05.05.2013

Abstract English

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The effects of whole body immersion on heart rate variability, cardiorespiratory coordination and temperature regulation at cool, neutral and warm water temperature

Background:

Whole body immersion in water (WI) constitutes a significant role in the area of CAM as well as in rehabilitation facilities. Medical baths have strong effects on the cardiovascular regulation and the autonomic nervous system, mainly mediated by buoyancy, hydrostatic pressure and water temperature. Little is known about the effects of different water temperatures on core body temperature (CBT) and spectral measures of heart rate variability (HRV). Hence, we investigated the effects of whole body water immersion (WI) with small changes in water temperature at 33 °C (WI33), 36 °C (WI36, thermoneutral) and 39 °C (WI39) on CBT and HRV during and after bathing, and we clarified the method of HRV as a probate Parameter to register differences.

Methods:

21 healthy subjects (average age: 24,3 ± 2,3 years, 11 female, 10 male) underwent WI with water temperatures of 33°C (WI33), 36°C (WI36), 39°C (WI39). "Dry-bath"(DB; bathtub without water to assure same body position as during WI) was used as a control. The procedure consisted of three successive intervals: 20 min of supine rest, 20 min WI in a therapy-tub and 30 min supine rest. The electrocardiogram, the nasal/oral airflow and the core body temperature using a rectal probe were recorded throughout the procedure except the first 10 min of rest before WI. Here, we report on the mean CBT, mean NN-interval (interval between two heartbeats), the standard deviation of the NN-interval (SDNN) and the spectral parameters of the HRV (VLF – very low frequency; LF – low frequency; HF – high frequency) with respect to the last 5 min at the end of each interval. Questionnaires were brought to the subjects before and after each bath to enquire body perception and mood.

Results:

During WI33 and DB the CBT decreased compared to rest before WI (difference: -0,2 °C, -0,1 °C), whereas WI39 led to an increase of the CBT (0,5 °C). During W36 CBT showed a small drop (<0,1 °C) which disolved after WI. Rest after WI showed different CBT, except for WI33 and DB.

The average cardiac cycle was strongly affected by the water temperature: during WI33 and during rest after WI33, the average NN-interval increased continuously (diff: 66 ms, 33 ms) compared to rest before WI. WI39 lead to a strong decrease of the NN-interval (diff: -284 ms) which continued during rest after WI39 (-210 ms). The average NN-interval also decreased during WI36 (diff: -60 ms) but disolved during rest after WI36. SDNN changed during WI33 and WI 39 according of the NN-interval. In WI36, SDNN showed an increase during rest after WI. VLF and LF decreased during WI39 (diff: -1,33; -1,60 ln ms^2), in WI36 they increased during rest after WI (0,76; 0,30 ln ms^2). HF showed a drop during WI39 (-3,01 ln ms^2) and stayed decreased during rest after WI (-0,49 ln ms^2). During WI33, HF increased (0,52 ln ms^2) and stayed constant during rest after WI (0,57 ln ms^2). In WI36, HF showed elevation during rest after WI (0,51 ln ms^2). The questionnaires could show a decrease in subjective well-being during WI33 and WI 39, whereas WI36 showed an increase. During WI33 vigilance showed an increase, during WI36 and WI39 vigilance decreased.

Conclusion:

The measurement of the HRV-parameters is a suitable method to register changes of autonomous regulations during and after WI at thermoneutral, warm and cold watertemperature. WI showed effects in CBT, NN-interval and HRV depending to water temperature. Even small changes in water temperature showed considerable and specific effects during and after WI.

Warm and cold WI showed opposite effects: At 39 °C, CBT increases and NN-interval and HRV decrease. At 33 °C, CBT decrease, whereas NN-interval and HRV showed an increase. The specific effects of water temperature also affect the rest after WI: During rest after WI33, NN-interval and HRV stay increased. During rest after WI39 KKT and NN-interval are still increased, whereas HRV normalises to initial values. At 36 °C water temperature HRV increases during rest after WI.

Respiration was not affected by the different WI. Questionnaires can show changes in subjective well-being and vigilance depending to water temperature.

Keywords:

Heart rate variability
Cardiac autonomic system
spectral analysis
head-out water immersion
core body temperature
bathing
thermoneutral
balneotherapy