Effects of manipulation of the thorax and intensity of the pressure biofeedback unit on the superficial cervical flexors muscle during craniocervical flexion exercise

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Abstract. [Purpose] This study examined the effects of manipulation of the thorax and the intensity of the pressure biofeedback unit on the superficial cervical flexors muscle during craniocervical flexion exercise. [Methods] Thirty three subjects participated in the experiment. Thirty three healthy people without any orthopedic history were also selected. The subjects could monitor the pressure applied to cervical vertebra 3 of the craniocervical junction by markings on the pressure biofeedback unit. Craniocervical flexion exercise was performed for 20 seconds per pressure, and two minutes of rest was allowed after exercise to reduce muscle fatigue. [Results] Significant differences in the post-training gains in the sternocleidomastoid and scalene were observed between the thorax fixation group and thorax non-fixation group. The thorax fixation group showed that muscle activation of the sternocleidomastoid and scalene was increased when the pressure biofeedback unit intensity was 40 mmHg than when pressure biofeedback unit intensity was 20 mmHg and 30 mmHg in the post-hoc result. The thorax non-fixation group showed that muscle activation of the sternocleidomastoid and scalene was higher when the pressure biofeedback unit intensity was 40mmHg compared to that when the pressure biofeedback unit intensity was 20mmHg in the post-hoc result. [Conclusion] Craniocervical flexion exercise is a clinically effective method that reduces the superficial neck flexor muscle activation. Key words: Craniocervical, Electromyography, Pressure biofeedback unit

INTRODUCTION

The deep neck flexor is made up of the longus colli, longus capitis, and rectus capitis anterior, and the superficial neck flexors is made up of the sternocleidomastoid (SCM) and scalene muscle1. Unlike the superficial neck flexor muscle, the deep neck flexors, which are attached to the cervical spine, support the cervical lordosis directly and give stability2.

Previous studies reported that 70% of patients with neck pain and headache showed a decrease in strength and endurance of the SCM and scalenus1. After applying craniocervical flexion exercise to patients with neck pain using a pressure biofeedback unit (PBU), there has been a significant increase in the strength of the deep neck flexor muscle in the forward head posture3. Another study claimed that when the thorax is not fixed during craniocervical flexion exercise, contraction of the SCM and anterior scalenus increased, among other superficial neck flexors5. On the other hand, the same study did not report conclusive results on whether manipulation of the thorax during craniocervical flexion exercise affects muscle...
activation. This study examined the effects of manipulation of the thorax and the intensity of PBU on the superficial cervical flexors muscle during craniocervical flexion exercise.

**SUBJECTS AND METHODS**

Thirty-three subjects participated in the experiment. This study also selected ten healthy people without any orthopedic history. Information on the study was provided to all subjects prior to their participation and written informed consent according to the ethical standards of the Declaration of Helsinki, to participate in the project was obtained. The average ages, heights, and weights were 29.91 ± 4.4 years old, 171.55 ± 7.78 cm, and 62.82 ± 8.57 kg in the experimental group, respectively. The Research Ethics Committee of Eulji University Hospital approved the study. For craniocervical flexion exercises, PBU (Chattanooga Group Inc., Hixson, USA), which was adopted in a previous study, was used to apply an increasing pressure of 20, 30, and 40 mmHg.

The subjects could monitor the pressure applied to cervical vertebra 3 of the craniocervical junction by markings on PBU. Craniocervical flexion exercise was performed for 20 seconds per pressure, and two minutes of rest was allowed after exercise to reduce muscle fatigue. The subjects were instructed to flex both of their hip joints and knee joints to limit the contraction of rectus abdominis in the supine position. The subjects pulled their chins downward during the exercise to contract the lungus colli and longus capitis. Care was taken to minimize neck bending by contraction of the superficial muscles, such as the SCM and ant. Scalene. The thorax of the subjects was fixed using a manual belt. To reduce the discomfort by pressure caused by the manual belt, a towel was placed between the belt and thorax to ensure that the subjects experienced no discomfort prior to the experiment.

