Effect of Deep Cervical Flexors Training Paradigm on neck pain and functional disability in Patients with Cervicogenic Headache

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Abstract

Background: Cervicogenic Headache (CGH) is a common condition causing significant disability. **Purpose:** This study was conducted to investigate the effect of deep cervical flexors (DCFs) training paradigm on pain and disability caused by headache in patients with CGH. **Methods:** Fifty patients with unilateral CGH of both sexes aged from 30 to 40 years were randomly assigned into two equal groups: study group received DCFs training paradigm which included DCFs training using pressure biofeedback unit (PBU), exercise ball and TheraBand in addition to a conventional physical therapy and control group received the conventional physical therapy only. Neck pain was assessed using Visual analogue scale (VAS) and functional disability was assessed by headache disability index (HDI). Outcome measures were assessed pre and post treatment. **Results:** There was a statistically significant decrease in mean scores of VAS and HDI of both groups after treatment compared with that pretreatment (p = 0.001). There was a statistically significant difference in mean scores of VAS and HDI between both groups post treatment in favor of the study group. **Conclusion:** Adding DCFs training paradigm using a pressure biofeedback is more effective in decreasing neck pain and disability than conventional physical therapy alone in patients with cervicogenic headache.

Key words: Cervicogenic headache, Neck pain, Stabilization exercises, Disability.

Introduction

Cervicogenic Headache (CGH) is a referred pain from cervical structures innervated by the upper three cervical spinal nerves (C1-C3) [1]. This pain is unilateral, starting from one side of the posterior head and neck spreading to the frontal-temporal and orbital region [2,3].

Cervicogenic headache is a secondary headache which is associated with cervical spine disorders [4]. It has a predominance among the female gender and account for 15- 20% of all chronic and recurrent headaches [5,6]. It tends to start earlier in life around ages 32-35 [7,8]. Headaches have negative effects on the quality of life of the individuals and impose socio-economic costs for the society [9].

Performance of deep cervical flexors (DCFs) are impaired in patients with Cervicogenic Headache [10]. Ylinen et al. [11] mentioned that weakness of DCFs tend to cause neck pain. Also, Javanshir et al. [12] mentioned that, there is relationship between reduction in strength and endurance capacity of the DCFs and neck pain. Moreover, DCFs training might directly influence pain sensitive structures of upper cervical region more than conventional training [13].

Ahmed et al. [14] found that deep neck flexors exercises using pressure biofeedback unit (PBU) is effective in reducing headache frequency in patients with the CGH.

Studies on the effect of DCFs training on neck pain and functional disability in patients with CGH are still insufficient, so this study was conducted to investigate the effect of the DCFs training paradigm on neck pain and functional disability in patients with CGH.

Materials And Methods

This randomized controlled study was conducted in the period from April 2023 to October 2023. Before participation in the study, every patient read and sign an informed consent.

Study population

Fifty patients with unilateral CGH of both sexes participated in this study. The patients were recruited from Outpatient Clinic of General Zagazig hospital. Patients were diagnosed as having CGH based on careful clinical examination by a neurologist. Cervicogenic headache was diagnosed according to the diagnostic criteria of the cervicogenic headache as described by International Headache Society [4]: 1) Pain localized in the neck and occiput, which can spread to other areas in the head, such as forehead, orbital region, temples, vertex, or ears and usually unilateral, 2) Pain is precipitated or aggravated by specific neck movements or sustained postures and 3) Patient has at least one of the following: A) Resistance to or limitation of passive neck movements, B) Changes in neck muscle contour, texture, tone, or response to active and passive stretching and contraction and C) abnormal tenderness of neck musculature.

The patients were included, if they have: 1) Unilateral cervicogenic headache persisting for more than three months; 2) Age ranged from 30 to 40 years; 3) Patient was able to understand and follow instructions; 4) Manual physical examination revealing muscle tenderness.

The patients were excluded; if they had: 1) Specified bilateral headaches(tension type headache), features suggestive of migraine and chronic respiratory disease; 2)Vascular, neoplastic or vestibular disease of the neck; 3) A diagnosis of fibromyalgia or rheumatoid arthritis; 4) History of mixed or multiple headaches; 5) A previous history of traumatic neck injury/surgery or cervical instability; 6) Known or suspected vestibular pathology; 7) Intracranial pathology; 8) Cognitive impairment; 9) Neurologic deficits; 10) Psychological disorders; 11)Visual problems and 12) Malignant conditions.

