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The ability of modified star excursion balance test to differentiate between women athletes with and without chronic ankle instability

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ABSTRACT

The Star Excursion Balance Test (SEBT) is one functional clinical test that widely used to assess dynamic balance in patients with ankle injuries. Since the ability of this test to detect impairments between athletes with and without chronic ankle instability(CAI) is not clear, the aim of present study was to determine if the modified SEBT could detect reach deficits in patients with unilateral CAI. A convenience sample of thirty elite and sub elite women athletes were selected and assigned into two groups: CAI group (Mean ± SD: age: 25±3.5 years; height: 1.68±0.09 m; weight: 62.7±7.3kg), and healthy controls (Mean ± SD: age: 26±4.2 years; height: 1.69±0.05 m; weigh t: 62.7±7.3 kg).The dynamic balance test was obtained using modified SEBT from both limbs of each participant. The independent sample t-test was used for both between group and within group inter-limb comparisons. There was no significant difference in any directions of modified SEBT between two groups in both limbs. No significant inter-limb differences were also observed within both groups. The modified SEBT may not enough sensitive to differentiate between athletes with and without CAI. Other factors such as ankle range of motion, muscle strength and pain intensity should be considered for better interpretation of the SEBT results.

INTRODUCTION

Ankle sprains are one of the most common lower extremity injuries and the most common injuries in sport[1]. After initial injury, the rate of recurrence may be as high as 80% among active individuals. Altered mechanical joint stability due to repeated disruptions to ankle integrity with resultant deficits in neuromuscular control has been described as chronic ankle instability(CAI)[2].

Several authors have speculated that sensorimotor deficits are the primary cause of CAI and should be the primary target of conservative intervention strategies[3-5]. Aspects of neuromuscular control may be quantified through measures of postural control[2]. Clinicians often use postural control assessments to evaluate risk of injury, initial deficits resulting from injury, and level of improvement after intervention[6]. Postural control deficits during quiet standing after acute lateral ankle sprain and in those with CAI have been frequently reported[7-9], however the sensitivity of these measures has been questioned [10].

One functional clinical test that may be useful to detect deficits related to CAI is the Star Excursion Balance Test(SEBT)[10-12]. The SEBT is a test of dynamic stability associated with lower extremity pathology that may provide a more accurate assessment of lower extremity functions than tests involving only quiet standing [1]. This test used widely in ankle problems such as acute lateral ankle sprain[13, 14], evaluate the risk of sustained ankle sprain[15]and CAI[2, 11, 16, 17].

Because this test consisting of 3 trials, each of 8 different reach direction may be very time consuming[11], the modified SEBT recommended that consists of only 3 reach directions including anterior(ANT), posteromedial(PM) and posterolateral(PL)[18]. This modification substantially reduces the time necessary to perform the SEBT, reduces the level of fatigue development and showed a good reliability in previous studies[6].

Although, in clinical and laboratory settings, the SEBT might be used to evaluate effective intervention and prevention program for lower extremity injuries[6], but there is poor relationship between clinical(reach distance) and laboratory (kinematic of reach) outcomes of this test[16]. Several factors can interfere with the results of the SEBT, including neuromuscular control, range of motion, sensory deficit and proprioception[19] that may affect the reliability of this test. Although the most of evidences support deficits in postural control measured by SEBT, the others revealed that this test is not enough sensitive to differentiate between ankle groups and also between CAI and control subjects [1, 18].

Some previous researches revealed that subjects with unilateral CAI reached significantly less far on their involved limb compared to uninvolved limbs and to the side -matched limbs of a control group[10]. While measures from the SEBTs are reliable, the ability of this tool to detect impairments between healthy and injured subjects has yet to be determined[10]. Based on current evidences, there are conflicting evidences about the ability of the SEBT to differentiate between patients with and without ankle injuries. Therefore, the aim of present study was to determine if the modified SEBT could detect reach deficits in patients with unilateral CAI.

