

3-D map of blood vessels in cerebral cortex holds surprises

June 9 2013

Blood vessels within a sensory area of the mammalian brain loop and connect in unexpected ways, a new map has revealed.

The study, published June 9 in the early online edition of *Nature Neuroscience*, describes vascular architecture within a well-known region of the [cerebral cortex](#) and explores what that structure means for functional imaging of the brain and the onset of a kind of dementia.

David Kleinfeld, professor of physics and neurobiology at the University of California, San Diego, and colleagues mapped blood vessels in an area of the [mouse brain](#) that receives [sensory signals](#) from the whiskers.

The organization of [neural cells](#) in this brain region is well-understood, as was a pattern of blood vessels that plunge from the surface of the brain and return from the depths, but the network in between was uncharted. Yet these tiny arterioles and venules deliver oxygen and nutrients to energy-hungry [brain cells](#) and carry away wastes.

The team traced this fine network by filling the vessels with a fluorescent gel. Then, using an automated system, developed by co-author Philbert Tsai, that removes thin layers of tissue with a laser while capturing a series of images to reconstructed the three-dimensional network of tiny vessels.

The project focused on a region of the cerebral cortex in which the [nerve cells](#) are so well known that they can be traced to individual

whiskers. These neurons cluster in "barrels," one per whisker, a pattern of organization seen in other [sensory areas](#) as well.

The scientists expected each whisker barrel to match up with its own blood supply, but that was not the case. The blood vessels don't line up with the functional structure of the neurons they feed.

"This was a surprise, because the blood vessels develop in tandem with neural tissue," Kleinfeld said. Instead, microvessels beneath the surface loop and connect in patterns that don't obviously correspond to the barrels.

To search for patterns, they turned to a branch of mathematics called graph theory, which describes systems as interconnected nodes. Using this approach, no hidden subunits emerged, demonstrating that the mesh indeed forms a continuous network they call the "angiome."

The vascular maps traced in this study raise a question of what we're actually seeing in a widely used kind of brain imaging called functional MRI, which in one form measures brain activity by recording changes in oxygen levels in the blood. The idea is that activity will locally deplete oxygen. So they wiggled whiskers on individual mice and found that optical signals associated with depleted oxygen centered on the barrels, where electrical recordings confirmed neural activity. Thus brain mapping does not depend on a modular arrangement of blood vessels.

The researchers also went a step further to calculate patterns of blood flow based on the diameters and connections of the vessels and asked how this would change if a feeder arteriole were blocked. The map allowed them to identify "perfusion domains," which predict the volumes of lesions that result when a clot occludes a vessel. Critically, they were able to build a physical model of how these lesions form, as may occur in cases of human dementia.

More information: The cortical angiome: an interconnected vascular network with noncolumnar patterns of blood flow, [DOI: 10.1038/nm.3426](#)

Provided by University of California - San Diego

Citation: 3-D map of blood vessels in cerebral cortex holds surprises (2013, June 9) retrieved 25 December 2022 from <https://medicalxpress.com/news/2013-06-d-blood-vessels-cerebral-cortex.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.