

Optoacoustic Imaging of the Glymphatic System

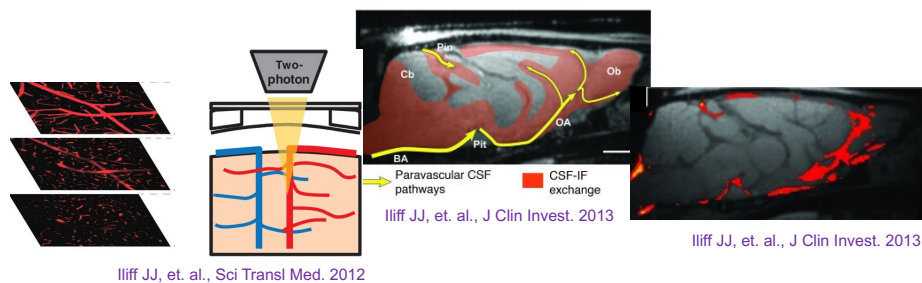
Sarah Shaykevich

Russell W. Chan, Chandni Rana, Mohamed Eltaeb, Justin P. Little, Daniel Razansky, Kevin C. Chan, Shy Shoham
10th Annual Meeting of the International Society for Neurovascular Diseases

22 July 2022

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In vivo methods for probing CSF flow/glymphatic system



Two-Photon Imaging

- High spatial resolution ($\sim 10 \mu\text{m}$)
- High temporal resolution (in the order of seconds)
- Small field-of-view (FOV)
- Limited depth
- Invasive

Gadolinium-enhanced MRI

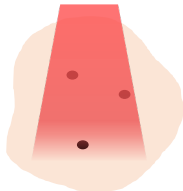
- Whole-brain FOV
- Non-invasive
- High/Lower spatial resolution ($\sim 75\text{-}300 \mu\text{m}$)
- Lower temporal resolution ($\sim 5\text{-}15$ mins)

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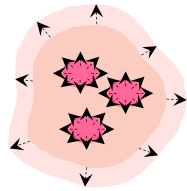
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Optoacoustic tomography (OAT)

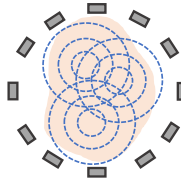
Laser excitation & absorption



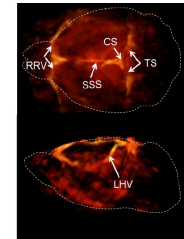
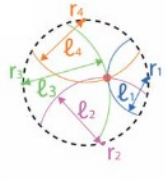
Heating & expansion



Ultrasound propagation & detection



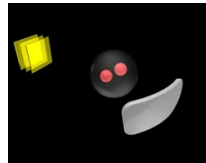
Reconstruction



Gottschalk et al, Nat. Biomed. Eng. 2019

Adapted: Deán-Ben et al, Chem. Soc. Rev. 2017

Rosenthal et al, Curr. Med. Imaging Rev. 2013



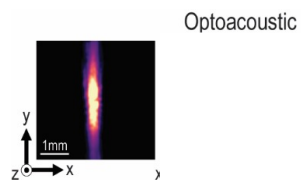
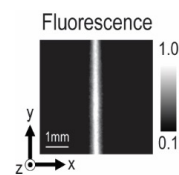
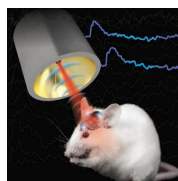
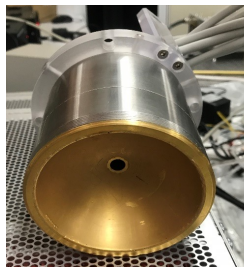
Advantages

- Large FOV
- Mesoscale resolution (50-100 μm)
- Minimally invasive
- Optical indicators at new depths

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OAT and fluorescence setup and characterization