In this study, electromyography (QEMG-4 System, LXM 3204 Laxtha, Korea) was used to measure the change in the values of muscle activation in the superficial muscles. Electromyogram electrodes were attached to the following areas: (1) SCM, between mastoid process and sternal notch; and (2) Ant. Scalene, behind the SCM, above the clavicle, and triangle shape formed by the upper trapezius. The electrodes were attached to the superficial muscles and the subjects bent their cervical vertebra for 20 seconds while their muscle activation value was recorded. The distance between the electrodes was 2 cm, and the sampling rate and band pass filter were set to 1,024 Hz and 20–450 Hz, respectively. In addition, the signals collected from each muscle were normalized to the maximal voluntary isometric contraction (%MVIC). SPSS Win version 12.0 was used for statistical analysis. To compare the change in superficial muscle activation by the PBU intensity of the chest fixed group and non-fixed group, 3 × 2 two-way repeated ANOVA was used, and a paired t-test was conducted to compare the difference in muscle activation between the two groups. A p value<0.05 was considered significant.

**RESULTS**

Significant differences in the post-training gains in the SCM and scalene were observed between the thorax fixation group and thorax non-fixation group (p<0.05).

The post-hoc result showed that the thorax fixation group showed that muscle activation of the SCM and scalene was higher when the PBU intensity was 40 mmHg than when the PBU intensity was 20 mmHg and 30 mmHg (p<0.01). The thorax non-fixation group showed also higher muscle activation of the SCM and scalene when the PBU intensity was 40 mmHg than when the PBU intensity was 20 mmHg (p<0.05) (Table 1).

**DISCUSSION**

Patients with neck pain exhibit reduced cervical region control ability due to a weakening of the deep neck flexor muscles. The SCM and anterior scalene, superficial muscles, are activated excessively in the early stages, limiting the bending of the cervical region. Such abnormal movement extends the chin forward, shortening the cervical muscle that is between the occipital region and cervical vertebra 1, and weakening the lungus colli and longus capitis. Falla et al. applied craniocervical flexion exercise to the normal cervical spine and witnessed an increase in muscle activation of the lungus colli and longus capitis.

**Table 1.** Comparison of the craniocervical flexion exercise groups (n=33) (units: %MVIC)

<table>
<thead>
<tr>
<th></th>
<th>22 mmHg</th>
<th>30 mmHg</th>
<th>40 mmHg</th>
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<tbody>
<tr>
<td>SCM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixation</td>
<td>5.41 ± 1.43</td>
<td>6.67 ± 4.24</td>
<td>8.60 ± 4.96</td>
</tr>
<tr>
<td>Non-fixation</td>
<td>6.83 ± 3.05**</td>
<td>9.32 ± 9.78*</td>
<td>11.80 ± 10.93*</td>
</tr>
<tr>
<td>Scalenus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixation</td>
<td>6.37 ± 1.83</td>
<td>7.46 ± 2.54</td>
<td>10.06 ± 4.47</td>
</tr>
<tr>
<td>Non-fixation</td>
<td>8.21 ± 3.59**</td>
<td>9.27 ± 4.36**</td>
<td>12.33 ± 5.80**</td>
</tr>
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*Mean ± SD: Mean ± standard deviation
*Significant intergroup difference between the gains achieved (p<0.05)
As a result, during craniocervical flexion exercise using PBU, the cervical region superficial muscle activation was lower when the thorax was fixed than when it was not. A previous study reported that lower muscle activation of the superficial neck flexor during craniocervical flexion\(^9\). This is because when thorax is fixed, activation of the SCM and scalenus decreases, which was also observed in the present study\(^9\). Therefore, craniocervical flexion exercise performed by neck pain patients with their thorax fixed is a clinically effective method that reduces the superficial neck flexor muscle activation\(^10\).

**REFERENCES**