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Technical and Measurement Report

Intrarater reliability of hand held dynamometry in measuring lower extremity isometric strength using a portable stabilization device

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ABSTRACT

Hand held dynamometry (HHD) is a more objective way to quantify muscle force production (MP) compared to traditional manual muscle testing. HHD reliability can be negatively impacted by both the strength of the tester and the subject particularly in the lower extremities due to larger muscle groups. The primary aim of this investigation was to assess intrarater reliability of HHD with use of a portable stabilization device for lower extremity MP in an athletic population. Isometric lower extremity strength was measured for bilateral lower extremities including hip abductors, external rotators, adductors, knee extensors, and ankle plantar flexors was measured in a sample of healthy recreational runners (8 male, 7 females, = 30 limbs) training for a marathon. These measurements were assessed using an intrasession intrarater reliability design. Intraclass correlation coefficients (ICC) were calculated using 3,1 model based on the single rater design. The standard error of measurement (SEM) for each muscle group was also calculated. ICC were excellent ranging from ICC (3,1) = 0.93–0.98 with standard error of measurements ranging from 0.58 to 17.2 N. This study establishes the use of a HHD with a portable stabilization device as demonstrating good reliability within testers for measuring lower extremity muscle performance in an active healthy population.

1. Introduction

The assessment of strength is a fundamental component of a physical examination. This is typically measured clinically by manual muscle testing (MMT), a procedure for evaluating strength and function of an individual muscle or a muscle group in which the patient voluntarily contracts the muscle against gravity load or manual resistance (Wadsworth et al., 1987; Bohannon, 1990). The tester interprets the results and assigns a grade using an ordinal scale that ranges from 0 to 5 (Wadsworth et al., 1987; Bohannon, 1990).

Despite being the current standard of practice, MMT has several known limitations. Many investigators have cited the inadequacy of MMT for measuring the forces generated by larger muscle groups that produce greater force, particularly in the lower extremities (Beasley, 1956; Wadsworth et al., 1987; Bohannon, 1990). A ceiling effect occurs when many people attain the maximum score on a given test (Bohannon, 1990; Roy and Doherty, 2004). As result, subjects are often given a maximum score despite potential strength deficits that may be detected with more objective tests (Hayes et al., 2002). This phenomenon also limits the ability of MMT to detect changes over time (Hayes et al., 2002).

The current gold standard is isokinetic dynamometry (IKD), which consists of large apparatuses that stabilize the subjects and provide controlled resistance from a motorized component (Deones et al., 1994). The most common isokinetic systems include Biodex, Cybex and Kincom. These options lack practicality in clinical settings due to cost, lack of portability and space requirements. A more clinically viable alternative is hand held dynamometry (HHD) (Wadsworth et al., 1987; Bohannon, 1990; Wikholm and Bohannon, 1991).

Researchers employing HHD have reported concurrent validity for measurement of muscle performance of lower extremity strength in healthy individuals (r = 0.74 to 0.78) when compared to gold standard isokinetic dynamometry (Kolber and Cleland, 2005). These researchers also reported intrasession intrarater reliability of

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lower extremity muscle performance healthy individuals ranging from ICC 0.16–0.98 (Kolber and Cleland, 2005). The wide range of reported reliability can be attributed to differences in testing methods and population investigated (Kolber and Cleland, 2005). Accuracy of HHD measurements can be affected by inadequate strength of the tester and lack of stabilization of subject and device (Wikholm and Bohannon, 1991; Kolber and Cleland, 2005). Studies that incorporate a stabilizing apparatus have demonstrated greater reliability (Nadler et al., 2000; Click Fenter et al., 2003; Kolber and Cleland, 2005; Kelln et al., 2008). Kolber et al. investigated the use of a portable PVC stabilization device (StabD) and HHD, reporting excellent test retest reliability for isometric external and internal rotation of the shoulder (ICC 3,1 = 0.971–0.972) (Kolber et al., 2007). No studies have investigated the use of a PVC StabD for the lower extremity in healthy individuals.

The purpose of this study was to investigate the intrasession intrarater reliability of HHD with use of a portable stabilization device when testing isometric muscle strength of hip external rotation, hip abduction, knee extension and ankle plantar flexion musculature. The Stab D protocol was instituted to address the potential sources of error with use of the HHD due to inadequate strength of the tester and lack of stabilization of subject and device.

2. Methods

2.1. Subjects

Fifteen asymptomatic adult subjects were randomly selected out of a sample of 75 runners recruited from a local running group as part of separate investigation. Subjects completed an intake questionnaire reporting demographic information and running related injury history. Subjects were excluded if they suffered from an injury requiring care from a medical professional or miss two running sessions within the past three months. Testing was conducted and data was recorded on bilateral lower extremities for each subject, N = 15 (30 limbs). Subjects who met study requirements were provided with an informed consent document approved by the Institutional Review Board at Nova Southeastern University.

2.2. Hand held dynamometer and stabilization device

Isometric muscle performance was measured using the micro*FET II*^{TM} (Hoggan health industries, Draper, UT, USA) portable hand held dynamometer (Fig. 1) is a battery-operated, load cell system with a digital reading of peak force ranging from 3.6 N to 1334.5 N in 0.4 N increments (MicroFet 2 Hoggan Health Industries, 2016).

Fig. 1. Micro*FET II*™.

Fig. 2. Hip abductor MP.

The StabD was constructed of PVC pipe with one end used to accommodate the microFET2 and a wider base on the other end to allow for greater surface area contact when stabilizing against a wall.

2.3. Procedures

Hip Abductor MP was measured in supine on a table with a stabilizing strap across the pelvis. The force pad of the HHD was placed 5 cm above the lateral malleolus with other end of StabD stabilized against a wall (Fig. 2).

Hip adductor MP was measured in supine on a table with a stabilizing strap across the pelvis. The force pad of the HHD was placed 5 cm above the medial malleolus with other end of StabD stabilized against a wall (Fig. 3).

Hip External Rotator MP was measured with subjects in the sitting position on the edge of a table with hips and knees flexed to 90°. The test leg was anchored with a strap at the thigh and a towel roll was placed between the legs to limit involvement of hip adductors (Ireland WJ et al, 2003; Leetun et al., 2004; Bolgla, 2008; Dierks, 2008). The force pad of the HHD was placed 5 cm proximal to the medial malleolus of test leg with other end of StabD against a wall (Fig. 4).

Knee Extensor MP was measured with subjects sitting on the edge of the table with hips and knees flexed to 90°. A stabilizing strap was placed over bilateral thighs just distal to the hip joint line

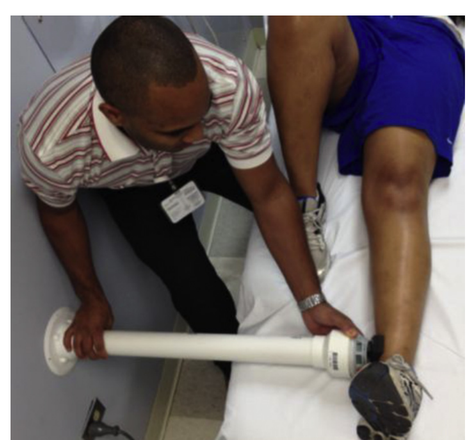

Fig. 3. Hip adductor MP.

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