Vol. 38 · October 2019
DOI: https://doi.org/10.7719/jpair.v38i1.734

Print ISSN 2012-3981
Online ISSN 2244-0445

Effect of Deep Cervical Flexor Training on Craniovertebral Angle and Muscle Endurance among Students with Forwarding Head Posture

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Originality: 100% • Grammar Check: 99% • Plagiarism: 0%

ABSTRACT

With the ease of use and a wide variety of choices of smartphones, it significantly affects the ways of life in terms of socializing, applications, gathering, and sharing information. Little do the people know that it can also affect the posture. This is where an introduction of exercise that targets the muscles involved in the impaired posture comes to maintain a proper posture. This study aimed to evaluate the effect of deep cervical flexor training on the craniovertebral angle and muscle endurance of students with forwarding head posture. The study is an experimental type of research that was utilized to thirty (30) junior high school students who had undergone fishbowl technique selection and assigned in two (2) groups namely control and experimental group. Craniovertebral angle and deep neck flexor endurance test were used to determine the pre- and post-test of both groups. There is a significant difference in the paired t-test result of pre- and post-test outcome of deep cervical flexor training of the experimental group in terms of CVA. In contrast to DNFET, there is no significant difference in the paired t-test result of pre- and post-test intervention of deep cervical flexor training of the experimental group. Deep cervical flexor training is useful to increase CVA.

***Keywords*—**deep cervical flexor, forward head posture, smartphone, CVA, DNFET

INTRODUCTION

Proper body mechanics can prevent anticipating injuries from happening. One of the aspects of body mechanics is posture. It is the primary function of the musculoskeletal system of the human body. The structures, bones, muscles, ligaments, and cartilages that make up the musculoskeletal system can be dependent on the mechanical stresses and force like gravity. Collectively, these stresses and force can disrupt the normal posture, thus creating an imbalance between the agonists and antagonists muscles. Hence, the body compensated the forces through posture deviations. One of these postural deviations is forward head posture.

Forward head posture (FHP) is one of the impaired posture in adolescents (Ruivo, Pezarat-Correia & Carita, 2016). FHP is an uncommon and unrecognized cervical problem (Talati, Varadhrajulu, & Malwade, 2018). It is characterized as advancing of the lower spine of the neck with respect to the line of gravity and exaggerated backward movement upper spine of the neck (Sheikhhoseini, Shahrbanian, Sayyadi, & O'Sullivan, 2018). In the study of Batistao et al. (2016), forward head posture is 53.5% on the age group 13-15. Prolonged FHP can precede another impaired postures and impairments (Singla & Veqar, 2017). This can lead to cervical pains, myofascial pain syndromes, temporomandibular diseases, cervicogenic headaches, tension-type headaches, and migraines (Celik et al., 2018). The duration of computer exposure, the bearing of backpacks, duration of smartphone usage, headaches, bad posture practice, or repetitive use of shoulder use an association on FHP (Singla & Veqar, 2017). Also, overuse and increasing stress in the cervical region and shoulders limit the action of deep cervical flexor muscles (Kim & Koo, 2015).

The muscles that are attached to the upper cervical spine or the deep cervical flexor (DCF) muscles, namely, longus capitis and colli, rectus capitis anterior and lateralis, hyoid muscles, contribute to the 80% of support in the cervical structure became weak (Durall, 2012). According to Iqbal, Rajan, Khan, and Algahir (2013), the head-on-neck posture important stabilizers are DCF muscles, which can be impaired due to loss of proper alignment. It is also shown that the high endurance of DCF improved the ability to hold upright the cervical spine (Gupta, B.G., Aggarwal, Gupta, B., Gupta, M., & Gupta, N., 2013). The neck muscles have a vital role in keeping stability and postural alteration while the head turns in any direction to avoid musculoskeletal disorders (Talati et al., 2018). Constant load on the cervical spine leads to changes in spine curvature, which can worsen and progress to cervical herniation of the intervertebral disc (Cho, Lee, E., & Lee, S., 2017). DCF training will focus on the DCF muscles and less movement of the superficial muscle (Saleh, Rehab, & Sharaf, 2018). Also, Durall (2012) stated that DCF training should focus on low levels of resistance and precise movement control to lessen the activation of superficial muscles. Therefore, DCF training is needed in FHP to restore the imbalance of muscles on the upper cervical spine to reduce, decrease neck discomforts and keep the head in line with gravity (Gupta et al., 2013).

