic musculoskeletal pain and impaired sensorimotor control. The cervical radiculopathy (CR) is usually accompanied by distorted cervicocephalic kinesthetic perception, which is attributed to muscle spindle and articular receptors dysfunction. Although neural mobilisation (NM) has been reported to produce positive effects in CR, its effect on cervical sensorimotor performance in patients with and without DM has not been studied properly.

Purpose: To determine the effects of neural mobilisation on cervicocephalic kinesthetic accuracy, pain, and neck related disability in persons with a cervical radiculopathy, randomised by diabetic status.

Methods : A prospective, experimental pre, post study was conducted that consisted of 84 participants who had established cervical radiculopathy. The subjects were randomly divided into two groups, namely, Group A (CR with DM, n=42), and Group B (CR without DM, n=42). Neural mobilisation of the median-nerve was used on both cohorts in association with the postural re-education exercises with three sessions a week over a period of six weeks. These outcome measures were the Head Repositioning Test (HRT), Neck Disability Index (NDI), and Numeric Pain Rating Scale (NPRS). Statistical evaluation was performed by use of SPSS version 21.

Results: Within-group comparisons showed that there were significant improvements in all the measured domains cervicocephalic kinesthetic accuracy (flexion, extension, right and left lateral flexion), pain, and disability scores ($p < 0.05$). Intergroup comparisons on the other hand indicated no clinically significant differences implying that the effectiveness of neural mobilisation was similar regardless of the diabetic status.

Conclusion: Cervical sensorimotor, pain and neck-related disability enhancements in cervical radiculopathy patients are significantly gained with neural mobilisation irrespective of diabetes mellitus. These results support the incorporation of neural mobilisation therapy into physiotherapeutic strategy to the management of cervical radiculopathy including diabetic patients**.**

Keywords: Cervical radiculopathy, diabetes mellitus, neural mobilization, cervicocephalic kinesthetic sense, head repositioning test

Introduction

Cervical radiculopathy refers to the neck pain that extends to the upper limb and is the most typical neuromusculoskeletal disorder which is often characterized by a sensory disturbance, motor weakness, and functional impairment (Young et al., 2009; Kuijper et al., 2009). The condition is often associated with foraminal stenosis, degeneration of interventricular disc and inflammatory or mechanical compression of cervical nerve roots, which lead to neural mechanosensitivity and changes in the afferent input to the central nervous system (Peng et al., 2021; Reddy et al., 2019). One of the most frequent results of such pathophysiological changes that disrupt sensorimotor control of the cervix is deficits in cervicocephalic kinesthetic sense and postural stability (Rix et al., 2021; Ntenezakos et al., 2021).

Neural mobilization has been found to be a good conservative therapy methodology to cervical radiculopathy. Neurodynamic methods should improve the restoration of normal mechanical and physiological activity of neural tissues by promoting gliding of neurons, decreasing intraneural edema, and improving axoplasmic flow to reduce pain and improve functional performance (Mohammed et al., 2019; Kim et al., 2017). Neural mobilization, used as a standalone intervention or as a part of conventional physiotherapy, is shown to have a significant positive impact on the severity of pain, the range of movements, grip strength, and disability in individuals with cervical radiculopathy based on many randomized controlled trials and systematic reviews (Pallewar et al., 2021; Fritz et al., 2014; Mathew et al., 2025).
Moreover, there is an increasing recognition that proprioceptives dysfunction is a major cause of chronic symptoms and functional loss in association with neck pain disorder. The error in movement and increased risk of recurrent symptoms may be caused by disturbed head-neck position sense due to altered cervical afferent input (Dugailly et al., 2015; Ntenezakos et al., 2021). To measure cervicocephalic kinesthetic impairments in neck pain individuals, reliable clinical assessment tools, such as Head Repositioning Test with a laser pointer technique, demonstrated sufficient validity and reliability (Rix et al., 2021; Shah et al., 2022).
Diabetes mellitus may worsen the cervical radiculopathy by modifying the peripheral nerve health due to the metabolic and microvascular and inflammatory alterations. The neural involvement of diabetes has increased pain sensitivity, slowed nerve healing, and reduced proprioceptive acuity and can affect the outcomes of rehabilitation (Rehling et al., 2019; Peng et al., 2021). This is because not many studies have examined the impact of neural mobilization on cervical sensorimotor function in diabetic and non-diabetic individuals, even though increasingly substantial evidence shows that neural mobilization is of benefit in cervical radiculopathy. Therefore, the present research studied the outcome of patients with and without diabetes mellitus to investigate the effectiveness of median nerve neural mobilization on cervicocephalic kinesthetic sense, pain intensity, and neck-related disability among patients with cervical radiculopathy. .

