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RESEARCH ARTICLE

Comparative effectiveness of PNF technique and Mulligan Concept of Mobilization on Pain, Range of motion, and Functional Mobility in Text Neck Syndrome

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ABSTRACT

Background: Text neck syndrome (TNS), a chronic progressive condition caused by excessive use of handheld devices, is a growing health concern affecting millions worldwide.

Objective: The aim of this study was to compare and analyze the effective treatment protocol between Proprioceptive Neuromuscular Facilitation (PNF) technique and mulligan mobilization technique on TNS.

Methods: The study with the ethical approval number GCUF/ERC/23/2419 was a quasi-experimental design and used purposive sampling. Data was collected from patients with ages between 18 and 40 years, history of neck pain in the previous 3 months, visual analogue scale (VAS) ≥ 5/10, and those who used mobile phones more than 5 hours per day were included in this study. Group A (n=15) received PNF technique; diagonal pattern and contract-relax, and group B (n=15) was treated with Mulligan's Mobilizations with Movement (MWM). Visual analogue scale, neck disability and cervical ROMs were analyzed by IBM SPSS version 24. Shapiro-Wilk Test was used to check normality of data and, paired T-test and independent T-test used to analyze within group and between groups comparison.

Results: The study compared pain levels and neck disability and cervical range of motion in two groups. Between groups analysis group A showed only significant difference in variable neck flexion ($p \leq 0.001$) while both groups indicated significant improvements in visual analogue scale, neck disability index and ROMs; flexion, extension, and rotational movements independently i.e. p-value<0.05.

Conclusion: In this study, both PNF and Mulligan mobilization techniques significantly improved pain, range of motion, and functional mobility in individuals with TNS.

Keywords: Chronic pain, disability, neck pain, range of motion, syndrome.

DOI: http://doi.org/10.33897/fujrs.v5i1.419

Introduction:

The cervical spine is a weight-bearing structure with six degrees of freedom of movement, including flexion/extension, axial rotation, and lateral bending. Its total range of motion (ROM) is 90º degrees of flexion, 70º degrees of extension, 20º to 45º degrees of lateral bending, and up to 90º degrees of rotation. (1,2) Text neck syndrome (TNS) a chronic progressive condition caused by excessive use of handheld devices, is a growing health concern affecting millions of people worldwide. The condition is primarily caused by forward head and shoulder posture, leading to neck pain, shoulder pain, upper back pain, chronic headaches, and increased curvature of the spine.(3) It can hinder daily activities, reduce productivity, and cause complications in breathing, digestion, and cardiovascular health.(4,5) The condition can also lead to increased irritability and mental health issues, such as depression and anxiety.(6) A descriptive cross-sectional study on Indian college students found a significant prevalence of TNS and associated pain due to prolonged mobile device use. The data also showed a notable engagement with mobile devices, with many using their devices for several hours daily, correlating with higher reports of neck and upper back pain.(7)

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Received: May 1st, 2024; **Revision 1:** August 12th 2024; **Revision 2:** December 2nd, 2024; **Revision 3:** December 23rd, 2024.

Acceptance: January 21st, 2025.

How to Cite: Husnain A, Abbas M, Ahmad A, Mehmood H, Dita A, Sadiq R. Comparative effectiveness of PNF technique and Mulligan Concept of Mobilization on Pain, Range of motion, and Functional Mobility in Text Neck Syndrome. Foundation University Journal of Rehabilitation Sciences. 2025 Jan;5(1) :25-32.

Fred Smedes et al. conducted a narrative review through databases like PubMed and Cochrane Library to evaluate the evidence supporting the Proprioceptive Neuromuscular Facilitation (PNF) concept in physical therapy. PNF is a widely used rehabilitation approach in physiotherapy education and postgraduate training. (8) It emphasizes a positive approach, a functional approach, and the use of motor learning principles. PNF basic principles and procedures include using various stimuli, approximation and traction techniques, and resistance to enhance muscle strength and motor learning. PNF techniques are applied across various patient populations, including neurological, musculoskeletal, and geriatric conditions.(8,9) Yong-Hun Kim and Ju-Hyeon Jung conducted a case study on 33-year-old male visual display terminal (VDT) worker with chronic VDT syndrome underwent a proprioceptive neuromuscular facilitation program for six weeks. The study found a significant reduction in perceived neck pain after six weeks of treatment, with VAS scores decreasing from 7 to 1. Cervical ROM measurements showed improvements, with cervical flexion increasing from 63.67 degrees to 72.33 degrees. Pressure Pain thresholds increased, indicating decreased sensitivity to pressure pain. The cervical Flexion-Relaxation Ratio (FRR) also improved, with the left-side FRR from 0.9 to 1.55.(10)

