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Presentation Abstract

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Title: Direct and simultaneous 2-photon imaging of intravascular and tissue oxygenation during the response to sensory stimulation in vivo

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Abstract: Brain activity largely relies on mitochondrial oxidative metabolism to meet the energy demands. However, our ability to probe microscopic availability of O_2 during different levels of neuronal activity has been limited to point measurements using O_2 electrodes. To overcome this limitation, we applied a novel phosphorescent probe for simultaneous 2-photon imaging of tissue and intravascular pO_2 in the rat primary somatosensory cortex.

The probe was microinjected directly into the brain tissue to report the pO_2 levels in the interstitial space. Microinjection was made at the center of neuronal response determined by surface potential mapping. The same probe was delivered also intravenously (IV) to label the vasculature. We employed multiple small-volume bolus IV injections until the levels of tissue and intravascular phosphorescence were matched. Stimulation consisted of a train of 100-μs electrical pulses delivered to a forepaw at 3 Hz for duration of 2 s. We measured pO_2 gradients at different cortical depths (down to 250 microns) and distance to the closest capillary, arteriole or venule. We observed steep gradients of pO_2 around the diving arteries and lesser

gradients around surfacing venules. In high-resolution scans, pO_2 gradients were also observed around some capillaries. Sensory stimulation induced an increase in tissue and intravascular pO_2 that was mostly pronounced around surfacing venules. In some instances, this response was preceded by an initial decrease in pO_2 (the "initial dip"). We also observed cases of a post-stimulus pO_2 decrease with temporal characteristics consistent with the "post-stimulus undershoot" as observed with fMRI methods. Further analysis is required to determine a possible dependence of these phenomena on the depth and distance from the closest feeding/draining vessels and the center of neuronal response.

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