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EFFECT OF A PERIOD OF CERVICAL FLEXION ON UPPER EXTREMITY MUSCLE STRENGTH

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ABSTRACT

Background: Technology is prevalent in almost every aspect of life, from hand-held phones to computers. Increases in cervical flexion can cause a strain on the neck and muscles of the upper extremity.

Objective: To examine the effect of 30 minutes of cervical flexion at 45 degrees. It was hypothesized that muscle strength will decrease after flexion, and there would be no significant differences between dominant and non-dominant arms or genders.

Study design: Twenty-four participants (12 male, 12 female) (n = 24; height = 173.1 ± 9.3 cm; weight = 73.33 ± 22.58kg) were measured before and after cervical flexion using a MicroFET2 Hand Held Digital Muscle Tester to test the middle deltoid, biceps brachii, and triceps brachii of each arm.

Results: Compared to pre-measures significant differences were found in both middle deltoids and both biceps brachii, but not in either triceps brachii ($p < 0.05$). Overall no limited significant differences were found between genders of muscles of either arm. Significant differences ($p < 0.05$) were found in the dominant biceps brachii, non-dominant biceps brachii, dominant triceps brachii, dominant deltoid, and non-dominant deltoid.

Conclusion: These results suggest that a normal daily degree of cervical flexion will decrease some upper extremity strength over the course of 30 minutes.

Keywords: *cervical, flexion, upper extremity, muscle, strength*

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INTRODUCTION

With an increased prevalence of handheld electronic devices and computer use, people of all ages are often staring down at a screen. Computers and cell phones have been integrated into daily life of both adults and children. Previous studies have been done to determine how much people look down when texting or using a cell phone. The average person inclines their neck at 45 degrees [9]. At this angle of flexion, a person's head weighs approximately 49 lbs [6]. People who constantly use computers for their jobs frequently report suffering from neck pain or shoulder pain [4, 5]. This "text neck" can be a threat to developing young spines, as people of younger ages are now using use smartphones and computers [3].

Previous studies have determined that a person's upper extremity muscle strength significantly decreased ($p < 0.05$) immediately after 30 degrees of cervical flexion [11]. Additional studies have been done to examine how a forward head position effects neck musculature and upper trunk activity, but not relative to the upper extremity [2]. Muscles including the sternocleidomastoid and middle trapezius showed significant changes in muscle activity when the head is placed in a forward position. Previous studies suggest that a change in muscle activity or strength may be due to an alteration in blood supply or peripheral nerve stretching, but no definite cause has been concluded.

It is hypothesized that after thirty minutes of cervical flexion muscle strength will significantly decrease. It is also hypothesized that there will be no significant differences between genders, and no significant differences between dominant and non-dominant arms. This study intends to apply these findings to a person's daily life, with a specific emphasis on students. Results of this study could shed light on what potentially may become an epidemic, as repetitive head flexion has already shown to be a risk factor for neck pain [9]. Additionally, this repetitive behavior may become a permanent change over time [6, 8]).

MATERIALS AND METHODS

A total of 26 participants aged 18–30 years old participated in the study. Two participants were excluded due to inability to complete the testing protocol. Therefore, data on 24 participants (12 males and 12 females; height = 173.1 $\pm$ 9.3 cm; weight = 73.33 $\pm$ 22.58kg), were used for analysis. Participants were excluded from the study if they suffered from vertigo or dizziness, experienced chest discomfort or unreasonable breathlessness with exercise, or were taking statins or cholesterol medication. Other exclusion criteria included any history of suffering a musculoskeletal injury to the arm, shoulder or neck, as well as any history of vascular disease in the head or neck.

