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ORIGINAL RESEARCH ARTICLE

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Efficacy of lumbar motor control training in treatment of patients with cervicogenic headache

Hagar A. Marzok[1*], Ahmed H. Ashry[2], Magda G. Sedhom[3] and Neveen A. Abd El-Raoof[4]

Abstract

Background Cervicogenic headache (CGH), is a secondary headache arising from cervical disorders. Training core muscles have a corrective effect on the whole spine. Moreover, increased deep neck flexors (DNFs) activation is closely linked with balanced core stabilization of the global cervical-thoracic-lumbopelvic chains. This study aimed to investigate the effect of lumbar motor control training combined with cervical stabilization exercises compared to cervical stabilization exercises alone in CGH patients.

Methods Fifty-two subjects of both genders with CGH and chronic mechanical neck pain (CMNP) participated in this study. They were recruited from the outpatient Physical Therapy Clinic at Mubarak Central Hospital, Giza, Egypt; their mean age was 28.1 ± 5.8 years and their BMI was 22.8 ± 1.6 kg/m^2. They received treatment for three sessions per week for 4 weeks. Subjects were assigned randomly into two equal groups; the control group: received cervical stabilization exercises (axial elongation, cranio-cervical flexion, cervical extension, rowing, and Y-exercise). Study group: received cervical stabilization exercise in addition to lumbar motor control training (abdominal draw-in maneuver, side plank, and quadruped position), each exercise had a 4-week progression. Headache frequency, duration, intensity by visual analog scale (VAS), and neck functional disability by Neck Disability Index (NDI) were measured before the first session and after the last session of the 4 weeks of treatment.

Results There was a high statistically significant difference in post-treatment mean values of headache frequency, headache duration, headache intensity, and neck functional disability between the two groups in favor of the study group.

Conclusion Adding lumbar motor control training to cervical stabilization exercise is more effective than cervical stabilization alone in decreasing headache frequency, duration, intensity, and neck functional disability in CGH patients with CMNP.

Trial registration NCT05952115. Registered 11 July 2023-retrospectively registered, https://register.clinicaltrials.gov/prs/app/action/LoginUser?ts=1&cx=-jg9qo4.

Keywords Cervicogenic headache, Lumbar motor control training, Cervical stabilization exercise

*Correspondence:
Hagar A. Marzok
hagar_marzok@yahoo.com
Full list of author information is available at the end of the article

Introduction

Cervicogenic headache is a referred pain spreading from cervical structures supplied by the upper cervical spinal nerve roots (C1–C3), this referred pain that starts from the posterior aspect of the head and neck is usually unilateral, and it also can spread to the frontal, temporal, and orbital aspects of the head [1]. The prevalence of CGH is estimated to be an average between 2.2 and 2.5% of the adult population, with four times higher risk in women [2]. The symptoms frequently include pain with neck movement and sustained poor neck posture, stiffness in the neck, tenderness across the suboccipital areas, and limited cervical spine range of motion (ROM) [3].

Despite Cervical stabilization exercises have been shown to improve neck pain, DNFs endurance, and ROM [4, 5], and reduce headache frequency in CGH patients [1], exercises that complement DNFs training should be considered. In particular, lumbar motor control training may reduce patterns of pain-driven maladaptive movement strategies originating from the neck and promote trunk stability, and re-education of a neutral lumbopelvic posture may be helpful to recruit the deep postural muscles of the cervical spine, due to more mechanical degrees of freedom to complete any task and function along the entire spine, rehabilitation beyond the initial site of pain may enhance treatment effects [6].

According to [7], "motor control exercise" improves the coordination and effectiveness of the muscles that support the spine. It can also improve coordination between the DNFs and superficial neck flexors and between core muscles of the lumbar region, which may decrease distorted movement patterns of the spine, making it more possible for the entire spine to adapt to different movement tactics that stem from a sore neck from a more secure base of support [6].

As far as the authors are aware, no previous study has examined the effects of lumbar motor control training in conjunction with cervical stabilization exercises on headache frequency, duration, intensity, and neck functional disability in patients with CGH and CMNP. Thus, the purpose of this study was to investigate the effects of adding lumbar motor control training to cervical stabilization exercises on headache frequency, duration, intensity, and neck functional disability in patients with CGH and CMNP.

Methods

Participants

Fifty-two patients (39 females and 13 males) diagnosed with CMNP and CGH referred by the orthopedist, were recruited from the outpatient Physical Therapy Clinic at Mubarak Central Hospital, Giza, Egypt, through a period from August 2022 to December 2022.

