Machine learning to predict the individual progression of AMD from imaging biomarkers

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Purpose: In patients with intermediate age-related macular degeneration (AMD), the risk and speed of progression to choroidal neovascularization (CNV) or geographic atrophy (GA) is highly variable. Current risk assessment strategies rely on population-level associations rather than personalized approaches. We developed a fully automated machine learning method to individually predict AMD progression based on retinal imaging and genetics.

Methods: Fellow eyes with intermediate AMD (n=379) of patients enrolled in the HARBOR trial were included. For each eye, progression to CNV or GA was diagnosed based on standardized evaluation of monthly SD-OCT by two independent masked graders. As quantitative imaging biomarkers, we obtained a volumetric segmentation of retinal layers, drusen, reticular pseudodrusen and hyperreflective foci by fully automated image analysis at baseline and month 1 to 4. We developed and validated a machine learning algorithm predicting the conversion to advanced AMD on an individual basis, using the extracted imaging biomarkers as well as known genetic risk factors of AMD (34 single-nucleotide polymorphisms) as input features.

Results: By Month 24, 88 eyes (23%) had converted. Of those, 68 eyes developed CNV and 20 eyes GA. The automated algorithm differentiated converting versus non-converting eyes with an area under the receiver operating characteristic curve of 0.73. It was also feasible to differentiate a priori between GA and CNV with an accuracy of 0.80 for GA and 0.66 for CNV. The most critical features for progression were intraretinal hyperreflective foci and reticular drusen. Including genetic markers did not further contribute to the prediction.

Conclusions: Automated analysis of OCT biomarkers allows a personalized prediction of AMD progression. In our cohort of patients with unilateral CNV, genetic characterization did not add additional accuracy to the prediction of AMD conversion of the fellow eye.