The Effect of Activation of the Deep Abdominal Muscle on the Activity of the Superficial Abdominal Muscle. A Comparison of Healthy Control with the Patients with Low Back Pain.

Takuya Miura¹, Masanori Yamanaka², Takumi Kobayashi³, Harukazu Tohyama².
¹Graduate School of Health Sciences, Hokkaido University, Sapporo, Japan, ²Faculty of Health Sciences, Hokkaido University, Sapporo, Japan, ³Hokuto Endowed Chair in Prevention of Joint Diseases, Faculty of Health Sciences, Hokkaido University, Sapporo, Japan.

Disclosures:

Introduction: Motor control of the trunk muscles has been studied extensively in people with and without low back and pelvic pain (LBP). Numerous changes in muscle recruitment have been identified in the LBP population, including increased activity of the superficial trunk muscles during trunk movements. This increased activity of the superficial trunk muscles may have potential for adverse effect on lumbar spine stability. Recently the effect of the deep trunk muscles on trunk stability has been attracting attention. Specifically, the deep abdominal muscle, Transversus abdominis (TrA), is implicated in the support and protection of the spine [1]. The TrA muscle is controlled independently of the other abdominal muscles and is activated early in a tonic manner prior to arm and leg movements. In contrast to healthy individuals, the TrA muscle is often delayed or reduced in people with LBP. The abdominal drawing-in maneuver (ADIM), a foundational exercise in trunk stabilization programs, is designed to facilitate a voluntary contraction of the TrA muscle. However, the influence of the activated deep trunk muscles on the activity of superficial trunk muscles has not been clear. The aim of this study is to investigate the effect of increased activity of the deep trunk muscles on the superficial trunk muscles activity using electromyographic activity (EMG).

Methods: A total of 10 healthy controls and 8 patients with LBP took part. The mean (± SD) age, height, body mass was 22.6 ± 1.5 years, 170.1 ± 4.0 cm, 63.7 ± 4.2 kg, respectively for the healthy controls and, 22.4 ± 1.8 years, 170.9 ± 4.5 cm, 60.4 ± 5.7 kg respectively for the LBP patients. The inclusion criteria were: persistent LBP without referred pain for at least 3 months, serious enough to require medical attention or absence from work. Exclusion criteria included: persistent severe pain, non-mechanical LBP, neurological symptoms, severe spinal instability, osteoporosis, structural deformity, systemic inflammatory disease, a compensated metabolic disease, previous spinal fusion, severe cardiovascular diseases, acute infection, recent abdominal surgery, uncontrolled alcohol/drug abuse, and decompensated psychopathological diseases. Further exclusion criteria for both groups included pregnancy within the last 2 years. They received verbal and written information about the trial before the test, and this study was approved by the IRB.

A wireless surface EMG (NihonKohden. Co, Tokyo, Japan) was used to measure the activity of the trunk muscles at 1000 Hz. The electrodes were attached to the skin overlying right side of the following muscle groups: anterior deltoid (AD); external oblique (EO); TrA-internal oblique (TrA-IO). Electrode placement for the TrA-IO was 2 cm medial and inferior to the anterior superior iliac spine. This location has been used to assess activation profiles of the TrA-IO and has been viewed as the best surface location for evaluating TrA muscle function [2]. Electrode placement for the EO muscle was 12 cm lateral to the umbilicus at an oblique angle of 45° to coincide with the muscle's fiber orientation. In the present study, the TrA-IO EMG activity was considered as the activity of the deep trunk muscle. Experimental protocol of this study was performed using the lifting task. Subjects were instructed to lift weights (0, 5, 10, 20%Body Weight; BW) in upright standing posture under two different conditions; lifting with ADIM and lifting without ADIM. The ADIM is one of the fundamental exercises used to train the deep trunk muscles. Therefore, this technique was adopted as a method to activate the deep trunk muscles in this study. In each task, measurements were performed three times. All EMG signals were band-pass filtered (15-500 Hz) and rectified using a root-mean-square. After performing the lifting task, EMG signals of maximum voluntary isometric contraction (MVIC) were collected two times for 5 seconds. Then, the EMG data was normalized by MVIC amplitudes of each muscle. Onset of the lifting was defined as the level +2SD above the mean baseline of the acceleration signal of the weight. The normalized EMG data of each muscle between 0 ms (lifting onset) and 200 ms was averaged for data analysis. For statistical analysis, a paired t-tests was performed to compare the normalized EMG data between the lifting with ADIM and lifting without ADIM under each weight condition. Differences were considered statistically significant at P < .05.

Results: In the healthy control group (Figure 1), the EO muscle showed significantly decreased activity during preforming the lifting with ADIM compared to the lifting without ADIM (P < .05) under the 5, 10 and 20%BW conditions. The activity of the TrA-IO was significantly increased during preforming the lifting with ADIM under the all, except 5%BW, conditions (P < .05). In the patients with LBP group (Figure 2), no significant difference was found in the EO muscle activity between two lifting conditions. The activity of the TrA-IO was significantly decreased during preforming the lifting with ADIM under the 5 and 10%BW.
conditions \((P < .05)\).

**Discussion:** The EMG activity of the EO muscle during the lifting with ADIM reduced compared to the lifting without ADIM in the healthy control group. These findings may suggest that the trunk stability was increased by performing the ADIM. This increase of trunk stability decreases the demand for the superficial trunk muscle to resist the perturbation of the trunk from performing the lifting. The excessive contraction of the superficial trunk muscles was considered to increase the lumbar spinal load. Although it is not clear whether the EO muscle activity in the present study is excessive or not, reducing the activity of the superficial trunk muscles may be useful for the rehabilitation of the LBP. The patients with LBP group showed no significant difference in the EO muscle activity between two lifting conditions. This finding indicated that the mechanism of stabilizing the spine provided by the deep abdominal muscles was not functioning properly in the patients with LBP. Altered motor control is thought to be a contributing factor to the development of chronic LBP \([3]\). Therefore further research is needed to investigate the effect of exercise that preferentially target the deep abdominal muscle on this altered motor control observed in the patients with LBP. The present study revealed the importance of activation of the deep trunk muscles and would help the clinicians to save the patients from the risks of occurrence of LBP.

**Significance:** The activity of the superficial trunk muscles can be reduced by activating the deep trunk muscles. To decrease the lumbar spinal load, therefore, the clinicians should train the deep trunk muscle of the patients with a probability of occurrence of LBP in the future.

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