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TRUTH ON FITNESS: ARE WE MYSTIFIED BY THE CORE?

PART II: QUANTIFICATION

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Introduction

Part I of this series, a definition of the core and differentiation between core strength and core stability was provided. Many have claimed that the core is critical to athletic performance, by potentially decreasing injury rates of the lumbar spine and lower extremities or by aiding in the transfer of power from the legs to the upper body. Because of this, various tests have been developed in an attempt to measure core function. In addition to testing, many of the activities in these protocols are commonly promoted as exercises to increase core strength or stability. Part II will critically examine many of the popular methods currently used to quantify core function.

Measures of core strength and stability

One of the most common core 'strengthening' exercises (and consequently, one of the most common tests of core function) is the plank to failure. McGill et al. (1999) presented a test of low back stabilization including a series of isometric holds until failure for a variety of trunk orientations. The conditions included: 1. the traditional prone plank, 2. a back extension test, where the subject lay prone with their pelvis and legs stabilized and the upper body unsupported, out over the edge of a table, and 3. left and right side bridges. Although this collection of tests has been validated for repeatability, it is not clear how the isometric endurance of the core musculature is related to its ability to apply force or produce motion. Despite this, the test has been used frequently in assessments of core strength (e.g., Nesser et al. 2008). Additionally, this test only measures the ability of the core to resist motion in a static condition, with no additional force or perturbation other than the individual's upper body weight. In conclusion, this test is a valid measure of the isometric endurance of the core musculature, but its applicability to traditional strength measures is tenuous at best.

In addition to the plank, the traditional body weight sit-up is another common core exercise and is even included in the physical fitness testing for all branches of the United States Armed Forces (Smith 2012). However, the sit-up is a high repetition low resistance exercise. A measure of recording maximal sit-ups in a given time frame is testing isotonic muscular endurance, similar to other low weight-high repetition exercises. Both planks and sit-ups to failure evaluate the ability of a muscle group to resist fatigue with a low external load when the muscle is shortening or maintaining a constant length. Training with planks and sit-ups, therefore, will result in an increase in isometric muscular endurance and fatigue resistance respectively, but not necessarily in core strength. Several studies illustrate how these and many similar core exercises only require minimal core muscle activity, rarely exceeding 30% of maximal voluntary contraction (Stevens et al. 2007), and are unlikely to result in significant strength gains. Another drawback of tests like these is that many target solely the rectus abdominis and other spine flexors while the core musculature contributes to many additional joint actions. Thus, it appears that these tests are not an adequate evaluation of core strength, or ideal strengthening exercises.

The Sahrmann core stability test involves measuring the pressure beneath the lumbar spine while a supine-lying subject lifts one or both legs (flexing at the hip, with the knee fully extended) to varying heights (Sahrmann 1991). A similar test, the double leg lowering test (Sharrock et al. 2011), has also been developed in an attempt to quantify core stability. Since both of these tests are performed at slow speeds, it would be hard to argue that they could be a good predictor of the ability of the core to maintain a desired spinal position during high speed, dynamic exertions. In addition, since they are performed with the subject lying supine with the trunk fixed, it is unknown how the test would transfer to conditions in which the subject's trunk was not stabilized, as is often the case during sport and exercise (e.g., running, jumping). It is valuable to note that this test is also a measure of the hip girdle musculature's ability to resist anterior pelvic tilt, the importance of which is unclear during functional tasks.

Cowley and Swensen (2008) have recently developed a test for muscular power of the core, named the Front and Side Abdominal Power Tests (FAPT and SAPT, respectively). These tests involve throwing a medicine ball a far as possible, with isolated joint action (flexion or abduction) at the spine and minimal contribution of the upper extremities. Although arguably a very good predictor of muscular power and strength, this test is likely inappropriate for describing the core's ability to resist motion due to a perturbation, despite the fact that the authors refer to it as a core stability test.

In a recent paper, Jamison et al. (2012) developed a method with which to quantify trunk strength and trunk stability based on the sudden force release test. Subjects were instructed to remain upright in a kneeling position while fixed in place at the pelvis. From this position, a harness was attached around the trunk fixed to a cable at approximately the height of the T10 vertebrae. To measure core strength, the subject would 'pull' isometrically against the cable with their trunk at a maximum effort. The orientation of the subject with respect to the cable could be easily manipulated to test different muscle groups. To measure trunk stability, the researchers instructed subjects to pull against the cable with 30% of their maximal value. At a randomized unknown time, between 1 and 5 seconds, the tension in the cable was released; thus, the ability of the core muscular to react to this by minimizing change in position would be related to trunk stability. With respect to trunk strength, this test appears to have the same limitations of others that record measures in an isometric fashion. And while the stability test undoubtedly measures the trunk musculature's ability to resist motion against a perturbation, the position of kneeling with a fixed pelvis may not be entirely representative of the conditions under which the core must provide stability during sport or activities of daily living. Finally, these tests would provide little evidence that the core musculature is critical in aiding in the transfer of power from the lower to upper extremity.

Static vs. Dynamic tasks

Regardless of whether a test is described as measuring core strength, stability, or endurance, it is clear that there are inherent limitations to all of them. A true overall measure of core stability should take both static and dynamic stability into account. As reviewed by Davis and Marras (2000), core muscle activity and co-contraction increase significantly with dynamic motion of the trunk compared to isometric conditions. It appears that an increase in both muscular strength and adaptability of motor learning patterns during dynamic activities are necessary to maintain safe levels of spinal loading and perhaps stability. None of these aforementioned tests can completely measure how one is able to develop a motor strategy about the spine to minimize injury risk and maximize performance, and there appears to be no gold standard for the measure of core strength or stability (Hibbs et al. 2008). It is clearly not an easy task to measure core function; consequently, it is not easy to quantify the effects that certain exercise protocols have on the core.

The ability of the core to aid in any function (be it goal acquisition or injury prevention) can vary significantly based on the demands of the particular task. With this in mind, it is unrealistic that a single test alone can predict the core's ability to produce or resist motion to meet functional demands. As a result, an appropriate next step is to analyze how various functional performance measures or injury rates are changed as a result of core training interventions. In this way, it is possible to determine if there is a link between core function and athletic performance or injury prevention. Part III will critically analyze the literature in an attempt to do this.

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