Randomization:

The patients who fulfilled the inclusion criteria were randomly assigned into two groups (group I and group II) using sealed envelope with 25 patients in each group. The study group received DCFs training paradigm in addition to conventional physical therapy. The control group received conventional physical therapy only.

Sample size calculation:

The sample size for this study was calculated using the G*power program 3.1.9 (G power program version 3.1, Heinrich-Heine-University, Düsseldorf, Germany). The sample size effect for the sample size calculation was obtained from the previous studies [6,14]. Sample size calculation based on F tests (MANOVA: Special effects and interactions), Type I error (α) = 0.05, power (1-β error probability) = 0.90, effect size f2 (V) =0.2484395, and Pillai V =0.3980001. The appropriate sample size for this study was 50 patients (25 patients in each group).

Evaluation

For patients in both groups, the subsequent evaluations were completed before and after six weeks of treatment.

A) Assessment of neck pain using Visual analogue scale (VAS):

Visual analogue scale is reliable and valid to measure pain intensity in neck pain [15]**.** It is a horizontal continuous scale, 10 cm in length, ended with two verbal pain descriptors on either end one is “no pain” (score of 0) and “pain as bad as it could be” or “worst imaginable pain” (score of 10) on other end [16]. The patients were asked to point the suitable score on the line that represent their pain intensity.

B) Assessment of disability caused by headache using Headache disability index (**HDI**):

It is useful in assessing the impact of headache, and its treatment on daily living [17]**.** The HDI has a very good reliability values ranging from 0.93-0.95 [18,19]**.** The alpha version of the HDI (alpha-HDI) consisted of 40 items, each requiring a "yes" (four points), "sometimes" (two points), or "no" (zero points) response based on items derived empirically from case history responses of patients with headache. From the alpha-HDI, a 25-item beta version (beta-HDI) were derived with the items sub-grouped into functional and emotional subscales. The internal consistency/reliability was strong, as was construct validity. The test-retest reliability for the beta-HDI was acceptable for the total score and functional and emotional subscale scores. A 29-point change (95% confidence interval) or greater in the total score from test-retest must occur before the changes can be attributed to treatment effects.

Interventions:

Patients in the study group received strength of DCFs using (PBU, Swiss ball and TheraBand).

1) The pressure biofeedback unit (Stabilizer TM, Chattanooga Group, INC., Chattanooga) is a tool developed by physiotherapists to aid the retraining of stabilizing muscles using specific exercises, and detects movement of the cervical spine in relation to an air-filled reservoir**.** The use of such pressure sensors can provide useful visual biofeedback during treatment, and an objective measure of the fatigue time of the deep cervical muscles. The use of a pressure biofeedback unit is also suggested as a more effective way of DCFs strengthening than conventional exercises [20]**.** Low load training of the cranio-cervical flexors (CCFs) followed the protocol described by **Jull et al.** [21]. This exercise specifically targets the DCFs (longus capitis and longus colli), while aiming to minimize the activation of the superficial cervical flexors (sternocleidomastoid and anterior scalene).

Initially, from a supine lying position the patients were taught to perform the cranio-cervical flexion (CCF) movement slowly and in a controlled manner, with the head and neck in a neutral position. Once the correct CCF motion achieved, patients begun to hold progressively increasing ranges of CCF using PBU (Stabilizer TM Chattanooga Group Inc., Tennessee, USA), which was placed behind the neck just next to the occiput and was inflated up to a baseline pressure of 20 mmHg. The patients performed CCF to sequentially reach five pressure targets in 2 mmHg increments from a baseline of 20 mmHg to the final level of 30 mmHg. For each target level, the patients were instructed to maintain the contraction for10 sec for 10 repetitions with brief rest periods between each contraction (3–5 sec). Once a set of 10 repetitions of 10 sec were achieved at one target level, the exercise was progressed to train at the next target level up to the final target level at 30 mmHg.