All measurements were taken in the Biomechanics Lab at Appalachian State University. Participants came to the lab once for testing. All measurements were taken using a MicroFET2 Hand Held Digital Muscle Tester to test muscle function on both the dominant and non-dominant sides. Each participant was seated in a position that allows for normal thoracic and lumbar stability. The arm was held at 90 degrees and was tested isometrically. Participants had peak upper extremity muscle strength tested initially with the head in a vertical position, and then had their head flexed downward at a 45-degree angle for 30 minutes. During the 30 minutes of testing, participants were permitted to use their phone or a computer, while continuing to maintain the proper angle of neck flexion. All angles were measured using a goniometer. The muscles that were tested included: biceps brachii, triceps brachii, and middle deltoid. The same muscle strengths were then tested immediately after the end of the 30 minutes, with the participants returning their head to a vertical position. Testing was repeated twice for each muscle, without repeating the same muscle twice in a row. Measurements were given in newtons.

Placement of device: To test peak muscle strength for the biceps brachii, the device was placed at the distal end of the radius with the hand in a supinated position. To test peak muscle strength for the triceps brachii, the device was placed at the distal end of the ulna with the arm in a neutral position. To test peak muscle strength for the middle deltoid, the device was placed just above the lateral epicondyle of the humerus.

A paired samples T-test was used to determine if there was significant change ($p < 0.05$) in the muscle strength between a vertical and cervical flexion position. An independent samples T-test was used to determine if there was significant difference in percent strength changes between males and females. All measured results were processed using IBM SPSS Statistics 24.

This study has been approved by the IRB at Appalachian State University, and participants had given their informed consent.

RESULTS

As shown in Table 1, after 30 minutes of cervical flexion at 45 degrees, there was a significant difference in pre/post strength measurements in the left biceps brachii ($p = 0.038$), right biceps brachii ($p = 0.001$), left middle deltoid (p = <.0001), and right middle deltoid (p = 0.028). There was no significance difference in the triceps brachii, however. It was also determined that there was a significant difference in percentage of strength change in the middle deltoids across each arm (p = 0.014). The same was not found when evaluating the biceps brachii or triceps brachii, as shown in Table 2. When comparing the percent strength change between genders, a significant difference was only found in the right biceps brachii (p = 0.034) as shown in Table 3. Table 4 shows that a significant difference was found between the dominant biceps brachii (p = 0.006), non-dominant biceps brachii (p = 0.013), dominant triceps brachii (p = 0.017), dominant deltoid (p = 0.005), and non-dominant deltoid (p = 0.001). No significant difference was found in the non-dominant triceps brachii pre- to post-measurement. To look at this further, percent strength changes between dominant and non-dominant arms were evaluated. There were no significant differences found in the percent strength change between dominant and non-dominant arms, as shown by Table 5.

Table 1. Changes in muscle strength measured in newtons (N) before and after intervention.

		Pre (SD)	Post (SD)	Statistical significance
Biceps brachii	Left	254.06 (101.53)	239.87 (103.03)	0.038*
	Right	270.67 (96.23)	254.53 (102.01)	0.001*
Triceps brachii	Left	160.77 (54.11)	157.70 (55.67)	0.239
	Right	145.01 (48.94)	136.13 (44.91)	0.061
Middle deltoid	Left	140.82 (54.27)	125.42 (51.27)	<0.001*
	Right	129.22 (46.10)	122.89 (49.76)	0.028*

* denotes statistical significance (p < 0.05)

Table 2. Comparison of percentage of strength change on left and right arms.

	Left (SD)	Right (SD)	Statistical significance
Biceps brachii	–6.14 (9.46)	–6.95 (6.89)	0.653
Triceps brachii	–2.08 (8.42)	–4.99 (12.50)	0.310
Middle deltoid	–11.17 (9.66)	–5.78 (10.88)	0.014*

* denotes statistical significance (p < 0.05)