MATERIALS AND METHODS

Subjects

A convenience sample of thirty elite and sub elite women athletes were selected and assigned to two groups: CAI group (Mean ± SD: age: 25±3.5years; height: 1.68±0.09m; weight: 62.7±7.3kg) and control group that were athletes without CAI (Mean ± SD: age:26±4.2years;height:1.69±0.05m;weight:62.7±7.3kg). The sample size was calculated with a power of 80% and significance level of 0.05. The athletes in both groups were played in volleyball, basketball and handball teams four times a week. The control group was matched in age, height, weight and the dominant leg with CAI group. The injured limb in CAI group was the dominant leg. Subjects completed an interview regarding their ankle injury history to determine if they met the eligibility criteria. The inclusion and exclusion criteria that endorsed by the International Ankle Consortium were considered in this study[20].

Subjects were diagnosed as unilateral CAI, if the patients: 1)had a history of at least one ankle sprain on the involved ankle and created at least one interrupted day of desired physical activity with inflammatory symptoms, 2) reported more than two episodes of the ankle giving way on the involved side in the past 6 months, 3) had no history of previous surgeries to the musculoskeletal structures, 4) had no history of a fracture in either lower extremity requiring realignment and, 5) had no acute injury to musculoskeletal structures of other joints of the lower extremity in the previous 3 months that impacted joint integrity and function, resulting in at least one interrupted day of desired physical. One of the diagnosis criterions of CAI in International Ankle Consortium guideline was the general self reported foot and ankle function questionnaire. This questionnaire was not considered as our inclusion criteria, because the reliability and validity of this questionnaire was not investigated to date in Persian. After that, the anthropometric data were collected and finally the dynamic balance test was obtained from each participant. The study was approved by the local ethical committee and an informed consent was obtained from all participants.

Procedure

Dynamic balance was assessed using the modified SEBT. The modified SEBT measures the reach distance in ANT, PM and PL directions of “injured” and “uninjured” limbs in CAI group and “involved” and “uninvolved” limbs in control group[21]. The participants were stood with barefoot in the center of grid laid on the floor with 3 lines extending at 135º and 90º increments from the center of grid (figure 1). They maintained a single leg stance on one leg, while reaching with the contralateral leg as far as possible along the chosen line.

Figure 1: The modified SEBT in anterior (left picture), posteromedial (middle picture) and posterolateral (right picture) directions

The maximal reach distance was measured by marking the tape measure with erasable ink at the point where the most distal part of the foot reached. The trial was discarded and repeated if the participant failed to maintain unilateral stance, lifted or moved the stance foot from the grid, touched down with the reach foot or failed to return the reaching foot to the starting position. The test was obtained from both sides with 5 minutes rest between them. Reach distances were then normalized to subjects' leg length, which was measured from the anterior superior iliac spine to the distal tip of the medial malleolus [22]. The mean of the normalized reach distances for the 3 trials in each direction were calculated and served as the dependent measures.

Statistical analysis

One-sample Kolmogorov-Smirnov test of normality was used to test the normal distribution of data. We used independent sample t-test for between group comparisons. We also used the independent sample t-test for within group comparisons to compare differences between two limbs in each group. The data were mentioned in Mean (95% CI) with a significance level of $p<0.05$.

RESULTS

Analysis revealed no significant differences between injured limb of CAI group and involved limb of controls in the mean group differences of reach distances. Also no significant differences were observed in the mean group differences of reach distances between uninjured limb of CAI group and uninvolved limb of controls(table 1).

Table 1: Between group comparisons of mean group differences in reach distances*

Reach direction	Injured-Involved mean differences (95% CI)	p-value	Uninjured –uninvolved mean differences (95% CI)	p-value
ANT	-0.69 (-4.48,3.11)	0.72	-1.52 (-5.27,2.23)	0.42
PM	-1.57 (-6.66,3.51)	0.53	0.71 (-4.02,5.43)	0.76
PL	-3.95 (-11.49,3.59)	0.29	-2.73 (-9.68,4.23)	0.43

**N=15 in each group*

Table 2: Within group comparisons of mean reach distances*

	CAI group		P	Control group		P
Reach direction	Injured	Uninjured		Involved	Uninvolved	
ANT	79.83 (76.47,83.19)	78.90 (75.44,82.37)	0.68	80.52 (78.40,82.64)	80.42 (78.57,82.27)	0.94
PM	108.24 (104.52,111.96)	110.82 (107.01,114.63)	0.31	109.81 (106,113.62)	110.11 (106.98,113.24)	0.89
PL	99.10 (93.26,104.94)	101.04 (95.37,106.71)	0.61	103.05 (97.75,108.36)	103.77 (99.23,108.31)	0.83

**N=15 in each group*

The results of within group comparisons showed no significant differences between the mean reach distances of two limbs in both CAI and control groups(table 2).