2) Strength training of deep cervical flexors using exercise ball: (Swiss ball: The exercise ball may be referred to as gymnast ball or stability ball or physio ball. The Swiss ball is widely used in the recreational training environment to be a training device for core stability exercise [22].

A 55cm diameter exercise ball was taken for the cervical stabilization exercise. Three types of exercise were given, out of which in first exercise where patients were in quadruped position and asked the patient to place the exercise ball under his/ her forehead while maintained a 'neutral' position of her neck and be sure to avoid protracting his/her head into the ball and held for 10 seconds. In second type of exercise, the patient had to lay on ball and keep her back in neutral position. Slowly lift arm forward, keeping elbow straight. Held and returned after 10 seconds; repeated on other side and kept ball steady. In third type of exercise, patient had to place the exercise ball under her forehead as the patient stood next to a wall, maintained a 'neutral' position of her neck and stabilized the ball with his/her head and didn't let the ball move and was sure to avoid protracting the head into the ball, held for 10 second [6]**.**

3) Strength training of deep cervical flexors using TheraBand:

A- From siting position: The patient placed the middle of the band around the front of his/ her head, held each end of the band at the side of his/her head near eye level, kept his/her neck in neutral position with the chin slightly tucked, pulled the ends of the band backward, slowly returned and kept his/her neck stable, then held and slowly returned to starting position. B- From standing position: Patient moved one step forward. Then held and slowly returned to starting position.

Conventional physical therapy program:

Patients in both study and control groups received the same conventional physical therapy program which included 1) Hot packs; the patient was instructed to lie prone and hot packs were applied on the neck for 15 minutes, 2) Stretching exercises for Sternocleidomastoid, Upper trapezius, scalenes, levator scapulae, pectoralis major and minor, and short suboccipital extensors [23]**.** The stretching' exercises comprised of a 30 second stretch followed by a 30 second pause, three times for each muscle. 3) Strengthening exercises for deep neck flexors while the patient was lying supine and the cervical spine was placed in a neutral position. Every patient was instructed to flatten the curve of the neck via nodding the head. This position was held for 10 seconds and was repeated 10 times. The therapist or patient monitors the sternocleidomastoid muscle to ensure that this muscle not or minimally activated during the deep neck flexors contraction as described by **Petersen** [24]**.** This conventional physical therapy treatment was repeated three times a week for six weeks.

Statistical Analysis:

Unpaired t-test was conducted for comparison of subject characteristics between groups. Chi-squared test was conducted for comparison of sex distribution between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social sciences (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

Results:

General characteristics of patients:

Fifty patients with CGH participated in this study. Table (1) shows the subject characteristics of group A and B. There was no significant difference between both groups in mean age, weight, height, BMI, duration of illness or sex distribution ($p > 0.05$).

Table 1. General characteristics of study and control groups.

	Study group	Control group	MD	t-	p-value
	Mean ± SD	Mean ± SD		value	
Age (years)	36.56 ± 3.24	37.16 ± 4.29	-0.60	-0.56	0.58
Weight (kg)	74.32 ± 13.19	75.00 ± 12.13	-0.68	-0.19	0.85
Height (cm)	163.40 ± 7.59	165.96 ± 6.65	-2.56	-1.27	0.21
BMI (kg/m²)	27.89 ± 4.98	27.25 ± 4.34	0.64	0.48	0.63
Duration of illness (month)	5.04 ± 0.84	4.88 ± 0.78	0.16	0.69	0.49
Sex, n (%)					
Females	18 (72%)	16 (64%)			
Males	7 (28%)	9 (36%)			

SD, standard deviation; p-value, level of significance

Effect of treatment on VAS and HDI scores:

Within group comparison

There was a statistically significant decrease in mean scores of VAS for neck pain and HDI of study and control groups post treatment compared with pretreatment ($p < 0.001$). The percent of change of VAS score and HDI score of group A was 67.92 and 69.46 % respectively and that in group B was 52.87, 60.19 % respectively ($p < 0.001$). (Table 2).

Between group comparison

There was no statistically significant difference between groups pre- treatment ($p > 0.05$). There was a statistically significant decrease in mean scores of VAS and HDI of the study group compared with the control group post treatment ($p < 0.01$).

Table 2. Comparison of mean scores of VAS and HDI of study and control groups pre and post treatment.

