Assessing Retinal Vascular Leakage with Optical Coherence Tomography Angiography (OCTA) and Deep Convolutional Neural Networks

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Introduction: Fluorescein angiogram (FA) is an invaluable tool to map out retinal vasculature and assess for vascular leakage. However, it remains an invasive test associated with potential adverse effects. Another imaging modality, optical coherence tomography angiography (OCTA), also can be used to map out the retinal vasculature without the introduction of a foreign dye. Although safer, unlike the FA, OCTA cannot directly assess for vascular leakage. However, a clinical question of whether OCTA can indirectly detect vascular leakage still remains. The objective of this study is to evaluate the feasibility of predicting vascular leakage from OCTA images using deep learning, specifically with convolutional neural networks (CNNs). We hypothesize that there are sufficient OCTA characteristics that may predict vascular leakage.

Methods: We performed a retrospective chart review between August 2018 and August 2023 of patients visiting the Department of Ophthalmology at St. Michael's Hospital (Toronto, Canada) who had at least one FA collected from at least one eye and a corresponding OCTA scan. Institution research ethics approval was obtained. Patient data was anonymized and categorized into either having vascular leakage or no leakage based on the FA test. We trained an ensemble of five deep CNNs based on the InceptionV3 architecture, using depth-encoded 2D OCTA fundus images as inputs and the FA leakage status as labels. We measured the accuracy and area under the receiver operating characteristic (AUROC) curve on a test set of patient images.

Results: FA and OCTA data from 130 patients was retrieved, resulting in a total of 258 OCTA images. We split the data into 104 patients for training and 26 patients for testing (80/20% split). After training for 50 epochs, we achieved a mean accuracy of 78% and mean AUROC of 0.805 on the test set.

Discussion/Conclusion: This feasibility study showed that an ensemble of five deep convolutional neural networks was able to predict presence of retinal vascular leakage from OCT angiography data alone with a high mean accuracy. Development of these technologies could eventually augment or even replace the need for FA testing to determine whether there is retinal vascular leakage.