Effect of Deep Neck Flexor Activation on Pain and Dysfunction in Chronic Nonspecific Neck Pain

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Abstract

Background: Chronic nonspecific neck pain is a very common musculoskeletal disorder that has many factors, such as prolonged posture or weakness in deep stabilizers of the neck. Deep neck flexor activation may have a role in stabilization of neck muscles. **Purpose**: The purpose of this study was to detect the effect of deep neck flexor activation on pain and dysfunction in patients with chronic nonspecific neck pain. **Patients and Methods**: Twenty-two Egyptian physiotherapy students aged 18 to 24 years with chronic nonspecific neck pain participated in this study and were treated with deep neck flexor activation using pressure biofeedback (PB) for 4 weeks, two sessions per week. Before and after treatment, all patients were evaluated for pain intensity using a visual analogue scale and neck disability using the Arabic version of the Neck Disability Index. **Results:** There was a significant improvement in pain and dysfunction post deep neck flexor activation. **Conclusion**: Deep neck flexor activation shows great improvement in pain intensity and good enhancement of function after four weeks of treatment.

Key words: chronic nonspecific neck pain, deep neck flexor activation, visual analogue scale, neck disability index, Egyptian physiotherapy students.

INTRODUCTION

Chronic nonspecific neck pain (NSNP) is a common musculoskeletal disorder that is considered in literature the fourth leading cause of disability with an annual prevalence rate exceeding 30% (1). Most individuals with disabling chronic neck pain show improvement in pain intensity over 1 year. However, 25% acquire fluctuating or a persistent pattern of pain over time despite undergoing a cycle of therapies for pain control (2).

Neck pain can be specific or nonspecific. Specific neck pain is caused by trauma or degenerative diseases, and nonspecific neck pain is characterized by sudden neck pain or neck pain with an unclear cause that occurs when the same posture is repeated or maintained for a prolonged time (3). Nonspecific neck pain (NSNP) is considered to be chronic if it lasts more than 3 months (4).

Physiotherapy students experience a high prevalence of nonspecific neck pain, with episodes ranging from 34.6% to 54.8% (5).These episodes may be related to their manual handling of patients during clinical placements, long training hours, anxiety, senior years of study, prolonged smartphone and laptop use, even backpacks, and poor posture, which forces them to increase forward head posture and inhibit their deep neck flexors (DNF) (6).

An essential postural role of the deep neck flexor (DNF) muscles is to sustain the cervical lordosis (7). Neck pain (NP), which results in muscular insufficiency, has been linked to reduced activation of the deep neck flexors (DNF) in prior investigations on cervical impairment (8,9). The posture of the head and neck may be affected by such weakening. So, there is a connection between forward head posture (FHP) and neck discomfort (10, 11).

The deep flexor muscles, such as the longus capitis and longus colli, which flex the neck rather than the head, are the focus of cranio-cervical flexor muscle training. Additionally, rather than working all the neck flexors used in the head-lifting exercise, these low-load exercises target the deep cervical flexors (12). According to earlier studies, activating the deep neck flexors (DNF) improves neck discomfort and disability (13-15).

Biofeedback (PB) training combined with deep neck flexor activation (DNF) enhances motor behavior by encouraging patients to engage in goal-oriented behavior (16, 17). Pressure biofeedback involves the use of an inflatable cushion that is connected to a pressure gauge (pressure biofeedback unit). The inflatable cushion is typically placed behind the neck while the person is in supine. As the user flexes their cervical spine and compresses the cushion, the reading on the pressure gauge increases. This gives the user an indication of how much their neck muscles are contracting (18). Also, it can augment the patient's sensory feedback mechanism, as visual feedback aids in regulating both the frequency of motor unit discharge and recruitment, which results in a more effective DNF training performance (19-21). Cranio-cervical flexion training with pressure biofeedback has proven to be more

effective in improving endurance of deep cervical flexors in patients with mechanical neck pain (16, 17).

MATERIALS AND METHODS

The study was conducted at the outpatient clinic of physical therapy at October 6 University from December 2024 to April 2025.

Study design:

A single group, pre-post intervention. The study received ethical approval from the Review Board of the Faculty of Physical Therapy, Cairo University **(approval number: P. T.REC/012/005365),** and all participants provided written informed consent.

Participants:

Twenty-two male and female Egyptian physiotherapy students with chronic NSNP who meet the following inclusion criteria were included in this study. All participants were treated with deep neck flexor activation (DNF) with biofeedback.

Inclusion criteria:

1- Physiotherapy students aged from 18 to 24 years. 2. Chronic nonspecific neck pain (NSNP) for at least 3 months (4). 3. Baseline score of 3 out of 10 on visual analogue scale (VAS) (22). 4. A score of more than 20% on the Neck Disability Index (NDI) (23). 5. Forward head posture with craniovertebral angle less than 50 degrees (24). 6. Normal body mass index (BMI) from 18.5 up to 24.5 (25).

