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Original article

The Star Excursion Balance Test: Criterion and divergent validity on patients with femoral acetabular impingement

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ABSTRACT

Background: A valid functional test, evaluating dynamic balance control, might be valuable clinic tool for evaluation of treatment outcome on patients with femoral acetabular impingement (FAI).
Objectives: The aim of this study was to evaluate criterion and divergent validity of the Star Excursion Balance Test (SEBT) on patients with bilateral FAI- changes, with unilateral clinical symptoms.
Method: In this cross sectional correlational and comparative study fifteen patients with bilateral FAI with unilateral symptoms and 15 controls participated. Criterion validity was determined by analysing agreement between SEBT and The Copenhagen Hip and Groin Outcome Score (HAGOS), The Hip Sports Activity Scale (HSAS), pain and leg strength on FAI patients. Divergent validity was determined by comparing SEBT on FAI patients with controls and by comparing SEBT on patient's symptomatic and asymptomatic hips.
Results/findings: SEBT posterolateral and posteromedial direction had high criterion validity in relation to HAGOS subscale pain intensity and symptoms ($r^s = 0.75$, $p = 0.001$, respectively $r^s = 0.70$, $p = 0.004$). Criterion validity was low in relation to HAGOS subscales sports, recreation, participation in physical activity and quality of life. SEBT in the posterolateral and posteromedial direction had good divergent validity ($p = 0.006$, respectively $p = 0.001$) and in the posterolateral direction SEBT could differentiate between patient's symptomatic and asymptomatic hip ($p = 0.005$).
Conclusions: SEBT in posterolateral and posteromedial direction has good criterion validity in relation to pain and other symptoms. In the posterolateral and posteromedial direction SEBT also had divergent validity. Clinically it is recommended to combine SEBT in the posterolateral and posteromedial direction with other measurements on patients with FAI.

1. Introduction

Femoral acetabular impingement syndrome (FAI) derives from morphological changes and symptoms related to the hip in young and middle-aged active adults. These are known as cam lesions (loss of femoral head–neck offset), pincer lesions (global acetabular over coverage) or a combination of the two, which is most the common (Bedi and Kelly, 2013). The typical changes can cause impingement between the neck and the rim of the acetabulum, resulting in hip-related pain and disability (Bedi and Kelly, 2013; Rubin, 2013). The prevalence of FAI pathology is unknown in the general population (Levy, 2011), but the typical morphological findings exist in 10–74% of asymptomatic individuals (Reiman and Thorborg, 2015).

FAI can induce changes in muscle forces and strain in the pelvic region and can affect hip add- and abductors, the hamstrings muscles and iliopsoas and contribute to abnormal stress and asymmetric load between the femoral head and the acetabulum in standing and in repetitive movements. This in turn can lead to instability of the hip joint and reactive hip pain in extreme flexion movements (Bedi and Kelly, 2013).

Non-operative treatments for FAI have been suggested to be the first treatments of choice. Wall et al. concluded in their review that physical therapy have some benefits to patients, but studies on the outcome of physiotherapy treatment are needed (Wall et al., 2013). To evaluate treatment, and possibly also for diagnostic purposes, functional performance tests can add valuable information. At

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present, it is unclear which functional performance tests are most appropriate to use in FAI patients (Kivlan and Martin, 2012), there is a great demand for functional tests that can determine pathology and treatment outcome (Reiman and Thorborg, 2015).

The Star Excursion Balance Test (SEBT) is a functional performance test to assess dynamic postural control (Winter et al., 1990). The SEBT has shown validity in relation to hip abductor muscle function (Hubbard et al., 2007; Norris and Trudelle-Jackson, 2011) and a relationship to the hip range of movement (ROM) (Robinson and Gribble, 2008). The SEBT has been used in research and in clinical practice to examine lower extremity injuries (Gribble et al., 2012). The test is suitable for young, physically active individuals but its validity has not been evaluated in relation to patients with FAI (Gribble et al., 2012).

The aim of this study was to evaluate criterion and divergent validity of the SEBT on FAI patients.

2. Material and methods

The study was cross-sectional with a correlational and comparative design.

Criterion validity was determined by comparing the agreement between the SEBT and the Copenhagen Hip and Groin Outcome Score (HAGOS), the Hip and Sports Activity Scale (HSAS), pain intensity and the chair stand test.

Divergent validity was determined between FAI patients and a group of individuals with no symptoms of FAI. Additionally, it was analysed whether SEBT differed between a patient's symptomatic and asymptomatic hips.

