Motion-Resistant Microvascular Imaging for Ocular Choroid Flow Visualization

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Background, Motivation and Objective

Reduced ocular blood flow is an early symptom of glaucoma (a leading cause of blindness). To assess ocular blood flow, the choroid layer is typically assessed using indocyanine-green angiography or optical coherence tomography angiography, but these methods are semi-quantitative at best. Contrast-enhanced ultrasound microvascular imaging has shown potential in visualizing microvessels in the choroid. Yet, the image resolution is often degraded by motion artifacts that arise during the long acquisition period. Here, we present a new framework called motion-resistant microvascular imaging (MRMVI) that can map the choroid microvasculature for vascular density measurement in the presence of tissue motion.

Statement of Contribution/Methods

MRMVI is specifically designed to suppress motion artifacts; it is equipped with a multi-angle vector Doppler estimator (T-UFFC 2016; 63:1733-1744) to estimate the tissue motion vector at different pixel positions. During image formation, microbubbles (MB) were detected and localized based on plane wave imaging and deconvolution principles (*Nature* 2015; 527:499-507). Artifacts due to local tissue motion-induced MB drifts were corrected using the estimated local tissue motion; these drifts were individually counter-shifted and the corrected MB positions were accumulated to form the final image. The performance of MRMVI was first evaluated on an *in vitro* micro-flow phantom that has two 50 µm flow channels (305 µm apart) with translational tissue motion. The optic nerve head of a rat eye was also mapped to further demonstrate the efficacy of our method.

Results/Discussion

MRMVI was able to correct the misalignment in MB localization (Fig. 1a) due to local tissue motion (streaks in Fig. 1b). The measured flow channel size, after motion correction, differs by less than 3 µm than the actual 50 µm flow channel. *In vivo* cineloops (will be shown in conference) have demonstrated that MRMVI can track local tissue motion consistently over extended period and correct the motion artifacts. Fig. 1c shows that MRMVI was able to highlight the rat's central retinal artery and other side branches with finer details compared to power Doppler mapping (Fig. 1d). MRMVI provides new opportunities to measure the vascular density of the choroid using ultrasound to facilitate our understanding of pathogenesis of glaucoma and other ocular disease models.