The Mulligan concept of mobilization, originating in New Zealand in the 1970s, and pioneered by Brian Mulligan focuses on restoring the accessory component of physiological joint movement.(11) It is particularly applied in physiotherapy by manual therapies for spinal conditions. Techniques include Sustained Natural Apophyseal Glides (SNAGs), Movements with Movements (MWMs) and Natural Apophyseal Glides (NAGs). The concept emphasizes an integrated approach to diagnosis and treatment, using mobilization techniques in conjunction with active movements to diagnose and relieve joint restrictions.(12) The concept is supported by anecdotal evidence and clinical experience, but recent efforts aim to explore the efficacy of these techniques through structured studies. The Mulligan concept is used extensively in clinical settings to treat various spinal and peripheral joint dysfunctions, continually evolving to improve treatment effectiveness.(13) Buyukturan et al. conducted a randomized controlled, double-blind study that compared traditional physiotherapy (TP) and TP with Mulligan mobilization (TPMM). Pre-treatment and post-treatment comparisons show significant improvements in pain, ROM, functional level, kinesiophobia, depression, and quality of life (QOL). The TPMM group showed better outcomes in terms of ROM ($p<0.001$), kinesiophobia, depression, and QOL ($p<0.05$). The study indicates that the Mulligan Mobilization Technique, when combined with traditional physiotherapy, leads to significant improvements in ROM and quality-of-life components. (14)

The main objective of this study was to compare how the proprioceptive neuromuscular facilitation (PNF) technique and the Mulligan mobilization technique work to treat TNS. Does the Mulligan mobilization technique provide superior outcomes in pain reduction, range of motion, and functional mobility compared to the PNF technique in individuals with Text Neck Syndrome? The study aims to determine which method more effectively reduces pain and improves the ROMs and functional mobility in individuals with this syndrome. Given the prevalence and impact of TNS due to the excessive use of handheld devices, there is a need for an effective treatment protocol to address the associated symptoms, which this study focused on establishing.

Methods:

The study was a quasi-experimental design conducted at Ahmad Polyclinic Faisalabad over 6 weeks, from October 2023 until December 2023.

The study was conducted in a real-world clinical setting at Ahmad Polyclinic, Faisalabad, where strict randomization was not feasible due to logistical constraints and the workflow of the clinic. So, a quasi-experimental approach allowed us to study the intervention's effects in a naturalistic way, maintaining external validity while accommodating these constraints. Randomization was not feasible due to practical and ethical constraints. In the clinical setting, altering patient assignments to physiotherapist, pre-assigned doctor-patient relationships and recruitment barriers further limit the ability to implement randomization. Despite this, we ensured methodological rigor by applying consistent data collection procedures, and pre-defining criteria to control for confounders.

The study used purposive sampling technique to collect data. The sample size of 30 patients equally into Group A (n = 15) and Group B (n = 15).(15) Using a power analysis with an alpha level of 0.05, a power of 0.80, and an expected moderate effect size (Cohen's d = 0.5), a minimum of 64 participants (32 per group) was required but sample size of 30 participants was determined based on logistical and feasibility constraints rather than a formal power analysis. Acknowledging this limitation, the small sample size

may affect the statistical power of the study, limiting the generalizability of its findings. This study protocol was reviewed and approved by Research and ethics committee (REC) college of physical therapy GCUF with Ref. No. GCUF/ERC/23/2419. Patients with age between 18 and 40 years, history of neck pain in previous 3 months, visual analogue scale (VAS) ≥ 5/10, and those who used mobile phones more than 5 hours per day were included in this study. The exclusion criteria for the study were patients with a history of spine and upper limb problems, head injuries, migraines, or neurological or orthopedic conditions. The study excluded patients with fractures, osteoporosis, spinal surgery, or nerve pain.

The data was analyzed by IBM SPSS version 24. To check the normality of data Shapiro-Wilk Test was used. Shapiro-wilk test showed p-value >0.05, it indicated that data is normally distributed and parametric tests were used. Paired T-test was used to assess within-group comparisons and an independent sample T-test was used to analyze the mean differences with standard deviation between the two groups for Visual analogue scale (VAS), neck disability index (NDI) and ranges of motion (ROMs). The considered significant P-value is less than 0.05 with confidence interval of 0.95.

