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COMPARISON OF STANDING POSTURE CONTROL BETWEEN PRE AND POST HEAD OUT WATER IMMERSION

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SUMMARY

The effects of autonomic nervous system by head-out water immersion at thermoneutral temperature will also influence the standing posture control. This study aimed to compare variations in posture control ability after standing from the water immersion at thermoneutral temperatures for healthy young Japanese adults. The healthy male college students (n=5) participated in this study. The body composition of the subjects was measured by bio-impedance method. Postural sway was recorded by detecting the body's center of gravity continuously with a force platform equipped with a data processor. The body sway of each subject was recorded for 1min, first with the eyes open (EO) and next with eyes closed (EC). During each task, the foot center of pressure (COP) position and horizontal ground reaction force were measured. Power spectra of body sway were evaluated by comparing powers in two frequency bands: 0.02–1.0 (BAND 1), 1.0–10.0 Hz (BAND 2). There was no significant difference between pre and post water immersion of COP in EO and EC. However, quiet standing posture sway in the medio-lateral axes tended to be lower post water immersion in both BAND 1 and BAND 2 in the EC condition. It was only a tendency to decrease in the BAND 2 in posture sway of medio-lateral axes. These results suggest that lower leg muscles to relax by water immersion can be maintained a stable standing posture in human. This was suggested to be due to inhibition of somatosensory by water immersion.

INTRODUCTION

Bathing (head out warm water immersion) has become usual life style for many years in Japanese people. Head out water immersion in humans alter the physiological functions affected by buoyancy, hydrostatic pressure, and temperature. Head-out water immersion at thermoneutral temperature in human induces the translocation of peripheral blood into the compliant thoracic vasculature, resulting in stimulation of the baroreceptor, which in turn decreases sympathetic activity and increases parasympathetic activity [3]. The effects of autonomic nervous system by head-out water immersion at thermoneutral temperature will also influence the standing posture control. This study aimed to compare variations in posture control ability after standing from the water immersion at thermoneutral temperatures for healthy young Japanese adults.

METHODS

The healthy male college students (n=5) participated in this study (Age 21-26yrs, Height 163.9-183.6cm, Weight 57.9-67.2kg, %fat 9.3-21.5%). Before the experiment, all procedures and any potential risks were explained to each subject, and an informed consent document was signed previous to participation. This study was approved by Japanese Red Cross Hokkaido College of Nursing Review Board for Health Sciences Research Involving Human Subjects. None of the subjects had either cardiovascular abnormalities or skin lesions. The body composition of the subjects was measured by bio-impedance method (BC-612, TANITA, Tokyo, Japan).

Postural sway was recorded by detecting the body's center of gravity continuously with a force platform equipped with a data processor (Gravicorder G-5000, Anima, Tokyo, Japan). Subjects were requested to stand on the platform with their feet parallel, gazing at a target, a black circle with a diameter of 10cm on a white background, fixed at a 1.5m distance and at the height of each subject's eyes. This arrangement of the visual target produced a visual angle of 5°. The body sway of each subject was recorded for 1min, first with the eyes open (EO) and next with eyes closed (EC). During each task, the foot center of pressure (COP) position and horizontal ground reaction force were measured. The path length of COP and area of body sway were registered. Spectrum analysis by fast Fourier transform (FFT) method of body sway in the medio-lateral and antero-posterior axes was performed. Power spectra of body sway were evaluated by comparing powers in two frequency bands: 0.02–1.0 (BAND 1), 1.0–10.0 Hz (BAND 2). Body sway of BAND 1 is predominantly stabilized by visual input and vestibular input from the otoliths, and body sway of BAND 2 is stabilized by somatosensory input from the ankles and feet [2]. Posture sway was recorded pre and post water immersion.

Each subject rested in swimming trunks in a recumbent position on a reclining seat for 15 min in a room at 26°C and 40% relative humidity. The subject was then immersed up to the nipples for 15 min in tap-water at a thermoneutral temperature of 35°C. The electrocardiogram (ECG) was recorded continuously using a multitelemeter system (Web-5000, Nihon Kohden, Tokyo, Japan). Cutaneous blood flow (BF) was measured on the upper chest and on abdomen by laser-Doppler flowmetry (ALF-21N, Advance, Tokyo,

Japan). The chest site was not immersed, whereas the abdomen site was immersed.

