The Relationship Between Transversus Abdominis and Lumbar Multifidus During the Lifting Task.

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Introduction: Motor control of the trunk muscles has been studied extensively in people with and without low back and pelvic pain (LBP). Recently the effect of the deep trunk muscles on trunk stability has been attracting attention. Specifically, the deep abdominal muscle, such as transversus abdominis (TrA) and lumbar multifidus (LM), is implicated in the support and protection of the spine. The TrA muscle is controlled independently of the other abdominal muscles and is activated early in a tonic manner prior to arm movements [1]. The LM muscle activates symmetrically in synchronization with the TrA muscle to provide the stability for the lumbar spine. Biomechanical studies have highlighted the role of the LM muscle in provision of segmental stiffness, control of the spinal segment’s neutral zone, and its capacity to stabilize the spine when spinal stability is challenged. Real-time ultrasound imaging is a golden method that is used in physiotherapy clinical practice both for assessment of the TrA muscle and the LM muscle function and size. However, most of research into functions of these muscles has been evaluated within the same muscle, or assessed in isolation, and examined changes in its thickness or cross sectional area (CSA) in a non-functional posture. In clinical practice, both muscles are trained together, based on the assumption that there is a relationship between two muscles. Therefore, the aim of study was to investigate the relationship between the TrA muscle and the LM muscle during the functional task using ultrasound imaging.

Methods: A total of 8 healthy subjects took part in this study. The mean (± SD) age, height, body mass was 21.0 ± 0.7 years, 174.8 ± 7.0 cm, 64.3 ± 7.6 kg, respectively for the healthy subjects. Exclusion criteria included: persistent severe pain, non-mechanical LBP, neurological symptoms, severe spinal instability, osteoporosis, structural deformity, systemic inflammatory disease, a decompensated metabolic disease, previous spinal fusion, severe cardiovascular diseases, acute infection, recent abdominal surgery, uncontrolled alcohol/drug abuse, and decompensated psychopathological diseases. They received verbal and written information about the trial before the test, and this study was approved by the IRB. Ultrasound imaging (MyLab 25, esaote) was used to measure both thickness of the TrA muscle and CSA of the LM muscle in B-mode with a 7.5-12 MHz linear head transducer. The location of the transducer to measure the thickness of the TrA muscle was placed on the skin halfway between the anterior superior iliac spine and the lower rib cage in the anterior axillary line. The LM muscle cross-sectional area was also measured at the L5 vertebral level. The CSA of the LM muscle was measured by tracing around the muscle border with the on-screen cursor. For consistency, the inner edge of the border was used. Prior to lifting the load, the subjects were standing symmetrically with the trunk flexed...
and the elbows and knees extended as starting position. Then subjects were instructed to lift the load (0, 5, 10, 20%Body Weight; BW), and to hold the load in upright standing posture with the shoulders flexed at 90°, elbows and knees extended. In each task, measurements of the TrA muscle and the LM muscle were performed three times. Therefore, the total trials were twelve times, and the total twenty four images were used for statistical analysis. Each task was completed with a minimum of 1 minute of rest between each load condition. For statistical analysis, the Statistical Package for Social Sciences (SPSS) was used for data analysis. The interrelationships between the thickness of the TrA muscle and the CSA of the LM muscle were quantified using Pearson’s correlation coefficients. Differences were considered statistically significant at P < 0.05.

Results: Results of the Pearson’s correlation coefficients showed that the thickness of the TrA muscle was significantly correlated with the CSA of the LM muscle at 0%BW (r = 0.71, P < 0.05, Figure 1) and 5%BW (r =0.56, P < 0.05, Figure 2) lifting. However, similar results were not obtained at 10%BW (r =0.23, P > 0.05) and 15%BW (r =0.17, P > 0.05) lifting.

Discussion: The present study revealed that the TrA muscle and LM muscle showed a positive correlation at low level activity. Hodges et al. [2] demonstrated that the TrA muscle and internal oblique muscle thickness increased incrementally only with activity less than 20% maximal voluntary contraction. At low activity levels small changes in muscle activity produce large changes in muscle architecture, while at higher activity levels muscle architecture changes relatively little. Moreover, Cholewicki and McGill [3] reported that the LM muscle activity comprising no more than 3% of maximal voluntary contraction was sufficient to ensure segmental stability of the lumbar spine. Therefore, our results may indicate that the TrA muscle and the LM muscle work in a coordinated manner to provide the stability to the spine at only low levels. At higher levels activity, the thickness of the TrA muscle and the CSA of the LM muscle did not indicate a correlation. This could be estimated to reach into plateau at that level of activity. Further, this study suggested that clinicians could confidently use ultrasound to measure muscle activation during low levels of the TrA muscle and the LM muscle. In clinical practice, both muscles are trained together based on the assumption that there is a relationship between two muscles. The present study revealed that the relationship between the TrA muscle and the LM muscle have been correlated at only low levels activity, but higher levels activity. Therefore, when clinicians attempt to rehabilitate these muscles, activation at low level may be more effective.

Significance: This study investigated the relationship between the TrA muscle and the LM muscle during the functional task using ultrasound imaging. Our results suggested that both muscles work in a coordinated manner to provide the stability to the spine at only low levels.
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**Diagram 1:**
- Thickness of the TA muscle vs. CSA of the LM muscle
- Linear relationship: \( r = 0.71, P < 0.05 \)

**Diagram 2:**
- Thickness of the TA muscle vs. CSA of the LM muscle
- Linear relationship: \( r = 0.56, P < 0.05 \)