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The Effects of Modified Chin Tuck Exercise on the Cervical Curvature, the Strength and Endurance of the Deep Cervical Flexor Muscles in Subjects with Forward Head Posture

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Abstract

Purpose : The purpose of this study was to investigate the effects of chin tuck exercise (CTE) on the craniovertebral angle (CVA), strength and endurance of deep cervical flexor (DCF) muscles in subjects with forward head posture(FHP). This study was performed on 30 subjects with FHP.

Method : Thirty subjects were divided into two groups; modified CTE (n=15), conventional CTE (n=15). Both of the group performed the exercise 4 times a week for 6 weeks. The subjects performed CTE in two different methods; modified CTE, with device designed that help keep cervical lordois curve, and coventional CTE, without using device. The CVA was measured using Image software version. A pressure biofeedback unit was used to measure the strength and endurance of the DCF muscles. The data was analyzed by the paired t-test for comparing before and after changes of variables in each group and the independent t-test for comparing the between groups.

Result : There was statistically significant difference of before and after strength and endurance of DCF muscles in modified CTE ($p<0.05$). There was statistically significant difference of before and after only endurance of DCF muscles in conventional CTE ($p<0.05$). There was statistically significant difference of between the two group in strength of DCF muscles ($p<0.05$).

Conclusion : Muscle strength to stabilize the spine plays an important role in maintaining a good posture. Therefore, we suggest that the application of CTE with a device designed to maintain the lordotic curvature in the neck is likely to yield better outcomes in FHP subjects in future studies.

Key words : cervical curvature, deep cervical flexor muscles, endurance, modified chin tuck exercise, strength

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Ⅰ. Introduction

A forward head posture (FHP), which is defined as the head being carried forward in the sagittal plane, can lead to the loss or reversal of the normal cervical lordosis. More specifically, FHP generally refers to a condition where the mid and lower cervical spine forms a loss of the normal curvature while the upper cervical spine (sub-occipital) is excessively extended (Braun & Amundson, 1989; Johnson, 1998; Khayatzadeh et al., 2017). The deep segmental cervical muscles such as the deep cervical flexor (DCF), are important for the control and support of the cervical lordosis and maintenance of cervical spine postural form (Boyd-Clark et al., 2001; Boyd-Clark et al., 2002; Conley et al., 1995; Mayoux-Benhamou et al., 1994; Vasavada et al., 1998). The muscle thickness of the longus colli of subjects with a FHP was reduced compared to that of subjects without a FHP (Ishida et al., 2015), thereas the muscle of the suboccipital extensors, superior obliques, inferior obliques, and rectus capitis was shorted (Page et al, 2010; Sahrmann, 2010).

FHP is one of the most common causes of rounded shoulders, migraines, myofascial pain syndrome, muscle tone imbalance, muscle spasms, numbness or tingling in the hands and arms (Chiou et al., 2012; Diab & Moustafa, 2012; Fernandez et al., 2007; Page et al., 2010; Yip et al., 2008; Yoo et al., 2008).

The neck stabilization exercises have gained recognition as the ideal method to keep the cervical spine in its normal position by strengthening the deep cervical flexor (DCF) muscles, including the longus capitis and colli muscles (Noh et al., 2013). While the head moves in various directions, the DCF muscles support the weight of the head in cooperation with each other and stabilize the neck through their low intensity static endurance.

The chin tuck exercise is generally used as an exercise method to strengthen DCF muscles. Previous studies discuss neck pain and its serious implications and suggest Mckenzie chin tuck exercise, one of the DCF exercises, as an effective therapeutic exercise by demonstrating its effectiveness in subjects with FHP (Cagnie et al., 2008; Iqbal et al., 2013; Kong et al., 2017; Murray et al., 2015: Noh et al., 2013). After Mckenzie chin tuck exercise was modified by several studies. The methods had involved putting a rolled towel under neck to maintain the cervical curvature (Durall, 2012) or using a pressure sensor for visual feedback or a sling for resistance in supine position. Some studies suggested the method without curvature support unit (Cagnie et al., 2008).

In studies have used rolled towels to maintain the cervical curvature, which is likely to proceed without considering the degree of curvature of the patient or not used, so it may be necessary to exercise with a device considering the degree of curvature. Therefore, we performed to determine the effects of chin tuck exercise while using a this device on cervical curvature as well as strength and endurance of the DCF muscles.