Methodology

Study Design
Experimental prospective post pre-intervention study was the type of research undertaken.

Sample Size and Sampling
Estimation of the sample size was done by use of G + Power 3.1.9.4 on the basis of data on Neck Disability Index of earlier literature in the view of an effect size of 1.08, alpha value of 0.05 and power of 0.95. The minimum sample size was 90 participants including a 15 percent dropout rate. Eighty-four respondents went through the study.

Participants
Those aged 18 to 60 years who experienced recent or repeated cervicobrachial pain, cervical pain that extends to one arm of the upper limbs, and positive outcome in the Upper Limb Tension Test, Spurling test, and Cervical Distraction test were considered eligible and recruited into the study.
Convenient sampling was used to place the eligible participants in two groups: Group A had to have the diagnosis of cervical radiculopathy and a history of not more than five years of diabetes mellitus, and Group B had to have the diagnosis of cervical radiculopathy only. The exclusion criteria included persons with neurological autoimmune conditions, cervical myelopathy, paralysis, recent cervical spine surgery, joint deformity of the upper limbs, neck pain of non-specific or mechanical nature, and recent intake of drugs that have sedative or neuromuscular side effects.

Baseline Assessment
Prior to the commencement of the intervention, baseline information was collected. Cervicocephalic kinesthetic sensibility of each participant was examined with the help of the laser pointer technique of the Head Repositioning Test (HRT). Pain intensity was measured with the help of Numeric Pain Rating Scale (NPRS), whereas the functional disability related to the neck was measured with the help of Neck Disability Index (NDI). Also baseline variables recorded included demographic variables (height, sex, age).

Intervention
The standardized neural mobilization method of the median nerve was applied to both groups to mobilize the C6 to T1 nerve roots which are usually associated with cervical radiculopathy. The intervention involved the performance of neural

mobilization of pain-free slider techniques of performing repeated passively flexion and extension movements of the affected upper limb, which include the elbow, wrists and fingers in a slow and oscillatory pace. The technique was first done in a neutral position of the shoulder and was eventually increased to 90 degrees of shoulder abduction and external rotation to assist in neural gliding and decrease neural mechanosensitivity. The treatments were done three times a week, six weeks and each session took about 1215 minutes. Besides, postural re-education exercises were given to all the participants in the rehabilitation program.

Post-Intervention Assessment

After six weeks of the intervention period, all the outcome measures were re-evaluated. The same standardized procedures that were used during the baseline to collect post-treatment data regarding cervicocephalic kinesthetic sense (HRT), pain intensity (NPRS), and the neck-related disability (NDI) were used to guarantee consistency and reliability of measurements.

Statistical Analysis

Statistical analysis was performed using SPSS software for Windows (version 21.0). Descriptive statistics were used to summarize demographic and clinical characteristics. Within-group comparisons between baseline and post-intervention data were conducted to evaluate treatment effects, and between-group comparisons were performed to examine differences between participants with and without diabetes mellitus. Statistical significance was set at $p < 0.05$.

Results

Eighty-four participants (42 in each group) passed the trial. Statistically significant changes were observed in all the measures of outcomes in both groups after six weeks of neural mobilisation ($p < 0.05$). Kinaesthetic Cervicocephalic sense that was evaluated through Head Repositioning Test established cervical flexion, cervical extension, right-side flexion, and left-side flexion improvements that were significant in both cervical radiculopathy patient groups with and without diabetes mellitus. Specifically, the accuracy of head-repositioning increased in flexion and extension ($p = 0.006$), right-side and left-side flexion ($p = 0.0017$, $p = 0.0017$). As measured using the Numeric Pain Rating Scale, the intensity of pain, compared between the baseline and the post-intervention levels in both groups, revealed a significant decrease in perceived pain between the two groups. Similarly, the disability related to the neck as the measure of the Neck Disability Index showed a considerable improvement in post-treatment, which was characterised by the increased capacity to engage in everyday activities. Even though there were statistically significant pre- to post -improvement of sensorimotor functionality, pain and disability between groups, between-group comparisons did not show any clinically significant difference in the response to treatment, which indicated that neural mobilisation was equally effective in patients with and without diabetes mellitus..