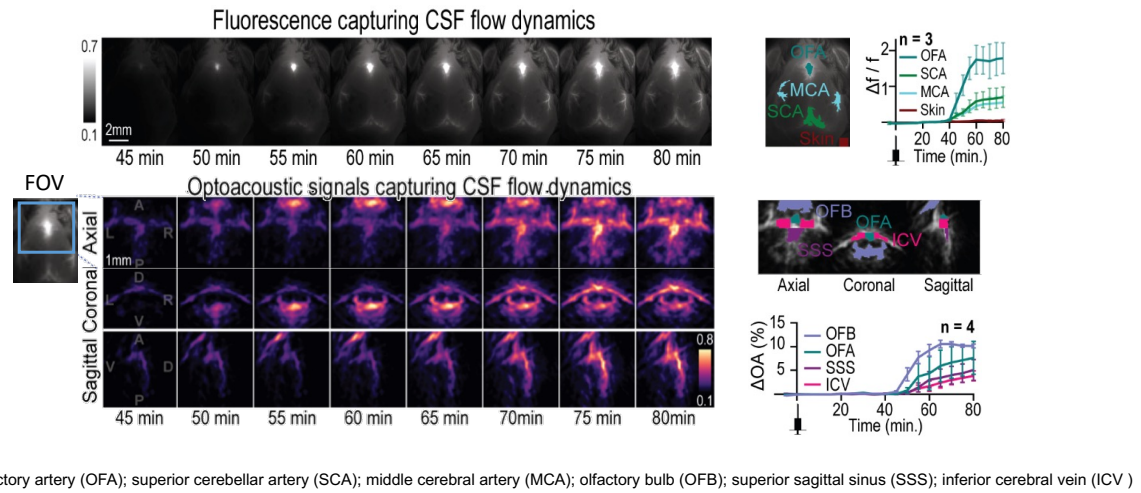


8x8 mm FOV
 ~150 μm resolution
 200 Hz PRF

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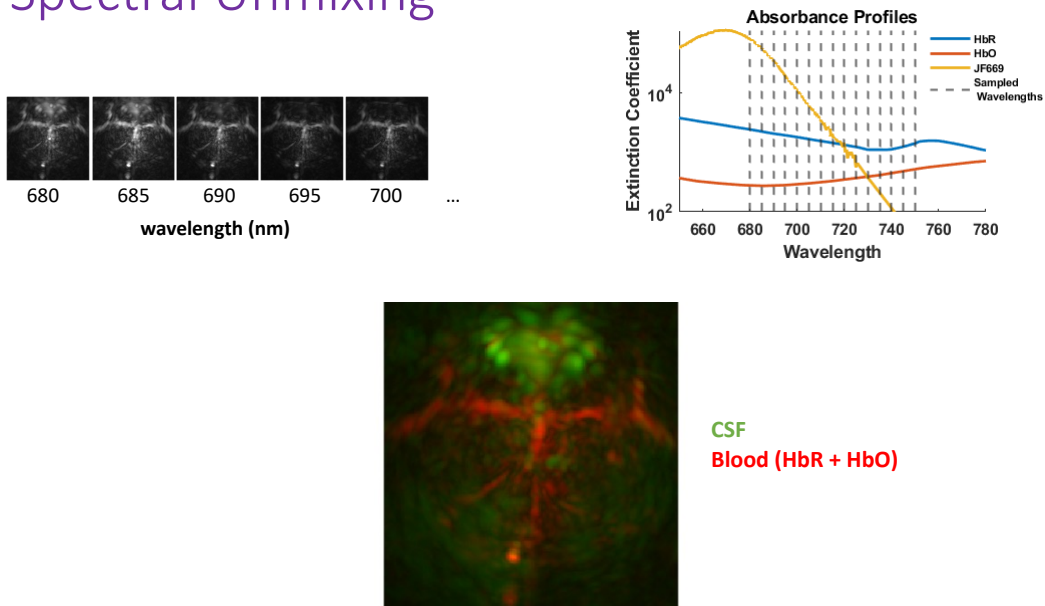
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Results: CSF flow



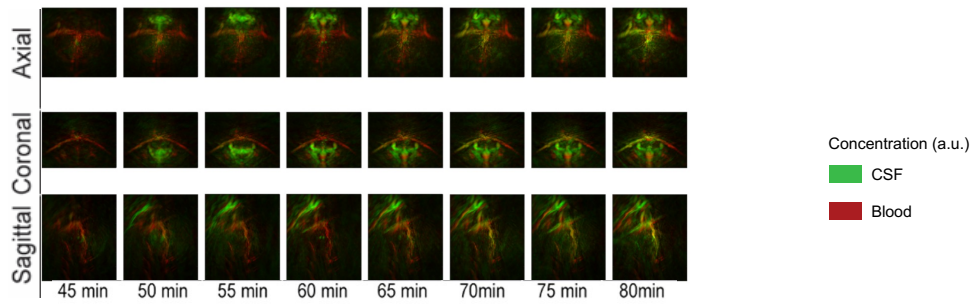
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Spectral Unmixing



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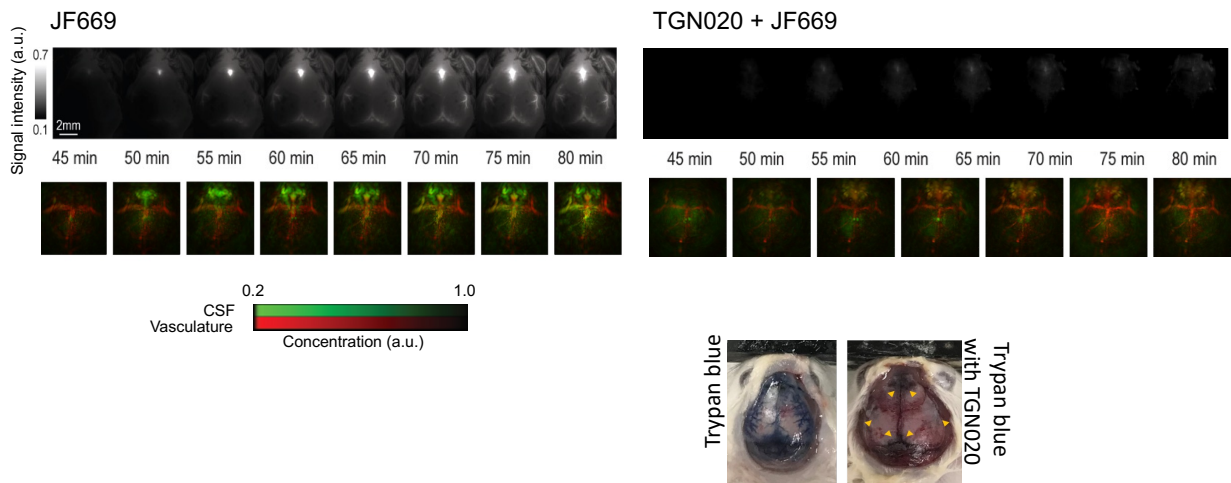
Results: CSF flow with spectral unmixing



