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Proprioceptive Neuromuscular Facilitation and Passive Vertebral Mobilization for Neck Disability in Patients with Mechanical Neck Pain

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DECLARATIONS

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ABSTRACT

Background: Mechanical neck pain is a common musculoskeletal disorder impacting functional mobility, frequently resulting in disability and reduced quality of life. Both proprioceptive neuromuscular facilitation and passive vertebral mobilization are common manual therapy interventions used in clinical practice. **Objective:** To compare the effects of proprioceptive neuromuscular facilitation and passive vertebral mobilization on neck disability, pain intensity, and cervical mobility in subjects with mechanical neck pain. **Methodology:** A single-blinded randomized controlled trial was conducted in the Department of Physiotherapy, University of Lahore Teaching Hospital, Lahore. Participants aged between 18 and 35 years diagnosed with pain localized in the neck region were included in the study. Participants who were diagnosed with ankylosing spondylitis, rheumatoid arthritis, fracture, congenital anomalies, positive neurological findings, uncontrolled dizziness, malignancy, or pregnancy were excluded. Data was gathered at baseline, as well as at the end of the second and fourth weeks. Group A was treated with the proprioceptive neuromuscular facilitation techniques employed included rhythmic initiation, a blend of isotonic, dynamic reversals, and contract-relax methods. Group B was treated with passive vertebral mobilization in the prone position. Numerical variables are summarized using mean and standard deviation, while categorical variables are presented as frequencies with corresponding percentages. The data were normally distributed using the Kolmogorov-Smirnov test, and parametric tests like the paired sample t-test and ANOVA were employed. **Results:** Both groups demonstrated significant improvement over time in neck disability index ($F=355.16$, $p<0.00$), numeric pain rating scale ($F=544.09$, $p<0.00$), and cervical range of motion ($F=33.41$, $p<0.00$). No group effect was found to be significant for neck disability index ($p=0.76$) or cervical range of motion ($p=0.98$). Group A demonstrated significantly greater pain decrease on pain score at baseline ($p=0.03$) and 4th week ($p=0.04$). **Conclusion:** Both proprioceptive neuromuscular facilitation and passive vertebral mobilization were effective in improving neck disability, pain intensity, and cervical range of motion in patients with mechanical neck pain over four weeks. While no significant differences were observed between groups for disability or mobility.

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INTRODUCTION

Neck pain is a common condition characterized by discomfort or pain in the neck area, ranging from mild to severe, and significantly impeding daily activities, sleep, and overall quality of life, requiring medical intervention for precise diagnosis and treatment.¹ Another type of neck pain is called mechanical neck pain, which is also known as mechanical cervical spine pain. It happens when the muscles, joints, and ligaments in the neck are overly tight or strained.²

Common signs of neck pain are a dull aching or sharp pain in the neck, shoulder, or arm; stiffness or a limited range of motion; soreness to the touch; pain or numbness that spreads; and headaches or migraines.³ Diagnostic criteria of mechanical neck pain can commonly incorporate an integration of medical history, physical examination, and imaging studies. Physical exam can also include palpation, range of motion, and muscular strength tests that can reveal pain, stiffness, or weakness.⁴ To ensure that there are no other abnormalities or to make sure that there is no mechanical neck pain, doctors can resort to such imaging tests as X-rays, CT scans, or MRIs.⁵

Physical therapy most commonly employs different techniques to assist in mechanical neck pain. Manual therapy is suitable to help with a range of motion, pain, and stiffness by using joint mobilization, soft tissue mobilization, and trigger point treatment.⁶ It is also recommended that therapeutic exercises be undertaken to increase the mobility, the strength, and the alignment of the neck through strengthening, stretching, and postural correction.⁷ Passive vertebral mobilization (PVM) is a type of technique applied by such healthcare professionals as physical therapists to soften the spine and make it less rigid. It includes the use of a mild, constant pressure on a designated section of the spine that enables joints, as well as the soft tissues that envelop these joints, to relax and move freely. This is usually done by the therapist sitting in a relaxed position, either using their hands or a mobilization device to apply the force to the patient.⁸

Proprioceptive neuromuscular facilitation (PNF) procedures are a combination of manual therapies that help the muscles to be stronger, flexible, and capable of movement. They involve stretching activities, strengthening activities, and control activities involving the neuromuscular system.⁹

Hold-relax, contract-relax, and hold-relax-contract are some of the PNF techniques. You passively stretch a muscle and hold it in the hold-relax procedure. The method of contract-relaxation is carried out with intense contraction of the muscle and its release. The hold-relax contract technique employs both techniques.¹⁰

Combining PNF with passive vertebral mobilization, which brings back normal spinal mechanics, may help people with mechanical neck discomfort by working on both their muscles and joints at the same time. This multimodal strategy offers thorough therapy of the fundamental neuromuscular and biomechanical elements that lead to neck dysfunction. The study's findings may enhance clinical outcomes and quality of life for those experiencing mechanical neck discomfort. The study aims to compare the effects of PNF and PVM on neck disability, pain intensity, and cervical range of motion in subjects with mechanical neck pain.