Ⅱ. Methods

1. Subjects

This study recruited students from college in the S city, South Korea, and 80 students voluntarily agreed to participate in the experiment after being informed of the purpose and methods of this study. Some students were excluded from the study for having acute neck pain, a previous history of neck surgery, neurological or orthopedic problems in the neck, other conditions that might affect the experiment, a fracture or other structural abnormality of the joint, nerve or a psychiatric problem/inability to understand instructions, or if they had participated in a neck rehabilitation program over the last six months.

A total of 30 subjects determined to have CVA of less than 52° in their photograph and were finally included upon their consent (Durall, 2012). The 30 subjects were randomly divided into the experimental group (n=15), who performed the modified chin tuck exercise with a device at the back of their neck to maintain the lordotic curvature of the cervical spine, and the control group (n=15), who performed the chin tuck exercise without using a device. The general characteristics of the subjects are summarized in Table 1.

Table 1. Characteristics of study subjects (n=30)

	Experimental group (n=15)	Control group (n=15)
Age (years)	20.47±0.92	21.00±2.10
Height (cm)	163.53±6.84	165.20±6.84
Weigh t(kg)	56.80±7.54	60.60±7.24

2. Instruments

The subjects were allowed to stand in a relaxed posture by placing their tragus of ears at the side of the postural grating plate on the side, and then gazing at the points shown on the front of the subject to prevent postural changes.

To measure the CVA, a sticker was affixed to the C7 vertebra, tragus of ears, and a acromion of shoulder of the subject. We took a digital camera (KENOX S600, Samsung, Korea) at a distance of 80 cm from the subject (Cheung Lau et al., 2009). The CVA was measured using Image software version 1.47 (National Institutes of Health, Bethesda, MD, USA). The CVA was measured as the angle formed by a horizontal line from the C7 vertebra and a line drawn from the tragus of the ear to the C7 vertebra on a lateral view photograph (Nejati et al., 2014).

A pressure biofeedback unit (Stabilizer®, Chattanooga, Hixson, TN, USA) was used to measure the strength and endurance of the DCF muscles. The strength and endurance of the DCF muscles were measured while the subject was lying in a supine position with a neutral head position and the device set at approximately 40 mmHg at the back of their neck (Murray et al., 2015). The strength of the DCF muscles was calculated and recorded as the average of the maximal voluntary contraction measured three times, which the subjects produced by pressing down on the device to the maximum extent possible while performing the chin tuck exercise. And then the endurance of the DCF muscles was measured by an electronic stopwatch with a holding time pressing the device with force of 50 % of the maximal voluntary contraction of retraction force after 2 minutes of rest (Murray et al., 2015).

3. Procedures

Both groups undertook an exercise training program consisting of warm up exercises and the main chin tuck exercise four times a week for six weeks. The warm-up exercises included neck flexion and extension, lateral flexion to the right and left sides, and rotation to the right and left as a set without restriction on training duration, and the set was repeated three times. The chin tuck exercise, which tuck the chin and press the neck down into the floor with tilt the head down as if nodding "yes" was performed in the supine position, and the examiner palpates their sternocleidomastoid muscle to minimize compensation during exercise.

The experimental group performed a modified chin tuck exercise maintaining the lordotic curvature of the neck. In order to maintain the lordotic curvature of the neck in a lying position, a height adjustable device was placed between the neck and the floor and the height was raised to the extent that the subject did not feel uncomfortable. This height was used as a reference value, and the height for increasing lordotic curvature of the neck was reset on a weekly basis.

The control group performed a general chin tuck exercise without maintaining the lordotic curvature of the neck. The general chin tuck exercise was performed by placing pressure biofeedback between the neck and the floor and setting the reference value to 20 mmHg for all subjects equally and then keeping the pressure soft and slow by 2 mmHg until 30 mmHg The holding time was 10 seconds, 10 repetitions, and the rest time of 10 seconds between the contractions. And gradually increased the holding time and frequency by 20 % (Kim, 2015).

Exercise was performed for 6 weeks, 4 times a week, 40 minutes a day. During the chin tuck exercise, the head was not lifted from the floor in order to selectively strengthen the DCF muscles of the neck.

4. Statistical analysis

Statistical analysis was performed using SPSS version 18.0 (IBM Co., Chicago, IL, USA). A paired t-test was used to evaluate the differences in the two groups before and after exercise. An independent t-test was used to evaluate the differences between the groups. An α =0.05 was considered statistically significant.

