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ORIGINAL RESEARCH

Effect of cognitive task on postural control of the patients with chronic ankle instability during single and double leg standing

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Chronic ankle instability;
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Summary *Objective:* The aim of this study was to investigate the effect of a cognitive task on standing postural control of the injured and non-injured leg of athletes with chronic ankle instability.
Methods: Postural stability was measured by center of pressure parameters while chronic ankle instability patients ($n = 8$) randomly performed single and double leg standing in isolation or concurrently with a digit-backward cognitive task.
Results: After performing a concurrent cognitive task, anteroposterior sway significantly decreased in injured leg ($P < 0.05$) and area significantly decreased in both injured and non-injured legs ($P < 0.05$). There was no significant difference in all center of pressure parameters between injured and non-injured legs.
Conclusion: The findings confirm the effect of a concurrent digit-backwards memory task on single leg standing balance in chronic ankle instability patients but the response to cognitive loading was not significantly different between the injured and non-injured legs.

Background

Chronic ankle instability (CAI) is one of the most common injuries that can affect a patient's daily living activities. People who experience ankle sprain are at risk for developing chronic ankle instability, which is characterized by

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repeated episodes of giving way after the initial sprain (Hertel, 2002). The recurrence rate has been estimated to reach 80% (Hertel, 2000). Impaired postural control during quiet standing has been reported in CAI patients compared with healthy subjects (de Noronha et al., 2006; McKeon and Hertel, 2008). Loss of sensory input from articular mechanoreceptors (Freeman et al., 1965), decreased muscle strength and endurance, mechanical instability of the ankle joint, and altered ankle range of motion (Riemann, 2002) are the factors contributing to impaired postural control.

While most researchers have investigated sensory and motor components associated with poor postural control in CAI patients (dos Santos et al., 2014; Freeman et al., 1965; Knapp et al., 2011; Loudon et al., 2008; Mitchell et al., 2008; Ross et al., 2009; Tropp et al., 1985), the role of higher cognitive processes of neural components affecting postural control in these patients remains unclear. Recent evidences has indicated that postural control needs some degree of attention, even in young healthy people (Kerr et al., 1985; Woollacott and Shumway-Cook, 2002); in most daily living activities; a balance task and at least one concurrent task are performed together (Huxhold et al., 2006).

In recent years, some researchers have used a new method to evaluate balance control by using dual-task performance (Tenenbaum and Eklund, 2007; Woollacott and Shumway-Cook, 2002). In this method, postural control (primary task) and a cognitive (secondary) task are performed simultaneously (Shumway-Cook and Woollacott, 2000; Woollacott and Shumway-Cook, 2002; Yardley et al., 1999). According to the dual-task method, when two tasks are performed simultaneously, they both compete for attention, which is a limited capacity; thus, the performance of one or both tasks is affected.

The performance of a cognitive load on body sway during a challenging balance task has been reported differently. Some researchers have reported increased body sway (Melzer et al., 2001; Pellecchia, 2003), while others have reported either decreased sway (Andersson et al., 2002; Dault et al., 2001)or no change in postural stability (Teasdale et al., 1993).

Most recent studies have investigated the effect of dual tasking on balance in young and older adults (Bergamin et al., 2014; Moghadam et al., 2011; Polskaia et al., 2015) or in patients with neurologic disorders such as Parkinson's disease or stroke (Jacobs et al., 2014; Ju and Yoo, 2014; Wang et al., 2015), but there is still limited information about this effect in musculoskeletal diseases, especially ankle sprain.

Rahnama et al. compared the interaction of postural and cognitive tasks between individuals with functional ankle instability (FAI) and a group of subjects without FAI. Postural stability during single-limb standing on a Biodex stability system was measured by stability index parameters (Rahnama et al., 2010).

However, to the author's knowledge there has been no study to investigate the effect of cognitive task on COP parameters in patients with chronic ankle instability.

Therefore, the aim of the present study was to examine the effect of performing a cognitive task on single and double leg standing postural control in patients with chronic ankle instability.

Materials and methods

Participants

Eight subjects with a history of chronic ankle instability (ages ranging from 18 to 36) participated voluntarily in this study. They were recruited from the student and staff population of a university community via posters. Subjects were included if they had a history of non-acute, non-operated ankle sprain with a minimum of one recurrent ankle sprain and the sensation of giving way in the last six months and excluded if they had a history of known visual, vestibular, or neurological disorder, auditory or cognitive (memory) deficit, diabetes, or use of any medicine that could affect their balance (Docherty et al., 2006; Mazaheri et al., 2010). The information was gathered by a trained physical therapist using self-report questionnaire and clinical examination. Based on the inclusion and exclusion criteria provided to a physical therapist, from total CAI patients referred to our research center, only three patients excluded. All participants signed an informed consent form approved by the Ethics Committee at Tehran University of Medical Sciences, Tehran, Iran.

Procedure

Postural sway was assessed using a force plate at 4 different levels of difficulty, including: (1) double-leg standing on the force platform with eyes open, (2) double-leg standing with eyes closed, (3) single-leg standing on the injured limb, and (4) single-leg standing on the noninjured leg. All positions were maintained while a cognitive task was performed concurrently. Subjects stood barefoot with their feet pressed together and their arms hanging at their sides. They were not permitted to move their limbs or head or to speak during the data collection period. In the eyes-open positions, subjects were instructed to simply look at a wall approximately 3.8 m in front of their faces. In the eyes-closed positions, subjects wore a blindfold to eliminate visual input.

In trials without a cognitive task as the control or "single task condition" of postural performance, subjects were instructed to stand relaxed for a 30-s data collection period. In single-limb standing (SLS) in the no-cognitive task condition, participants were instructed to stand on one limb with open arms (30° abduction) for 20 s of data collection. The knee of the unsupported leg was in slight flexion (30°) (Mazaheri et al., 2010; Salavati et al., 2009).

During 30-s postural data collection for cognitive conditions, participants were instructed to do silent digit-backward counting by 7 in their minds, starting from a random number, for example, between 200 and 300. They were asked to be as accurate as possible on the cognitive task. Immediately after postural data was collected, subjects were required to tell the number they had reached. This mental cognitive task was chosen to avoid any motor