Exclusion criteria:

1. Specific causes of neck pain, such as rheumatic and systemic neuromuscular diseases. 2. Cognitive impairment. 3. Cervical radiculopathy 4. Cervical spondylolisthesis. 5. Previous surgery. 6. Any musculoskeletal disorders except neck pain. 7. Don't receive any physical therapy or medical intervention as electrotherapy ,exercises ,analgesics or anti inflammatory medication (26).

Sample size:

The sample size was calculated using G*Power software (version 3.1.9.2). The power analysis performed for NDI results revealed sufficient power (100); according to that, the sample size of the study included 22 subjects **(figure 1).**

Tests of Within-Subjects Effects

Measure: NDI

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
time	Sphericity Assumed	4939.601	1	4939.601	122.919	.000	122.919	1.000
	Greenhouse-Geisser	4939.601	1.000	4939.601	122.919	.000	122.919	1.000
	Huynh-Feldt	4939.601	1.000	4939.601	122.919	.000	122.919	1.000
	Lower-bound	4939.601	1.000	4939.601	122.919	.000	122.919	1.000
Error(time)	Sphericity Assumed	843.899	21	40.186				
	Greenhouse-Geisser	843.899	21.000	40.186				
	Huynh-Feldt	843.899	21.000	40.186				
	Lower-bound	843.899	21.000	40.186				

Figure (1): power analysis for NDI

Assessment procedures:

1. Assessment of pain intensity :

Pain intensity was measured by the visual analogue scale (VAS). VAS is a reliable and valid tool for the measurement of pain. The reliability of VAS ranges from 0.60 to 0.77 and validity from 0.76 to 0.84 (27). The VAS is a horizontal line extending 100 mm, with the pain descriptors "no pain" on the left and "the worst pain imaginable" on the right. Patients were instructed to mark the VAS with a line that was perpendicular to the VAS to indicate how much pain they were experiencing at the moment (28, 29).

2. Assessment of neck disability:

Neck disability was measured by the Arabic version of the Neck Disability Index (NDI). The NDI is a reliable and valid tool for neck disability with moderate validity from 0.50 to 0.70 and test-retest reliability (30-32). The Arabic version of NDI (NDI-Ar) is a valid and reliable tool for measuring disability in patients who speak Arabic. It revealed excellent test-retest reliability (ICC=0.96) and construct validity with a 2-factor structure of 67.58 % and concurrent validity of 0.92 with the original English version (33).

The NDI-Ar consists of 10 questions that are self-reported and cover topics such as pain intensity, personal hygiene, lifting, reading, headaches, attention, work, driving, sleeping, and leisure. Scores range from 0 (no disability) to 5 (complete disability) for each item. Fifty is the highest possible score. Nonetheless, the NDI is commonly expressed as a percentage by dividing the total score by 50 and multiplying by 100 (30, 34).

Treatment procedures:

Deep neck flexor activation with pressure biofeedback:

DNF activation using visual pressure biofeedback (Stabilizer™, Chattanooga Group Inc. USA) is significantly effective for reducing neck pain (NP) (35). The pressure biofeedback device consists of a meter and a flat pocket pneumatic pump, where the force generated by the contraction of the deep muscles is transferred to the pressure biofeedback device to measure the pressure (36).

It is performed with the patient in a hook-lying position. The pressure biofeedback unit was centered just below the occiput between the plinth and the upper back of the neck and inflated to a baseline of 20 mmHg. Preparation of measurement includes asking the patient to gently nod the neck while holding 2 seconds at each increment from 22 mmHg up to 30 mmHg without rest. The highest level at which the patient reached without any substitution, such as contraction of superficial muscles (sternocleidomastoid and scalenus or neck tremors) was selected for training. This level was repeated using proper technique until the patient's ability to hold 10 seconds at that level with ten repetitions in each set for three sets, with 30 seconds rest in between **(figure 2)** (17, 35, 37).

All patients received two sessions per week for four weeks. The treatment session lasted for 20 to 30 minutes . They were instructed to do active exercises as home program consisting of 1- Neck active range of motion (ROM) in all directions (flexion, extension, right and left rotation, and right and left side bending). 2- Shoulder active ROM included shoulder flexion and abduction up to 90◦ and external rotation/internal rotation while the elbow was 90◦ flexed and the arms were beside the body. 3 All participants were advised to complete their active ROM exercises in the sitting position without holding at the end range. 4- They also performed a shoulder shrug while they are standing. In addition, participants were asked to sit on a chair and put their hands besides their hips , press down their hands and try to lift their body . Home program was repeated five times daily during first week with increasing number of repetition up to 20 repetition daily through the 8 week program (38).