7

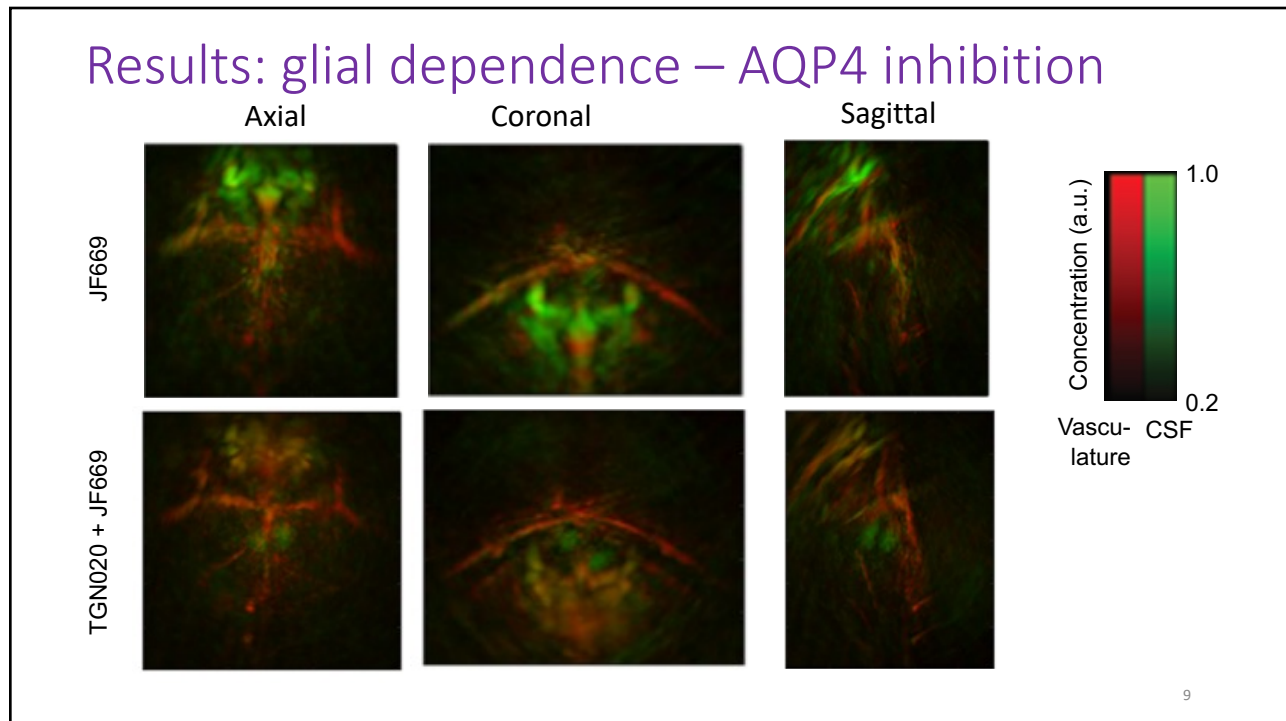
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Results: glial dependence – AQP4 inhibition



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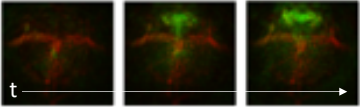
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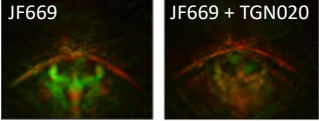
Summary

- Multispectral OAT of CSF flow provides mesoscale FOV, resolution, and depth along with fast frame rates and optical contrast



- Observed potential CSF influx, exchange, and efflux

- Observed AQP4 dependence



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Thank you!



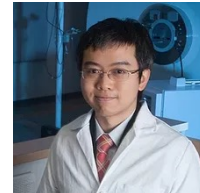
Dr. Russell Chan



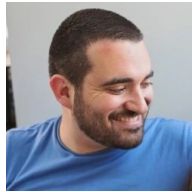
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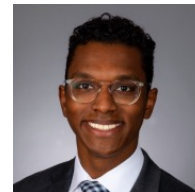
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