CYBEX RESEARCH INSTITUTE

TRUTH ON FITNESS: ARE WE MYSTIFIED BY THE CORE?

PART III: SIGNIFICANCE

Cory L. Hofmann, M.S.
Research Project Manager,
Cybex Research Institute

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Introduction

With an understanding of the definitions related to the core as well as tests currently utilized to measure core function, now it is possible to attempt to determine what aspects of core function hold any significance toward injury prevention or functional outcomes. Are we mystified by the core, or is there evidence to suggest that it is truly critical to function?

Injury prevention and rehabilitation

One of the sparks behind the importance of core stability training resulted from studies showing changes in the timing and pattern of neuronal firing of the core musculature in individuals suffering from lower back pain (LBP; Hodges and Richardson 1996, Hodges and Richardson 1998). This should not be surprising, as it is well known that motor unit recruitment is altered as a result of pain, injury, or fatigue and these changes can vary between static and dynamic conditions (Graven-Nielsen and Arendt-Nilsen 2010). Despite this, core stability training has been touted as the best way to rehabilitate LBP while ignoring the fact that many forms of exercise, even ones not focused on the core, are equally effective in rehabilitating back pain (Ariyoshi et al. 1999, Cairns et al. 2006). The idea that a stable core is critical in reducing LBP has expanded to the notion that increasing core strength can prevent back pain, a process commonly referred to as 'prehab.' However, research tracking athletes over the years following a core strengthening program has shown no advantage in its ability to reduce the occurrence of LBP in healthy collegiate athletes (Nadler et al. 2002).

If the core musculature is critical to maintaining spinal stability, then it might be valuable to examine the injury rates of populations as a consequence of diminished core muscle function. This idea is discussed in a review examining the relation between abdominal muscle strength and spinal stability (see Lederman 2008). One example of a population with reduced abdominal muscle function is pregnant women, as childbearing results in significant changes in the length and tension-generating capabilities of the abdominals during and up to eight weeks following pregnancy (Gilleard and Brown 1996). One study demonstrated that sit-up performance had no relation to back pain in pregnant women, despite the fact that the ability to perform a sit-up was significantly compromised, an indication

of abdominal insufficiency (Fast et al. 1990). It is possible however, that this inability to perform the sit-up was partially due to the size of the subjects' abdominal region. In a study that measured the effects of a physiotherapist intervention on low back pain following pregnancy, the authors found that only 14% (126/869) of their initial pool of subjects required the experimental treatment due to 'quick recovery in two weeks time' (Bastiaenen et al. 2006). This is intriguing because the incidence of LBP was drastically reduced during a time when all anterior core muscles (e.g., transversus abdominis, internal and external obliques) would be significantly compromised soon following pregnancy. Does this indicate that the core musculature is not important, or that the muscles of the posterior core (e.g., erector spinae) are more critical to maintaining lumbar spine stability? This suggests that the relation between core muscle activity and LBP is weak at best, and in fact that relation between abdominal muscle strength and spine stability might be very weak as well (Lederman 2008).

Some have argued that postural control of the trunk would have an effect on the loading of the lower extremities due to the trunk's mass (Jamison et al. 2012). With this in mind, has core training been associated with a decreased risk of injuries other than that of the lower back? Numerous studies have attempted to answer this, with mixed results. Leetun et al. (2004) found that, out of various measures of hip and core muscle strength and endurance, only external hip rotation strength was a useful predictor of lower extremity injury risk in collegiate basketball and track athletes. Jamison et al. (2012) found that including trunk stabilization exercises with traditional strength training decreased knee abduction moments more so than the same strength training protocol without core exercises, leading the authors to suggest that the core exercises might be important in minimizing the risk of ACL tears. However, these results are confounded by the fact that the trunk stability group was the only group performing lower extremity frontal plane strength training (lateral lunges), which may be a better explanation of that group's decrease in peak knee abduction moment.

Functional Outcomes

It is commonly accepted in the fitness world that core strength and stability are critical for improving athletic performance, and this is often targeted toward runners. One article on the topic states that 'core stability is essential for middle and long distance runners,' followed ironically by the claim that 'in many runners… even at an Olympic level, the core musculature is not fully developed' (Fredericson and Moore 2005). Without providing a single reference in support of their stance, or the rationale behind how an athlete can become an Olympian while lacking such an 'essential' attribute, the authors continue with a discussion of dozens of what they deem to be core stabilizing exercises. Is there any research that supports the claim that the core is critical to performance?

