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Review Article

Activity of Core Musculature during Bridging Variations – An Overview

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Abstract

Neutral zone in spinal stability plays a vital role in core stability .it has been proven that before initiation of any limb activity first transverses abdominis is electrically active and then peripheral concerned musculature acts. Difference in activation and cross-sectional area of trunk muscles have been demonstrated between LBP patients and healthy controls. As part of stabilization exercises bridging is a common exercises. Bridging has many variations and it becomes imperative that exercise which elicits maximum electrical activity may be therapeutically more suitable. . The supine posture with knees and hips bent used during bridging exercise is to most LBP patients a comfortable, pain-free posture. From this position more graded activities can be performed such as lifting the pelvis. In order to create more functional tasks, limb movements can be added. An unstable support surface cause body perturbation, leading to an increase in activity by the trunk muscles in an effort to maintain postural stability. An unstable surface is used during the bridging exercise; the co activation of trunk muscles may be enhanced to reduce body perturbation. **Conclusion:** Along with limited literature there is conflicting evidence as to the activation of core musculature with different bridging stabilization exercises.

Keywords: EMG; Core muscles; Bridging; Transversus abdominis; Multifdus; Unstable surface.

Concept of core

The core could be understood as a muscular cylinder with the abdominals anteriorly, gluteals posteriorly, the diaphragm as roof , and the pelvic floor as the floor.[1] The core musculature generally support the lumbo-pelvic-hip complex eventually stabilizing the pelvic and spinal region, and kinetic chain during functional movement.[2] Tse *et al* define the core musculature includes muscles of the trunk and pelvis that are responsible for maintaining the stability of the spine and pelvis and are critical for the transfer of energy from larger torso to smaller extremities during many sports activities.[3]

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Anders Bergmark classified the musculature of core into local muscle system and global muscle system.[4] Local muscle system consists of slow twitch fibers which are shorter in length and are controlling inter segmental motion in responding to the changes in posture and extrinsic loads. These muscles are primary stabilizers because they do not generate enough force to create movements in the joints through which they pass.[5] Local muscles include transverse abdominis, multifidi, internal oblique, deep transversospinalis and pelvic floor muscle. On the other hand global muscle system comprise of fast twitch fibers which are longer in length and possess large lever arms, allowing to produce large amounts of torque and gross multiplanar movements while countering external loads for transfer to the local musculature.[2] Global muscles include erector spinae, external oblique, rectus abdominis and quadrates lumborum.[6]

The musculatures of the abdominals are the very vital component considering core. The transverse abdominis received more attention in spinal stabilization. The transverse abdominis originates from multitude of structures and finally inserts into the diaphragm, inguinal ligament and iliac crest.[7] The fibers of TrA runs horizontally (except for the most inferior fibers, which run parallel to the internal oblique muscle) creating a belt around the abdomen found the fascicles of transverse abdominis varied in their orientation between regions, in upper regions the fascicles are horizontal and increasingly inferomedial in the middle and lower regions.[8]. The internal oblique and the transverse abdominis work together to increase the intra-abdominal pressure from the hoop created via the thoracolumbar fascia. Increased intra-abdominal pressure has been shown to impart stiffness to the spine.[9]

The unisegmental lumbar multifidus are the most medial of the lumbar spine muscles ascending from the spinous processes caudally two to five levels, functioning primarily as an extensor of the spine [10]. Being twice as large in number as any other muscle in the lumbar region and unique in its fiber arrangement indicates it's architecturally designed to produce very large forces over a narrow range of length.[11] Additionally, research has reported a smaller cross sectional area of the lumbar multifidus has been associated with increased hip, groin, and thigh muscle injuries in athletes.[12] The transverses abdominis and multifidi fire prior to any movement.[13,14] However, patients with LBP have delayed contraction of the transversus abdominis and multifidi prior to limb movement.[13] This Evidence suggests its preparatory stabilizing effect to the trunk will allow force production at the extremities.