Ⅲ. Results

1. Differences in the two groups before and after exercise

Based on the CVA measured before and after exercise, both the experimental and control groups showed no significant changes in CVA. Comparing the changes in the strength of the DCF muscles, the experimental group showed a statistically significant increase after exercise ($p<0.05$), whereas the control group showed no significant change. However, both groups showed statistically significant improvement in muscle endurance after exercise (Table 2).

Table 2. Comparison of parameters pre and post exercise (n=30)

	Experimental group (n=15)			Control group (n=15)		
	Pre	Post	*p*	Pre	Post	*p*
CVA (°)	46.06±3.38	47.58±5.87	.871	47.03±2.87	46.72±4.63	.882
DCFMst (㎜Hg)	10.53±4.82	16.07±8.79	.021	9.87±3.23	11.47±5.99	.072
DCFMen (sec)	93.60±54.00	334.10±109.40	.007	118.40±71.10	424.30±123.10	.002

Mean±SD, CVA; craniovertebral angle, DCFMst; deep cervical flexor muscles strengthen, DCFMen; deep cervical flexor muscles endurance

2. Differences between the groups

There was a statistically significant difference in strength between the two groups ($p<0.05$). But no statistically significant difference in endurance (Table 3).

Table 3. Comparison of changes between groups (n=30)

	Experimental group (n=15)	Control group (n=15)	*p*
CVA (°)	1.52±5.89	-0.31±5.18	.17
DCFM strengthen (㎜Hg)	5.53±3.87	1.60±3.17	.023
DCFM endurance (sec)	240.53±55.4	305.87±56.0	.075

Mean±SD, CVA; craniovertebral angle, DCFM; deep cervical flexor muscles

Ⅳ. Discussion

Many studies have been performed to investigate the effects of various neck exercises, including chin tuck exercise, on CVA, muscle activity, and the strength and endurance of the DCF muscles in subjects with FHP. However, there has been little research on differences in the effects of modified chin tuck exercise with corrected alignment on cervical curvature, the strength and endurance of the DCF muscles. so we conducted this study to determine the effects of modified chin tuck exercise with maintain the cervical curvature on the CVA, the strength and endurance of the DCF muscles.

Kong et al. (2017) reported that a 4-week modified cervical exercise, which performed three times per day was effective for correcting FHP in smartphone users. As the result, the mean of the participants' CVA was significantly increased from 49.0±5.1 to 57.8±4.8 ($p<0.05$). The results of this study showed that there were not significant differences between pre and post exercise in both group in CVA. However the mean was increased from 46.06±3.38 to 47.58±5.87 in experimental group, and decreased from 47.03±2.87 to 46.72±4.63 in control group. This finding implies that the chin tuck exercise combined with a device designed to help form an angle of cervical lordosis was more effective than general chin tuck exercise in forming a cervical lordosis angle and eventually correcting FHP.

Iqbal et al. (2013) reported that neck exercises, including chin tuck exercise with a biofeedback balloon placed at the back of the subject's neck, significantly increased the strength and endurance of the DCF muscles. In this study, the post-exercise strength of the DCF muscles increased in the experimental and control groups, but only the experimental group showed a statistically significant increase the strength of the DCF muscles ($p<0.05$). Thus, the application of an exercise device that helped subjects maintain their cervical curvature appears to have contributed to this result.

The post-exercise endurance of the DCF muscles showed statistically significant increases in both groups, matching the findings of previous studies. The deep flexor muscles play the greatest role in maintaining the stability of the cervical vertebrae, and when the stability of each segment of the cervical vertebrae falls, the movement of the superficial flexor muscle such as sternocleidomastoid becomes more active than in the deep cervical flexor muscles (Winters et al., 1993). For this reason, the modified exercise in this study provided the stability of each segment of the cervical vertebrae, which is thought to result in improved muscular strength of the deep flexor muscles.

This study has limitations that may have affected the results: the camera stand was not adjusted according to the height of the subjects when taking a picture of each subject and quantification of the device to maintain the curvature of the neck is necessary. If we consider the method to overcome these limitations, we can get better results.

Ⅴ. Conclusion

The purpose of this study was to determine the effects of chin tuck exercise combined with a device for cervical curvature. The chin tuck exercise performed with a device to allow FHP subjects to maintain the lordotic curvature in their neck led to significant increases in the strength of the DCF muscles. Therefore, we suggest that the application of chin tuck exercise combined with a device designed to maintain the lordotic curvature in the neck is likely to yield better outcomes in FHP subjects in future studies.

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