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Differential Control of Blood Flow in Facial and Limb Muscles During Stress

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Abstract

Different patterns of sympathetic activation may be elicited by different stressors (stressor-specificity) and the effects generally depend on the location of the different tissues and organs examined (differential sympathetic activation). In this respect, different vascular control has been reported for cutaneous tissues of the head as compared to limbs', whereby dilatation rather than constriction is often reported in the facial districts. Whether a different hemodynamic response to stress also concerns skeletal muscles is unclear. The aim of this study was to test the hypothesis that a differential vascular control also concerns head and limb muscles, under stress exposure.

Near infrared spectroscopy (NIRS) was used to measure changes in tissue haemoglobin index (THI) and tissue oxygenation index (TOI). From these parameters changes in blood flow can be inferred. One NIRS probe was placed over the masseter muscle and one over the biceps muscle. Cardiac output, HR and ABP were also measured by continuous finger-pulse photoplethysmography. Twelve participants (9 males, 3 females; age 26 ± 3 years) in supine position were subjected to a randomized series of stressors, including cold pressor test (CPT, left hand immersed in 8 deg water for 2 min) and mental arithmetic test (MAT, repeatedly subtracting from 1000 consecutive odd numbers starting from 1). Stress-induced changes in TOI and THI were evaluated by comparing the time average over the last 10 s of stress exposure, with the baseline (10-s interval before stress exposure). Statistical significance ($p<0.05$) was assessed by Student-t test and Hochberg's Method with Dunn/Sidak alpha correction for multiple comparisons.

The masseter TOI exhibited a significant increase during both CPT (from 79.5 ± 2.9 to

81.1 ± 2.2 %) and MAT (from 80.5 ± 3.1 to 82.5 ± 3.6 %), while in the biceps, the TOI significantly decreased (-4.8 ± 4.1%) in CPT and non-significantly increased in MAT (1.5 ± 2.8%). As for blood volume changes, THI exhibited a significant change only in masseter muscle during CPT (+8.7 ± 9.1 %, from baseline).

To conclude, simultaneous monitoring of hemodynamic changes by NIRS in facial and limb muscles evidence larger responses of THI and TOI suggesting increased vascular dilatation and blood flow in facial compared to limb muscles. We speculate that this could result from a general strategy aimed at preserving blood flow to the head region, which is characterized by lower perfusion pressure due to hydrostatic gradients, during erect posture.