According to Mak et al. (2014), as cited in Cha and Seo (2018), 21% of teenagers in the Philippines have smartphone dependence. For this reason, the researcher focused the study on teenagers, specifically students that are enrolled in Junior High School, that are more exposed to social media and mobile games like mobile legends, rules of survival, Minecraft, and PUBG. Smartphone users bent their head down to glance at the device and kept this position in a lengthy period may associate with the occurrence of neck discomfort (Lee, Kang, & Shin, 2015). Also, there is discomfort in the shoulder and thumb, and seriousness of discomfort depends on the duration of use (Jung, Lee, N., Kang, Kim, & Lee, D., 2016). Smartphones can cause a further strain on the cervical regions than computers because of sustained forward bending of the head (Kim & Koo, 2015). As stated by Hansraj (2014), the head weighs 10 to 12 pounds within line of gravity; an extra 27 pounds of force will apply at the cervical flexion at 15°, 40 pounds at 30°, 60 pounds at 60°. Cho et al. (2017) stated that the load increased 3.6 times than the load in neutral. Thus, the more angled the FHP, the more it is susceptible to the weakening of the neck structures.

As stated by Talati et al. (2018), posture is a fundamental piece of normal balance. Musculoskeletal impairments arose from the prolonged use of a smartphone (Lee & Seo, 2014) and impaired the stability of the deep cervical flexors due to the forward bend of the head (Gupta et al., 2013). The researcher aims to focus on deep cervical flexor muscles on the students who have FHP due to prolonged use of smartphones. The researcher supposed that improving craniovertebral angle and endurance has an effect on postural function in supporting and maintaining the cervical lordosis and withstand the gravitational force that is being applied to the cervical region.

FRAMEWORK

To clarify the concepts, the researcher conceptualizes a framework to have a visual representation of the ideas and variables that may involve in this study:

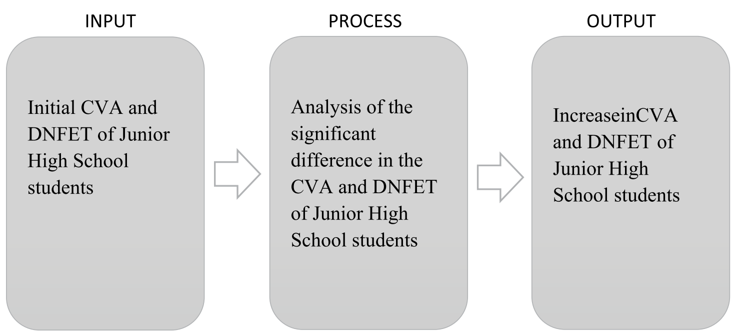

Figure 1. Research paradigm on the effect of deep cervical flexor training on CVA and DNFET

Figure 1 presents the conceptual framework on the effect of deep cervical flexor muscle training among students with a forwarding head. This study focused on determining the initial craniovertebral angle (CVA) and deep neck flexor endurance test (DNFET) among Junior High School students with forwarding head posture. The researcher will analyze the significant difference in the craniovertebral angle and deep neck flexor endurance test of Junior High School students. Increased in CVA and DNFET among students with forwarding head posture served as the output of the study.

OBJECTIVES OF THE STUDY

This study aimed to (1) to determine the mean of craniovertebral angle of the participants before and after the implementation of deep cervical flexor training in control and experimental group, (2) to determine the mean of deep neck flexor endurance test of the participants before and after the implementation of deep cervical flexor training in control and experimental group, (3) to know the significant difference between the pre-test and post-test outcome in terms of craniovertebral angle of the control group and experimental group, and (4) to know the significant difference between the pre-test and post-test outcome in terms of deep neck flexor of the control group and experimental group

METHODOLOGY

Research Design

The study used a pretest-posttest controlled design to have a baseline measurement before and after the intervention. Dimitrov and Rumrill (2003) defined pretest-posttest design as commonly used in behavioral research, for the purpose groups and/or measuring change comparison resulting from experimental treatments. The measurement of change provides a vehicle for assessing the impact of rehabilitation services, as well as the effects of allied health interventions. It was conducted at a physical therapy laboratory in CEFI.

