EFFICACY OF DEEP CERVICAL TRAINING COMBINED WITH MOBILIZATION TECHNIQUES ON FORWARD HEAD POSTURE

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Abstract

Background: The condition known as forward head posture occurs when the head is positioned in front of the trunk and protrudes forward in the sagittal plane of the cervical vertebrae. As a result, the head's structural center shifts forward and upward, putting a greater load on the cervical vertebrae.
Aim of the study: To investigate the impact of adding cervical & thoracic spinal mobilization techniques to deep cervical training compared to deep cervical training alone on Deep Neck Core Strength & Craniovertebral angle (CVA).
Methods: Sixty-Six patients from both sexes with forward head posture, with age range from 18-25 years was randomly assigned to 3 groups. It was conducted between June 2022 and December 2022. The ethical committee number is: P.T.REC/012/003524 registered by the faculty of physical therapy, Cairo university. Group (A) received deep cervical training; Group (B) received deep cervical training + upper cervical mobilization & Group (C) received deep cervical training + upper thoracic mobilization. Mean readings for CVA, deep neck flexor strength, were analyzed using a mixed MANOVA to examine the effect of time, the impact of treatment, in addition to the interaction of time and treatment. for the possibility for multiple comparisons in the results, post-hoc testing utilizing the Bonferroni correction were performed.
Results: Pre-treatment comparisons showed no statistically significant differences between the groups. Groups B and C showed statistically significant improvements in CVA as well as deep neck core strength post-treatment in comparison with group A ($p < 0.05$). When comparing groups B and C, the results showed no significant difference in CVA as well as deep neck core strength ($p > 0.05$).
Conclusion: Combination of deep cervical training & mobilization techniques for the upper cervical and thoracic region had a significant effect on improving the neck core stability and CVA comparing to the deep cervical training only.

Keywords: Deep cervical Training – Neck core stability – craniovertebral angle – Forward Head Posture

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1. INTRODUCTION

Forward head posture is among the most prevalent form of poor neck posture, and it is linked to a number of other postural abnormalities, including sway back deformity and rounded back, in addition to neck pain, cervical rib, obesity, as well as breathing difficulties **(Molaeifar et al., 2021).**
When the head is positioned in front of the trunk or rotates, this is known as forward head posture (FHP), that occurs when the cervical vertebrae forward in the sagittal plane. As a result, the head's structural center shifts forward and upward, placing a greater load on the neck **(Choi 2021).**

The deep cervical flexor (DCF) muscles such as Longus colli as well as Longus Capitis) support the cervical spine by acting anterior to the axis of rotation of the atlanto-occipital alongwith intervertebral joints. When these muscles are weak, the cervical spine and joints don't get the support they need, which can cause pain and improper posture in the neck **(Alghadir and Iqbal, 2021) (Jull and Falla; 2016).**
As FHP often presents as excessive extension of the atlas, occiput, as well as upper cervical spine in addition to excessive flexion of the lower cervical spine as well as upper thoracic spine **(Lee and Jung, 2009).** Therefore, it is necessary to address

not just the cervical spine but additionally the upper thoracic vertebrae **(Lee et al., 2013).**

The FHP has been corrected by the favored intervention strategy of cervical as well as thoracic spine joint mobilization. Spinal joint mobilization refers to the passive repositioning of vertebral segment joints toward their anatomically ideal positions, with the goals of improving mobility and relieving pain **(Jeon et al., 2020).**

2. PATIENTS AND METHODS

1. Patients

This study was a randomized controlled clinical trial to investigate the efficacy of adding different mobilization techniques on forward head posture comparing to the deep cervical training alone & comparing both mobilization groups to each other. It was conducted between June 2022 and December 2022. The ethical committee number is: **P.T.REC/012/003524** registered by the faculty of physical therapy, Cairo university. Sixty-six male and female individuals were recruited by both spoken and written advertisements from the outpatient clinic of an Egyptian Chinese university. After listening about the scope of the study and how it would be conducted, every individual signed an informed consent form. Patient de-identification using numeric ids for all participants ensured the privacy of all delivered data.

