On the Origin of MRI Signal In Stroke

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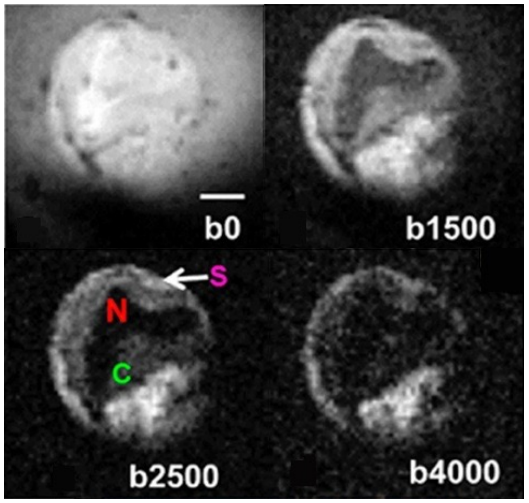
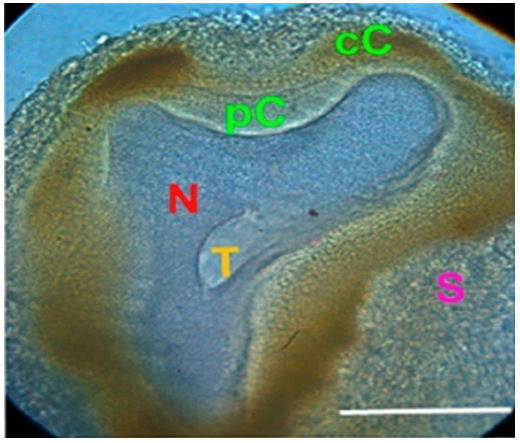
Glial cells represent a major fraction of the total brain volume, and they are responsible for maintaining homeostasis to ensure accurate and consistent neuronal function. In diffusion magnetic resonance (MR) microscopy studies of tissue infarct using isolated *Aplysia* (sea slug) neurons, they are surrounded by satellite glial cells which appear hyperintense, as they balance water to the neuron following injury, compared to the hypointense dark interior of the neuron. *Instead of a swelling in the neuronal cells, this research presents evidence that a swelling of glial cells following ischemia is the cause of the MR hyperintensity in stroke, potentially solving a 30 year old mystery on the origin of the MRI signal in stroke victims.*

A quantitative understanding of changes in glial cell volume will allow the development of working mathematical models that can be used on tissues *in situ* to understand signal changes in disease, like reversible and irreversible ischemia. *Instrumentation is being developed to improve these measurements by moving to higher magnetic fields, including the MagLab's 32T magnet.* These studies ultimately aim to improve clinical MR significantly by increasing its sensitivity and specificity.

We expect that this work will lead to improved diagnostics for other brain disorders where glial cells may play a role, including mood disorders, sleep disorders, movement disorders such as Parkinson's, and memory disorders such as Alzheimer's.





Diffusion MR microscopy of a sea slug neuron at 7.8 µM resolution (**top**) showing hyperintensity (brightness) due to water diffusion in glial satellite cells. The cellular structures can also be identified using 40X traditional light microscopy (**bottom**).

N = nucleus
C = cytoplasm (perinuclear and cortical)
T = trophospongium (sea slug invagination)
S = satellite cells.

Scale bar is 100 µm.

Facilities and instrumentation used: AMRIS Facility, AMRIS RF capabilities including the micro-5 3000 mT/m imaging gradient that enables imaging at 7.8 µm in-plane resolution, MagLab's User Collaboration Grant Program.

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