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Effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) along with Kendall's Exercises in Improving Physical and Functional Performance in Text Neck Syndrome: A Comparative Study

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Abstract

Background: Long term use of smartphones has led to the modern epidemic of "text neck syndrome," a repetitive stress injury characterized by neck pain, forward head posture (FHP), and functional disability. While various therapeutic exercises exist, there is a need to evaluate and compare their combined efficacy.

Objective: This study aimed to evaluate and compare the effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) techniques combined with Kendall's exercises against Kendall's exercises alone in individuals with text neck syndrome.

Methods: A prospective, randomized controlled trial was conducted with 30 college students (aged 18-25) who used mobile phones for ≥3 hours daily. Participants were randomly allocated into two groups. The experimental group (n=15) received PNF techniques (rhythmic stabilization and dynamic reversal) along with Kendall's exercises, while the control group (n=15) received only Kendall's exercises and conventional neck exercises. Interventions were delivered four times per week for four weeks. Primary outcome measures included the Neck Disability Index (NDI), Numeric Pain Rating Scale (NPRS), and Craniovertebral Angle (CVA).

Results: Statistical analysis using paired t-tests revealed that both groups showed significant improvements ($p < 0.001$) in all outcome measures post-intervention. However, the experimental group demonstrated significantly greater improvement in reducing NDI scores (from 13.2 to 6.8) and NPRS scores (from 5.5 to 1.8), and in increasing CVA (from 44.9° to 48.4°) compared to the control group.

Conclusion: The combination of PNF techniques and Kendall's exercises is more effective than Kendall's exercises alone in reducing neck pain and disability and correcting forward head posture in patients with text neck syndrome. This combined approach is recommended for integration into clinical physiotherapy practice to address the postural demands of the modern digital lifestyle.

Keywords: Text Neck Syndrome, Proprioceptive Neuromuscular Facilitation (PNF), Kendall's Exercises, Forward Head Posture, Smartphone addiction

1. Introduction

As India is taking leap towards the modern technological era, smartphones and laptops are becoming more and more important for various purposes. Earlier smartphones were a need and now it has become an addiction. The prevalence of smartphone addiction is more common among the youngsters especially in college going students. Term used to describe smartphone addiction is called "nomophobia". The term "text neck syndrome" was first coined by an US chiropractor Dr. Dean L. Fishman. It is described as a repetitive stress injury occurring in the neck, shoulder and upper back due to excessive use of smartphones and other hand help devices [1].

Today smartphone is indeed very vital for our day-to-day life, starting from educational purposes and information to e-reading, gaming and management works. Smartphones cannot be avoided completely as it may affect daily living. Aftermath of prolonged text neck syndrome is chronic neck, upper back and shoulder pain along with headaches and increased curvature of spine [2]. Extensive periods of neck flexion are the ultimate risk factor text neck syndrome. The end results of text neck syndrome can lead to cervical degeneration, flattening of spinal curve, shortening of muscle fibers, overstretched muscles, vertigo and early onset of arthritis [2, 3, 4, 5]. During upright posture the ears are aligned with center of the shoulders. Force perceived by the neck is around 10 to 12 1b, which is weight of a person's head. But this thing changes as the neck starts tilting forward. Excessive periods of cervical spine flexion can lead to forward head posture. Forward head posture causes excessive load on cervical spine. The primary characteristic of Forward head posture is head being positioned anterior to the shoulder girdle. According to reports, with 15º of forward neck flexion the force exerting on neck increases to 27 lb. With 30º it increases to 40 1b, with 45º to 49 1b and with 60º it increases up to 60 1b [1, 6, 7, 8]. Not only prolonged forward neck flexion but frequent neck flexion can also cause disorientation of cervical spine, changes in supporting ligaments, tendons and musculature causing pain [4].

2. Aims of the study

- Addressing a modern epidemic of text neck syndrome, which is directly linked to modern lifestyle.
- Informing treatment choices for text neck syndrome, although there is no gold standard treatment option until now. This study directly focuses on already established approaches of PNF and Kendall's exercises.
- This study will help enhancing rehabilitation protocol. Findings will provide more insights about designing a rehabilitation protocol and expand the toolkit available to therapists.

3. Objective and hypothesis

3.1. Objective- To evaluate and compare the effectiveness of PNF and Kendall's exercises as a treatment approach for patients suffering from text neck syndrome.

3.2. Null hypothesis- PNF applied with Kendall's exercises will significantly improve functional performance in individuals with text neck syndrome.

