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Power spectral analysis of critical closing pressure and resistance area product of the cerebral circulation

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Frequency domain analysis was applied to estimate autopower spectra in critical closing pressure (CrCP) and resistance area product (RAP). Spectral analysis of CrCP and RAP were performed by Fast Fourier Transform (FFT). The CrCP of the cerebral circulation indicates the value of the arterial blood pressure (ABP) at which cerebral blood flow (CBF) approaches zero. Measurements in animals and humans have shown that the CrCP is significantly greater than zero. Studies of the cerebral circulation need to take CrCP and RAP into account, to obtain more accurate estimates of cerebrovascular resistance changes, to reflect the correct dynamic relationship between instantaneous ABP and CBF. By modelling the cerebral circulation we have attempted to understand it and predict its response to various physiological challenges in clinical issues. This analysis was performed on 48 healthy subjects and 11 hypertensive subjects. Arterial blood pressure (ABP) and cerebral blood flow velocity (CBFV) were non-invasively recorded using photoplethysmography (Finapres) and Transcranial Doppler ultrasonography (TCD).

We found the power spectra in CrCP, RAP, could be diffracted into three components at specific frequency ranges, designated as high-frequency (HF, 0.1Hz-10th harmonic), low-frequency (LF, 0.05 Hz-5th harmonic), and very low-frequency (VLF, 0.02Hz-2nd harmonic) components. We have not directly measured middle cerebral artery diameters, and caution must therefore be exercised in interpreting our RAP results. Our spectral analysis results indicated that low-frequency power (2nd harmonic) is a reliable index of autoregulation. The previously reported very low frequency oscillations in CBF detected using TCD in human also identified frequency bands around 0.0064Hz, 0.02Hz and 0.037Hz. Therefore frequency domain analysis offers an opportunity to understand underlying mechanism of dynamic regulation in cerebral circulation.

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