Quantitative Assessment of Retinal Vasculature Using Artificial Intelligence-Based Analysis of Fluorescein Angiography in Age-Related Macular Degeneration

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Introduction: This study seeks to investigate associations between quantitative vascular measurements derived from ultra-widefield fluorescein angiography (FA) and baseline characteristics on optical coherence tomography (OCT) in patients with neovascular age-related macular degeneration (nAMD).

Methods: We prospectively recruited patients over the age of 50 years old with a diagnosis of active choroidal neovascularization in the context of nAMD, presenting to a single centre in Toronto, Canada from 2017-2023. Patients were imaged with FA using an ultra-widefield scanning laser ophthalmoscope and images were processed using the artificial intelligence-based RETICAD FAassist system to extract quantitative data pertaining to blood flow, perfusion, and blood-retinal barrier (BRB) permeability. Associations between blood flow, perfusion and BRB permeability with best-corrected visual acuity, central macular thickness (CMT) and macular volume (MV) were examined using univariable and multivariable regression models. Research ethics board approval was obtained for our study.

Results: A total of 81 eyes from 81 nAMD patients and seven eyes from seven healthy controls were included. Among patients with nAMD, most were female (n=50, 61.7%) and Caucasian (n=61, 75.3%), with a mean age of 79.8 ± 7.9 years old. In eyes with nAMD, central BRB permeability and perfusion were significantly higher than peripheral retinal values ($p<0.001$ and $p=0.009$, respectively). Compared to healthy controls, BRB permeability in the central and peripheral retina was significantly higher in nAMD patients ($p<0.001$ and $p<0.001$, respectively). Nonetheless, there was no significant difference observed in both perfusion and blood flow in nAMD eyes compared with healthy control eyes. On univariable analysis, BRB permeability measured centrally was significantly associated with CMT ($p=0.035$), while perfusion and blood flow measured centrally were significantly associated with MV ($p=0.043$ and $p=0.037$, respectively). BRB permeability remained significantly associated with CMT upon adjustment for demographic variables ($p=0.026$). No significant associations were observed between BCVA and FA quantitative vascular parameters derived from ultra-widefield FA.

Conclusions: Quantitative vascular biomarkers on ultra-widefield FA, particularly BRB permeability, were associated with baseline OCT characteristics in nAMD patients. Future works should explore longitudinal associations between quantitative FA parameters and clinical characteristics in diverse nAMD patient populations.