Participants

The researcher screened the participants to determine if they were eligible. This screening was comprised of a questionnaire and measurement of the craniovertebral angle before the inclusion of the study. The inclusion criteria are the following: (1) craniovertebral angle (CVA) of less than 50^{o}; and (2) smartphone use of greater than 4 hours. Part of the inclusion criteria is that participants should not have been diagnosed with any diseases or injury relating to the musculoskeletal system. A total of 30 participants were randomly assigned in the intervention group (n=15) and control group (n=15) through the fishbowl technique.

Instrumentation

To measure the CVA, the researcher used a goniometer. In standing position, the craniovertebral angle (CVA) was measured in the sagittal plane with the fulcrum of the goniometer is inlined laterally to the C7, the distal arm is parallel to the floor and the proximal arm in the tragus of the ear. The researcher took the measurement three times. The mean of the three measurements was the final measurement that was used as the baseline measurement (Oliveira & Silva, 2015).

To measure the endurance, the researcher used the deep neck flexor endurance test. The DNFET had an interrater (ICC, 0.78), and interrater (ICC, 0.88) values were good to excellent. The test was performed in supine, hook-lying position with the arms by the side. The participants were asked to tuck the chin and lift the head for approximately 2.5 cm from the bed. The researcher started the time and placed her fingers stacked under the posterior occiput. The test was stopped if one of the following happens for more than 1 second: (i) the participants' head dropped on the researcher's finger, (ii) loss of skin folds over the neck, or (iii) if the participants want to stop the test due to fatigue or pain. The test was performed twice with a 5-minute rest interval. The mean of two trials of DNFET was used in statistical analysis (Jarman et al., 2017).

Ethics Protocol

An approval from the Calayan Educational Foundation, Inc. Research Ethics Committee was obtained. Participants were informed about the nature, purpose, voluntary withdrawal, and duration of the study before they signed informed consent.

Data Collection

The pre-test in both groups was administered to the participants using the craniovertebral angle (CVA) measurement and deep neck flexor endurance test (DNFET) before the start of the intervention. The deep cervical flexor training was implemented for six sessions. After the completion of six sessions, the post-test was recorded using the same measurements that were administered in the pre-test.

Statistical Techniques

Statistical analysis was performed by SPSS. To compare the effectiveness of the intervention in CVA and muscle endurance of both groups, a paired t-test was used at the a significant level of 0.05.

RESULTS AND DISCUSSION

This chapter deals with the presentation of data with the analysis and interpretation. Tables are used to present the data statistically and arranged into the following:

Table 1. Pre and Post Intervention Mean in terms of CVA

		Mean	Interpretation
Control	Pre-test	44.09°	Medium FHP
	Post-test	43.71°	Medium FHP
Experimental	Pre-test	42.60°	Medium FHP
	Post-test	51.49°	Slight FHP

Legend: Range of Craniovertebral Angle

56° - above	-	Normal FHP
48° - 55°	-	Slight FHP
40° - 47°	-	Medium FHP
0° - 39°	-	Severe FHP

Table 1 shows the mean craniovertebral angle of control and experimental group of the students with forwarding head posture according to their pretest and posttest.

The craniovertebral angle in the experimental group before and after the implementation of the deep cervical flexor training has a pretest mean of 42.60° interpreted as medium FHP while the post-test mean 51.49° interpreted as slight FHP. The control group pre-test mean is 44.09° can be interpreted as medium FHP while he post-test mean is 43.71° interpreted as medium FHP. Therefore, the result indicates that the use of smartphones affects the posture of students.

In the study of Alshahrani et al. (2018) of healthy individuals who used smartphones for a long period of time (4 h+) during any daytime was divided into light use (less than 4 hours) and heavy use smartphone users (greater than 4 hours). The computed mean is interpreted as medium FHP. In contrast to the study from Selvaganapathy, Rajappan, and Dee (2017), the light smartphone users' computed mean is interpreted as both in slight FHP.