Table 3. Percent strength change between genders

	Mean		
	Males	**Females**	**Statistical significance**
Left biceps brachii	–4.37 (11.11)	–7.92 (7.55)	0.370
Right biceps brachii	–4.02 (6.31)	–9.89 (6.39)	0.034*
Left triceps brachii	1.42 (6.97)	–2.75 (9.94)	0.708
Right triceps brachii	–6.16 (14.83)	–3.83 (10.18)	0.657
Left deltoid brachii	–9.80 (10.71)	–12.53 (8.74)	0.501
Right middle deltoid	–2.99 (9.13)	–8.57 (12.14)	0.216

*denotes statistical significance ($p < 0.05$)

Table 4. Changes in muscle strength in dominant versus non-dominant arms

	Biceps brachii	
	Dominant	Non-dominant
Pre	272.80(100.77)	251.94(96.59)
Post	269.15(108.98)	235.25(95.74)
Significance	0.006*	0.013*
	Triceps brachii	
	Dominant	Non-dominant
Pre	151.63(54.59)	154.15(49.68)
Post	141.34(51.32)	152.49(51.59)
Significance	0.017*	0.599
	Middle deltoid	
	Dominant	Non-dominant
Pre	132.60(47.92)	137.44(53.21)
Post	124.02(49.13)	124.27(51.92)
Significance	0.005*	0.001*

*Denotes significance

Table 5. Percent strength change between dominant and non-dominant arms

	Dominant	Non-dominant	Significance
Biceps brachii	–6.25(7.48)	–6.84(9.01)	0.742
Triceps brachii	–6.01(11.29)	–1.07(9.56)	0.079
Middle deltoid	–7.05(10.83)	–9.90(10.27)	0.216

DISCUSSION

The main findings of this study show significant strength decreases in both biceps brachii and both middle deltoids after the period of cervical flexion, but this was not seen in the triceps brachii. During cervical flexion, there are slight structural changes in the neck. With flexion, there is an increase in size of the intervertebral foramen, where nerves and blood vessels exit. Previous studies have found that, with a loss or cervical lordosis, there is cervical neck muscle weakness [1]. It has been well documented that cervical extension can lead to cervical radiculopathy. In the case of cervical flexion, however, nerves are getting stretched. This peripheral nerve stretching has been discussed as a potential mechanism of change for the observed decrease in muscle strength. The middle deltoid is innervated primarily by the C5 nerve root, the biceps brachii by C6, and the triceps brachii by C7. In contrast with a study done by Vetra et al, no significant differences were found in the triceps brachii [11].

It has been well documented that that stretching C5 spinal nerve root will interrupt the innervation of the deltoid muscle [10]. The concept that head position affects upper extremity kinematics is also supported by past studies [8]. When the neck undergoes excessive flexion, there is a degree of stretching in the nerves that innervate the upper extremity. The concept of nerve stretching has been covered in depth when dealing with areas in the upper extremity itself – not distal to the brachial plexus. Additional studies must be done to evaluate nerve structure closer to the nerve root during cervical flexion.

Furthermore, a study done by Xie et al. concluded that a static and flexed spinal posture is more associated with desktop computer typing [12]. This posture is very common with students today. In addition to the everyday life of the public and students, these findings may have an impact on strength training with athletes. If athletes train frequently with a flexed neck posture, they may not be reaching their maximum muscle strength. Avoiding cervical flexion during maximal lifts may result in increased performance. Lifting with the head in a more retracted posture has shown to be a safer method as well [7]. An increased trunk and sternocleidomastoid activity and decreased spine flexion associated with lifting with a more retracted neck may help to lower the risk of spinal pain.

It is also important to note that this study evaluated cervical flexion separately from forward head posture. Many studies have shown when forward head posture is added in, this causes additional stress to the neck musculature [13, 6]. The present study recognizes limitations, including testing participants at various times during the day. There is a potential for events during the day to impact testing, such as previous exercises. Much research has been done with regards to neck musculature and upper trapezius function during head movement. Future studies may look at how a longer period of flexion impacts muscle strength, and how long it takes to recover from any decreases, as people do not permanently get weaker after a period of cervical flexion, this is a short-term effect.

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