

Role of Transverse Abdominal Muscle in Trunk Stability

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Description

Mechanical stability of the lumbar spine is known to have implications for injury and chronic low back pain. Even though this topic is fairly covered by scientific literature, the role of abdominal muscles, in particular the deep ones, is often neglected. Especially transverse abdominal (TA) muscle might play privileged role: with mainly transverse muscular fibers, both activated TA muscles compress abdominal cavity generating increase in intra-abdominal pressure (IAP) without exerting any moment on the spine and trunk. It is hypothesized that TA muscles may significantly contribute to lumbar spine stability through increased IAP acting on lumbar lordosis. They may also act through traction in thoraco-lumbar fascia resulting in compressive forces applied to lumbar spine. In contrast to the other abdominal muscles, TA activation seems independent of the direction of the imposed loading. Next paragraphs attempt to provide deeper insight in TA privileged role in spine stability and IAP control.

Inward movement of the lower abdominal wall in supine position produces the most independent activity of TA relative to the other abdominal muscles [1]. The authors reported that regions of TA were recruited differentially and they found an inverse relationship between lumbo-pelvic motion and TA electromyography. During posterior pelvic tilting, internal oblique muscle was most active and with abdominal bracing, external oblique muscle was predominately recruited.

Regional differences were observed in the postural responses of TA with limb movement [2]. According to the authors, the onset of contraction of the upper TA region is delayed compared to the lower and middle TA regions. The postural responses of the abdominal muscles depend on body positions, with recruitment delayed in sitting compared to standing. The authors concluded that there is regional differentiation in TA activity with challenges to postural control and that body position influences the postural responses of the abdominal muscles.

According to [3], TA activation level is uniquely associated with increased postural demand caused by elevated center of mass: TA activation and IAP increase together with imposed flexion moment (arms extended horizontally forward). In contrast to the other abdominal muscles, TA activation is independent of the direction of the imposed moment. Thus, TA assists in counteracting trunk flexion via increased IAP and contributes to general spine stabilization when the trunk is exposed to moderate flexion and extension moments.

In [4], the authors demonstrated on previously developed mechanical model [5] that a single muscle cannot be identified as the most important for the stability of the lumbar spine. According to the authors, spine stability depends on the relative activation of all trunk muscles and other loading variables. The anatomical model consisted of a rigid pelvis and sacrum, five lumbar vertebrae separated by a lumped parameter disc and ligament equivalent for rotational stiffness

about the three axes, rigid ribcage and 90 muscle fascicles. Muscles were represented with the centroid line approach; many of them were forced to pass through several nodes attached to the various vertebrae to account for the curved lines of action. Each muscle consisted of an active contractile part, a passive parallel elastic element, and a passive non-linear tendon [5]. Note that the authors only used surface electromyography data in the biomechanical model to estimate stability of the lumbar spine. This could result in a bias in the model output especially in relation to deep trunk muscles. Also the model assumed spine with no translational laxity with constrained joint translations.

Current scientific evidence suggests that TA muscles play a role apart among abdominal muscles. Depending on postural demands, they contribute to spine stability through IAP generated together with other abdominal muscles, diaphragm and pelvic floor muscles. The onset of their contraction is usually ahead of other abdominal muscles and stronger, thus, having a preparatory role in load bearing action of the trunk independent of direction from which the loading comes. Shortening of trunk muscles latencies occurs under unexpected condition. TA activation level correlates with the arm movement amplitude under expected condition showing anticipatory preparation.

This privileged role of TA muscle might have important implications and should be accounted for in workplace ergonomics, in therapies as well as in special surgical techniques like Transverse Abdominis Release (TAR) which is a posterior component separation performed in complex abdominal wall reconstruction [6]. Dysfunction in this deep abdominal wall muscle might impair trunk stability possibly resulting in injury and/or chronic low back pain.

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