1 - *Control group (Group A)* (Deep cervical training) (N=22)

2 - *Experimental group I (Group B)* (Deep cervical training + Upper cervical mobilization group) (N=22)

3- *Experimental group II (Group C)* (Deep cervical training + Upper thoracic mobilization group) (N=22)

- **Inclusion Criteria:**

1 – The craniovertebral angle (CVA) is less than 50 degrees **(Worlikar et al., 2019).**

2 – Age ranges from 18 to 25 years old **(Naz et al., 2018; Mamania et al., 2019).**

3 - Forward head is associated with neck pain **(Cho and Lee, 2017).**

- **Exclusion Criteria:**

A history of any of the subsequent conditions:

1-Previous surgery regarding the spine or shoulders**. (Bernal et al., 2020).**

2-Vertebral fractures regarding the cervical spine or the skull. **(Bernal et al., 2020).**

3-Positive neurological signs or evidence of spinal compression **(Tejera et al., 2020).**

4-Headaches that don't originate in the cervical region or that occur before neck pain **(Bernal et al., 2020).**

5-Inner ear or vestibular Problems **(Tejera et al., 2020).**

6-Whiplash Injuries **(Tejera et al., 2020).**

2. Procedures:

1-Measuring cervical angles using photogrammetry method **(Figure 1).**

The pictures were taken using a digital camera and imported into a personal computer, where an angle measurement tool in ImageJ was used to determine the spine's orientation. ImageJ has been used in prior studies to analyze sitting posture, wheelchairs seated posture, as well as brow position **(Hida et al. 2020).**

The CVA biomarkers were computed from the obtained pictures in ImageJ and used to evaluate the amount of sagittal spinal postural alignment. Standing CVA has been found to be an indicator of head inclination toward the front in prior studies. **(Hazar et al., 2015).**

The CVA was made when a horizontal line across the middle of the back crossed a vertical line from the tragus of the ear to the middle of the back **(Hazar et al., 2015).**

Figure (1): Craniovertebral Angle (55.8 °)

2 – The deep neck core strength: using the Cranio cervical flexion exercise: **(Figure 2)**

The Cranio cervical flexion exercise was carried out with the patient in the crook lying position, having the neck in a neutral position without cushion, ensuring that the line of the face is transverse as well as a line dividing the neck longitudinally is transverse to the training surface. The uninflated pressure sensor is positioned behind the neck, against the occiput, and then inflated to a stable starting pressure of 20 mm Hg. This is a standard pressure that is enough to cover the space among the underlying surface as well as the neck without forcing the neck into a lordotic position. To ensure the patient completed all five steps of the workout as intended, the device gave them feedback and instructions at each point. This is not a strengthening exercise, instead it's a precision exercise, the patient was directed to do **(Jull et al., 2008).**

Head nodded slowly and carefully (as if expressing "yes") was the method of movement used. As part of the Cranio cervical flexion exercise, the participant aimed to repeatedly target five, 2-mm Hg progressive pressure rises from a starting pressure of 20 mm Hg to reach the maximum of 30 mm Hg, all while maintaining an isometric contraction during the progressive pressures to perform an endurance task. The patient's performance was measured by the maximum pressure they were able to attain (activation score) and maintain for 10 consecutive, 10-second trials. Patient performance was measured by the number of times they were able to maintain the set pressure for 10 seconds. Performance of 26 mmHg or higher was determined to be necessary for approval. There are three sets for every training session, and ten reps are performed in each set. An overall of 4 weeks were completed, with each week consisting of 4 sessions. In between each set, a 2-minute rest was taken **(Jull et al., 2008).**

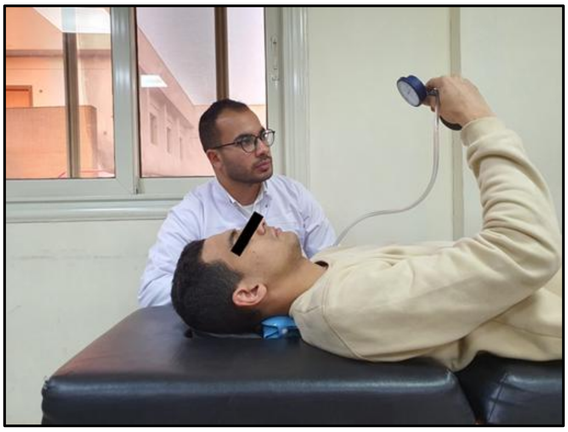

Figure (2): Cranio Cervical Flexion Exercise.

