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Research themes

Central regulation of blood pressure and heart rate and the role of muscle afferent input

In the first theme, a model of electrically-evoked isometric muscle contractions has been used to distinguish between signals arising from the local muscle milieu and those from central command that feed into the central regulation of heart rate, blood pressure and cardiac output distribution. This work has defined important modulations of afferent input by muscle training status, fibre type and habitual activity pattern. It has identified interactions between local metabolic and mechanical signals that link muscle inactivity and detraining to the impaired cardiovascular/ respiratory responses to exercise in chronic heart failure. Current studies are investigating baroreflex function, arterial stiffness, and specific measures of sympathetic neural activity in heart failure.

Control of skeletal muscle microcirculation and vascular growth

In the second theme, studies of haemodynamic forces and angiogenic growth factors in conditions of high (exercise) or low (ischaemia) blood flow have shown that whereas metabolic and growth factors are both conducive to vascular growth, modulation of vascular endothelial function by shear stress is also a prime requirement. This has led to the use of local muscle stimulation in peripheral vascular disease and heart failure patients to enhance blood flow and microvascular growth and improve functional walking capacity. Studies are also investigating the impact of gender and body composition on vascular reactivity in relation to the aetiology of orthostatic intolerance and venous disease.

Investigations of central respiratory rhythm

Within the third theme, a novel technique to cause hypocapnia has been developed to reveal the role of the central respiratory rhythm in breath-holding and to reveal the effects of hyocapnia on baroreflex function and ECG. This techique has been patented and is now undergoing clinical trials as new non-invasive method of detecting coronary artery vasoconstriction in patients with early coronary artery disease.

Mechanisms of pulmonary and cerebral blood flow control

In the fourth theme, the powerful tools of Doppler ultrasound and MRI brain imaging are being used to examine the pulmonary and cerebral circulations during exercise and during precise manipulation of blood gases to replicate extreme environmental conditions or disease. The research has shown that pulmonary circulation responds during static exercise by vasoconstriction, a potentially detrimental reaction in patient groups with impaired lung function, and further investigations during hypoxia are exploring how it affects brain blood flow and function.

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