3.3. Alternate Hypothesis- Both PNF and Kendall's exercises will significantly improve functional performance in individuals with text neck syndrome.

4. Methods and materials

4.1. Study design- This study is designed as a prospective and randomized controlled trial.

4.2. Participants size- 30 college students are divided equally and randomly into 2 groups.

4.3. Inclusion criteria

4.3.1. Students aged 18 to 25 were selected for this study.

4.3.2. Both male or female individuals were selected for this study.

4.3.3. Mobile phones should be used ≥ 3hours a day.

4.3.4. Participants not taking any medications for text neck syndrome were selected.

4.3.5. Participants did not go for physiotherapy management somewhere else were included.

4.3.6. There was no history of physical trauma, severe injury, neurological or cardiovascular issues that could elicit neck pain in participants.

4.3.7. Participants who usually drive their motorcycles or cars etc. are included in the study.

4.4. Exclusion Criteria

4.4.1. Subjects with any other medical cause that could lead to pain in neck, subjects with pain in cervical region due to congenital or traumatic history have not been included in this study.

4.4.2. Subjects with spinal cord injury or history of arthritis have been excluded.

4.4.3. Subjects above the age of 25 and less than 18 years are not included in the study.

4.4.4. Subjects using mobile phones less than 3 hours are not taken for the study.

4.4.5. Participants having any medications are not taken for the study.

4.5. Apparatus and materials

Figure 1- Goniometer

Figure 2- Resistance bands

4.6 Therapeutic intervention-

- Rhythmic stabilization- Therapist is resisted an isometric contraction at varying degrees of cervical flexion or extension or lateral flexion. The patient is asked to maintain the position of the head without any movement. Patient holds the position for 5 seconds. The resistance is then increased with if the patient responds well with matching forces. Resistance can be increased to involve the antagonist muscle also. This procedure is repeated in 3 times in cervical flexion, extension, lateral flexion each at varying degrees of range of motion. Repetitions are done with breaks of 30 seconds to 1 minute according to patient's comfort.
- Dynamic reversals- Therapist asks the patient to move his head forwards and provides passive resistance. Position is held for 5 seconds. Then patient is asked to move his head backward and therapist provides passive resistance. Again, position is held for 5 seconds. This is continued for 3 repetitions. Therapist then asks the patient to laterally flex his neck in one side and provides passive resistance. Position is held for 5 seconds. Then the patient is asked to do the same on the opposite side. This is continued for 3 repetitions.
- Kendall's exercises
  - Stretching of cervical extensors- In sitting position, patient is asked to put both of their hands across the occipital area. Spine is the flexed. It is important to keep the neck straight. Patient is asked to flex their neck while touching the chin to chest. It is vital to maintain appropriate posture.
- Stretching of pectoralis major and minor- Therapist stands behind the patient keeping the patient's hands on occipital region. Then therapist abducts the arm and pulls it backward. It stretches bilaterally the pectoral muscles.
- Strengthening of cervical flexors- Subjects is in supine position. Subjects are asked to lift the head and asked to perform chin tuck. Subjects are asked to maintain it for 5- 10 seconds.
- Strengthening of shoulder retractors- Maintaining an upright posture shoulder blades can be brought together encircling a resistance band and pulling it back from both sides.

4.7 Outcome measures-

Neck disability index (NDI) is used to measure the due to its high reliability and validity. This scale comes with 10 sections rated from 0 to 5. An overall score from 0 to 4 implies no impairment, 5 to 14 means mild impairment, 15 to 24 means moderate impairment, 25 to 34 means severe impairment and more than 34 means full disability. NDI shows high test-retest reliability of 0.96 and Cronbach's alpha value of 0.89 showing good internal consistency of the scale [9]. Also, a study by Wu et al shows a strong correlation between NDI and VAS with a construct validity score of 0.75 [10]. Numeric pain rating scale (NPRS) is a good and convenient tool to measure pain intensity of a patient. It is easy to administer and score with minimal language translation difficulties [11]. A systemic review has indicated good to excellent test-retest reliability with intraclass correlation coefficients (ICCs) scores from 0.58 to 0.93 [12]. Craniovertebral angle (CV angle) is used to look for forward head posture. It is measured by universal goniometer. Normal value for it is 48 to 50 degrees. The fulcrum is placed at posterior end of C7 vertebrae. The angle between the horizontal line and line connecting the fulcrum to tragus of ear is measure. Studies have shown that CV angle have excellent inter-rater and intra-rater reliability with ICCs score 0.95 and 0.98 respectively [13, 14].