Core stability

Core stability or core strengthening is a well known term in the sports medicine and rehabilitation. The terms "core stability" and "core strength" are commonly interchanged throughout literature.[15,16,17] The focus of the rehabilitation research is on improving the quality of life of non-athletic people who are suffering from low back pain, leaving them unable to perform simple everyday tasks.[14] According to Hibbs *et al*, general everyday tasks, such as walking, require much less core strength and stability as compared to dynamic athletic movements, due to their low load nature. It is quite reverse in the athletic setting, which is focused on enhancing performance through training that involves heavily loaded and dynamic movements (i.e., athletic movements).[14] Leetun *et al* noted that athletes must have adequate strength in the lumbo-pelvic-hip complex in order to provide spinal stability throughout athletic movements.[18] Panjabi defines ''clinical instability as the loss of the spine's ability to maintain its patterns of displacement under physiologic loads so there is no initial or additional neurologic deficit, no obvious deformity, and no disabling pain''.[19] Punjabi defines spine stability as combination of interdependent elements: Passive subsystem (osseous, articular and ligamentous elements), Active subsystem (muscular elements) & Neural subsystem (neural elements).[20,21]

Passive subsystem only provides stability towards the end ranges of motion as the ligaments develop tension that resist spinal motion.[22] Proprioceptive capability is the paramount function of passive subsystem.[23]

Active subsystem provides substantial stability to the spine in the vicinity of the neutral zone (region of intervertebral motion around the neutral position (neither in flexion nor in extension)) with the contribution of neural elements. The ligamentous spine will fail or buckle under compression loads of as little as 2 kg or 20 N).[24,25] This inherent instability along with the tremendous demand required during different activities necessitates the role of active subsystem. Due to inherent instability the role of musculature is to stiffen the spine during the movements. [9] Therefore, the active spinal muscles of the trunk and pelvis are responsible for maintaining core stability as well as providing and transferring energy from proximal to distal body parts.[26] Activation of muscle and the stiffness is an important concept. Activation of muscle increases stiffness, both in muscles itself as well as joints which it crosses. Activating a group of muscle synergists and antagonists in the optimal way becomes a critical issue.[27] Leetun *et al* stated that the motor control and muscular capacity create core stability.[17] It is been well estabilished that the core muscles provide an important role in stabilizing the spine.[27,28] In the neutral zone Neural subsystem provides afferent information related to intersegmental joint position. When there is a normally functioning subsystems, the size of the neutral zone is maintained, providing mechanical stability of the spine. The size of the neutral zone has been shown to increase with ligamentous injury and intervertebral disc degeneration[29] and is thought to increase gradually due to dysfunction of any of the subsystems leading in consequences of chronic pain and disability. Finally, dynamic stability is dependent on two-way neuromuscular input to control the trunk during movements in response to forces generated from distal body segments for expected or unexpected perturbations.[30] The stability of the core is dependent on the integration of sensory, motor processing and biomechanical strategies and the ability to anticipate change.[31]

Neuromuscular control of core

The motor control model of spinal stabilization focuses on the function of deep spinal muscles because these structures are thought to have the ability to control motion between vertebral segments. The motor control approach emphasizes that subjects learn isolated volitional activation of deep trunk muscles.[32] Primarily the transverse abdominis (TrA) and lumbar multifidus (LM). It is commonly identified motor control deficits thought to be present in nearly all types of patients with LBP. A growing body of neurophysiologic and clinical evidence suggests that the deep stabilizing muscles of the spine are impaired in those with LBP.[33,34] Richardson *et al*, which has led to the development of the motor control intervention approach for LBP.[7,35]

Success in a majority of sports is dependent upon producing external forces while maintaining dynamic stability. Balance is maintained by keeping the body's centre of gravity over its base of support. External forces have the potential to disrupt balance by altering the centre of gravity. [36] While external loads are acting on the body, internal forces particularly in the lumbo-pelvic-hip complex are utilized to maintain equilibrium of the body.[37] Communication between the musculature of the core and neuromuscular system is what enables the body to regain this new equilibrium state and allow for core stability to occur.[38]

Once above mentioned mechanism of core stability fails instability results. Instability is the failure of the core musculature to apply enough force to maintain correct vertebral alignment. [39] In this context loss of core stability would lead to a suboptimal production of external forces. When stability is present, there is a failure to maintain correct vertebral alignment, Cowley *et al* argue that core instability could be caused by deficiencies in muscular strength, muscular capacity and coordination of limb movement or a combination of any of these.[40]

Anticipatory postural adjustments

When a simultaneous task to perform a fast, focal voluntary movement coexists with a task to maintain equilibrium, feed forward adjustments in the activity of the postural muscle are used to counteract the perturbing forces. These reactions are generated by the CNS in anticipation of a perturbation, and therefore they have been termed "anticipatory postural adjustments".[41] There is a pre programming of the postural musculature, demonstrated this concept in showing that other muscles contract before the limb agonist when stability is challenged due to limb movement.[26] This postural adjustment allows the body to increase proximal stability and allow distal mobility.

