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Original Article

The effect of cocontraction of the masticatory muscles during neck stabilization exercises on thickness of the neck flexors

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Abstract. [Purpose] The purpose of this study was to determine the effect of the cocontraction of masticatory muscles during neck stabilization exercises on changes in the thickness of the neck flexors. [Subjects and Methods] Twenty subjects performed neck stabilization only exercise and neck stabilization exercise with simultaneous contraction of the masticatory muscles. Changes in the thickness of the longus colli and sternocleidomastoid were then measured by ultrasound. [Results] The thickness of the longus colli increased significantly fallowing cocontraction of the masticatory muscles and neck stabilization exercise, whereas the exercise method used had no significant effect on the thickness of the sternocleidomastoid. [Conclusion] Cocontraction of the masticatory muscles during neck stabilization exercise is helpful in increasing the thickness of longus colli muscle.
Key words: Masticatory muscle, Neck stabilization exercises, Thickness of neck flexors

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INTRODUCTION

Neck pain is a frequently experienced symptom that most people have at least once in their lifetime; chronic neck pain is a general musculoskeletal disorder[1–3)], and is associated with compensatory hypertension in superficial muscles, such as the sternocleidomastoid, and atrophy of the deep cervical flexors, such as the longus colli and longus capitis[4, 5)].

Many position sense proprioceptors are distributed over the longus colli and longus capitis. They produce suitable movements depending on the stability and posture of the neck region, as they input posture information as quickly as possible by early contraction during movements of the head or upper limb[6)]. However, atrophy of the longus colli and longus capitis in patients with chronic neck pain can restrict neck stabilization during head or upper limb movements, resulting in unnatural and nonfunctional mobility of the neck. Therefore, in the clinical field, many intervention methods have focused on strengthening and re-educating the longus colli and longus capitis. Neck stabilization exercise is aimed at flattening the curvature of the cervical spine without head movement, with chin nodding directed into the occiput side in a lying-down position on the back[7)]. This motion is intended to induce selective contraction of the longus colli and longus capitis. As patients with chronic neck pain cannot maintain this posture for a long time, this motion can be used as a diagnostic criterion of neck pain and utilized as a therapeutic exercise to increase muscle strength.

Patients with temporomandibular joint disorder and neck disorders have neck pain. The neck pain is thought to be associated with anatomical and physiological dysfunction of the temporomandibular region[8, 9)]. Giannakopoulos et al.[10)] reported that the coordination of neck muscles differed during teeth clenching, depending on the direction and strength of the mastication. Tecco et al.[11)] also found that the position of the mandible during opening of the mouth and mastication significantly changed the activation of cervical muscles. Furthermore, Oie et al.[12)] proposed that the direction of mastication influences systemic balance, suggesting that masticatory muscles affect not only masticatory function but also systemic balance and proprioception. Therefore, the current literature hints that cocontraction of masticatory muscles during neck stabilization exercise could affect the activation of neck muscles or cause changes in proprioception. Few studies have specifically investigated effects of such cocontraction on the superficial and deep muscles in the neck.

Therefore, this study aimed to determine the effect of cocontraction of masticatory muscles during neck stabilization exercise on changes in the thickness of deep and superficial cervical flexors.

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SUBJECTS AND METHODS

Twenty healthy adults were included in this study. All the subjects voluntarily participated in this study and signed an agreement for this experiment. The selection criteria were no neck pain, temporomandibular joint pain, or headache in the previous 6 months. This study was approved by the Committee on Bioethics, Catholic University of Pusan (CUPIRB-2014-032).

Prior to the experiment, the subjects were told how to perform the neck stabilization exercise and were given 3 min to familiarize themselves with the method. The neck stabilization exercise was conducted as follows: While in a supine position, the subject tucked in his/her chin, and a pressure biofeedback unit was placed at the back of the subject's neck and inflated to 20 mmHg for 10 sec. The subject lay on a bed in a supine position and performed the neck stabilization exercise first, followed by the neck stabilization exercise and simultaneous teeth clenching to contract the masticatory muscles. To prevent damage to the teeth and temporomandibular joints, the subject wore a mouthpiece during the teeth clenching.

