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NEUROSCIENCE 2012

Presentation Abstract

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Presentation Title: Investigating laminar specificity of neurovascular coupling using OCT angiography

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Abstract: Depth-resolved Optical Coherence Tomography (OCT) angiography was used to investigate neurovascular coupling in the rat somatosensory cortex. In contrast to other optical microscopic imaging modalities, OCT affords sufficient penetration depth to image up to cortical layer V in the rat. We recently developed an angiography technique that enables simultaneous, depth-resolved imaging of hemodynamic changes. The goals of this study were (i) to establish theoretically and empirically that our OCT angiogram yields a depth-specific measurement of red blood cell (RBC) content under our experimental conditions, (ii) to investigate subtle timing differences in the RBC responses across cortical layers, and (iii) to characterize the RBC response across arteriolar, venular, and capillary compartments. Five Sprague-Dawley rats anesthetized with alpha-chloralose were used for these preliminary experiments. Imaging was performed through a closed cranial window during forepaw stimulation. The Spectral / Fourier domain OCT light source at 1310 nm consisted of two superluminescent diodes combined with a 50/50 fiber coupler, yielding an axial resolution of approximately 3.6 microns and a penetration depth of approximately 1 mm. Either a block stimulus paradigm (2 s or 4 s, 3 Hz) or parametric stimuli with varying stimulus frequencies (4 s, 1-5 Hz) were applied. For parametric stimuli, simultaneous surface potentials were recorded. Two-dimensional or three-dimensional scanning protocols were used to investigate laminar

or compartment differences, respectively. Our data show that the hemodynamic response, as determined by RBC content, occurs earliest in layer IV, and is delayed in layers I-III and layer V, consistent with recent findings obtained using two-photon microscopy and BOLD fMRI. We observe responses (increases in RBC content) in all three vascular compartments, with the largest and earliest response found in the arterial compartment. Furthermore, our data shows virtually no evidence of "all or nothing" capillary recruitment, in agreement with earlier studies using confocal microscopy. We anticipate that these techniques we have developed will enable more detailed and comprehensive characterization of the neurovascular relationship across cortical layers than was previously possible.

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