2.1. Study samples

All participants were recruited from the orthopaedic department of a regional hospital in a Central Swedish city between February and April 2014.

2.1.1. FAI group

Twenty-nine patients, all of whom were referred to the physiotherapy department at the same hospital, were checked for eligibility and asked to participate. Those patients had all X-ray-verified bilateral morphological changes and were diagnosed by two experienced orthopaedic surgeons. They were scheduled for arthroscopic treatment and were referred to the physiotherapy department for a pre-operative examination.

Inclusion criteria: Diagnosed FAI with one symptomatic hip/side and age 16–60 years.

Exclusion criteria were: Previous injury and/or diseases (except FAI) which could influence balance and strength in the lower extremities, spontaneous improvement since decision for arthroscopic treatment, or deficient Swedish language.

Seven of the 29 eligible patients had bilateral clinical symptoms and X-ray-verified FAI, two had trochanteritis, one had hip osteoarthritis, one had another disease affecting balance, one declined to participate, one failed to show up and one had markedly improved at the second measurement. Fifteen patients fulfilled the study criteria and participated in the study.

2.1.2. Comparison group

Fifteen individuals with similar age and gender profile as the patient group, but without symptoms of FAI were recruited from the personnel staff of the transport, service and logistic department in the same hospital. Inclusion and exclusion criteria for this group were similar as those for the FAI group. There were no significant differences between the FAI and comparison groups outside of pain and the FAI diagnosis (Table 1).

In connection to the physiotherapy visit, the patients who met the criteria received oral and written information about the study and were asked to participate by the physiotherapist who did the preoperative test. Written consent was obtained from all participants.

2.2. Measurements

All participants were tested using the SEBT and HSAS. The HAGOS, pain intensity and one leg raise tests were only performed on the FAI patients. All measurements were performed by the same physiotherapist (HK) who had several years' experience of this patient group.

Patient-reported hip and groin disability was measured by the Copenhagen Hip and Groin Outcome Score (HAGOS), which comprises 37 items in six Likert subscales, each with grading from 0 to 4 where 0 represents no symptom/disability and 4 represents constant symptom/disability. The subscales are symptoms (7 items), pain (10 items), physical function in activities of daily living (ADL) (5 items), function in sports and recreational activities (8 items), participation in physical activities (2 items) and hip- and/or groin-related quality of life (5 items). Each subscale is computed by a matrix, and the total score can vary from zero to 100 (Thorborg et al., 2011).

The HAGOS has acceptable psychometric properties (Munro and Herrington, 2010) (Thorborg et al., 2011). The HAGOS has been recommended as suitable for patients undergoing treatment for FAI (Thorborg et al., 2011; Harris-Hayes et al., 2013). The test has been culturally adopted and translated into Swedish (Thomee et al., 2014).

Physical activity level was measured by the Hip Sports Activity Scale (HSAS). This scale is based on the Tegner activity level scale (Tegner and Lysholm, 1985) and ranges from 0 to 8, where 0 represents no physical exercise and 8 represents competition in sports at a national or international top level. The scale was adjusted to hip-related disability by an expert panel and has been reported to have excellent test–retest reliability in both German and English, with intraclass correlation coefficients of 0.94 and 0.96, respectively, and acceptable content and construct validity (Naal et al., 2013). It has been adopted and translated into Swedish (Sansone et al., 2014; Thomee et al., 2014). In this study, the patients reported current and desired activity level.

Pain intensity at activity during the most recent week was measured by the Visual Analogue Scale (VAS) on a 0–10 scale (Price et al., 1983).

Functional strength was measured by a one leg raise test from sitting to standing. The test was a modification of the 30 s chair stand test, accomplished on one leg only, from a chair with a height of 44 cm. The patients crossed their arms in front of their chest and the opposite leg was unsupported and extended in front of the body. The number of correct rises during 30 and 60 s were measured. The original test has shown satisfying test–retest reliability (Jones et al., 1999).

Dynamic balance was measured by the Star Excursion Balance Test (SEBT) (Gray, 1995) The test is a series of single-limb squats where the patient stands on the leg to be tested and uses the non-stance limb to reach maximally and touch a point along one of eight designated lines on the ground. The lines are arranged in a grid that extends from a centre point and are 45° from one another, formatting a stylistic star. The directions of the pointing leg are anteromedial, anterolateral, medial, lateral, posterior, posteromedial and posterolateral. Good reliability and validity of this test have been reported, and the test has been recommended for both healthy people and for people with injuries to the lower extremities (Gribble et al., 2012). In this study, the test was modified and only the