High-amplitude oscillations in human skin blood flow are distinct from known cardiac or respiratory influences

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We have recently described the presence of high-amplitude skin blood flow ($\dot{Q}_{sk}$) oscillations in humans (Haley *et al*., 2004a) and animals (Haley *et al*., 2004b). These oscillations had a characteristic frequency of ~0.4 Hz, spanning ~700-800 ms, and were comprised of high-amplitude peaks that are up to 7-fold greater than basal $\dot{Q}_{sk}$. We hypothesised that the high-amplitude oscillations may be related to previously identified lower-amplitude (±30 %) oscillations in $\dot{Q}_{sk}$ caused by respiration (0.15-0.4 Hz) and cardiac frequency (0.4-1.6 Hz) (Stefanovska *et al*., 1999). Hence, we sought to compare the spectra of respiratory and cardiac activities, with the $\dot{Q}_{sk}$ time-frequency spectrum.

Forearm $\dot{Q}_{sk}$ (ventral aspect), cardiac frequency and respiration were measured simultaneously (20 Hz) from eight males (27.9 yr (SD 6.4), 181.1 cm (SD 4.8), 75.8 kg (SD 7.5), during semi-recumbent rest at 25°C (50% R.H.), on two separate days, for a 5-6 min period. Skin blood flow, was estimated using laser-Doppler flowmetry (TSI Laserflo BPM2, Vasamedics Inc., U.S.A.), cardiac frequency was collected using a three-lead electrocardiogram (ECG: model 100, Humtec, Australia) and respiration was measured from rib cage movement (mercury-in-silastic strain gauge: Hokansen EC-4SB, U.S.A.). Respiratory, ECG and $\dot{Q}_{sk}$ data were analysed using a wavelet transform in the frequency domain of 0.05-2 Hz; the dominant frequency band for each variable was calculated as the central portion accounting for 95% of the total integrated power of the time-averaged frequency spectrum. Data are means ± standard errors.

The dominant frequency band for the $\dot{Q}_{sk}$ spectrum (0.72 ±0.03) was significantly different (P<0.05, paired t-test) from both the respiratory (0.22 ±0.02) and ECG spectra (1.31 ±0.01). Variations between studies (n=16) in the $\dot{Q}_{sk}$ dominant frequencies were not significantly correlated with between study variations in either cardiac (r=0.02, P =0.94) or respiration (r=-0.15, P=0.60) dominant frequencies. These results indicate that the high-amplitude $\dot{Q}_{sk}$ oscillations are not directly related to either cardiac frequency or respiratory function. Instead, we propose that these oscillations are related to local factors, such as changes in transmural pressure, or the release of substances that alter vascular endothelial and smooth muscle function.

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Stefanovska, A., Bracic, M & Kvernmo, H.D. (1999) *IEEE Transactions on Biomedical Engineering*, 46(10), 1230-1239.