Automated identification of disease activity and therapeutic response in neovascular AMD by deep learning

Abstract Number: 2623

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Background: Optimal determination of leakage activity is essential for guiding treatment decisions in every regimen of anti-VEGF therapy in neovascular age-related macular degeneration (AMD). However, central retinal thickness does not correlate with visual function and identification of intra- and subretinal fluid on a clinical base is challenging resulting in suboptimal therapeutic outcomes in the real world. Deep learning offers the opportunity to accurately localize and quantify fluid based on conventional optical coherence tomography (OCT).

Patients and method: Patients with treatment-naive neovascular AMD undergoing treatment with intravitreal ranibizumab over 2 years were evaluated using a standardized protocol of spectral-domain (SD) OCT imaging (Cirrus HD OCT III, Carl Zeiss Meditec, Dublin, CA). An algorithm was developed to automatically detect and measure intra- and subretinal fluid (IRF/SRF) on SD OCT. The method was validated against manual segmentation performed by certified readers from a reading center.

Results: The deep learning method was able to precisely discriminate and quantify IRF and SRF in neovascular AMD in a fully automated manner. The validation in 400 patients resulted in a mean accuracy of 0.93 (AUC) for IRF and 0.98 (AUC) for SRF. The correlation between automated and manual reading was high yielding 0.90 for IRC and 0.96 for SRF, Pearson's correlation coefficient. Automated fluid analyses was performed in 1097 patients at baseline and during follow-up, accurately monitoring the therapeutic response regarding the resolution of fluid types over time. Correlation with best corrected visual acuity (BCVA) outcomes demonstrated a strong impact of IRF on retinal function and a progressive loss of correlation between fluid and BCVA over time.

Conclusion: Deep learning introduces defined and quantified parameters into the treatment of neovascular AMD. The reproducible and reliable standard of measuring disease activity and therapeutic response may vastly improve disease management and visual outcomes in clinical practice, particularly as deep learning methods can be applied inexpensively in large dimensions.