Coherent Hemodynamics Spectroscopy

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Technology description

• A novel quantitative hemodynamic model relating physiological perturbations in cerebral blood volume, blood flow, and oxygen consumption to the associated hemodynamic effects that are measurable with functional near-infrared spectroscopy (fNIRS) and functional magnetic resonance imaging (fMRI)
• CHS in conjunction with the new hemodynamic model, is capable of assessing cerebral hemodynamics integrity and localized cerebral autoregulation
• This technology helps in the diagnosis and monitoring of cerebrovascular disorders, neurological deficits, vascular dementia, and impaired cerebral autoregulation
Background
• Cerebrovascular diseases are the second leading cause of death and dementia, and the leading cause of disability worldwide
• More accurate measurements of the concentration and oxygen saturation of hemoglobin in brain tissue will improve efforts in early detection of cerebral ischaemia, vascular cognitive impairment, assessment of recovery from strokes, and functional brain studies
• The medical diagnosis of brain disorders can be difficult due to the sensitivity of brain tissue to invasive medical probes and there is a significant need for non-invasive diagnosis and monitoring
Invention
• Coherent Hemodynamics Spectroscopy in conjunction with the new hemodynamic model, allows for the assessment of physiological and functional parameters including:
o the blood transit time in the microvasculature
o the relative arterial, capillary, and venous blood volume fractions
o cerebral autoregulation effectiveness
• The new hemodynamic model can be used to:
o predict fNIRS and fMRI signals associated with given perturbations in cerebral blood volume (CBV), cerebral blood flow (CBF), and cerebral metabolic rate of oxygen (CMRO2)
o identify a set of perturbations in CBV, CBF, and CMRO2 that are consistent with measured signalsPublished in Canada, Europe and the United States
1.Neuroimage. 2013 Apr 10. pii: S1053-8119(13)00315-7. doi: 10.1016
2.Neuroimage. 2013 Apr 2. pii: S1053-8119(13)00286-3. doi: 10.1016

Advantages

• This hemodynamic perturbation model treats the complex microvasculature as a whole, without making assumptions about its detailed architecture, and without introducing a large number of parameters to describe it
• Thus, an advantageous compromise is made, sufficiently describing the complexity of the microvasculature while making use of a limited number of free parameters
• The hemodynamic perturbation model utilizes a new frequency-resolved measurement scheme that opens up a new technical avenue that may find numerous applications in the design of new instrumental techniques and in a number of research areas
• The hemodynamic perturbation model is capable of predicting data representative of localized cerebral autoregulation
• This is an improvement over conventional cerebral autoregulation measurement systems which rely on inferring data representative of global cerebral autoregulation based on a systemic measurement of arterial blood pressure and a global cerebral measurement of blood flow
• CHS has been demonstrated on a group of healthy human subjects, validating its feasibility and ability to provide measures of local cerebral autoregulation
• The quantitative hemodynamic model has been validated on fNIRS and fMRI data reported in the literature to demonstrate its accuracy at relating measured fNIRS and fMRI signals with the associated perturbations in CBV, CBF, and CMRO2

Institution

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