METHODOLOGY

A single-blinded randomized controlled experiment was conducted in the Department of Physiotherapy, University of Lahore Teaching Hospital, Lahore. The sample size was 62, with 31 participants in each group, determined using Statulator software. Participants aged between 18 and 35 years were included in the study.¹¹, diagnosed with pain localized in the neck region, with no radiating pain beyond the shoulder or fingers¹², and having no history of major trauma or surgery to the cervical spine were included.¹³ Participants who were diagnosed with ankylosing spondylitis, rheumatoid arthritis, fracture of the spine, cancer, or congenital anomaly of the cervical spine, or positive neurological findings, uncontrolled dizziness or vertigo, known malignancy, or pregnancy were excluded.^{11,12}

The university's ethics committee (REC-UOL-506/08/24) gave the study its ethical approval, and the experiment was registered on clinicaltrials.gov (NCT07042230). Patients signed a permission form and were randomly placed in either group using a lottery procedure. The evaluator did not know about the therapy administered to either group. Data was gathered at baseline, as well as at the end of the second and fourth weeks. Before the intervention, baseline evaluations were done. Post-intervention evaluations were taken just after the intervention.

Group A was treated with the PNF techniques employed included rhythmic initiation, a blend of isotonic, dynamic reversals, and contract-relax methods.¹⁴ Ten times each pattern was done. The therapy was administered three times a week for four weeks.¹⁵ For craniocervical extension with left rotation, the patient tries to extend their head and neck as the therapist gently pushes down and to the left. For craniocervical flexion with right rotation, the patient tries to bend their head and neck while the therapist gently pushes up and to the right. For craniocervical flexion with left rotation: The opposite of the procedure. For Craniocervical extension with right rotation, the reverse of the method is used.¹⁶ The therapist guides the patient through slow, rhythmic movements to initiate the desired PNF pattern.

Group B was treated with PVM in the prone position; the cervical vertebrae were glided posteroanteriorly. Begin with grades I and II, then go on to grades III and IV. Each session should have 5 to 10 repetitions.^{11,17} Physiotherapists utilize Maitland mobilization, a manual treatment method, to make joints more flexible and relieve pain.¹⁸ Posterolateral glides of cervical vertebrae in prone lying with head turned slightly towards the side being mobilized. Begin with Grade I, small amplitude oscillatory movements within the physiological range of motion (ROM) were applied. In Grade II, passive glides at the end of the available ROM, inducing a slight stretch, were used. During Weeks 3-4, gradual progression was made to Grades III & IV mobilizations as tolerated. In Grade III, sustained passive glides are applied with gentle pressure beyond the end of the available ROM. For Grade IV, passive glides are applied with moderate pressure with rhythmic or sustained movement at the end of ROM. Frequency: Each grade (I & II, then III & IV) repeated for 5-10 repetitions per session.^{18,19}

The data was entered and analyzed using SPSS Version 24. Numerical variables, such as age, are summarized using mean and standard deviation (SD). Categorical variables, including gender groups, are presented as frequencies with corresponding percentages. The normality of the data distribution was assessed using the Kolmogorov-Smirnov test. The data were normally distributed, and parametric tests such as the paired sample t-test and ANOVA were employed. The p-value of less than 0.05 was considered statistically significant.

RESULTS

Descriptive analysis is given in Table 1; the two groups were similar in terms of their starting characteristics. Group A's average age was 26.16 years, whereas Group B's average age was 27.10 years. Both groups had identical BMI values (21.23 vs. 21.98). Over the course of four weeks, both groups showed improvements in the Neck Disability Index (NDI), the Numeric Pain Rating Scale (NPRS), and the Active Cervical Range of Motion (ACROM). The NDI scores were down for both groups, with Group A going from 19.46 to 15.44 and Group B going from 19.74 to 15.96. The pain scores (NPRS) went down more in Group A (4.42 to 2.31) than in Group B (5.56 to 3.50). Both groups' cervical ROM increased. Group A went from 40.60° to 43.20°, while Group B went from 39.37° to 44.42°. Both treatments worked; however, PNF (Group A) worked a little better in reducing pain and impairment overall.