An ultrasound system (SonoAce X4, MEDISON, Seoul, South Korea) with a 7.5 MHz linear probe, which was placed on the longus colli of the subjects, measured the thickness of the muscle three times in every motion in B mode. The location of measurement was indicated with a marker 2 cm below the thyroid cartilage, and the right side of the mark was scanned with the probe placed in a vertical direction relative to the longitudinal axis to visualize cross sections of the neck. To measure the thickness of the muscle, the muscle with the longest length in cross-section images was used[13]. The SPSS 19.0 software was used for statistical analysis. Percentage and frequency analysis were used to determine the subjects' general characteristic and a paired t-test was used to determine changes in the thickness of the longus colli and sternocleidomastoid. The significance level was set at $\alpha=0.05$ to determine the effect of the exercise methods.

RESULTS

The general characteristics of the subjects are shown in Table 1.

Table 2 shows the differences in the thickness of the longus colli and sternocleidomastoid while performing the neck stabilization exercise only and the neck stabilization exercise with simultaneous teeth clenching. The thickness of the longus colli muscle increased significantly in the neck stabilization with simultaneous teeth clenching exercise ($p<0.05$), but there was no significant difference in the thickness of the sternocleidomastoid between the two exercise methods ($p>0.05$).

Table 1. Characteristics of the subjects (N=20)

Variables	Value
Gender (M/F)	16/4
Age (y)	21.73 (1.8)
Height (cm)	173.89 (5.4)
Weight (kg)	69.42 (7.5)

Table 2. Differences in longus colli and sternocleidomastoid thickness according to training maneuver (units: cm)

Muscle	Maneuver	Mean±SD
LC	NSE	0.50±0.15
	NSE with clenching	0.60±0.14
SCM	NSE	0.71±0.19
	NSE with clenching	0.77±0.21

LC: longus colli; SCM: sternocleidomastoid; NSE: neck stabilization exercise. *p<0.05.

DISCUSSION

This study aimed to find an effective neck stabilization exercise to reduce compensatory hypertension in superficial cervical flexors while strengthening deep cervical flexors, which are weak in patients with chronic neck pain.

The results demonstrated that the increase in the thickness of the longus colli was more significant with the combined exercise (i.e., neck stabilization with simultaneous teeth clenching) than the neck stabilization exercise alone.

Previous reports[14–16] of an increase in the activities of the cervical muscles in proportion to the strength of contraction of the masticatory muscle are consistent with the findings of the present study. The application of a load to the neck stabilizes the biomechanical movements of the head that occur during the contraction of the masticatory muscles while clenching the teeth. This increases the contraction of the longus colli and has a positive effect on neck stabilization[10].

Zafar et al.[17] reported that opening and closing the mouth always involved head movement and mandible depression. They found that opening the mouth caused neck extensor movements in the cranio-cervical region, in particular, as well as head extension and mandible elevation, and that closing the mouth caused neck flexor movements. In their study, teeth clenching pulled the mandible in the upper direction during neck stabilization exercise, thereby causing contraction of the cervical flexor. Their findings are consistent with those of the present study.

Oie et al.[12] reported that masticatory direction and mouth opening could affect systemic body balance and the center of mass distribution. They attributed this finding to stimulation of the fascia located between the teeth and gums and the stimulation affecting a nearby fascia in the neck muscles, thereby influencing proprioceptors and balance. Another study reported that contractions of the temporomandibular joint and cervical regions can trigger contraction of other regions due to structural and neurological associations between the regions[18]. Therefore, the temporomandibular joint, cervical flexors, and head cannot be viewed as individual regions but are regions that perform coordinated actions due to neuromuscular control. As a result, cocontraction of the masticatory muscles can induce selective muscle contraction of deep cervical flexors and aid cervical stability.

These results suggest that cocontraction of the masticatory muscles during neck stabilization exercise can help increase neck stability in patients with chronic neck pain.

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