To be enrolled in this study, patients had to be between 20 and 35 years old, with a BMI of 18–25 kg/m^2, with unilateral headache for > 3 months aggravated by neck movement and/or sustained awkward head positioning [1], headache intensity moderate to severe [8]. In physical examination, they exhibit positive cervical flexion rotation test (CFRT) [1], joint tenderness in at least one of the upper three cervical joints with palpation [8], and abnormal performance in cranio-cervical flexion test (CCFT) [9]. Patients were excluded from the study if they had fractures or previous surgery on the vertebral column, spinal stenosis, disc prolapsed, headache with autonomic involvement, dizziness or visual disturbance, congenital condition of the cervical spine or neck pain < 3 months [1].

The sample size was calculated using G* power (version 3.1.9.7, Franz Faul, Universitat Kiel, Germany). *F*-test MANOVA within and between interaction effects was selected. Considering a power of 80%, an alpha level of 0.05 (2-tailed), and an effect size of 0.4; two groups and response variables of four, a sample size of 52 subjects was required; 26 subjects in each group.

The Ethical Research Committee of the Faculty of Physical Therapy at Cairo University accepted this study with approval number P.T.REC/012/003835. Also, it had a Clinical trial.gov registration (NCT05952115). All participants signed an informed consent after a detailed explanation of the aims, benefits, and risks of this study. They acknowledged that they could freely withdraw from the study at any time according to their will. The type of randomization was a closed envelope, using two envelopes one was the control and the other was the experimental, the patients were asked to randomly choose one of these two closed envelopes, and the patients were assigned to the group they randomly chose. Patients in the control group ($n = 26$) received cervical stabilization exercises 3 times/week for 4 weeks. Patients in the study group ($n = 26$) received the same exercises as patients in the control group, plus lumbar motor control training 3 times/week for 4 weeks. Throughout the study, there was no dropout among the patients (Fig. 1).

Procedures

Prior to the first session, patients' demographic data including name, age, weight, height, BMI, and medical history were collected from each patient. Patients in each group were tested for outcome measures twice, pre- and post-4 weeks of receiving the assigned treatment interventions.

Headache frequency was measured as the number of days with headache in the last week, ranging from 0 to 7 days [8]. Headache duration was measured in total hours of headaches in the past week [2]. The patients

