Short Communication

Postural sway following cryotherapy in healthy adults

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ABSTRACT

In light of the wide use of cryotherapy and its potential negative effects on postural stability, little is known about how postural sway is affected, particularly when the whole lower limb is immersed. The purpose of this study was to analyze the influence of cryotherapy on postural sway in healthy males. Twenty-six subjects were randomly assigned into two intervention groups: control (tepid water at ~26 °C) or ice (cold water at ~11 °C). Postural sway was measured through the center of pressure (COP) position while they stood on a force plate during bipedal (70 s) and unipedal (40 s) conditions before and after the subjects were immersed in a water tub up to the umbilical level for 20 min. COP standard deviation (SD) and COP velocity were analyzed in the anterior–posterior (AP) and medial–lateral (ML) directions. Statistical analysis showed that in the bipedal condition cryotherapy increased the COP SD and COP velocity in the ML direction. During the unipedal condition, a higher COP velocity in the AP and ML directions was also reported. Our findings indicate that cryotherapy by immersing the whole lower limb should be used with caution before engaging in challenging postural control activities.

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1. Introduction

Cryotherapy is one of the most common and inexpensive forms of treatment for both acute and chronic athletic injuries [1,2]. Analgesia and enhanced endurance activities are some of the many benefits that can be experienced with cryotherapy prior to sports participation [1,3]. In contrast, cryotherapy can lead to a loss of sensation by the mechanoreceptors, which may contribute to altered postural stability [4].

There has been conflicting evidence in the literature on whether cryotherapy affects postural stability with some studies observing impaired postural control [4,5], while others reporting no effect [6–8]. This conflicting literature may be attributed to the lack of a control group in studies that investigated the effects of cryotherapy intervention [4–6,8]. Without a control group, attributing the effects to the water temperature or to others factors is difficult.

Another potential difference in the effects of cryotherapy on postural control is that the different studies have investigated only bipedal standing [4,6] or only unipedal standing [5,7,8]. Bipedal standing might be considered a trivial task and a minor effect of

cryotherapy may not be evident. In contrast, unipedal standing is more challenging and changes in postural control due to cryotherapy would potentially be more noticeable. Hence, the investigation of both bipedal and unipedal standing conditions enhances the understanding of the effects of cryotherapy on postural control.

Cold lower body immersion prior to sport participation has increased in popularity despite the fact that its use could potentially impair postural control, which may increase the risk of injury as a result of impaired stability [9]. Hence, a need for greater understanding of the immediate cryotherapy effects on postural control in a controlled study is identified. The aim of this study was to determine the effects of cryotherapy (whole lower body immersion) on postural sway during bipedal and unipedal quiet standing conditions in healthy males. We hypothesized that cryotherapy would increase postural sway in both standing conditions.

2. Methods

2.1. Participants

Twenty-six healthy males were recruited and randomly assigned to either a control or ice group. Detailed demographic information is provided in Table 1. All subjects were recreationally active and were free of any lower extremity injury within the six months prior to the

Table 1
Mean and ± 1 SD characteristics of the subjects in each group and the t-value and p-value for a between-group statistical comparison.

	Control	Ice	t-Value	p-Value
Age (years)	22.9 ± 3.1	26.8 ± 3.9	−2.805	0.007[*]
Height (cm)	176.9 ± 6.1	177.2 ± 10.2	−0.701	0.944
Body mass (kg)	72.1 ± 7.2	75.6 ± 8.1	−1.159	0.253
BMI (kg/m²)	23.0 ± 1.7	24.1 ± 2.3	−4.369	0.163

[*] Statistically significant difference at an alpha of 0.05.

study. Subjects that presented a history of any circulatory, vestibular or contraindication to cryotherapy including Raynaud's disease were excluded from the study. Prior to the test, all subjects read and signed a consent form approved by the Conjoint Health Research Ethics Board by the University of Calgary (E-24788).

2.2. Procedures

Each participant was tested through: (1) standing on both legs for 70 s (bipedal quiet standing) and (2) standing on the force plate on their right leg for 40 s (unipedal quiet standing). During the bipedal condition, the feet were placed with an angle of 30° with the heels positioned 3 cm apart. For the unipedal condition, the right foot of each subject was placed in the middle of the force plate. Ground reaction forces (GRF) were collected with a force plate (Z4852/c, Kistler Instrument AG, Winterhur) at 60 Hz and the signal was amplified with a gain of 2000. In both conditions, subjects were required to stand as still as possible with their arms at their sides in a comfortable position while looking at a cross-marker positioned on the wall 4 meters straight ahead at the subject's eyelevel. After the baseline data collection, they were asked to remain sitting in a water tub for 20 min, immersed up to the umbilical level. The water temperature was constantly monitored and it was set at 26 °C (tepid water) for the control group and at 11 °C (cold water) for the ice group. Following the water immersion, the data collection procedures were repeated to determine the effect of the water intervention.