All data are expressed as means \pm SD. Statistical evaluation of the data was done by repeated-measures two way ANOVA, using Turkey test for post hoc multiple comparisons, where appropriate. Significance level was set at the $p < 0.05$.

RESULTS AND DISCUSSION

To examine whether the tremor component was related to the frequency feature of COP sway, the correlation between the tremor component and BAND1 and BAND2 of COP was assessed in both pre and post water immersion (Fig 1). There was no significant difference between pre and post water immersion of COP in EO and EC. However, quiet standing posture sway in the medio-lateral axes tended to be lower post water immersion in both BAND 1 and BAND 2 in the EC condition. It was only a tendency to decrease in the BAND 2 in posture sway of medio-lateral axes.

Based on the dynamics of human quiet stance, the human body was approximated as a single joint inverted pendulum that rotates about the ankle joint [1]. Biomechanical study has indicated that anterior–posterior balance is predominantly under ankle control, whereas medial–lateral balance is under hip control [4]. Furthermore, body sway of BAND 2 (1-10Hz) was stabilized by somatosensory input from the ankles and feet. Therefore, it is considered somatosensory has reduced by head-out water immersion at thermoneutral temperature.

These results suggest that lower leg muscles to relax by water immersion can be maintained a stable standing posture in human.

CONCLUSIONS

In present study, it has been found that our data can contribute to a more a stable standing posture by head-out water immersion at thermoneutral temperature. This was suggested to be due to inhibition of somatosensory by water immersion.

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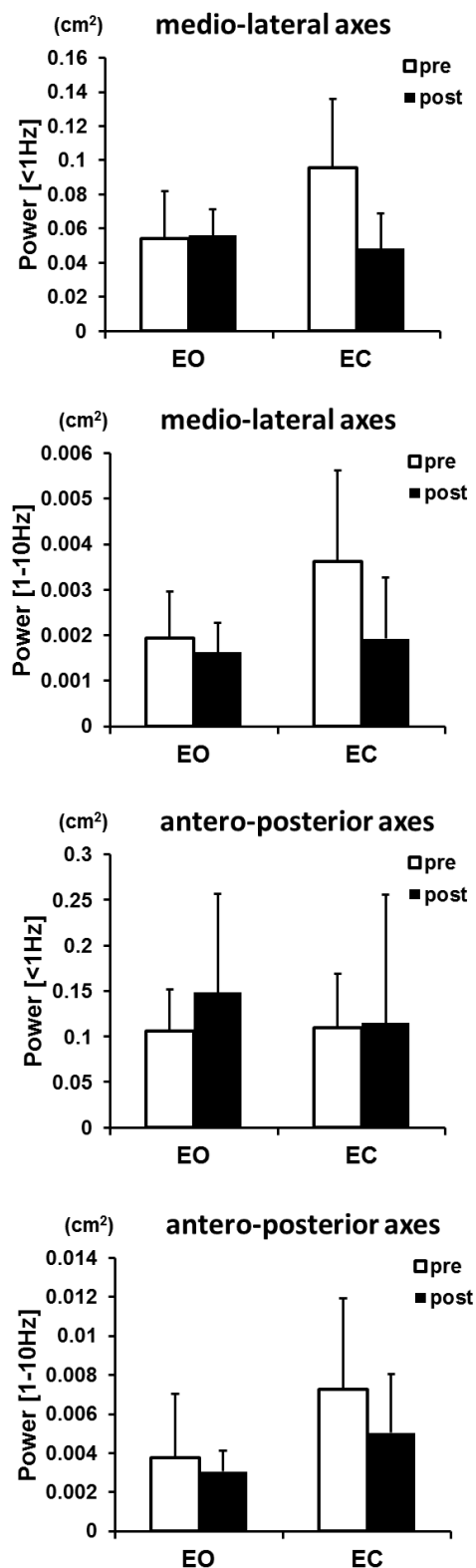


Figure 1: BAND1 (A) and BAND2 (B) component of medio-lateral axes and BAND1 (C) and BAND2 (D) component of antero-posterior axes of COP sway during quiet standing with eyes open (EO) and closed (EC). Open and filled bars indicate pre and post water immersion, respectively.