Core endurance

Nesser et al. (2008) found statistically significant correlations between core endurance and various sprinting and strength performance measures in football players; however, these correlations were only weak to moderate, leading the investigators to suggest that '…the challenge of determining the effectiveness of core strength and stability on sport performance remains.' Nesser and Lee (2009) found similar inconclusive relations between core endurance and performance in soccer players, while Okada et al. (2011) found moderate, but significant, correlations between core endurance and two measures of athletic performance: number of single leg squats to failure, and T-run agility test. The researchers concluded that performing poorly in the core endurance test did not influence performance, but these results are somewhat confounded by the limitations of the endurance test protocol (as discussed in Part II). Interestingly, Lehman (2006) and McGill (2002) both argue that only a small level of muscular tension is necessary to stabilize the core, and as a result, core endurance is the most important factor in maintaining spinal stability. However, the demands of simply maintaining a stable lumbar spine versus that of athletic performance are likely different.

Core stability

In order to correlate core stability with several athletic performance measures, Sharrock et al. (2011) performed the double leg lowering test on a group of athletes. The researchers found that the only athletic measure to have a significant correlation was a medicine ball throw, but it was a negative correlation – indicating that higher core stability measures were associated with decreased performance. Jamison et al. (2012) incorporated 'trunk stability' exercises into one of two otherwise identical training groups and found that the trunk stability group demonstrated increased core endurance but no differences in any other strength or agility measure such as the three-cone test, 20-yard short shuttle test, and standing broad jump. Stanton et al. (2004) sought to examine the effects of 'core stability' training on core muscle activity and running economy only to find no significant differences following training, although others have claimed to see improvements in 5K performance following core training, despite no measurable changes in lower extremity biomechanics (Sato and Mokha 2008).

Core power

Utilizing the front and side abdominal power test developed by Cowley and Swensen (2008), Nikolenko et al. (2011) found weak correlations between several performance measures (40-yard dash, shuttle run, vertical jump)

and core power. The researchers did find a statistically significant, but moderate, correlation between core power and back squat strength when normalized to body weight. The group concluded that either '…the core field tests were not [sports] movement-specific, or the core plays little role in the performance tests utilized.' In an effort to develop the abdominal power tests further, Shinkle et al. (2012) performed similar throws with and without the trunk strapped in place, in order to quantify the role of the core, specifically in transferring power to the upper extremities. The researchers compared these fixed (static) and un-fixed (dynamic) medicine ball throws to bench strength, squat strength, jump height, proagility test, and 40 yard dash speed. They found that the only statistically significant strong correlations were between 1) the left static medicine ball throw and 40 yard dash, and 2) the right static medicine ball throw and the proagility test. All other measures of performance, including squat strength, bench press strength, and counter movement jump height, demonstrated little to no correlation with any of the medicine ball throws. An interesting point of note in this study was that the researchers failed to fix the subjects' legs to the ground while performing the dynamic forward throw. Since this was performed in a seated, upright position, the subjects likely were in a significant disadvantage to generate power in this direction; this may account for the fact that the forward throws did not display any strong relations with athletic performance.

The issue with many of these studies is that correlation does not imply causation – in other words, just because some measure of core function demonstrates a strong correlation to functional performance, this does not mean that increased core function would cause an increase in performance. Dozens of variables, with plenty of overlap, can play a role in affecting one's results in a core test or performance test.

Concluding remarks

Finally, there is the possibility that core stability exercises might actually be detrimental to performance. Despite the recent focus on functional training and core targeted exercises, rates of abdominal injury in the sport of baseball have been steadily rising over the past twenty years (Conte et al. 2012). Indeed, Brown et al. (2006) suggests that 'sensory feedback and reflex control of the abdominal muscles is functionally related and would therefore be difficult to separate by conscious effort… Conscious, voluntary overdriving of this natural pattern (of resisting a posteriorly directed perturbation) often resulted in unbalanced muscular activation schemes and corresponding decreases in stability levels.' Although this hardly constitutes evidence that core training is bad, it does, potentially, lead one to question the utility of the practice, especially when coupled with all of the evidence suggesting poor correlations between the core and performance.

The truth is, the core very well may be a critical component of athletic performance, but the limitations in the current methods to quantify core function leave this argument unclear. Thus, not only is there no truly appropriate way to measure the core's importance as it relates to a particular task, but there is also no reliable way to quantify whether core exercises are truly effective. Many studies have shown that training in one particular way makes the subjects better at that particular task, but the issues arise when that new found ability is applied to different tasks. A common thread amongst many of these research studies is the need for specificity – the core test or exercises in question should be similar in nature as the desired functional performance measure. It is difficult to imagine one single test that can accurately describe the core's importance. Ultimately, the core need only function in such a way that accounts for the loading associated with the demands of the task, static or dynamic. Skepticism will remain until a valuable way of measuring the function of the core is developed.

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