5. Data analysis and procedure-

College students (both male and female) were asked to participate this study. Participants were complaining of neck pain after maintaining a prolonged neck forward flexion posture due to various activities. Subjects were selected on the basis of inclusion criteria mentioned earlier. 30 students were selected who met the inclusion criteria. Participants voluntarily participated in the study and signed a consent form. Participants were given a form to fill their demographic profile. After that each participant were asked to fill neck disability index form (NDI form) given to them. Universal goniometer was used to measure the craniovertebral angle of each participant. NPRS was used to measure pain intensity.

Subjects were then randomly divided into 2 groups. Group A (experimental group) received proprioceptive neuromuscular facilitation (PNF) and Kendall's exercises. PNF techniques like rhythmic stabilization and dynamic reversals were used in group A. In Kendall's exercises, stretching of pectoralis major, pectoralis minor and cervical extensors were done. Along with this strengthening of cervical flexors and shoulder retractors were done. Interventions were given for 4 weeks with 4 sessions per week.

Figure 3- Therapist giving dynamic reversals to patient

Group B (control group) received Kendall's exercises and conventional treatment that includes neck isometric exercises and stretching of neck musculature were given

Figure 4-Therapist giving rhythmic stabilization to patient

Figure 5- Cervical flexor strengthening in supine lying

Figure 6- Control group performing neck isometric exercises

6. Results

34 participants were assessed for eligibility; Four participants were excluded as they declined to participate later. 30 participants were assigned randomly in both the groups, each group consisting of 15 participants. No significant differences were found between two group's age differences and screen-time per day (shown in table 1) after an independent t-test was done ($p>0.05$).

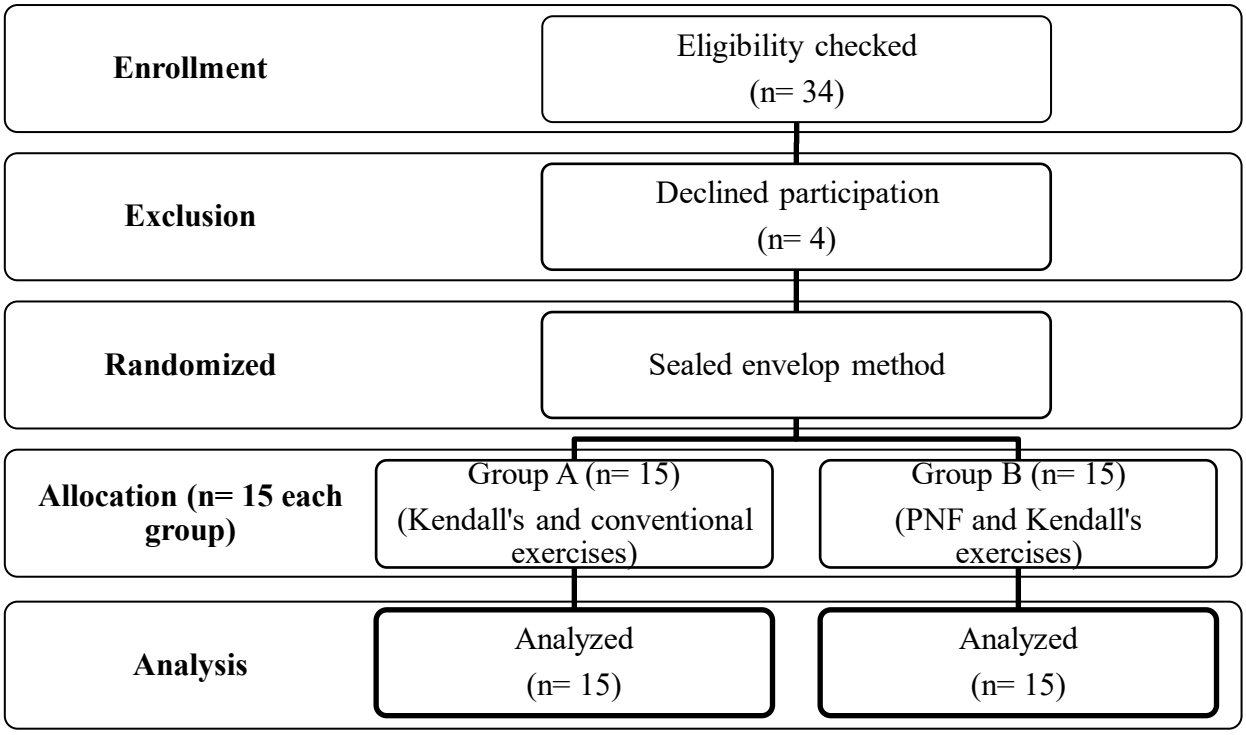

Figure 7- The process of the study based on CONSORT flow diagram. (CONSORT= Consolidated Standards of Reporting Trials).

