Detection of Cerebral Edema Using Optical Coherence Tomography

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Cerebral Edema
Cerebral edema, an increase in brain tissue water content, is responsible for significant morbidity and mortality in many disease states, including traumatic brain injury (TBI) and stroke.

The two types of cerebral edema are:
- Vasogenic edema – tissue swelling
- Cytotoxic (cellular) edema – glial cell swelling

Current clinical methods for detecting edema
- Computed tomography (CT)
- Magnetic resonance imaging (MRI)

Optical Coherence Tomography
Optical coherence tomography (OCT) is an imaging modality which allows for in-vivo continuous imaging while providing tissue specific properties, such as the extinction coefficient.

Here, OCT was utilized to detect and monitor the progression of cerebral edema by examining the transient behavior of the tissue intensity.

Inducing Cerebral Edema
Water intoxication was used to simulate severe cerebral edema. Female WT mice (10-12 weeks old) were prepared for imaging by thinning the skulls. A bolus injection of 30% of the mouse body weight in water was administered intraperitoneally.

OCT Imaging of Cerebral Edema
OCT images were collected before the injection of water to obtain baseline intensities. Imaging continued until the mice expired. Images were continuously collected during the entire experiment at a rate of 2.4 Hz. The images below are an average of all images collected in one minute. Only images for 1 minute (1A), 10 minutes (1D), 20 minutes (1E), 30 minutes (1F), 40 minutes (1G), and 50 minutes (1H) post-injection are displayed. All images are 2 mm x 1.5 mm.

Intensity Changes During Edema

Conclusion and Future Work
Using OCT, the increase in brain water content can be detected and monitored continuously. This provides information about the rate of swelling and may be used in selecting the appropriate therapy for patients with cerebral edema.

Future studies will include determining the optimal position of the OCT probe, determining the minimum increase of brain water content that can be detected, and extending the detection of brain water content changes to more clinically relevant models.

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