Table 2. Pre and Post Intervention Mean in terms of DFNET

		Mean	Interpretation
Control	Pre-test	13.66sec	Minimum DNFET
	Post-test	19.11sec	Average DNFET
Experimental	Pre-test	11.93sec	Minimum DNFET
	Post-test	20.83sec	Average DNFET

Legend: Hold time of Deep Neck Flexor Endurance Test

33.97sec - 65.79sec	-	Maximum DNFET
18.61sec - 33.96sec	-	Average DNFET
0 - 18.6sec	-	Minimum DNFET

Table 2 shows the mean deep neck flexor endurance test of control and experimental group among students with forwarding head posture.

The mean deep neck flexor endurance test in the control group has a pretest mean of 13.66sec interpreted as minimum DNFET, while the post-test mean is 19.11 sec interpreted as average DNFET. The same interpretation in the experimental group is given to the pre-test, and post-test mean in terms of DNFET. The study showed the pre-test and post-test results of DNFET of students with forwarding head posture showed that both groups and interpreted as minimum deep neck flexor endurance capacity in agreement with Oliveira and Silva (2015). It showed that minimum DNFET in students with FHP has less muscle activation of longus colli compared to non-FHP (Lee, Yu, & Seo, 2018). Thus, the result indicates that the lower the DNFET, the lesser the length-tension relationship of DNF muscles to stabilize the cervical region against stresses.

Table 3. Paired Samples Test in terms of CVA

	Paired Differences	
	Mean	p-value
Control	1.49	.483
Experimental	-7.78	.003*
*<0.05 = significance		

Table 3 presents the computed p-value of the control group pre-test, and post-test is 0.483. The p-value is greater than the p-value 0.05. Therefore, the null hypothesis is accepted. There is no significant difference between the pre-test and post-test intervention in terms of CVA. In terms of the experimental group pre-test and post-test, the p-value is 0.003, which is less than the p-value 0.05. Therefore, the null hypothesis is rejected. There is a significant difference between the pre-test and post-test intervention in terms of CVA. When the control and experimental group is compared, the latter has a significant difference *(p*=0.003).

The result of the study is similar to the study of Gupta et al. (2013), found that the deep cervical flexor training is effective due to the significant differences in the pretest and posttest after the implementation of the experimental group. There is evidence which has indicated that addressing these muscle control problems with the use of specific exercise strategies, leads to maintain an upright posture.

Table 4. Paired Samples Test in terms of DNFET

	Paired Differences Mean	p-value
Control	1.73	.358
Experimental	-1.72	.751

*<0.05 = significance

The computed p-value of the control and experimental group pre-test and post-test is 0.358 and 0.751, respectively. The p-value is greater than the p-value 0.05. Therefore, the null hypothesis is accepted. When the control and experimental group is compared, both have no significant difference.

According to Oliveira and Silva (2015), authors argued that the absence of significant difference in DNFET was the unequal proportion of males and females, different age groups and/or sample size might have contributed to the contrasting results. Furthermore, Domenech et al. (2011), as cited in Jarman et al. (2017), another factor to be considered is the performance variability of males and females. Since there were 30 participants, this may have contributed to the results of the study.

CONCLUSIONS

In terms of CVA, the experimental group shows marked improvement after the implementation of deep cervical flexor training while there is no improvement in the control group. Thus, in terms of CVA, there is a significant difference between the experimental and control group. Deep cervical flexor training is an effective exercise to improve the ability of the deep cervical flexor muscles to maintain an upright posture.

In terms of DNFET, the experimental group and control group shows little improvement after the implementation of deep cervical flexor training. Thus, in terms of DNFET, there no is a significant difference between the experimental and control group. Deep cervical flexor training is not useful in increasing the muscle endurance of the deep cervical flexor muscles.

TRANSLATIONAL RESEARCH

The researcher recommends extending the training schedule from 6 sessions to 12 sessions. The researcher would also recommend implementing the deep cervical flexor training to other populations and considering the factors that affect the researcher's result in DNFET.

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