3. RESULTS

- **Data Analysis**

The subjects' characteristics were compared between groups using a (MANOVA) test. The Chi-squared test was performed to compare the gender as well as device used distribution. The Shapiro-Wilk test was used to determine whether or not the data in each variable had a normal distribution. The homogeneity of the groups was tested using Levene's test for homogeneity of variances.

We used MANOVA to compare CVA, deep neck core strength, within as well as between groups. To account for the possibility for multiple comparisons in the results, post-hoc testing using the Bonferroni correction were performed.

All statistical tests were performed at the $p < 0.05$ level of significance. IBM SPSS Statistics Version 25 for Windows (*Chicago, Illinois, USA*) was used for all statistical analysis.

- Subject characteristics:

The subject characteristics of group A, B as well as C were revealed in **Table (1).**No significant difference has been detected among groups in age, weight, height, BMI, chest expansion, screen time, sex and device used distribution ($p > 0.05$.)

Table (1): Basic characteristics of participants

	Group A	**Group B**	**Group C**	**p-value**
	mean ± SD	**mean ± SD**	**mean ± SD**	
Age (years)	20.86 ± 1.21	21.18 ± 1.68	20.86 ± 0.99	0.66
Weight (kg)	71.5 ± 14.77	70.5 ± 15.56	71.18 ± 17.73	0.98
Height (cm)	170.45 ± 11.66	169.22 ± 8.34	172.18 ± 10.28	0.63
BMI (kg/m²)	24.38 ± 3.64	24.58 ± 4.77	23.93 ± 5.29	0.89
Sex, n (%)				
Females	10 (45%)	12 (55%)	11 (50%)	0.83
Males	12 (55%)	10 (45%)	11 (50%)	

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

Effect of treatment on Craniovertebral Angle, deep neck core strength:

Mixed MANOVA showed that there was a significant interaction of treatment as well as time (F = 18.94, p = 0.001, Partial Eta Squared = 0.55). There was a significant main impact of time (F = 406.27, p = 0.001, Partial Eta Squared = 0.96). There was a significant main impact of treatment (F = 2.95, p = 0.005, Partial Eta Squared = 0.16).

- ***Within group comparison***

There was a significant increase in CVA and deep neck core strength in the three groups post treatment when compared to that pre-treatment (p < 0.001). In Group A, the percentage increase in aCVA as well as neck core strength was 4.48 and 4.62%, while in Group B it was 13.71 and 10.72%, whereas in Group C it was 12.62 and 9.59%.

- ***Between group comparison***

No significant difference has been detected among groups pre-treatment (p > 0.05). While Post treatment, a significant improvement in CVA as well as deep neck core strength of group B and group C when compared to that of group A (p < 0.05). No significant difference has been detected in CVA and deep neck core strength among group B and C (p > 0.05). **(Table 2).**

Table (2): Mean CVA, deep neck core strength, NRS and NDI pre and post treatment of group A, B and C

	Group A	Group B	Group C	p-value		
	mean ± SD	mean ± SD	mean ± SD	A vs B	A vs C	B vs C
CVA (degrees)						
Pre treatment	42.68 ± 3.65	42.09 ± 3.39	42.13 ± 3.09	1	1	1
Post treatment	44.59 ± 3.38	47.86 ± 3.28	47.45 ± 3.33	0.006	0.01	1
MD (% of change)	-1.91 (4.48%)	-5.77 (13.71%)	-5.32 (12.63%)			
p-value	***p = 0.001***	***p = 0.001***	***p = 0.001***			
Deep neck core strength (mmHg)						
Pre treatment	23.81 ± 2.03	25 ± 2.11	24.18 ± 2.21	0.21	1	0.61
Post treatment	24.91 ± 2.11	27.68 ± 1.55	26.5 ± 2.13	0.001	0.02	0.14
MD (% of change)	-1.1 (4.62%)	-2.68 (10.72%)	-2.32 (9.59%)			
p-value	***p = 0.001***	***p = 0.001***	***p = 0.001***			