Table 1. Demographic Characteristics of Participants

Variable	Group A: Cervical Radiculopathy with Diabetes (n=42)	Group B: Cervical Radiculopathy without Diabetes (n=42)
Sex ratio (F:M)	24:18	25:17
Age (years)	43.8 ± 1.32	38.26 ± 4.33
Height (feet)	5.51 ± 0.27	5.64 ± 0.35

Table 2. Between-Group Comparison of Outcome Measures (Pre–Post Analysis)

Outcome Measure	Group A Mean ± SD	Group B Mean ± SD	p-value
HRT – Right Side Flexion (Pre)	5.31 ± 1.22	7.14 ± 0.13	0.0017
HRT – Right Side Flexion (Post)	5.49 ± 1.06	8.14 ± 0.42	0.0017
HRT – Left Side Flexion (Pre)	4.66 ± 0.63	6.14 ± 0.42	0.001

Outcome Measure	Group A Mean ± SD	Group B Mean ± SD	p-value
HRT – Left Side Flexion (Post)	4.87 ± 1.38	7.68 ± 0.43	0.001
HRT – Flexion (Pre)	4.72 ± 0.65	6.14 ± 0.71	0.006
HRT – Flexion (Post)	4.77 ± 0.85	7.29 ± 0.70	0.006
HRT – Extension (Pre)	4.06 ± 0.67	6.71 ± 0.13	0.006
HRT – Extension (Post)	4.15 ± 0.90	7.08 ± 0.50	0.006
Neck Disability Index (Post)	46.96 ± 1.84	43.86 ± 2.51	< 0.05
Numeric Pain Rating Scale (Post)	4.77 ± 0.85	3.29 ± 0.70	< 0.05

Discussion

As shown in the current study, median-nerve neural mobilisation has significant effects on cervicocephalic kinesthetic awareness, the intensity of pain, and neck-related impairment of persons with cervical radiculopathy regardless of diabetes status. The described improvement of the head-repositioning accuracy is consistent with the previous studies, which suggest that neurodynamic interventions contribute to cervical sensorimotor control through the reduction of neural mechanosensitivity and the normalisation of mechanoreceptor afferent input (Rix et al., 2021; Ntenezakos et al., 2021).
The significant reduction in pain intensity after the intervention is also in line with previous systematic reviews and randomised control studies that report about the analgesic benefits of neural mobilisation of cervicobrachial pain or cervical radiculopathy (Mohammed et al., 2019; Kim et al., 2017; Mathew et al., 2025). The recommended mechanisms are augmented intraneural circulation, decreased intraneural pressure, and central pain-processing pathways modulation (Pallewar et al., 2021; Fritz et al., 2014). Similar results have been obtained in controlled studies examining the use of median-nerve neural mobilisation in patients with cervicobrachial pain (World Institute of Pain, 2017).
Neural mobilisation has also been shown to be having functional benefits, such as improvement of neck-related disability based on the Neck Disability Index. The results are consistent with the findings of previous studies demonstrating that neurodynamic interventions produce clinically meaningful improvements in daily performances of activities and quality of life in addition to cervical traction, or traditional physiotherapy (Savva et al., 2021; Routine Physical Therapy with and without Neural Mobilisation, 2024). The validity and interpretability of the presented results are made strong by the application of the validated outcome indicators including the Neck Disability Index and the Numeric Pain Rating Scale (Vernon and Mior, 1991; Jensen et al., 1986).
There are potential underlying metabolic and microvascular changes that can have long-term neural adaptation and recovery even though those with diabetes mellitus showed similar gains as those without the disease. The previous studies show that diabetic neural tissues are more prone to mechanical loads and have a reduced regenerate process, which may have an influence on long-term recovery results (Rehling et al., 2019; Peng et al., 2021). Neural mobilisation is safe and effective even in patients with early-onset diabetic neural damage since there are no noteworthy intergroup variations in the current study.
In general, the findings of this study add to the growing body of evidence on the benefits of median-nerve neural mobilisation as a conservative modality of neuromotor control improvement, pain management, and positive functional outcomes in patients with cervical radiculopathy. Future studies would use bigger samples, use electrophysiological evaluation, and infuse in the long-term follow-up in order to clarify the impact of metabolic variables on neuronal repair.

Conclusion

Neural mobilisation is a physiotherapeutic intervention that is effective in enhancing cervicocephalic kinesthetic sensation, pain reduction, and cervical radiculopathy disability with or without diabetes mellitus. Neural mobilisation should be introduced early on because it could prevent sensorimotor deficits and functional disability, especially among people with metabolic comorbidities.

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