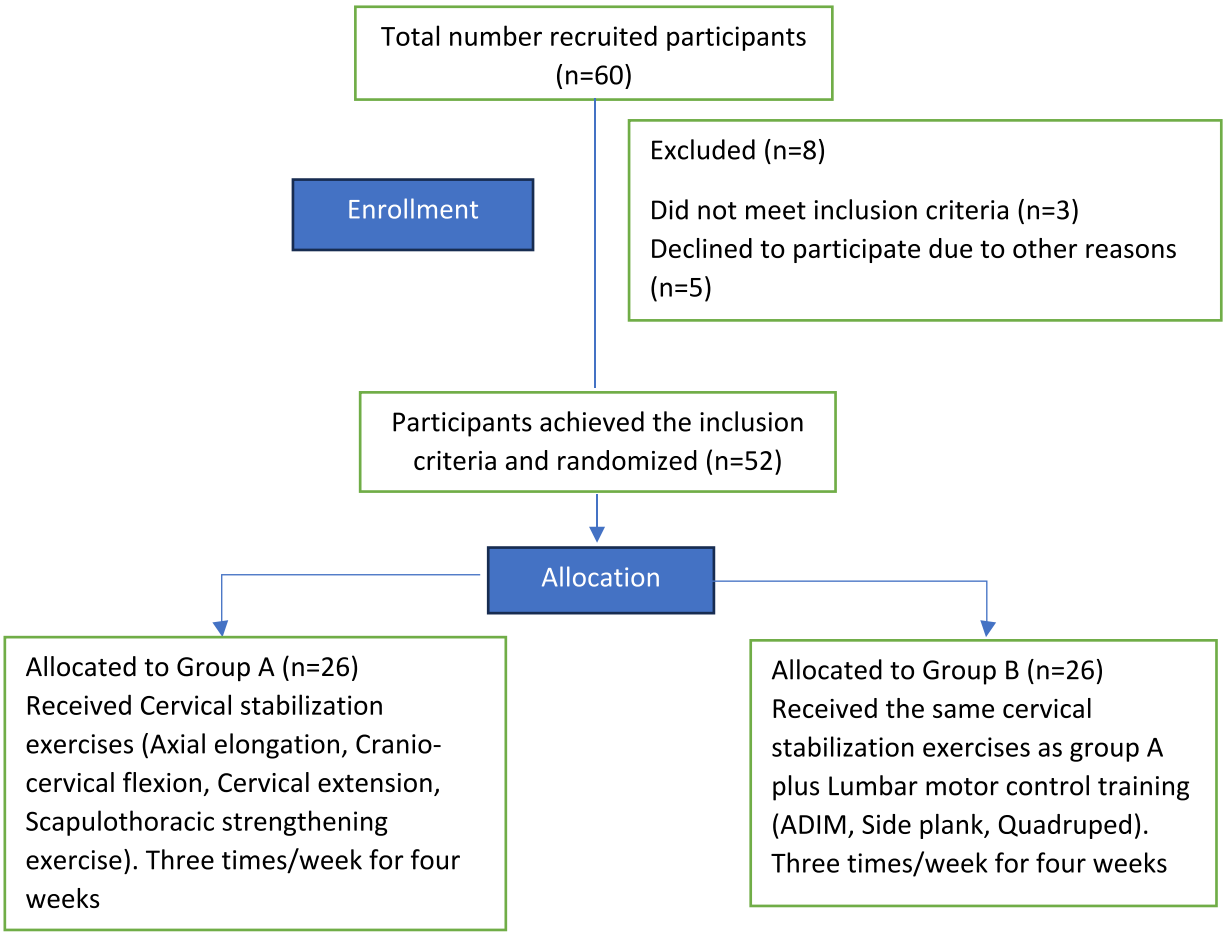

Fig. 1 Flow of patients through the trial

described the duration of their pain, 0 = absent duration of pain, while 24 h indicated that pain lasted all day long [10]. The VAS was used to assess the patient's intensity of the headache. It has been demonstrated that this assessment technique is valid and reliable for assessing chronic pain, including headaches [1]. Interpretation: no pain 0–2 mm, mild pain 2–17 mm, moderate pain 17–47 mm, severe pain 47–77 mm, very severe pain 77–96 mm, most severe pain imaginable 96–100 mm [11]. Neck functional disability was measured by the Arabic version of the Neck Disability Index, which has been validated for the evaluation of functional disabilities due to neck pain**,** it consists of 10 sections: pain intensity, personal care, lifting, reading, headache, concentration, work, driving, sleeping, and recreation. Each section is expressed by the range 0–5, with 0 = no disability and 5 = highest disability. The total score ranges from 0 to 50% [12]. Interpretation: 0–4 = no disability; 5–14 = mild disability; 15–24 = moderate disability; 25–34 = severe disability; over 34 = complete [13].

Intervention

Patients in group A received only cervical stabilization exercises 3 times/week for 4 weeks, 20 min/session. All exercises were performed for 10–15–20 repetitions, each held for 10 s, with 3–5 s rest in between contractions, consisting of axial elongation from sitting to correct posture, and cervical extension exercise in a prone position [14]. Cranio-cervical flexion exercise was performed in hook lying with a pressure biofeedback unit (PBU, Chattanooga, TN, USA) placed behind the occiput, and the cuff pressure sensor inflated to a baseline of 20 mmHg, and subjects targeted 5 increments between 22 and 30 mmHg. Target movement was nodding the head as if saying "yes" [15], and then Cervical-scapulothoracic strengthening exercises were performed using resistive bands in standing while maintaining chin-in posture and neutral spinal alignment [14].

Patients in group B received the same as group A in addition to lumbar motor control training 3 times/week for 4 weeks, 40 min/session [16], starting with Abdominal draw in maneuver (ADIM) in hook lying with PBU

placed under the lumbar spine with 40 mmHg pressure, the patients pulled the navel deeply to the lumbar region, the 2–4 mmHg pressure increase was held while patients maintained neutral lumbar lordosis and transversus abdominis (TrA) contraction [6]. Once the patients could perform ADIM from hook lying using PBU (cognitive stage), holding the contraction for 10 s for 10 repetitions, controlled upper and lower extremity movement was added (associative stage) [17], in a 4-week progression each progression is done for 3 sets of 10 contractions, with a 10-s hold and 15-s rest. Side-bridge and Quadruped exercises were also performed in a 4-week progression while maintaining ADIM and neutral lumbar spine**,** each progression was held for 10 s, repeated 3 times, with 15 s rest between contractions [16].

