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Presentation Abstract

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Presentation Title: Two-photon microscopy of oxygen distributions in mouse cerebral microvasculature

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Abstract: 1. Introduction
Detailed microscopic measurements of the variation in oxygen content in cerebral microvasculature are needed to better understand cerebrovascular pathologies and to guide interpretation of macroscopic measures such as fMRI blood-oxygen-level dependence (BOLD). In this work we have obtained the high-resolution and high-density PO2 maps and detailed PO2 distributions in microvascular segments down to 450 um depth from the mouse cortical surface using a novel two-photon microscopy imaging of intravascular PO2. We have measured the oxygen intravascular distribution in normocapnic and hypercapnic states as a function of various morphological parameters such as branching order from pial arteries and veins.
2. Methods
We used a custom built two-photon microscope and two-photon enhanced oxygen sensitive phosphorescent dye PtP-C343. Imaging was performed through a sealed cranial window in C57BL/6 mice anesthetized by isoflurane (1-2% in a mixture of O2, air, and CO2). Approximately 400 PO2 measurements were collected in various microvascular segments down to 450 μm depth from the cortical surface. After collecting the PO2 measurements, we obtained structural images of the cortical

vasculature by labeling the blood plasma with dextran-conjugated fluorescein (FITC) and constructed the graphs of the microvascular network. All experimental procedures were approved by the Massachusetts General Hospital Subcommittee on Research Animal Care.

3. Results and Discussion

Typical measurements during normocapnia reveal ~100 mmHg (SO2 ~90%) in pial arteries, ~45 mmHg (SO2 ~60%) in pial veins, and largely heterogeneous PO2 in the capillary network. Assuming that capillary diameters are <7 um, the results are showing that significant portion of SO2 (up to 20%) is reduced before the blood reaches the capillaries. At the same time, the most significant increase in SO2 during hypercapnia (up to 20%) was measured in the parts of capillary network distal to precapillary arterioles.

3. Conclusion

Our methodology provides a high signal-to-noise statistics of cortical microvascular oxygenation in anesthetized mice. The high PO2 density measurements were performed down to 450 um below the cortical surfaces. The maps of PO2 values were analyzed using the graph representation of the actual microvascular trees. The methodology was used to infer cortical microvascular oxygenation distribution as a function of various vascular morphological parameters and to assess the influence of elevated blood flow on microvascular oxygen delivery.

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