EMG

Prescribing exercise based on these traditional methods may elicit an insufficient training approach. Alternatively, knowledge of neuromuscular activity through various physical fitness exercises can contribute to an improved understanding of function and informed prescription. EMG has been the one of the most researched technique in measuring the electrical activity of the muscle.[42] Recently, other modalities of estimating muscle activation have been implemented including muscle functional magnetic resonance imaging and ultrasound imaging.[43,44] Difference in activation, and cross sectional area of trunk muscles have been demonstrated between LBP patients and healthy controls.[45,46,47] In order to understand the reason for changes in muscle activation related to LBP, understanding about the muscle characteristics in healthy individuals is needed.

Rehabilitative ultrasound imaging (RUSI) permits visualization of the musculature and has been used to examine the function of the TrA.[48] RUSI is a valid tool at measuring muscle activation compared to MRI during an abdominal hollowing task with a correlation of .87.[49]

It also had been found that the multifidi and abdominal muscles require only 5% of a MVC for activities of daily living and 10% of a MVC for rigorous activities to stiffen the spinal segments.[50] Therefore a forced maximal contraction is not needed in order to increase core stability. Work done by researchers found that the amount of stability provided during a given task is dependent upon the load and direction of the load placed on the core.[27,51] Stability is greatest during the most difficult tasks and decreases during periods of low muscular activity.[27]

Bridging exercise as a stabilization exercise

Bridging exercises are a commonly used form of stabilization exercise for the trunk muscles and they can also be applied to a large spectrum of patients with LBP.[52] The supine posture with knees and hips bent used during bridging exercise is to most LBP patients a comfortable, pain-free posture. From this position more graded activities can be performed such as lifting the pelvis. In order to create more functional tasks, limb movements can be added.The movement can strengthen global musculature through weight bearing. It can also facilitate pelvic motion in a standing posture and in preparation for the stance phase of gait.[53]

Unstable surface

An unstable support surface cause body perturbation, leading to an increase in activity by the trunk muscles in an effort to maintain postural stability.[54] Therefore, if an unstable surface is used during the bridging exercise, the co activation of trunk muscles be enhanced to reduce body perturbation. When a back bridging exercise was performed on a unstable supporting surface using a balance pad or an air cushion, the trunk muscle activity increased.[52] The transverse abdominis activity ratio increased during a sling based back bridging exercise when the exercise were performed with abduction of the hip. Although, Imai *et al* used various stabilization exercises and unstable support surfaces.[54] The changes of muscle activities in the back bridging exercise could not be isolated in their study, and there are conflicting opinion on whether using unstable surfaces such as a Swiss ball is effective at increasing the level of difficulty.[55,56]

In a separate study, performing a bench press on an unstable surface was shown to have no effect on electromyographic (EMG) recordings, al-though, force output was decreased.[57,58] In contrast, trunk muscle activity increased when performing a squat on an unstable surface . The patients with LBP demonstrated a tendency to activate their trunk (global mobilizer and local stabilizer) muscles to higher % MVIC levels during the unstable surface, in the supine and prone positions.[59] Concerning the abdominal muscle activity, several studies investigated only the activity of the rectus abdominis (RA) and external oblique (EO).[60,61,62, 63,64, 65,66] Both classified as so-called global muscles. Concerning the back muscle activity, the erector spinae muscles were often considered as one muscle group.[67,52,68]

Conclusion

Consequently, there is a dearth of complete overview of relative abdominal and back muscle activity. As interplay between local and global muscle systems is considered important, analysis is needed to detect the relative contribution of the local to global muscle activity. Hence, further research should emphasize on establishing the differences in electrical activity of various bridging variants.

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