Data were expressed as mean ± SD. Unpaired *t*-test was used to compare between subjects. To determine the characteristics of the two groups, the chi-square test was used to compare between groups' sex distribution. Shapiro–Wilk and Kolmogorov–Smirnov tests were used to test the normality of data distribution. MANOVA was performed to compare within and between groups' effects for parametric variables and Wilcoxon and Mann–Whitney tests for non-parametric variables. The statistical package for the social sciences computer program (version 20 for Windows; SPSS Inc., Chicago, IL, USA) was used for data analysis. $P \leq 0.05$ was considered significant.

Results

There were no significant differences between both groups in the mean values of age, weight, height, BMI, sex, and job distribution ($p > 0.05$) (Table 1).

Data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. Shapiro–Wilk and Kolmogorov–Smirnov tests for normality showed that headache frequency and duration were not normally distributed, while headache intensity and NDI variables were normally distributed.

There was no statistically significant difference between groups A and B in the pre-treatment median values of headache frequency ($p = 0.330$) and headache duration ($p = 0.433$) (Table 2), and the pre-treatment mean values of headache intensity ($p = 0.426$) and neck functional disability ($p = 0.119$) (Table 3). While there was a statistically significant difference ($p = 0.001$) in post-treatment values of all measured variables in favor of experimental group B. The percentage of change was 25% and 66.7% for groups A and B respectively in headache frequency and 47% and 88.9% for headache duration (Table 2), 33.3% and 75% in headache intensity 32.5% and 72.5% for neck functional disability (Table 3).

Discussion

When the literature was reviewed, many physiotherapy programs for individuals suffering from neck pain and CGH generally focused on the cervical region, while other parts of the spine are often overlooked. Despite numerous studies indicating an interaction between different segments of the spine [18, 19], there have been no studies investigating the effects of lumbar motor control training combined with cervical stabilization exercises in patients with CGH, hence this current study.

The results of this study agreed with [20], who investigated the effect of corrective exercises on CGH with forward head posture (FHP) compared to the medication

Table 1 Demographic data of subjects in both groups

Demographic data	Control group A	Experimental group B	t-value	*p*-value
Age (years)	28.9 ± 6.7	27.4 ± 4.9	0.947	0.348
Weight (kg)	65.9 ± 8.2	63.3 ± 6.6	1.244	0.219
Height (cm)	169.3 ± 7.8	167.3 ± 6.6	1.04	0.303
BMI (kg/m^2)	22.9 ± 1.8	22.7 ± 1.4	0.339	0.736
Sex distribution	Number (%)	Number (%)		
Males	8 (31%)	5 (19%)	$\chi^2 = 0.923$	0.337
Females	18 (69%)	21 (81%)		
Job				
College student	8 (31%)	7 (27%)	5.7	0.336
Engineer	2 (7.5%)	2 (7.5%)		
Housewife	3 (11.5%)	2 (7.5%)		
Nurse	6 (23%)	3 (11.5%)		
Office work	4 (15.5)	2 (7.5%)		
Physical therapist	3 (11.5%)	10 (39%)		

SD standard deviation, χ^2 chi-square

Table 2 Median (IQ) of cervicogenic headache frequency and duration pre- and post-treatment of both groups

Variables	Pre-treatment Median (IQ)	Post-treatment Median (IQ)	% of change	*P* value
Headache frequency (days/last week)				
Control group A	4 (3–4.25)	3 (3–3.25)	25%	0.001*
Experimental group B	3 (3–4)	1 (1–2)	66.7%	0.001*
(*P* value)	0.330	0.001*		
Headache duration (hours/last week)	4 (3–4.25)	3 (3–3.25)		
Control group A	36 (24–48)	19 (18–31.5)	47%	0.001*
Experimental group B	27 (17–60)	3 (2–6)	88.9%	0.001*
(*P* value)	0.433	0.001*		

IQ interquartile range, *p* value probability value

* Significant

Table 3 Mean ± SD of headache intensity and NDI pre- and post-treatment of both groups

Variables	Pre-treatment Mean ± SD	Post-treatment Mean ± SD	% of change	*P* value
Headache intensity (cm)				
Group A	7.5 ± 0.9	5 ± 1.15	33.3%	0.001*
Group B	7.3 ± 0.95	1.8 ± 0.66	75%	0.001*
(*P* value)	0.426	0.001*		
NDI (%)				
Group A	43 ± 5.3	29 ± 4	32.5%	0.001*
Group B	40.1 ± 7.8	11 ± 3	72.5%	0.001*
(*P* value)	0.119	0.001*		