Table 2 showed inferential statistics that all three outcome measures, NDI, NPRS, and ACROM, improved significantly over time within the same group, with F-values of 355.16, 544.09, and 33.41, respectively ($p < 0.00$ for all). Mauchly's Test showed that each measure broke the rules of sphericity; therefore, Greenhouse-Geisser adjustments were used, with epsilon values between 0.50 and 0.83. There were no significant

Table 1: Descriptive statistics of variables

Variables		Group A	Group B
		Mean±SD	Mean±SD
Age (years)		26.16±4.83	27.1±5.38
BMI		21.23±1.73	21.98±1.65
NDI	Baseline	19.45±5.27	19.73±5.41
	2 nd week	17.66±5.34	18.06±5.49
	4 th week	15.44±5.41	15.96±5.53
NPRS	Baseline	4.42±1.92	5.55±2.29
	2 nd week	42.04±12.3	41.89±13.12
	4 th week	2.3±2.08	3.50±2.47
ACROM	Baseline	40.59±11.16	39.37±12.0
	2 nd week	42.04±12.3	41.89±13.12
	4 th week	43.19±12.50	44.41±13.7

Table 2: Inferential statistics

Variables	F-value	p-value	Sphericity Violation (GG)	Between-Group Sig. (Week 4)
NDI	355.16	0.00	0.83	0.70
NDI * Groups	0.33	0.71	0.83	0.70
NPRS	544.09	0.00	0.50	0.04
NPRS * Groups	0.16	0.84	0.50	0.04
ACROM	33.41	0.00	0.80	0.71
ACROM * Groups	3.43	0.03	0.80	0.71

Group-by-time interaction effects for NDI ($p=0.71$) or NPRS ($p=0.84$), which means that both treatments worked about the same over time. There was a significant interaction effect for ACROM ($F=3.43$, $p=0.03$), which means that the groups' improvements in mobility were not the same. Independent t-tests indicated that there were no significant changes between the groups in NDI and ACROM at week 4 ($p>0.05$). However, Group A (PNF) had a substantially higher decrease in pain than Group B (PVM) on NPRS at week 4 ($p=0.04$). These results imply that both treatments worked to reduce disability, discomfort, and improve cervical mobility, but PNF may have better short-term pain-relieving effects.

DISCUSSION

The current study indicated that both PNF and passive vertebral mobilization yielded statistically significant enhancements in pain intensity, cervical range of motion, and neck disability over the 4-week intervention, with a notable main effect of time for all outcomes (NDI: $p<0.00$, $F=355.16$; NPRS: $p<0.00$, $F=544.09$; ACROM: $p<0.00$, $F=33.41$). Nonetheless, there was no statistically significant group impact seen for neck disability ($p=0.76$) or pain reduction ($p=0.53$) in the comparisons across groups.

These results align with the findings of Ashfaq et al. (2022), who also indicated equal post-treatment outcomes between PNF and vertebral mobilization for mechanical neck discomfort. In the present study, the PNF group had substantially lower NPRS ratings at baseline ($p=0.03$) and at the fourth week ($p=0.04$), indicating a more expedited decrease in pain levels relative to mobilization. This result may

be ascribed to the improved sensory integration and muscle activation inherent in PNF approaches.¹¹ Both therapies produced clinically significant enhancements; nevertheless, the statistical advantage of PNF in early-stage pain alleviation may inform its precedence in acute or subacute cases.

Gashi et al. (2023) examined PNF in patients with cervical radiculopathy and found substantially larger reductions in both pain and neurological symptoms in the PNF group compared to the control group ($p<0.05$), which differs from our findings. In our study, both groups demonstrated pain reduction; however, the absence of a neurological component in mechanical neck discomfort may clarify the negligible intergroup differences. Additionally, the pathophysiology of radiculopathy may render it more receptive to neuromotor-based therapies such as PNF, particularly when scapular and limb patterns are utilized to enhance proximal stability.²⁰ This diagnostic inconsistency underscores the importance of symptom classification in assessing therapeutic effectiveness.

Husnain et al. (2025) compared PNF and the Mulligan concept in patients with text neck syndrome, finding statistically significant differences between the groups that preferred PNF for reducing discomfort ($p<0.05$) and increasing cervical range of motion. Our findings somewhat corroborate theirs, as both therapies yielded improvements; nevertheless, there were no statistically significant differences between groups for ACROM ($p=0.71$). The difference may lie in the fact that text neck is a chronic issue stemming from bad posture, potentially more amenable to

correction by PNF compared to the broader biomechanical factors contributing to mechanical neck discomfort.²¹ Moreover, disparities in outcome measures and study duration may have influenced discrepancies in statistical significance.

