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Full Length Article

Load release balance test under unstable conditions effectively discriminates between physically active and sedentary young adults

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ABSTRACT

This study investigates test-retest reliability and diagnostic accuracy of the load release balance test under four varied conditions. Young, early and late middle-aged physically active and sedentary subjects performed the test over 2 testing sessions spaced 1 week apart while standing on either (1) a stable or (2) an unstable surface with (3) eyes open (EO) and (4) eyes closed (EC), respectively. Results identified that test-retest reliability of parameters of the load release balance test was good to excellent, with high values of ICC (0.78–0.92) and low SEM (7.1%–10.7%). The peak and the time to peak posterior center of pressure (CoP) displacement were significantly lower in physically active as compared to sedentary young adults (21.6% and 21.0%) and early middle-aged adults (22.0% and 20.9%) while standing on a foam surface with EO, and in late middle-aged adults on both unstable (25.6% and 24.5%) and stable support surfaces with EO (20.4% and 20.0%). The area under the ROC curve >0.80 for these variables indicates good discriminatory accuracy. Thus, these variables of the load release balance test measured under unstable conditions have the ability to differentiate between groups of physically active and sedentary adults as early as from 19 years of age.

1. Introduction

Traditionally, systems based on force platforms have been utilized to evaluate various aspects of postural control: steadiness, symmetry, dynamic stability, and dynamic balance (Guskiewicz & Perrin, 1996). Steadiness is the ability to keep the body as motionless as possible. Symmetry is the ability to distribute weight evenly between the two feet in an upright stance. Dynamic stability is the ability to transfer the vertical projection of the center of gravity around a stationary supporting base (Goldie, Bach, & Evans, 1989). Dynamic balance is characterized by postural responses to external perturbations from a platform tilting toes up and down or shifting in anterior-posterior and medio-lateral direction. Platform perturbations on some systems (ProBalance Master, EquiTest) are unpredictable and are determined by the subjects positioning and sway

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movement. Other systems (Chattecx Balance System) have a more predictable sinusoidal waveform, which remains constant regardless of subject positioning.

Dynamic posturography aims to distinguish between sensory and motor deficits underlying postural control (Mancini & Horak, 2010). For instance, the Sensory Organization Test (SOT) consists of six conditions designed to evaluate the effects of vision, proprioception, and vestibular input during standing. During the assessment, inaccurate information is delivered to the patient's eyes, feet and joints through sway referencing of the visual surround and/or the support surface. The condition of the SOT during which the support surface is sway-referenced and the subject's eyes are closed is the most sensitive for the assessment of post-exercise postural stability in athletes (Zemková et al., 2005). Dynamic posturography is also more sensitive to differentiate balance performance in healthy young subjects than an assessment of balance under stable conditions (Zemková, Hamar, & Böhmerová, 2005).

However, a variety of systems currently utilized in research laboratories have problems with the standardization of protocols in reporting all characteristics of platform perturbations (Zemková, Kováčiková, Jeleň, Neumanová, & Janura, 2015). These include displacement waveform used to drive plate motion, the range and direction of platform motion, the peak velocity obtained, and the magnitude and timing of peak acceleration and peak deceleration (Brown, Jensen, Korff, & Woollacott, 2001). In addition, most of the dynamic posturography systems are expensive, are not portable, and are more suited for use in clinical medicine. The unstable foam cushion may represent a more practical alternative. It can even be more effective in simulating conditions of daily life, such as thick and plush carpeting, rough and uneven terrain, or certain types of heavily padded shoes. Experience indicates that standing on an unstable foam surface or a spring-supported platform while testing balance function is more efficient for discriminating within-group and between-group differences as compared to static balance tests (Zemková & Hamar, 2015). Unstable conditions are also more effective in revealing slight changes in sensorimotor functions following exercise programs (Zemková, 2010).

It appears that the combination of an unstable foam cushion and unexpected body perturbations may be an appropriate alternative for assessing postural stability in young individuals. Instrumented tests such as trunk repositioning and load release tasks (Reeves, Cholewicki, & Silfies, 2006; Silfies, Cholewicki, Reeves, & Greene, 2007) which are a quick-to-administer, could serve as a possible alternative to overcome the limitations of dynamic posturography. The trunk repositioning tasks require a subject to actively or passively return to a neutral spine position following a predefined displacement. Load release tasks require the subject to perform an isometric trunk contraction at a predefined intensity against an external load, which is subsequently released, and the displacement of the trunk is quantified. Athletes with a recent lower back injury exhibit altered recruitment of the core musculature following load release (Cholewicki et al., 2002). In addition, the repositioning error and the magnitude of trunk displacement during load release are predictive of a lower extremity injury (Zazulak, Hewett, Reeves, Goldberg, & Cholewicki, 2007a, 2007b). While these tests certainly hold prognostic value of injury risk, their relation to physical performance variables in healthy young adults is unknown. This is mainly due to very limited research in this field and that they are mainly used in clinical medicine to test functional impairment among the elderly and those with concurrent neck or lower back pain (Jørgensen et al., 2011; Karayannis, Smeets, van den Hoorn, & Hodges, 2013; Michaelson et al., 2003; Sturnieks et al., 2013). Therefore we intended to partly fill this gap by introducing a test which is easy to administer and could be utilized in rehabilitation and preventive practice.

The primary goal was to estimate the test-retest reliability of the parameters of a load release balance test while standing on both stable and unstable support surfaces. The secondary aim was to determine the sensitivity by comparing physically active young, early and late middle-aged adults with sedentary subjects of matched age. We assumed that the reliability of such a measurement would be comparable to static balance tests, however with a more enhanced potential to discriminate between subjects with varied levels of physical fitness.

2. Materials and methods

2.1. Participants

Six groups of 251 subjects of varied ages (ranging from 19 to 24 years, 25–44 years, and 45–64 years) and levels of physical fitness, volunteered to participate in the study (Table 1). They were recruited mainly from students and employees of various universities and participated in the study over a period of 10 weeks. Three of the groups were physically active while the remaining three were comprised of sedentary subjects.

Sedentary or physically inactive subjects are defined as those with less than 30 min of daily physical activity, which is the generally agreed threshold level for health benefits as a result of physical activity (Booth & Lees, 2006). The sedentary young and middle-aged adults in our study met these criteria. They had not previously participated in any regular exercise program. The physically active subjects participated in sport at a recreational level with an average amount of physical activity of 15 h per week. However, none had performed any specific balance and core exercises or high intensity resistance and aerobic exercise training prior to the study.

Only participants who met the inclusion criteria were allocated to the study. Exclusion criteria included having sustained a lower limb, pelvic, or back injury in the past 6 months, or any neurologic or systemic disease affecting a balance function. Also, subjects with pain or other clinically relevant problems were excluded in order to guarantee that all subjects had a