2 The cortical angiome: an interconnected vascular network
with noncolumnar patterns of blood flow.

Blinder P, Tsai PS, Kaufhold JP, Knutsen PM, Suhl H, Kleinfeld D

Recommendations:

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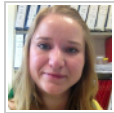
Marcello Rosa
F1000 Neuroscience
Monash University, Clayton, VIC, Australia.

Victoria Johnstone
F1000 Neuroscience
Monash University, Clayton, VIC, Australia.

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Confirmation, Good for Teaching, New Finding

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This is the first study to use high-throughput histology to construct 3D maps of the microvasculature supplying the mouse vibrissae primary sensory cortex. Neuronal activity in the primary sensory cortex is arranged in cortical columns (or barrels), each receiving afferent input primarily from a single whisker on the snout of the animal. In this study, the complete angioarchitecture was reconstructed in conjunction with the positions of all neuronal somata within multiple cubic millimetre regions of the primary sensory cortex. It has previously been suggested that the neurovasculature supplying each barrel may be arranged as autonomous units, each sourced by a penetrating arteriole and drained by a penetrating venule with a mesh network between the two that lines up with the functional structure of the surrounding neurons. This article challenges that notion and, instead, demonstrates that the microvasculature forms complex interconnected loops, and that the topology of the vasculature cannot be used to predict the loci of cortical columns. Instead, blood flow to a column is controlled at the level of the microvessels. They additionally presented vascular maps of blood flow that allowed them to identify 'perfusion domains', which predict the lesion volumes that would occur if a clot occludes a vessel. These findings have broad implications for how functional images are interpreted and how post-stroke cortical lesions are demarcated.

Abstract:

What is the nature of the vascular architecture in the cortex that allows the brain to meet the energy demands of neuronal computations? We used high-throughput histology to reconstruct the complete angioarchitecture and the positions of all neuronal somata of multiple cubic millimeter regions of vibrissa primary sensory cortex in mouse. Vascular networks were derived from the reconstruction. In contrast with the standard model of cortical columns that are tightly linked with the vascular network, graph-theoretical analyses revealed that the subsurface microvasculature formed interconnected loops with a topology that was invariant to the position and boundary of columns. Furthermore, the calculated patterns of blood flow in the networks were unrelated to location of columns. Rather, blood sourced by penetrating arterioles was effectively drained by the penetrating venules to limit lateral perfusion. This analysis provides the underpinning to understand functional imaging and the effect of penetrating vessels strokes on brain viability.