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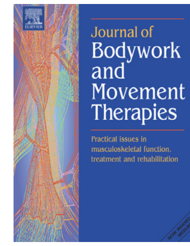

EXERCISE PHYSIOLOGY

Antagonist coactivation of trunk stabilizer muscles during Pilates exercises

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Summary The purpose of this study was to compare the antagonist coactivation of the local and global trunk muscles during mat-based exercises of Skilled Modern Pilates. Twelve women performed five exercises and concurrently, surface EMG from internal oblique (OI), multifidus (MU), rectus abdominis (RA) and iliocostalis lumborum (IL) muscles was recorded bilaterally. The percentage of antagonist coactivation between local (OI/MU) and global muscles (RA/IL) was calculated. Individuals new to the practice of these exercises showed differences in coactivation of the trunk muscles between the exercises and these results were not similar bilaterally. Thus, in clinical practice, the therapist should be aware of factors such as compensation and undesirable rotation movements of the trunk. Moreover, the coactivation of global muscles was higher bilaterally in all exercises analyzed. This suggests that the exercises of Skilled Modern Pilates only should be performed after appropriate learning and correct execution of all principles, mainly the Centering Principle.

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Introduction

The Pilates Method is a kinesiotherapeutic technique widely used by therapists that was created during the First World War by Joseph Pilates. The prescription and composition of the exercises was based on his experience with the rehabilitation of injured people (Loss et al., 2010). This method is based on six principles: concentration, control, flowing, precision, breathing and the centering principle, considered a differential technique of the method (Gladwell et al., 2006). The Centering Principle consists of an isometric contraction of the internal oblique and transverse abdominis muscles, which contributes to increased antagonist coactivation of the deep lumbar muscles (Marques et al., 2012).

Currently, the Pilates Method has been widely applied in physiotherapy for flexibility training, stimulation of blood circulation, improvement of postural alignment and body awareness (Muscolino and Cipriani, 2004). The exercises challenge the stability of the trunk and activate the deep muscles of the lumbo-pelvic region (multifidus, internal oblique and transversus abdominis), and require endurance of trunk muscles (rectus abdominis, iliocostalis lumborum and latissimus dorsi) (Endleman and Critchley, 2008). Thus, the Pilates Method has been used for both prevention and rehabilitation of low back pain (Muscolino and Cipriani, 2004; Endleman and Critchley, 2008).

Low back pain is a common musculoskeletal symptom in modern society that results in significant costs to healthcare systems. It is estimated that 90% of cases of low back pain have a nonspecific origin, so this condition has a multifactorial and complex etiology (Ebenbichler et al., 2001). Among the possible causes of nonspecific low back pain are muscle dysfunctions, changes in motor control and inadequate recruitment of trunk muscles, which lead to reduced stability of the segments of the spine and altered distribution of loads in this region (Ebenbichler et al., 2001).

Recently, Skilled Modern Pilates has been proposed as an adaptation of the traditional Pilates Method which has been widely applied in physiotherapy. This new approach to the Pilates Method uses the philosophy created by Joseph Pilates, but decreases the range of motion of the exercises and requires a neutral lumbar-pelvic posture (Latey, 2001, 2002). Neutral lumbar-pelvic posture is more adapted to the physiological curvature of the lumbar spine and also provides an optimal position to increases the recruitment of deep lumbar and abdominal muscles (Sapsford et al., 2001; O'Sullivan et al., 2006).

According to O'Sullivan et al. (2006), in the lumbo-pelvic upright sitting posture, that is, neutral lordosis of the lumbar spine, the local muscles, multifidus and internal obliquus, had 62% and 30% higher activity (respectively) compared to an extended thoracolumbar spine posture, and 62% and 48% higher activity (respectively) compared to a relaxed thoracolumbar spine with a posteriorly rotated pelvis. Additionally, spinal stability is increased with the coactivation of the local trunk muscles and this strategy promotes protection of spine structures during the performance of functional activities (Arokoski et al., 2004). In this regard, electromyography has proven to be an important tool to study the function of the neuromuscular system of the low back by quantifying the coactivation of antagonist muscle groups (Granata et al., 2005).

The stability of the segments of the spine is provided by the interaction of three subsystems: active, composed by skeletal muscles surrounding the spine; passive, composed of vertebrae and their articular structures; and neural, composed of afferent, efferent, and central neural control mechanisms (Panjabi, 1992). In physiological conditions, these subsystems provide spinal stability, principally, with the recruitment of the trunk muscles, which provide dynamic stability (Panjabi, 2003). Moreover, it is suggested that the most widely used mechanism for the maintenance of spinal stability is the coactivation of trunk muscles, since this strategy promotes protection of spinal structures during the performance of functional activities. In this regard, electromyography has proven to be an important tool to study the function of the neuromuscular system of the low back by quantifying the coactivation of antagonist muscle groups (Granata et al., 2005).

Studies of spinal stability point to structural differentiation of local and global trunk muscles based on their direct or indirect attachment to the vertebrae. The local muscles, such as multifidus (MU) and internal oblique (OI), despite having a limited capacity to generate torque, have insertions on the vertebrae, which contribute to control the movement of each lumbar vertebra. On the other hand, the global muscles, such as the rectus abdominis (RA) and the iliocostalis lumborum (IL), cross several joints with attachments to the pelvis and the thorax, have a larger moment arm, and are suited to the control of trunk orientation and the resistance of external forces (Bergmark, 1989; Hodges, 2003).

In clinical practice, the largest recruitment of global muscles seems to be associated with an increase in spinal load that has the potential to cause injury or worsen pain in patients with low back pain (Arokoski et al., 2004). According to Arokoski et al. (2004) therapists should find more cautious exercises to challenge the local stabilizing muscles of the lumbar spine without placing an excessive load on the structures of this region. Thus, considering the importance of lumbopelvic and segmental spinal stability and the relationship to the trunk muscle response, the mat-based Skilled Modern Pilates exercises can be an alternative to improve conditioning and strength of trunk muscles without overloading the passive structures of the spine (Arokoski et al., 2004).

In addition to focusing on the activation of local muscles, the Skilled Modern Pilates exercises are performed in a neutral position that leads to greater local muscle recruitment than global recruitment (O'Sullivan et al., 2006). Also, these exercises can be considered functional since they require the recruitment and sensoriomotor control of the trunk muscles while performing limb movements (Menacho et al., 2010).

To our knowledge, no study had investigated the differential activation of local and global trunk muscles during these exercises. Therefore, the purpose of this study was to compare the antagonist coactivation of the local and global muscles during several mat-based Skilled Modern Pilates exercises to ascertain which exercises stimulate