The Independent t-test also showed no significant differences between both the group's pre-NDI score, pre NPRS score and pre craniovertebral angle (CV-angle). A paired t-test was done which showed both the groups have shown improvement every aspect. But the reduction in NDI scores, NPRS scores and increase in CV-angle was more in experimental group as shown in table 2.

Variable	Experimental (n=15)	Control (n=15)	p
Age in years			
Mean (SD)	21.1 (1.3)	21.0 (1.3)	0.8
Screen time (hours/ day)			
Mean (SD)	7.4 (1.7)	7.3 (1.6)	0.8
Gender			
Male	7	8	
Female	8	7	

Table 1- Characteristics of participants (n=30)

Group	Mean		Standard deviation		t-value	p-value
	Pre- test	Post test	Pre-test	Post test		
Experimental Group	13.2	6.8	5	4.3	15.9	<0.001
Control group	13.2	11.6	3.2	3.4	13.2	<0.001

Table 2- Comparison of pre and post value of NDI among experimental and control group

Group	Mean	Standard deviation	t-value	p-value

	Pre- test	Post test	Pre-test	Post test		
Experimental Group	5.5	1.8	1.4	0.9	20.5	<0.001
Control group	5.6	4.1	1.2	1.5	8.8	<0.001

Table 3- Comparison of pre and post value of NPRS among experimental and control group

Group	Mean		Standard deviation		t-value	p-value
	Pre- test	Post test	Pre-test	Post test		
Experimental Group	44.9	48.4	1.1	0.6	-16.1	<0.001
Control group	45.7	47.8	1.1	1.0	-9.0	<0.001

Table 4- Comparison of pre and post value of CV-angle among experimental and control group

Table-4 summarizes the effects of interventions in both the groups. Both the groups were similar in terms of baseline values. Improvement was more in experimental group rather than control group. This shows the effectiveness of PNF techniques applied along with Kendall's exercises.

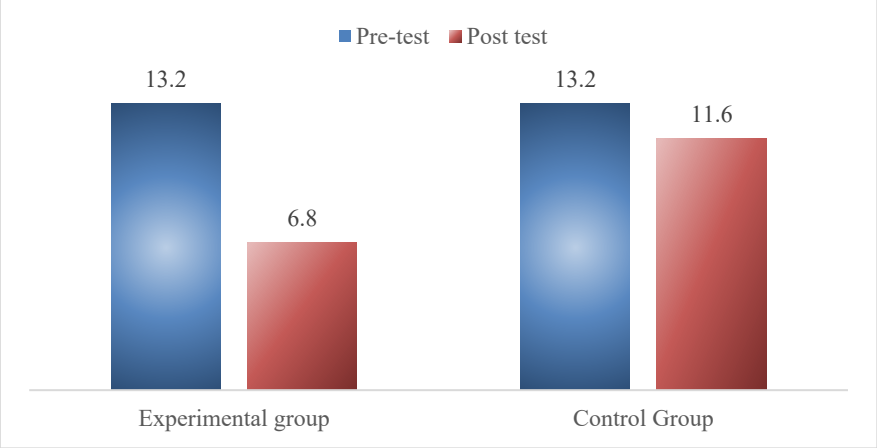

Figure 8- Graphical representation of mean of NDI scores in Experimental and control group

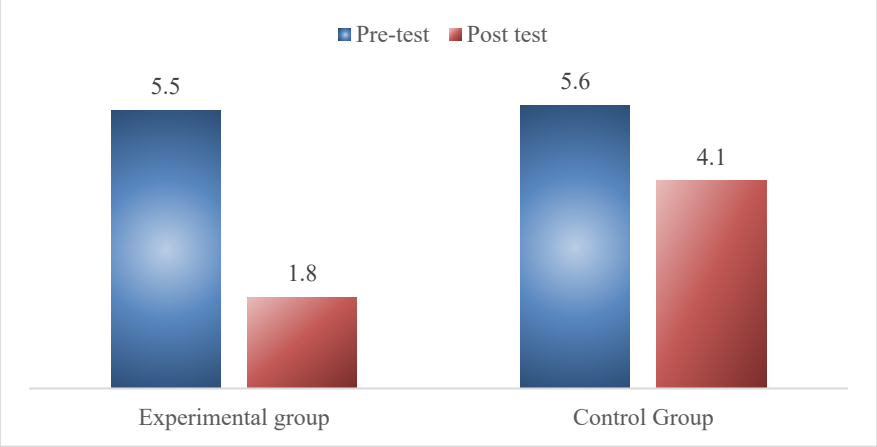

Figure 9- Graphical representation of mean of NPRS scores in Experimental and control group