DISCUSSION

The aim of present study was to compare the dynamic stability of athletes with and without CAI, based on functional modified SEBT. The primary finding of our study was that there was no significant difference in any directions of modified SEBT between two groups in both limbs. The within group comparisons also showed no significant inter-limb differences in both groups.

The validity of the SEBTs to detect reach deficits in subjects with CAI has yet to be clearly established. This is a difficult challenge, as no dynamic functional test is considered a gold standard for validation of the SEBTs, and there is limited evidence to support the use of specific functional tests to differentiate between individuals with and without CAI.

Dynamic postural control measures usually used to assess the risk of musculoskeletal injury, post injury deficits and amount of improvement after treatments[2,17,23-25]. The ankle is the most common joint that addressed with SEBT. Ankle instability lead to various balance and sensorimotor deficits and these deficits can result in worse SEBT reach distances than healthy subjects. Pathologies of lower extremity can result in postural and neuromuscular control deficits.

The SEBT is a functional method to determine the level of dynamic postural control in individual with lower extremity injury including patellofemoral pain syndrome[26], anterior cruciate ligament reconstruction[23], and CAI [10,17,18,27-30]. In clinical and laboratory settings, the SEBT might be used to evaluate effective intervention and prevention program for lower extremity injuries. The body of evidences suggest that, the SEBT has potential to predict lower extremity injury and is an objective measurement that can determine dynamic postural control impairment related to lower extremity injury[6].

Despite to the results of our study, most of previous studies revealed that ankle instability can lead to postural control deficits measured by SEBT[10,11,27-29, 31]. But the SEBT's data were not normalized in some of these studies. We found only two studies that were similar to our results. Martinez et al reported that reach distances are not enough sensitive and have lower accuracy to differentiate between ankle groups, and wavelet analysis and/or force plate measurements can detect this impairments better[1].

Also, Soften et al revealed that the SEBT cannot discriminate between CAI and control subjects. They conclude that several factor such as muscle strength, flexibility and activity level contributes to SEBT results. They mentioned that inhomogeneity of their population may be the other confounding factor[18]. Some other factors that may change the reliability of the SEBT results are neuromuscular control, core stability, range of motion, balance and proprioception[19].

A recent literature review conclude that outcomes have the low effect size in the ankle instability literature, moderate effect size(o.35) in the anterior cruciate ligament deficient and very strong effect sizes(range:1.30-1.80) for patients with patellofemoral pain syndrome. They also mentioned that all of the confidence intervals in the CAI literatures, crossed zero that have the lesser clinical importance. Similar to ankle literature, in our study, differences in all reach directions crossed zero and this means that they aren't clinically important[6]. Evidences showed that there is poor relationship between clinical and laboratory outcomes, and SEBT is not enough accurate to detect differences between CAI and control subjects[18]. Some recently published guidelines, classified the patients after lateral ankle sprain to lateral ankle sprain coppers(that recovered from initial injury without symptom progression) and CAI[32, 33]. It is mentioned that lateral ankle sprain coppers used different sensorimotor adaptation and different motor strategies after injury[15, 34].

Doherty et al investigated the results of SEBT in three groups and showed that participants with CAI had dynamic balance deficits in relation to both other groups. They observed no differences between lateral ankle sprain coppers and control subjects. In our study we didn't used aforementioned classification system in diagnosis of patient after lateral ankle sprain. Maybe the most of patients in our study were lateral ankle sprain coppers that had not significant balance deficits.

Participants in our study, were included from inhomogeneous population from different sport specialty(volleyball, handball and basketball), that may contribute to our results. We also didn't use functional disability questionnaires as important diagnostic criteria, because the Persian version of these questionnaires were not translated and validated. Considering the smaller sample size, is the other limitation of this study and using the greater sample size can cover the great deal of variability.

It can be concluded that the modified SEBTis not sensitive enough to differentiate between athletes with CAI and the healthy ones. Researchers are encouraged to consider other factors such as ankle range of motion, muscle strength, pain intensity and the other aforementioned confounding factors to narrowly diagnose and classify the CAI and better determination of sensitivity of SEBT for dynamic postural control screening.

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