2.3. Data analysis

The data were filtered with a fourth order low-pass Butterworth filter with a 10 Hz cut-off frequency [10]. From the GRF data we computed the center of pressure (COP) displacement in the anterior–posterior (AP) and medial–lateral (ML) directions. The specific variables analyzed in both bipedal and unipedal quiet standing conditions were COP standard deviation (SD) and COP velocity in the AP and ML directions [11]. All variables were computed using custom algorithms written in Matlab 7.14 (Mathworks Inc., Natick, USA).

2.4. Statistical analysis

Median across trials for each aforementioned variable was obtained for each subject and used in the statistical analysis. A 2×2 mixed factorial ANOVA was carried out, with Intervention (Ice and Control) as a between group factor and time (pre and post) as a within group factor. If a significant interaction between factors was found, a t-test with Bonferroni adjustment was undertaken in the post hoc analysis. A significant level of 0.05 was adopted for all statistical tests. In addition, effect size estimates were computed using eta-squared, η^2, or partial eta-squared, η_p^2. All statistical analyses were performed in R 2.15.1 (R Foundation, Vienna, Austria).

3. Results

Mean and standard deviation of the COP data during bipedal and unipedal standing for groups and conditions are shown in Figs. 1 and 2, respectively.

3.1. Bipedal standing

For the COP SD ML variable, there was a main effect of time ($F(1, 24) = 7.491$, $p = 0.011$, $\eta_p^2 = 0.24$) and an interaction effect between Intervention and time ($F(1, 24) = 10.780$, $p < 0.01$, $\eta_p^2 = 0.31$). The post hoc analysis indicated larger values of the COP SD ML post intervention for the ice group ($p = 0.017$, $\eta^2 = 0.53$). For the COP velocity ML variable, there was a main effect of time ($F(1, 24) = 6.459$, $p = 0.018$, $\eta_p^2 = 0.21$) and an interaction effect between Intervention and time ($F(1, 24) = 10.122$, $p < 0.01$, $\eta_p^2 = 0.30$), whereas the post hoc analysis revealed a larger COP velocity ML post intervention in the ice group ($p < 0.01$, $\eta^2 = 0.41$).

3.2. Unipedal standing

For the COP SD ML variable, there was a main effect of time ($F(1, 24) = 4.845$, $p = 0.038$, $\eta_p^2 = 0.17$, respectively) and no
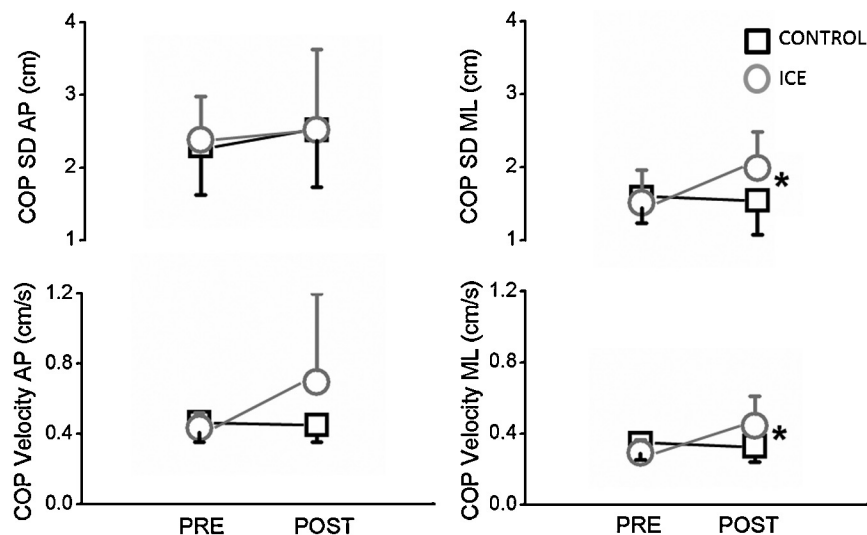

Fig. 1. Mean and standard deviation of the variables COP SD and COP velocity in the anterior–posterior (AP) and medial–lateral (ML) directions for control and ice group during the bipedal stance. *$p < 0.05$.