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THREE-DIMENSIONAL ANALYSIS OF RETINAL VASCULATURE USING OPTICAL COHERENCE TOMOGRAPHY ANGIOGRAPHY (OCT-A) AND DEEP LEARNING

Poster

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Purpose:

Optical coherence tomography angiography (OCT-A) is an imaging modality enabling 3D visualisation of the human retinal vasculature in vivo. Accurate automated extraction of the 3D vasculature could increase understanding of how these systems are affected in diabetic retinopathy. We report a deep-learning approach for semantic segmentation of 3D vasculature.

Methods:

35 OCT-A images were obtained on the Zeiss Plex Elite 9000. 16 images (size 12x12x3mm) were acquired from 10 patients with diabetic retinopathy. 19 OCT-A images of scan sizes 12x12x3mm, 15x9x3mm and 3x3x3mm were acquired from 10 healthy participants not ascertained for disease status. Vessels were semi-automatically segmented using a custom-built Python software which outputted the vasculature in graph format. With these ground truth labels a 3D UNet was trained. Accuracy and dice scores were used as performance metrics and 5-fold cross validation was employed. Metrics of vessel branching angle, length, tortuosity, and volume were evaluated for each scan size.

Results:

Mean branching angle was 104.3 (sd 45.3) for diabetic retinopathy patients and 104.4 (42.3) for healthy controls. Mean vessel length was 64.4 (sd 52.8) for diabetic retinopathy and 71.0 (55.2) for healthy controls which was statistically significantly different by 2 sample t-test ($p<0.001$). Mean tortuosity was 267.4 (285.5) in diabetic retinopathy and 287.5 (314.7) for healthy controls (statistically significant by 2-sample t-test ($p<0.001$). 5-fold cross validation demonstrated validation accuracy between 0.61-0.63 (mean: 0.62, sd: 0.0064).

Conclusions:

This pilot study indicates potential of deep learning-based methods for extraction of 3D vessel structures. Further work is required to validate the performance of this algorithm in retinas of diverging disease status. Differences in vessel metrics and structure could be a promising biomarker for retinal disease for use in clinic.