Group A received PNF techniques; diagonal pattern and contract-relax, and the procedure was performed on patients in the sitting position. The targeted muscles were sternocleidomastoid (SCM), anterior scalene, splenius capitis, upper trapezius, and levator scapulae. During this session, the therapist stands slightly to the right of the patient, behind them, aligning their body posture diagonally towards the direction of the neck's intended movement. We position patients upright to enhance functional neck mobility and stabilization. The therapeutic focus is on guided neck movements encompassing flexion, extension, lateral flexion, and rotation. The therapist strategically applies therapeutic grips, placing the right hand on the chin to control upper cervical flexion and rotation and the left hand on the head to control lower cervical motions. Movement commands such as "Tuck your chin in" or "Look towards your left hip" direct the patient to engage specific neck muscles, enhancing both the range and precision of motion. We apply resistance to each patient's capacity, ensuring strain-free movement execution, focusing on smooth transitions between flexion and extension, and enhancing overall neck mobility and stability.(16)

Group B received manual therapy techniques utilizing Mulligan's Mobilizations with Movement (MWM), and the procedure was performed with patients in the sitting position. During this session, the therapist positions themselves directly behind the patient, strategically placing their hands for optimal mobilization. The therapist's stance is stable, allowing for the controlled application of movement. Seated upright, the therapist facilitates active engagement and improves proprioceptive feedback from the cervical region. The focus of the therapy is on enabling pain-free movement of the neck through specified directions, which include flexion, extension, lateral flexion, and rotation combined with longitudinal spinal traction. The therapist uses one hand to apply gentle pressure on the occiput, facilitating upper cervical mobilization, while the other hand may apply a counterforce or assist in guiding the direction of movement. Verbal cues such as 'Gently extend your neck' or 'Lean your head towards your shoulder' are used to direct the patient's movements, focusing on achieving movement within pain-free ranges.(13) This approach ensures that the movements are not only safe but also contribute to the functional improvement of neck mobility and comfort.

The interventions in our study adhered to established clinical guidelines approved by the Research and Ethics Committee of the College of Physical Therapy, GCUF (Ref. No. GCUF/ERC/23/2419), ensuring compliance with ethical and professional standards. The Proprioceptive Neuromuscular Facilitation (PNF) technique followed principles from "PNF in Practice: An Illustrated Guide", focusing on diagonal patterns and contract-relax methods targeting cervical muscles such as the sternocleidomastoid and upper trapezius, with strain-free movement protocols enhancing precision and range of motion. The Mulligan Mobilization Technique, based on "Manual Therapy: NAGS, SNAGS, MWMs, etc." utilized movements with mobilization (MWM) to restore accessory joint movements, emphasizing active engagement within pain-free ranges, combined with gentle manual techniques. Both methods were integrated with standardized physiotherapy procedures, including patient education on posture correction, ergonomics, and exercises for managing Text Neck Syndrome.

Results:

Figure 1 shows frequency distribution of gender of both groups; female 12 (40.00%) and male 18 (60.00%). Table 1 shows descriptive statistics of age, daily mobile usage and neck pain history.

Table 1: Descriptive Statistics of Patients

Variables		N	Mean	SD	Min.	Max.
Age	Group A	15	24.40	3.45	20	33
	Group B	15	30.00	5.55	20.00	38.00
Daily mobile usage (hours)	Group A	15	5.87	1.18	4.00	8.00
	Group B	15	6.16	1.26	4.00	8.00
Neck pain history (months)	Group A	15	5.16	1.24	3.50	8.00
	Group B	15	5.16	.872	3.70	7.00

Within groups analysis showed VAS, NDI and neck ROM values (goniometer) have statistical significant differences means p-value <0.05.

Table 2: Paired sample T-test within group analysis

Variables	Groups	Pre data	Post data	P value
		Mean±SD	Mean±SD	
VAS	Group A	6.06±1.27	2.067±0.88	<0.001
	Group B	6.53±1.50	1.80±0.86	<0.001
NDI	Group A	22.6±2.50	9.40±1.76	<0.001
	Group B	22.93±3.45	9.46±3.20	<0.001
Flexion	Group A	41.13±2.16	57.50±1.80	<0.001
	Group B	41.66±2.25	54.66±1.50	<0.001
Extension	Group A	34.00±1.77	48.13±1.72	<0.001
	Group B	35.46±1.50	48.20±1.61	<0.001
Right ROT.	Group A	51.60±2.38	71.86±2.19	<0.001
	Group B	52.20±1.65	71.83±2.63	<0.001
Left ROT.	Group A	53.60±3.04	69.20±2.04	<0.001
	Group B	53.66±2.46	68.60±2.13	<0.001

Table 3 shows between groups analysis of both treatment groups after 6th week of intervention: VAS, NDI, extension and bilateral rotation did not show statistical significance (p>0.05) except neck flexion (p<0.05) in group A.

