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PHYSIOLOGY

Effect of low back pain on postural stability in younger women: Influence of visual deprivation

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Summary This study investigated the effect of low back pain (LBP) on body balance during normal and visual deprivation during standing in a LBP group (10 women) and a control group (10 women). A 3-D force plate was used to measure the center of pressure (COP) anteroposterior and mediolateral displacements, and resultant velocity. ANOVA was used to compare situations. LPB group presented higher amplitudes of COP for anterioposterior direction ($p < 0.01$) in conditions of open (3.07 ± 0.53 cm) and closed eyes (3.70 ± 0.71 cm) than healthy women (1.39 ± 0.17 cm and 1.75 ± 0.36 cm, for open and closed eyes, respectively). Similar results were found for COP involving mediolateralsway. The resultant COP velocity was larger for LBP group ($p < 0.05$) when visual information was removed (3.03 ± 0.68 m/s and 3.63 ± 1.33 m/s for LBP and healthy women, respectively). LBP influenced the stability of young women during quiet standing, and the visual deprivation appears to reinforce LBP effects.

Introduction

The ability to control of body balance during standing is dependent on the activity of central nervous system (CNS). The CNS plays a fundamental role for generation and regulation of proper muscle activity to control the relationship between the center of mass projection and the area of support (Winter et al., 1998). The postural stability usually is described by changes in the center of pressure – COP – excursion (Winter et al., 1998). The CNS regulates the body stability while standing or during locomotion mainly by means of afferent information from the visual system (Mergner et al., 2005), proprioceptors organs (Bove et al., 2003; Tresch, 2007), cutaneous inflow (Kavounoudias et al., 1998), and changes in vestibular input (Bacsi and Colebatch, 2005).

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When some restriction occurs, such as absence of visual feedback while standing with the eyes closed, the stability is expected to decrease (Schieppati et al., 1999). Elite gymnast athletes evaluated during bipedal, unipedal and handstand postures in different levels of complexity presented not only direct effect of visual deprivation on the stability evaluated by COP surface and COP mean velocity, but also, for example, the influence of the segment's orientation (Asseman et al., 2005). Visual deprivation can also increase instability in dancers (Hugel et al., 1999). This supports the concept that visual information can influence postural stability mainly by changing the interaction with the environment.

Fear or apprehension, for instance, while standing on platforms of various heights (0.8, 1.6, and 3.2 m) resulted in increased COP variation depending on the degree of fear of falling and anxiety detected (Davis et al., 2008). Additionally, subjects evaluated under a similar protocol also presented changes in H-reflex that could not be explained by the background muscle activation, but were dependent on presynaptic inhibitory mechanisms anxiety-related (Sibley et al., 2007). The authors suggested this theoretical mechanism is also possible due to pain. Indeed, young-trained gymnasts of normal weight and anxiety-free but with low back pain (LBP) presented increased variability of center of pressure (Harringe et al., 2008). The authors investigated whether athletes training and competing with LBP would change their strategies for postural control. The anteroposterior COP excursion while standing with eyes closed on a foam surface was greater in LBP subjects compared to subjects with lower extremity injury (Harringe et al., 2008).

LBP affects the ability to control standing posture (Brumagne et al., 2008a, b). Studies suggest LBP as a public health problem with prevalence up to 20% in USA and up to 40% in European countries (Van Tulder, 1996). Nonspecific LBP has been considered resultant of articular and/or muscular imbalances of the lumbo-pelvic complex (Vogt, 2003) and is more frequent for women (Clarke and Buckley, 1980; Andersen et al., 2006). Among the factors underlying LBP are decrease of agility, coordination and postural control (Alaranta et al., 1994). The low muscular conditioning of muscles of the trunk and lumbo-pelvic complex has also been suggested as influencing the hip strategy for control of body balance in LBP subjects (Carpes et al., 2008).

As a corollary, LBP is known to negatively influence the proprioceptive capacity (Mientjes and Frank, 1999; Brumagne et al., 2008a), which probably leads to increased dependence on the visual system (Brumagne et al., 2000, 2008a). This would be related to similar pre-synaptic inhibitory mechanisms similar those observed in fear/anxiety situations (Sibley et al., 2007; Davis et al., 2008). In this regard, under both quiet stance and dynamic conditions, vision cannot be readily replaced by other sensory inputs in normal subjects (Schmid et al., 2007). If so, the ability to control the body balance in nonspecific LBP subjects, deprived of vision, should result only from non-visual sensory feedback. Thus, visual deprivation in LBP patients may result in more remarkable effects on body balance than would be the case for healthy subjects. The purpose of this study was to investigate the effects of vision deprivation on the body balance of younger women reporting nonspecific LBP.

Methods

Subjects

Institutional approval for all phases of this study was obtained from the Committee of Ethics in Research with Humans of the Institution where this study was developed (IRB number 23081.001276/2007-32). Subjects signed a consent form affirming voluntary participation in the study. The subjects were divided into two groups. The experimental group (LBP) comprised 10 women reporting chronic nonspecific LBP for more than three months (mean $\pm$ standard-deviation age of 20.7 ± 2.1 years old, body weight of 57.6 ± 0.6 kg, and height of 1.65 ± 0.04 m). The LBP group was paired to a control group (healthy) without any LBP episode and without history of lumbar surgery, spine abnormalities, neuromuscular, joint and reflex deficits, cauda equina, carcinoma, pregnancy, or radicular symptoms observed during functional evaluation. These 10 healthy women presented mean $\pm$ standard-deviation age of 20.2 ± 1.7 years old, body weight of 56.7 ± 0.2 kg, and height of 1.66 ± 0.03 m.

The inclusion in the LBP group was based on LBP uni- or bilaterally with nonspecific origin for more than three months, which was confirmed by use of functional tests previously described in the literature for the low back (Gross et al., 1996). The subjects of both the groups had not been involved with regular physical activity during the six months prior to evaluation.

Pain evaluation

LBP was rated by each subjects by means of a visual analog scale from 0 to 10, where 0 represented 'no pain', and 10 represented 'unbearable pain'. The pain grade also suggested 0—2 as 'light pain', from 3 to 5 'light to moderate pain', from 6 to 7 'moderate to intense pain', and from 8 to 10 'unbearable pain' (Bird and Dickson, 2001).

Body balance biomechanical assessment

The biomechanical assessment of body balance followed the protocol described in a recent publication (Carpes et al., 2008). The changes in center of pressure (COP) displacement were measured using a biomechanical 3-D force plate (Advanced Mechanical Technology, Inc., Watertown, MA, USA) placed in the center of a quiet environment and calibrated as described by the manufacturer recommendations. The force plate was embedded at the level of the laboratory floor, and the room presented no visual or auditory distractions. The subjects had their feet positioning marked on the force plate surface in the first trial, and each individual used this template for all the subsequent trials.

Subjects were oriented to stand quietly barefoot separated at a comfortable width (about shoulder-width apart) with their arms resting at their sides. The trials had a duration of 30 s with the subjects maintaining a static posture, and were repeated three times randomly with closed eyes (CE) or opened eyes (OE) in an attempt to minimize variability. The eyes closed characterized the visual deprivation, which was observed by the researcher to make sure that subjects