SD, Standard deviation; **p-value**, Level of significance

4. DISCUSSION

This research study intended to show the impact of adding cervical & thoracic spinal mobilization techniques to deep cervical training compared to deep cervical training alone on Deep Neck Core Strength & Craniovertebral angle. This study used a non-invasive, reliable as well as valid instrument, the pressure biofeedback unit **Khan et al. (2022)**, to strength the deep neck flexors and the photogrammetry method **Saad et al. (2012)** to monitor the progress of craniovertebral angle. Mobilization techniques **Cho et al. (2019)** were added to the deep cervical training to adjust the alignment of the spine giving the deep cervical muscle a more correct position for better activation. The findings of this study showed that adding cervical and thoracic mobilization techniques to the deep cervical training had a better outcome on the craniovertebral angle & deep neck core strength respectively (0.006, 0.01) (0.001, 0.02), However there was no significant difference among the two mobilization groups regarding the measured outcomes.

When the neck is in motion, the atlanto-occipital along with intervertebral joints are stabilized by the DCF muscles, which work anterior to the axis of rotation. If these muscles aren't working properly, it can cause problems with your neck and shoulders like pain and bad posture (due to inadequate coordination, activation, as well as support for your cervical components). The exercise program relies on the finding that individuals with FHp carry out craniocervical flexion with lower EMG activity of the deep neck flexors along with higher activity as a compensatory mechanism of the sternocleidomastoid as well as anterior scalenus in comparison with those without FHp**Blomgren et al. (2018).**

The intervertebral discs along with their ligaments have innervation by the ventral rami of the spinal nerves as well as the sympathetic nervous system, whereas the posterior tissue of the vertebral column are supplied by the branching of the dorsal rami. The sinuvertebral nerves are recurring branches of the ventral rami that exit the spinal canal through the intervertebral foramina. Each of these nerves has a somatic root originating from a ventral ramus as well as an automatic root coming from the gray ramus communicants, making it a mixed nerve. In addition to this relationship, the occipital as well as trigeminal nerve branches additionally innervate the cervical spine **Ghan& Babu,(2021).** These relationships explain why cervical spinal manual therapy (SMT) has been shown to have several therapeutic impacts at the spinal, supraspinal, as well as peripheral levels **Bialosky et al. (2009)**

Suvarnnato et al. (2019) observed that deep neck Flexor Trainin led to improved range of motion in the cervical spine, providing support to the current study's results. At 6 weeks as well as 3 months, the CV angle increased significantly in both the extensor and flexor groups compared to the control group (P=0.008 and P=0.01, respectively). The flexor group showed a statistically significant (P=0.006) increase in CV angle after 1 month.

Moreover, this study came in agreement Partially by the study of **Cho et al. (2017)** who demonstrated The CVA in standing position revealed a significant group-by-time interaction ($F_{2,29} = 4.549$, $p = .014$, $\eta_p^2 = .132$), with the thoracic mobilization group indicating significantly ($t_{29} = 2.13$, $p = .042$) greater improvement in CVA (3.9°; 95% CI: 1.8, 6.0) across time rather than those in the cervical mobilization group (0.6°; 95% CI: -1.9, 3.1).

The findings of present study have been supported Partially by the work of **Sheikhhoseini et al. (2018)** who found that the therapeutic exercise for the neck especially forward head posture corrective exercises (Deep Cervical Training) had a better outcome.

Suvarnnato et al. (2019) discovered that deep neck Flexor Training led to improved range of motion in the cervical spine, adding support to the current study's results. At 6 weeks as well as 3 months, the CV angle increased significantly in both the extensor and flexor groups compared to the control group (P=0.008 and P=0.01, respectively). The flexor group showed a statistically significant (P=0.006) increase in CV angle after 1 month.

Buyukturan et al. (2017), Dandale et al. (2023) &Gumuscu et al. (2023) found that deep cervical training had a significant effect on head posture, cervical ROM, Pain & neck disability.

5. CONCLUSION

Combination of deep cervical training & mobilization techniques for the upper cervical and thoracic region had a significant effect on improving the neck core stability and craniovertebral angle comparing to the deep cervical training only. Although both groups improved from deep cervical training and mobilization approaches, there was no statistically significant difference among them.

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