WAYNE STATE UNIVERSITY

The WSU Program for Traumatic Brain Injury Research

presents a Special Topic Seminar

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"Modeling of Cerebral Hemodynamics: What We have learned and What are the Challenges?"

Abstract: Cerebral circulation is unique in that brain is only about 2% of body weight, but receives 15-20% of cardiac output. Hemeostasis of brain perfusion is maintained by autoregulatory mechanisms. Traditionally, the pressure-flow relationship of the cerebral circulation has been described by a sigmoid shaped autoregulatory curve with a wide "plateau" indicating that cerebral blood flow (CBF) remains constant despite large changes in arterial pressure under steady-state conditions. With the advent of the transcranial Doppler for measurement of CBF velocity in the basal cerebral arteries with high temporal resolution, spontaneous fluctuations in CBF velocity has been observed revealing various amplitudes at different time scales.

The transfer function method and other linear modeling methods have been applied both in research and clinical studies to understand the underlying mechanisms of dynamic cerebral autoregulation and to assist clinical diagnosis of neurovascular diseases. However, the study of dynamic cerebral autoregulation using the linear system methods has been hindered by the intrinsic nonlinearity of the cerebral circulation. Both the dynamic and static nonlinearity of the cerebral circulation have been evidenced. For example, estimates of coherence function between spontaneous changes in arterial pressure and CBF velocity generally is low (<0.5) in the low frequency ranges of 0.02-0.07Hz where autoregulation is likely to be effective. In addition, estimation of coherence function appears to be dependent on spectral power of arterial pressure. Recently, nonlinear modeling methods based on the Volterra-Wiener approach have been used to identify nonlinear properties of the cerebral circulation. Consistent with previous findings, significant nonlinearity was identified in the low frequency ranges of changes in arterial pressure and CBF velocity. In addition, it appears that the nonlinear dynamic pressure-flow relationship is modulated by changes in end-tidal CO_2.

In summary, recent study of the cerebral hemodynamics using linear and nonlinear modeling methods has opened a new and fruitful research field. Significant insights have been gained in understanding the dynamic regulation of CBF in human subjects. Further research using advanced modeling methods holds great potential for development of efficacious and non-invasive methods for clinical diagnosis of neurovascular diseases.

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Location: 1328 Scott Hall
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