Abstract

Artificial Intelligence (AI)-based Quantification of Vascular Lesions in Fundus Fluorescein Angiography

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Fundus Fluorescein Angiography (FFA) is the most commonly used tool for assessing retinal neovascularization and vascular leakage in eye diseases such as retinopathy of prematurity (ROP), diabetic retinopathy (DR), and neovascular age-related macular degeneration (nAMD). Notably, the quantification of the vascular leakage in FFA is a widely used endpoint measurement in the preclinical animal model of these conditions.

The conventional methods for quantifying vascular lesions in FFA images are both labor-intensive and time-consuming. To address this limitation, we have devised an AI-assisted analysis pipeline aimed at efficiently quantifying the vascular lesions in the FFA images. AI-integrated Nikon NIS-Elements NIS.ai suite was used in our studies. The AI-based analysis pipeline was trained and evaluated on FFA images from two mouse models of ocular angiogenesis: (1) *Vldlr*$^{-/-}$ mouse, a model of spontaneous pathological neovascularization involving retina and choroid, and (2) laser-induced choroidal neovascularization (CNV), a mouse model of nAMD. The vascular lesions in the FFA images were first manually defined using segmentation tool. The manually segmented images were subsequently used to train the AI component of the NIS software to recognize, enumerate and compute total and individual lesion areas. The training dataset encompassed a total of 12 unique images, encompassing instances without lesions as well as those portraying lesions of varied morphologies, sizes, and positions.

Our method consistently recognized and analyzed the lesions but needed supervision to improve the accuracy. However, with additional training on the curated images, we observed an improvement in the performance of the analysis pipeline. This was evident as the lesions were accurately identified without the inclusion of prominent blood vessels or non-lesion regions. Ongoing efforts are aimed at training the AI software on more images to improve the accuracy. We expect that, once optimized, this AI-powered analysis method will facilitate the automated quantification of neovascular lesions in FFA providing metrics such as lesion count, individual lesion area, mean lesion area and total lesion area. We predict this automated framework will not only enhance the accuracy but will also expedite the analysis process reducing several hours of manual analysis to just few minutes.