Age-related changes in oscillatory components of microvascular blood flow

A Bernjak[1], J Owen-Lynch[2], P V E McClintock[1] and A Stefanovska[1]

[1]Department of Physics, Lancaster University, Lancaster LA1 4YB, UK
[2]Biomedical and Life Sciences Division, School of Health and Medicine, Lancaster University, Lancaster, LA1 4YB, UK

Question

The cardiovascular system, including the microvascular system is known to change with aging and, despite advances in the understanding of the cellular and molecular mechanisms of vascular aging, studies of integrated *in vivo* blood flow dynamics, where multiple regulatory mechanisms act in combination, have been lacking. Wavelet transform analyses of blood flow signals recorded by laser Doppler flowmetry enable to study the physiological mechanisms involved in the regulation of microvascular blood flow. In particular, the combination of laser Doppler flowmetry with iontophoretically-administered acetylcholine ACh and sodium nitroprusside (SNP) allows for *in vivo* non-invasive studies of endothelial function. We investigate how these mechanisms are affected by aging.

Methods

Cardiovascular signals were recorded from a cohort of 223 healthy, resting, normotensive subjects (115 males, 108 females, aged 16-90 years), including ECG, respiration, blood pressure and blood flows in the skin. Basal flows were measured on the right arm and the right leg and responses to ACh and SNP were obtained from the left forearm. Wavelet transform with the Morlet mother wavelet and logarithmic frequency resolution was used to evaluate the oscillatory components in the blood flow from a relatively wide frequency interval between 0.005 Hz and 2 Hz. These oscillations are related to physiological mechanisms, such as the activity of the heart, respiration, myogenic, neurogenic, nitric oxide (NO) endothelial related activity and non-NO endothelial related activity. Their contribution to the blood flow and age related changes are presented.

Results

We demonstrate that aging results in a significant alteration of the relative contributions of the oscillatory components in the dynamics of blood flow. In response to ACh- and SNP-induced vasodilation, the wavelet spectra of four out of the six oscillatory components show age-related decline, including the components associated with endothelial activity. The oscillation resulting from cardiac output increases with age and the respiratory component remains stable.

Conclusion

Our data show that aging affects several independent aspects of the dynamics of blood flow including smooth muscle and endothelial function. This is a macroscopic approach which provides information about the different inputs to blood flow dynamics and how these are controlled and regulated. It provides a starting point for the development of hypotheses at the cellular and molecular level concerning both the origin of the oscillatory components and how these are altered through the aging process.