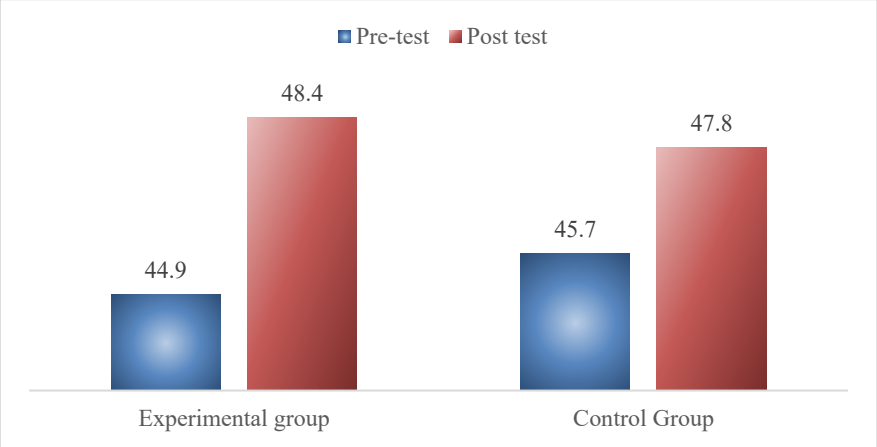

Figure 10- Graphical representation of mean of CV-angle in Experimental and control group

7. Discussion

The present study was conducted to investigate the effects of PNF techniques like rhythmic stabilization and dynamic reversal, along with Kendall's exercises in students suffering from text neck syndrome. In this study, it was found that when PNF exercises along with Kendall's exercises provided 3 sessions per week for 4 continuous weeks can be beneficial to the improvement of their condition. This study shows significant decrease in neck pain and neck disability after treatment with PNF applied along with Kendall's exercises. Our findings are in line with previous done studies available digitally. Neck issues are very common due to over-usage of smartphones, laptops and other smart devices for engaging in talking, messaging, social media interactions and some other creative jobs. Also, the overuse of this can cause discomfort and pain around the neck and upper extremity areas, which can further lead to disability [15]. Forward head posture is one of the commonest syndromes that is seen in individuals who work consistently for prolonged periods of time in front of computer [16]. Normal curves of cervical spine get altered with repetitive and prolonged neck flexion [17].

The principle finding of this study is the combined efficacy of proprioceptive neuromuscular facilitation and Kendall's exercises for text neck syndrome mainly dealing with poor posture, pain and disability. Our findings are consistent with previous works like Rajopadhaye et al (2023) [19], Rahul S et al (2024) [20] and Kaya et al (2024) [3] etc. While previous studies focused on a single approach of using either PNF or Kendall's exercises, our study evaluates the combined effect of PNF and Kendall's exercises, while also proving Kendall's exercises to control group too. This finding is important for determination of practical implication of therapeutic approaches in patients scomplaining of neck pain and forward head posture. This study open-up another therapeutic option for physiotherapists while treating text neck syndrome.

8. Conclusion

In summary, we have shown that if PNF techniques when combined with Kendall's exercises can produce significant improvements in patients suffering from Text neck syndrome. It can reduce neck disability and neck pain. This approach can also increase cranio-vertebral angle thus fixing forward head posture. Implementation of these exercises can reduce reliance on medication and reduce chronic neck pain. Integration of these exercises are strongly recommended in clinical physiotherapy practice to address postural demands of modern digital lifestyle.

9. Limitations

a. The generalizability of these findings is limited by the sample size of this study, as it only consists of 30 participants, a larger population can be included to get better and more specific insights.
b. Another limitation of this study is it does not study the long-term consequences as the duration of the study is only 4 weeks.
c. This experiment is only done on students studying physiotherapy from one college thus it does not provide insights of people working in other fields.

10. Future recommendations

To address these limitations, future research should consider taking a larger sample size. It should include people from different fields of works rather than sticking to one field only. People from different age groups can also be taken. Future research should investigate and explore the mechanism of developing text neck syndrome and factors associated with it. In addition, it is important that future research should focus more on evaluating the proper design of study and work furniture and knowledge of good and poor posture.

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