Theme: Imaging Research in Basic and Clinical Science: Neuroscience, Cardiology and Oncology

Interrogation of neurovascular coupling development using a multimodal approach

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Abstract:
Neurovascular coupling (NVC) is the process through which alterations in local neural activity are coupled with changes in cerebral blood flow. This dynamic regulation of blood flow is an essential component of normal brain health and is also the basis of the signals measured in functional brain imaging, which measures blood oxygen level-dependent (BOLD) signals to infer brain activity. Intriguingly, functional imaging studies in the newborn developing brain often report unexplained variation and early inverted BOLD responses. There is a knowledge gap in explaining the discrepancy in the newborn hemodynamic signals that require to be addressed for better understanding functional imaging data. The goal of this project is to identify the origins of the developmental shift from negative (or unreliable) to consistently positive hemodynamic signals. We will achieve this by leveraging a multimodal approach based on advanced methodologies to study the maturation of the hemodynamic response in neonates (range from postnatal day 11 to 21). Additionally, adult mice were used for physiological comparation. We used BOLD-fMRI (Functional magnetic resonance imaging) to assess changes in blood oxygenation levels in the somatosensory cortex in response to neuronal activation by whisker stimulation. Laser Doppler flowmetry (LDF) was employed to monitor real-time cerebral blood flow changes during the same experimental paradigm. Additionally, magnetic mass spectrometry was used to characterize the neurochemical profile, including neurotransmitters and metabolites, in the same region. While preliminary, our results demonstrate that neonates displayed more incipient and inconsistent hemodynamic response to whiskers stimulation as compared to adults. fRMI and LDF results suggest that adults possess a more refined vascular response to stimuli compared to young mice. Moving forward, multi-photon live imaging will provide cellular-level resolution to complement this preclinical approach.

Keywords: Neurodevelopment, cerebrovascular, functional magnetic resonance imaging, magnetic resonance spectrometry, laser Doppler flowmetry, multiphoton microscopy.