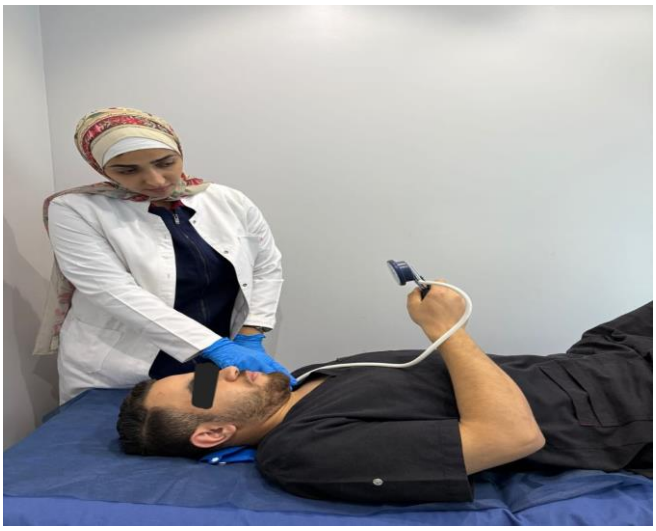

Figure (2): DNF activation using pressure biofeedback

Statistical analysis:

Statistical analysis was conducted using SPSS for Windows, version 26 (SPSS, Inc., Chicago, IL). Before final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores, and the *p*-value was set at < 0.05. This analysis was done as a prerequisite for parametric testing of the analysis of differences.

A comparison between mean values of the different parameters in the group was performed using paired sample t-test to determine the significant differences between both times testing intervals (pre and post)

RESULTS

Twenty-two patients with chronic NSNP were included in the current study who received DNF activation. Neck pain and disability were measured pre-treatment and at post treatment intervention after 8 weeks.

The distribution of females and males in the study group was 81.82 % (18) and 18.18 % (4) respectively. The mean values of age, height, weight, and BMI for all patients in the study groups is shown in Table 1.

Table 1: Descriptive statistics of the demographic data for the study group.

Variable	**Study group** **N = 22** **Mean ± SD**
Age (years)	21.82 ± 0.795
Height (cm)	164.59±9

Weight (Kg)	63.95±9.5
BMI (kg/m2)	23.39 ± 1.22

*SD= Standard deviation,

Effect of DNF on pain and function:

Paired-sample t-test was conducted to study the effect of DNF on Pain intensity and functional disability of the neck in patients with chronic NSNP.

There was a significant difference between pre and post-DNF activation for both pain intensity and functional disability. The results revealed an improvement in the form of a reduction of pain intensity post DNF activation and enhancement of function as illustrated in Table 2 and Figures 3&4.

Table 2: Paired sample t-test for the effect of DNF activation on pain intensity and functional disability

	Mean ± SD	**Paired Differences**			**t-value**	**Sig**
		Std. Error Mean	**95% Confidence Interval of the Difference**			
			Lower	**Upper**		
VASpre (mm)	63.84±13.81	2.30	41.33	50.89	20.06	**<0.001***
VASpost (mm)	17.73±9.34					
NDIpre (%)	30.35±10.47	1.91	17.22	25.16	11.087	**<0.001***
NDI post (%)	9.16±4.57					

