Electromyographic Analysis of Thoracic and Lumbar Erector Spinae Activity Using the Abdominal Drawing-in Maneuver and Chin Tuck During Prone Thoracic Extension Exercises

Ki-song Kim¹, MPH, PT, Gyu-wan Lee¹, MSc, PT, Dong-joon Choi², BHSc, PT, Heon-seock Cynn³, PhD, PT, Oh-yun Kwon³, PhD, PT
¹Dept. of Physical Therapy, Gangnam Severance Hospital Yonsei University, College of Medicine, ²Dept. of Ergonomic Therapy, The Graduate School of Health Science, Yonsei University, ³Dept. of Physical Therapy, College of Health Science, Yonsei University

Abstract

This present study investigated the effects of the abdominal drawing-in maneuver (ADIM) and chin tuck (CT) on middle thoracic erector spinae, lower thoracic erector spinae, and lumbar erector spinae muscle activity during three prone thoracic extension (PTE) exercises. Twelve healthy subjects performed preferred PTE, ADIM PTE, and ADIM-CT PTE. Surface electromyography was used to collect data on the muscle activity of dominant middle and lower thoracic erector spinae muscles and the lumbar erector spinae muscles. Middle and lower thoracic erector spinae muscle activity significantly increased when ADIM and CT was performed (p<.05). However, lumbar erector spinae muscle activity significantly decreased in ADIM PTE compared to preferred PTE (p=.017) and significantly increased in ADIM-CT PTE compared to ADIM PTE (p=.004). In conclusion, ADIM-CT PTE effectively increased middle and lower thoracic erector spinae muscle activity, and ADIM PTE decreased lumbar erector spinae muscle activity. Hence, ADIM PTE could be a recommended exercise maneuver to strengthen thoracic erector spinae without over activation of lumbar erector spinae.

Key Words: Abdominal drawing-in maneuver; Chin tuck; Prone thoracic extension; Surface electromyography.

Introduction

The weakness or fatigue of trunk muscles can increase the risk of neuromuscular deficits, which, according to Panjabi’s theory of the spinal stabilizing system, causes uncontrolled intervertebral movements (Granata and Gottipati, 2008; Panjabi, 1992). Thoracic extension exercise is performed to activate or strengthen weak and fatigued thoracic erector spinae (TES). Various thoracic extension exercises are applied in the clinical setting and previous studies have reported positive results (Pfeifer et al, 2004; Sinaki, 1982; Sinaki and Lynn, 2002; Sinaki et al, 2005).

However, prone thoracic extension (PTE) can induce an undesirable compensatory deviation. Previous studies showed that lumbar extension can increase with exaggerated anterior pelvic tilt and/or cervical lordosis, leading to microtrauma and pain during
PTE (Sinaki et al., 1996). Moreover, excessive use of lumbar erector spinae (LES) is often associated with chronic low back pain (Holmström et al., 1992). Furthermore, repetitive lumbar extension and anterior pelvic tilt may contribute to over activation of LES and less activation of TES. Hence, prescribing PTE alone may also increase cervical and/or lumbar lordosis (Kuramoto et al., 2011), which is not desirable for individuals with lumbar extension syndrome.

Several modes of exercise have been developed for improving the muscular function of the back (Menacho et al., 2010). Hongo et al. (2007) found that modified PTE is required for preventing unwanted effects in order to increase the strength of TES and the quality of life of patients with osteoporosis (Hongo et al., 2007). Another previous study advocated internal or external stabilization for the application of TES without increasing lumbar lordosis (Kisner and Colby, 2007).

Abdominal drawing-in maneuver (ADIM) was advocated to stabilize lumbo-pelvis and to reduce unwanted compensation in various previous studies (Cynn et al., 2006; Oh et al., 2007; Park et al., 2011). The pressure biofeedback unit was utilized in a different body position to educate and confirm the lumbo-pelvic stabilization (Richardson et al., 2004).

The chin tuck (CT) exercise has been recommended to provide craniocervical stability and to activate deep cervical stabilizers, such as rectus capitis anterior, rectus capitis lateralis, longus capitis, and longus colli. In particular, weakness of deep cervical stabilizers and over activation of global muscles (e.g., sternocleidomastoid and scalenus muscles) were noticed in patients with cervical pain. CT has been practiced in the clinical interventions for patients with chronic cervical pain to correct the forward head posture. In the previous study, there was no significant differences in improvement of craniocervical flexor performance in the fifty female patients with chronic mild neck pain (O’Leary et al., 2007).

However, no previous study was performed to investigate whether ADIM can alter the muscle activity of TES and LES during PTE. In particular, the role of CT exercises in craniocervical stability has not been evaluated in the literature. Thus, this study aimed at determining the effect of ADIM and CT on the muscle activity of the middle and lower TES and LES during three different PTEs in healthy subjects. The research hypothesis is that during PTE, ADIM and CT increase the muscle activity of middle and lower LES and decrease the muscle activity of LES.

**Methods**

**Subjects**

A power analysis was performed to calculate the sample size in this study. From the data of a pilot study of 5 subjects, the necessary sample size of 12 subjects was to achieve the effect size of ηp^2 (calculated by partial η^2 of .14) with an alpha level of .05, and the power of .8. Twelve healthy subjects were recruited to accommodate the calculated sample size. The characteristics of the subjects are shown in Table 1. The inclusion criteria for the subjects were as follows: 1) no current pain at neck, thoracic, and lumbar pain, 2) not participating in any regular flexibility or strengthening exercise programs, 3) no history of surgery at neck, thoracic, or lumbar spine.

The exclusion criteria for the subjects were as follows: 1) previous pain at neck, thoracic, or lumbar spine within six months of entering this study; 2) taking any muscle relaxant or steroid injection re-

<table>
<thead>
<tr>
<th>Table 1. General characteristics for this subjects (N=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>Age (yrs)</td>
</tr>
<tr>
<td>Height (m)</td>
</tr>
<tr>
<td>Weight (kg)</td>
</tr>
<tr>
<td>BMIF^b</td>
</tr>
<tr>
<td>Dominant side (right/left)</td>
</tr>
</tbody>
</table>

^a body mass index, ^b mean±standard deviation.