SD standard deviation, *p* value probability value, *NDI* Neck Disability Index

* Significant

group, the exercises were effective in terms of headache frequency, duration, intensity, NDI, and neck pain, the exercises included training the DNFs muscles, and strengthening the lower trapezius and rhomboids muscles, and retrained the TrA muscle while performing stabilizing exercises. However, in the current study TrA training was conducted by ADIM by PBU, and the global muscle system was also trained using side plank and quadruped positions [16]. They used an 8-week treatment duration while the current study used 4 weeks, which adds an advantage to the current study achieving the same results in a shorter time.

The results of this study correlated with [21], who concluded the effectiveness of an exercise program compared to the medication group for patients with recurrent headaches such as CGH with neck pain, the exercises included a low load exercise for DNFs and scapulothoracic muscles, a generalized postural correction exercises, the results showed a significant difference in headache frequency, intensity, duration, neck disability, and pain. However, they added cervical mobilization and stretching, and measured cervical ROM, quality of life, and the average daily medication dose, which was not conducted in the current study, and can be concluded in future research.

The results were consistent with [22], who studied the effects of postural modifications in the cervical, scapulothoracic, and lumbar regions along with specific active-exercise programs to address movement impairments in these three regions, which reduced headache frequency and intensity, and improved neck functional disability. This case report suggests that not only impairments in the cervical region but also in the scapulothoracic and lumbar regions may be important to consider when treating CGH patients, emphasizing the importance of actively performing treatment in the form of exercise rather than passive treatment.

The findings of this study disagreed with [23], who investigated the effectiveness of a global versus localized exercise program in reducing disability and pain and enhancing kinematic, neuromuscular, and sensorimotor control features in women with chronic non-specific neck pain. The results showed that both interventions were equally effective in reducing neck pain and disability, improving neck mobility, and reducing the activity of the superficial cervical flexor muscles during a test of motor control. On the other hand, neither intervention influenced postural stability. The lack of superiority of one treatment over the other reveals that both options could be considered for the treatment of chronic non-specific neck pain.

In contrast to the findings of this study [24], which compared three treatment groups for chronic neck pain, they concluded that both DNFs muscle training or core stabilization exercises combined with conventional treatment (transcutaneous electrical nerve stimulation, ultrasound, hot packs, and isometric exercise) may be more effective for pain intensity, posture, cervical ROM and

disability than the conventional therapy alone, but core stabilization with conventional had no superior statistically significant difference in all measured parameters than using DNFs training with conventional. Moreover, core stability had no superiority over conventional treatment in terms of cervical extension and left lateral flexion.

Limitations of this study

1. Psychological status of the patient
2. Patient compliance.

Conclusion

The results of this study support the importance of adding lumbar motor control training to cervical stabilization exercises as a physiotherapy exercise program for CGH patients, to improve headache frequency, duration, intensity, and neck functional disability.

Recommendations for further studies

Further studies are needed to follow up to ensure more valid long-term results, comparison between different age groups, comparison between different male and female groups, investigate changes in neck posture (CVA), DNFs muscle endurance (CCFT), cervical ROM, and neck position sense. Examining the combination of the exercise program in this study with one of the manual therapy techniques proved to be effective in CGH patients.

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Authors' contributions
The study's idea, data collection, design, statistical analysis, data interpretation, and the study's writing and critical editing were done in collaboration by all authors. The authors read and approved the final manuscript.

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Availability of data and materials
All the data and materials of this research are available for any interested researchers and journals upon request by email to the corresponding author.

Declarations

Ethics approval and consent to participate
The study was approved by the Faculty of Physical Therapy, Cairo University Supreme Council of Post-Graduate Studies and Research and Human Research Ethics committee under number (P.T.REC/012/003835). All participants signed a written informed consent before starting the study.

Consent for publication
The authors of this research consent that this research has not been sent to any journal for publication and it is not considered for publication by any other journals.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]Cairo University (2015), Cairo, Egypt. [2]Faculty of Medicine, Cairo University, Cairo, Egypt. [3]Department of Basic Science, Faculty of Physical Therapy, Cairo University, Cairo, Egypt. [4]Basic Science Department, Vice Dean for Education and Student Affairs, Faculty of Physical Therapy, Cairo University, Cairo, Egypt.

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