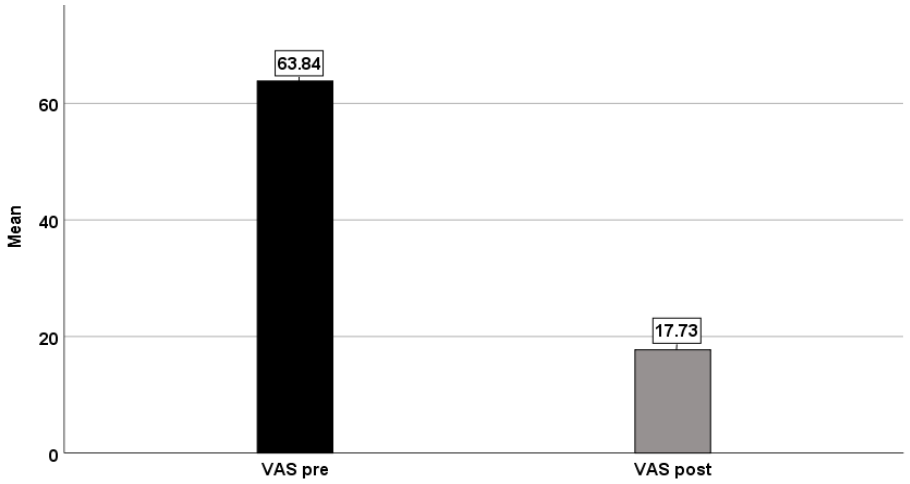

Figure 3: Mean values of VAS pre- and post-DNF activation

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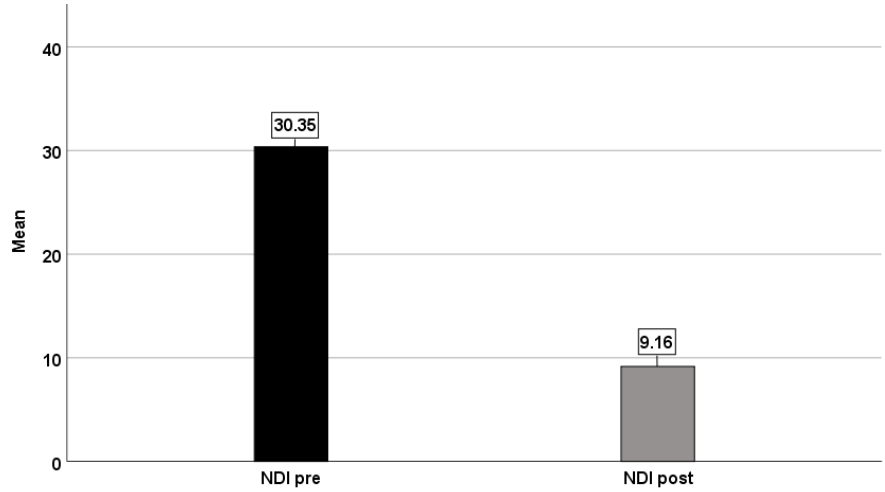

Figure 4: Mean values of NDI pre- and post-DNF activation

DISCUSSION

The results of this study showed that nonspecific neck pain and related impairment are significantly reduced when DNF muscles are targeted and trained. These findings are in line with Blomgren et al. (2018) that have shown the vital role of deep cervical musculature training in preserving the stability of the cervical spine and lowering mechanical strain (39).

Several recent studies have demonstrated that (DNF) activation exercises lead to significant reductions in pain for individuals with NSNP. Tsiringakis et al. (2020), Iqbal et al. (2021), Villanueva et al. (2021), Abdel-Aziem et al. (2022), Garzonio et al. (2022), and Ataei Cheragh et al. (2023) consistently supports the effectiveness of DNF exercises in alleviating pain. The mechanisms behind this improvement may involve enhanced cervical stability and neuromuscular control, reducing compensatory muscle overactivity and mechanical stress in the neck. These findings align with the growing body of evidence suggesting that DNF activation is a beneficial approach to managing neck pain. The consistent results of these studies emphasize the clinical relevance of incorporating DNF activation in rehabilitation programs aimed at reducing pain in individuals with NSNP (40-45).

While DNF activation significantly reduced pain in the majority of trials, several investigations produced contradictory findings. Some studies showed mixed results. Specifically, Abbas et al. (2022) and Najafi et al. (2024) did not directly assess pain as a primary outcome. Najafi et al. (2024) focused more on functional and postural improvements, while Abbas et al. (2022) concentrated on range of motion and muscle strength measurement, with pain reduction being a secondary observation. Also, Villanueva et al. (2021) stated that DNF training just focuses on one element of nonspecific neck discomfort. Other factors, such as psychological, occupational, and broader musculoskeletal variables, must be

considered. So, multimodal therapies may be required for the best possible care (42, 43 ,45).

Several recent studies to have demonstrated that deep neck flexor (DNF) activation exercises lead to reduced disability for individuals with nonspecific neck pain. Martin-Gommez (2019), Tsiringakis et al. (2020), Iqbal et al. (2021), Abdel-Aziem et al. (2022) and Ataei Cheragh et al. (2023) reported significant reductions in disability levels among participants with NSNP . On the other hand, studies by Villanueva et al. (2021) and Garzonio et al. (2022) consistently report that specific neck exercises targeting the deep cervical flexors contribute to reducing disability and improving function. But the degree of improvement in disability and function varied across studies, and the overall evidence quality in these studies was considered moderate to low, suggesting a need for more high-quality, standardized research (16, 40, 44-47).

Clinical Implications

According to the results of this study , it can be quite helpful to include DNF activation activities in rehabilitation programs for people who have nonspecific neck pain. To guarantee long term adherence and comprehension of the exercise's goal, clinicians should emphasize on appropriate training of DNF activation and take patient education in consideration.

Limitations and recommendations

The results of this study for the effect of DNF activation on decreasing non specific neck pain and improving neck dysfunction are promising , but there are a few limitations to keep in mind. First, there is a lack of a control group. During clinical application, there was difficulty in using pressure biofeedback back in patients with weak vision. Furthermore, the long-term preservation of improvements after the intervention period was not evaluated in this study. Future research should examine the combined effects of DNF activation with other interventions, such as manual therapy, ergonomic advice as well as randomized controlled trials with longer follow-up periods.

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