Jeong et al. (2022) investigated the immediate effects of PNF stretching on cervical range of motion and craniovertebral angle, noting statistically significant enhancements following the intervention ($p < 0.01$), despite the intervention being aimed at the hamstrings. These findings, albeit concentrated on distal musculature, substantiate the concept of regional interdependence in musculoskeletal treatment.²² Our research enhances these findings by illustrating enduring cervical enhancements after cervical-specific PNF interventions. Despite variations in anatomical targeting, both investigations underscore the systemic advantages of neuromuscular stimulation, presumably facilitated by fascial continuity and motor control networks.

Kaya et al. in 2024 documented substantial improvements in cervical proprioception and discomfort among individuals with text neck syndrome after PNF treatments. The enhancements noted in our PNF group's NPRS scores at both baseline and the fourth week ($p < 0.05$) align with their results.²³ Nonetheless, Kaya et al. omitted a comparison intervention, constraining intergroup interpretation. The focus on sensorimotor retraining and postural correction in their study may elucidate the uniformity in pain results, hence further substantiating PNF's effectiveness in mitigating neuromuscular dysfunction in postural neck diseases.

A previous study in 2024 compared PNF to the muscular energy method in cases of persistent mechanical neck pain. They found that both groups showed statistically significant gains, although PNF was better at lowering pain and increasing mobility ($p < 0.05$).²³ Our investigation noted more substantial numerical enhancements in pain within the PNF group; nevertheless, the disparities in NDI ($p = 0.70$) and ACROM ($p = 0.71$) persisted as statistically non-significant. The discrepancies may stem from variations in chronicity; patients examined in the previous study may exhibit heightened responsiveness to motor retraining due to central sensitization, whereas our sample comprised acute and subacute instances.²³

Maicki et al. (2024) conducted a comparison between PNF and manual treatment, finding no statistically significant difference between the groups following the intervention, with both demonstrating clinical improvements.²⁴ This result clearly corroborates our findings, as the group effect for NDI ($F = 0.08$, $p = 0.76$) and ACROM ($F = 0.00$, $p = 0.98$) failed to achieve statistical significance. Nonetheless, our investigation indicated that pain reduction was more pronounced in the PNF group at certain time intervals, perhaps due to the active component and the repetitive stretch-hold techniques employed in PNF. These results endorse a multimodal strategy for mechanical neck pain, allowing for intervention selection to be customized according to individual patient preferences and therapist proficiency.

Sezerel and Yüksel (2024) investigated the effects of cervical mobilization compared to osteopathic MET in cervical spondylosis, revealing significant enhancements in pain, proprioception, and disability for both interventions ($p < 0.05$), with cervical mobilization demonstrating marginally greater efficacy in improving proprioceptive outcomes. Our study concentrated on mechanical neck pain instead of spondylosis; nonetheless, the general trend of enhancement by mobilization-based therapies is consistent.²⁵ In our investigation, the interaction effects of ACROM were significant ($F = 3.43$, $p = 0.03$), although comparisons between groups at particular time points were not. This may be elucidated by disparities in degenerative disease compared to mechanical dysfunction, necessitating unique treatment objectives.

The four-week therapy duration could have been inadequate to assess the long-term impact and durability of changes, especially for chronic or recurring neck pain issues. The absence of a non-intervention or placebo control group constrains the capacity to distinguish intervention effects from spontaneous recovery or placebo responses. The study was limited to young adults aged 18-35 years, which restricts its applicability to older individuals or individuals with comorbidities that frequently exhibit mechanical neck discomfort in clinical environments. The intervention was not blinded to participants or therapists, which may cause bias in outcome reporting.

Subsequent research ought to incorporate follow-up evaluations at 3 and 6 months following the intervention to examine the enduring effectiveness

and sustainability of treatment benefits. Including a control group that does not receive any intervention or sham treatment would enable a more stringent assessment of intervention-specific effects. Replicating the findings in older demographics or those with concomitant musculoskeletal or neurological disorders would augment external validity. To lessen bias and make the results more reliable, a blinded evaluation and, if possible, participant blinding should be used.

CONCLUSION

Both proprioceptive neuromuscular facilitation and passive vertebral mobilization were effective in improving neck disability, pain intensity, and cervical range of motion in patients with mechanical neck pain over four weeks. While no significant differences were observed between groups for disability or mobility outcomes, the proprioceptive neuromuscular facilitation group showed significantly greater pain reduction at specific time points. These results highlight the potential advantage of proprioceptive neuromuscular facilitation for early pain management.

DECLARATIONS

Consent to participate: Written consent had been obtained from patients. All methods were performed following the relevant guidelines and regulations.

Availability of Data and Materials: Data will be made available upon request. The corresponding author will submit all dataset files.

Competing interests: None

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