	Pre treatment	Post treatment	MD	% of change	p value
	Mean ±SD	Mean ±SD			
VAS					
Study group	6.36 ± 1.22	2.04 ± 0.39	4.32	67.92	0.001
Control group	6.28 ± 1.02	2.96 ± 0.67	3.32	52.87	0.001
MD	0.08	-0.92			
	p = 0.80	p = 0.001			
HDI					
Study group	46.76 ± 9.19	14.28 ± 4.67	32.48	69.46	0.001
Control group	45.92 ± 7.16	18.28 ± 2.87	27.64	60.19	0.001
MD	0.84	-4.00			
	p = 0.72	p = 0.001			

SD, Standard deviation; MD, Mean difference; p value, Probability value

Discussion:

Patients with CGH experience significant limitations in their daily activities, social participation and emotional distress. Patients score the "worse" in the physical function category when compared to migraine patients [25]**,** so this study was conducted to investigate the effect of DCFs training paradigm on neck pain and headache disability in patients with CGH.

Regarding VAS score for neck pain, the result of this study showed that there was a significant decrease in neck pain in both groups post treatment. This might be attributed to mechanisms of pain reduction through exercises received by both groups. The increase in endorphins that occurs after training and better neuromuscular control may decrease pain. Muscle contractions activate stretch receptors. Afferent from these muscles causes endogenous options to be released and also the beta-endorphins from the pituitary gland. These secretions may cause both peripheral and central pain to be blocked [26].

Also, pain reduction might be attributed to the effect of heat therapy that applied for both groups because its effect on pain and spasm and thus can attribute to pain relief and improved tissue extensibility in both groups. Reduction in the pain following static stretching can be explained on the basis of inhibitory effects of Golgi tendon organ and Pacinian corpuscle modification. These reflexes allow relaxation in musculotendinous unit tension and decreased pain perception [27].

Regard to pain intensity in the study group, there is a significant decrease in pain intensity level in the study group than control group. This result comes in agreement with **Ylinen et al.** [28] who found that neck exercises using TheraBand reduced neck pain and headache in patients with CGS. Also, **Gupta et al.** [29] mentioned that DCFs training improved chronic neck pain more significantly than conventional physical therapy. Furthermore, **Ahmed et al.** [14] who found that deep neck flexors exercises using PBU is effective in the reducing neck pain in patients with CGH than conventional therapy only.

More significant reduction of pain in the study group than the control group might be attributed to more significant improvement of DCFs strength in the study group. This explanation is supported by the opinion of **Ylinen et al.** [11] who mentioned that weakness of DCFs tend to cause neck pain. Also, **Javanshir et al.** [12] mentioned that, there is relationship between reduction in strength and endurance capacity of the DCFs and neck pain. Moreover, DCFs training might directly influence pain sensitive structures of upper cervical region more than conventional training [13].

Furthermore, the significant reduction of neck pain in the study group in comparison with control group might be explained by neuromuscular control improvement between superficial and deep neck flexors as continuous imbalance between the superficial and deep neck muscles leads to further forward head position from the body causing neck pain [30]. This justification was consistent with the finding of **Izquierdo et al.** [31] who mentioned that retraining of the DCFs using CCF exercises causes significant improvements in neuromuscular coordination between the deep and superficial neck flexors. Restoration of the supporting capacity of DCFs parallels decrease in neck pain [30].

Regarding HDI score, the results of this study showed significant decrease in disability caused by headache in both groups post treatment. This reduction in disability might be attributed to the reduction in headache intensity which can bring about improvement in disability. This might be attributed to the fact that there is quite strong relationship between pain and disability as headache intensity is one of the areas addressed in HDI so a relationship between these variables would be expected.

Limitations:

This study has some limitations. The primary limitation was the lack of following up the long-term effects of DCFs training paradigm on neck pain and disability caused by headache in patients with CGH. In addition, it was not be possible to blind the physiotherapist due to the nature of the interventions which need the direct communication between the physiotherapist and the patients. Furthermore, the initial selection of the patients was represented as a convenient sample rather than a random sample of the whole population.

Conclusion:

Deep cervical flexors training paradigm was shown to be more effective than conventional physical therapy alone in decreasing neck pain and disability caused by headache in patients with CGH.

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