Discussion:

This study observed significant within-group improvements in pain, range of motion (ROM), and functional mobility for both PNF and Mulligan mobilization techniques. However, the lack of significant between-group differences for most outcomes warrants further exploration. Potential subgroup differences, such as age, severity of symptoms, or baseline ROM, could influence the observed effects. Future research should investigate these factors to tailor interventions effectively.

This study examined the comparative effectiveness of proprioceptive neuromuscular facilitation techniques and Mulligan mobilization on improving pain, ROM, and functional mobility in individuals with TNS. The

Table 3: Between Groups Comparison after Intervention

Outcome Measure after treatment	Treatment Groups				Independent T-test
	Group A		Group B		P-value
	Mean	SD	Mean	SD	
VAS	2.066	0.88	1.80	0.861	0.410
NDI	9.40	1.76	9.46	3.22	0.945
Flexion	57.40	1.80	54.60	1.50	<0.001
Extension	48.13	1.72	48.20	1.61	0.904
Left side rotation	71.86	2.119	71.93	2.63	0.941
Right side rotation	69.20	2.04	68.60	2.13	0.438

results indicate that both PNF and Mulligan mobilization are beneficial in reducing pain and enhancing ROM and functional mobility among individuals with TNS.

A literature review discussed the potential benefits of PNF stretching, which combines passive stretch with isometric and concentric muscle actions, in improving ROM and reducing pain and functional disability in subjects with TNS.(17) Another systematic review examined the effectiveness of PNF in treating mechanical neck pain. PNF, recognized for its role in improving neuromuscular and structural dysfunctions, serves as a potential therapeutic modality to enhance pain management, ROM, and functional outcomes in people suffering from neck pain.(18) A RCT study found that adding PNF to regular physical therapy significantly improved VAS, NDI and shoulder posture, internal rotation, and external rotation as measured by the Constant-Murley scale.(19)

A study evaluated the effects of passive and PNF stretching on the ROM in older adults. The study divided 54 participants over 13 weeks into three groups: passive stretching, PNF stretching, and control. Both stretching groups showed significant improvements in shoulder and hip ROM, while the control group saw a decrease in hip ROM and no change in shoulder ROM. The study concluded that both stretching methods effectively enhance ROM in older adults, supporting their inclusion in flexibility training programs to improve functional capacity and independence.(20) A systematic review examined the effectiveness of PNF techniques in reducing pain and disability in chronic low back and neck pain. Nine studies and 416 participants evaluated pain and disability using the VAS, NRS, ODI, and Roland Morris Disability Questionnaire (RMDQ). The study discovered that PNF could potentially relieve low back pain and associated disability, but more research is required to ascertain its long-term impacts and advantages for chronic neck pain.(21)

A RCT compared PNF exercises for lower trapezius muscle strengthening to gentle skin palpation for chronic neck pain. The six-week intervention involved 30 minutes of PNF exercises three times per week. Results showed that PNF exercises significantly reduced neck pain, disability, and improved cervical ROM compared to the control group.(22) Another RCT study examined PNF neck patterns in adults with forward head posture. It involved 39 subjects, divided into two groups. The intervention group underwent specific PNF neck exercises three times weekly. The intervention group did better than the control group in the absolute rotation angle (ARA), anterior weight bearing (AWB), range of flexion and extension motions (RFEM), and NDI. All of these improvements had p-values less than 0.05, which means they were statistically significant.(23)

A study investigated the effects of three different stretching protocols; active, passive and PNF on knee flexion range in 117 patients after total knee replacement (TKR). Participants followed their assigned stretching protocol alongside standard rehabilitation, including pain relief, knee mobilization, strengthening exercises, and balance training. Measurements of knee flexion, pain levels, knee circumference, and analgesic use were taken. Results showed significant improvements in both active and passive knee flexion across all groups, with

no significant differences between protocols. Active knee flexion increased by 19.9° in the active stretching group, 25.3° in the passive group, and 22.5° in the PNF group, while passive knee flexion improvements were 18.8°, 24.5°, and 22.7°, respectively.(24)

A randomized controlled, double-blind trial to evaluate the effects of Mulligan Mobilization Technique (MMT) on older adults with neck pain (NP). The study included 42 participants who were randomly divided into two groups: one receiving traditional physiotherapy (TP) and the other receiving a combination of traditional physiotherapy and Mulligan mobilization (TPMM). The treatment lasted for 10 sessions, and the participants were assessed before and after treatment on several outcomes, including pain, range of motion (ROM), functional level, kinesiophobia, depression, and quality of life (QOL). Both groups showed significant improvements in all these areas ($p < 0.05$). However, the TPMM group demonstrated greater benefits in terms of ROM (except for left lateral flexion and right/left rotation), kinesiophobia, depression, and QOL, indicating the added value of Mulligan mobilization when used alongside traditional physiotherapy. These findings suggest that MMT is an effective treatment for older adults with NP, improving both physical and psychological outcomes, with greater improvements observed in the TPMM group, particularly in kinesiophobia and QOL, highlighting the value of MMT when performed by specialists.(14)

