

SKIN TEMPERATURE AND MUSCLE RELATIVE BLOOD VOLUME IN THE HAND: ARE THEY CORRELATED?

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Aims

Reduced blood flow has been implicated in the pathophysiology of musculoskeletal disorders. A major determinant of skin temperature is blood flow. The purpose of this study was to determine if mean skin temperature in the dorsal hand (THand), as a surrogate for cutaneous blood flow, was correlated with relative blood volume (RBV) in the first dorsal interosseous (FDI) muscle as measured through near infrared spectroscopy (NIRS) during a 10 minute post-recovery period after typing.

Methods

An infrared camera (A40M, FLIR Instruments, Billerica, MA) measured skin temperature and a custom NIRS probe with optodes at 11 mm apart (depth = ~5.5 mm) measured relative absorbance of oxy- and deoxy-hemoglobin in the FDI. ThermaCAM Researcher (FLIR Instruments, Billerica, MA), OOIBase32 Spectrometer Operating Software (OceanOptics Inc., Dunedin, FL), Excel (Microsoft Corporation, Redmond, WA), Stata (StataCorp LP, College Station, TX) and SAS (SAS Institute, Inc., Cary, NC) software was used in data analysis. Office workers ($n = 11$) without symptoms of upper extremity musculoskeletal disorders (UEMSDs) rested their hands on a 3/4 inch acrylic slab on a desktop for one minute before typing for nine minutes. Hands were returned to the desktop for ten minutes after typing. Adhesive paper markers were positioned underneath their fingers to insure that subjects placed their hands in the same location before and after typing. Thermographic images were taken of the hands for one minute prior to typing, and at three intervals post-typing (0-2 minutes post-typing [T1], 3-5 minutes post-typing [T2], and 8-10 minutes post-typing [T3]). For the purpose of the present analysis, the thermography sampling rate was 7 Hz and NIRS sampling rate was 0.1 Hz. The UCL6 algorithm encoded into software was utilized to determine relative blood volume (total hemoglobin) from the initial measurement. Mean relative temperature changes in the dorsum (defined as an area from the crotch of the thumb to the head of the ulna) from baseline and mean FDI RBV were calculated for each post-typing period. Three trials at an ambient temperature of $22^{\circ}\pm 1^{\circ}$ C were run for each individual. Ten of the 33 observations were removed from analysis, due to operator error or loose NIRS probe. For subjects with replicate observations, preliminary analyses demonstrated no statistical difference in response between replicates within subjects. Therefore, univariate analyses are based upon data averaged within subjects for those with multiple observations. The univariate relationship between RBV and temperature change was analyzed separately for the three post-typing time periods using Pearson's correlation coefficient. Mixed effects models were used to comprehensively assess RBV and temperature change over time; multiple observations per subject were accounted for in the covariance structure, and subject was included as a random effect.

Results

The Pearson correlation coefficient between the two measures was determined as 0.38 ($p = 0.25$) at T1, 0.38 ($p = 0.25$) at T2, and 0.68 ($p = 0.02$) at T3. The mixed model of RBV demonstrated an overall increase in RBV (slope = 0.01, $p < 0.001$) over the three post-typing periods. RBV change between T1 and T2 was minimal, with most of the change occurring between T2 and T3 (slope = 0.02, $p = 0.04$). After a mean initial post-typing rise of 0.3° C (SD = 0.4° C), overall temperature change during the three time periods showed a significant decrease (slope = -0.10, $p = 0.002$). This decrease occurred both between T1 and T2 (slope = -0.15, $p = 0.002$) and between T2 and T3 (slope = -0.05, $p < 0.001$).

Conclusions

THand and FDI RBV do not appear to be associated immediately after typing. However, they do correlate by approximately 10 minutes post-typing. This suggests that skin temperature is not indicative of muscle oxygen demand immediately following low-level exercise. There are a number of possible explanations for the observed results.

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