A single blinded RCT study at the National Institute of Rehabilitation Medicine in Islamabad, Pakistan, involved 90 patients with mechanical neck pain aged 18-65 years. The patients were divided into three groups: PNF + RPT (Proprioceptive Neuromuscular Facilitation + Routine Physical Therapy), PVM + RPT (Passive Vertebral Mobilization + Routine Physical Therapy), and RPT Only (Routine Physical Therapy). Results showed significant improvement in NDI score, with PVM + RPT being more effective in helping patients manage daily activities. The study highlights the importance of proper treatment for neck pain.(25)

A RCT, double-blind study compared traditional physiotherapy (TP) alone versus TP combined with the mulligan mobilization technique (TPMM). The study investigated the effects of both protocols on older adults with neck pain. Results indicated improvements in pain, range of motion, functional level, Kinesio phobia, depression, and QOL for both groups, with TPMM showing superior results in most metrics ($p<0.05$). The main findings emphasized that MMT enhances therapy outcomes when performed by a specialist.(14) A study aimed to assess the effectiveness of the MMT in treating mechanical neck pain (MNP). Forty participants, predominantly female, were randomly divided into two groups: one received MMT plus a home exercise program, while the other received only the home exercise program. The treatment involved 10 sessions over two weeks. Measurements were taken included pain intensity, muscle strength, range of motion, pain threshold, disability level, QOL, depressive symptoms, and cervical performance. Results showed significant improvements in all measured parameters in both groups post-treatment, with the MMT group showing more pronounced benefits. The study concludes that MMT is effective in alleviating pain, enhancing ROM and muscle strength, and improving overall QOL in patients with MNP.(26)

A RCT study compared Mulligan (SNAGs) technique and Maitland's Mobilization in treating neck pain. 50 patients were divided into two groups: Group one received conventional therapy plus SNAG, while their group received conventional therapy plus Maitland's mobilization. Results showed that both groups improved symptoms of neck pain, but Maitland's group showed better improvement. The study suggests that Maitland mobilization with conventional therapy should be the treatment of choice for neck pain, rather than SNAGs with conventional therapy.(27)

Both PNF and Mulligan mobilization were effective in improving pain, ROM, and functional mobility, as demonstrated in prior research. A study highlighted the comparable effectiveness of Mulligan techniques in improving ROM and quality of life for neck conditions. (14) Similarly, another study has shown significant pain reduction and functional improvement with PNF in neck-related dysfunctions.(22) The underlying mechanisms shared by both techniques explain the similar results in our study. Both approaches focus on enhancing joint mobility and reducing muscle tension, which could lead to overlapping outcomes. Additionally, the natural variability in individual response to manual therapy may contribute to the absence of significant differences.

The study includes a small sample size of 30 participants, which may affect the statistical power and generalizability of the results. The 6-week intervention period may not be sufficient to assess the long-term effects of the treatments, and the purposive sampling method may limit the representativeness of the sample. The lack of follow-up to evaluate the sustainability of the treatment effects may weakens the conclusions.

Additionally, the study may have been influenced by selection bias due to the purposive sampling method.

Variability in patient adherence to the intervention protocols and potential therapist influence during treatment sessions could also affect the generalizability and reliability of the findings. Addressing these factors in future studies will be essential for strengthening evidence.

The study suggests that while the current treatment shows improvements, further research is needed to explore the long-term effects of PNF and Mulligan mobilization on pain, range of motion, and functional mobility. Future studies should consider different demographics, age, occupation, and lifestyle factors.

Investigating the combination of PNF and Mulligan techniques with other interventions, such as ergonomic training or cognitive-behavioral therapy, could offer comprehensive solutions for managing Text Neck Syndrome. Incorporating advanced tools like motion capture systems for precise measurement, studying psychological factors, and clinician training in manual therapy techniques, and integrating patient education on posture and device usage can enhance patient care.

Conclusion:

In this study, both PNF and Mulligan mobilization techniques significantly improved pain, ROM, and functional mobility in individuals with TNS. Regular use of these methods could provide significant relief and improve daily functionality for affected individuals.

Disclaimer: None to declare.

Conflict of interest: None to declare.

Source of funding: None to declare.

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