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Real-time detection and quantification of retinal fluid in neovascular age-related macular degeneration on optical coherence tomography using artificial intelligence

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Objective

Artificial intelligence (AI)-supported assessments of macular optical coherence tomography (OCT) scans has improved greatly over the last years.[1] The „Vienna Fluid Monitor“ has been validated in various post-hoc analysis of randomized controlled trials,[2,3] and has become ready for implementation in the clinical workflow in a real-world outpatient clinic setting.[4]

Detection rates of macular fluid (human grader vs. human grader, or human grader vs. AI) using OCT have been evaluated using data from randomized controlled trials.[5,6] Nonetheless, a prospective evaluation of AI vs. human grader in a real-world setting is still missing.

The purpose of this study was to evaluate the implementation of AI-supported, real-time detection and quantification of retinal fluid on optical coherence tomography (OCT) for neovascular age-related macular degeneration (nAMD).

Patients and Methods

Consecutive patients with active nAMD were included and OCT imaging (6x6 mm, Spectralis HRA+OCT, Heidelberg Engineering, Heidelberg, Germany) was performed in a real-world outpatient care setting. A validated deep learning based algorithm was used on the baseline OCT volumes to detect and quantify macular fluid within the central 1 mm.[7] Active nAMD was defined as any disease activity (either subretinal fluid or intraretinal fluid) on the OCT volume.

Cohen’s Kappa of fluid detection of AI in comparison with a human grader was assessed in the central 1mm and the total 6mm area and possible reasons for discrepancies explored. Differences in fluid volumes between previously treated and treatment-naïve are compared using Wilcoxon rank-sum tests.

Results

Fifty-two eyes with active nAMD were recruited from the outpatient clinic of the Department of Ophthalmology and Optometry (Medical University of Vienna) and included in the study. All eyes were both assesses by the AI and a human grader.

Median (IQR) for IRF and SRF in the central 1 mm was 0.02 (11.63) nl and 16.27 (40.01) nl, respectively. There was no difference in quantitative IRF and SRF volumes between previously treated and treatment-naïve eyes (both $p>0.05$).

There was excellent agreement in the detection of retinal fluid between the AI and the human grader (Cohen’s Kappa: 0.94, 0.92, 0.81 and 0.76 for SRF 1mm, IRF 1mm, SRF 6mm and IRF 6mm, respectively). There was no difference in the detection of macular fluid between previously treated and treatment-naïve eyes. Fluid volumes in the central 1mm for cases that showed discrepancies in fluid detection between AI and a human grader were clinically insignificant (SRF and IRF each <0.12nl).

Conclusion

AI-based detection and quantification of retinal fluid is a precise and reliable tool to assess macular OCT volumes on an individual level. In addition to detection, the quantification of fluid volumes is only feasible with AI support. An AI output for clinical consultations will support treatment management and ensure reading center precision for each patient in the real world, especially in a non-hospital community-based setting.

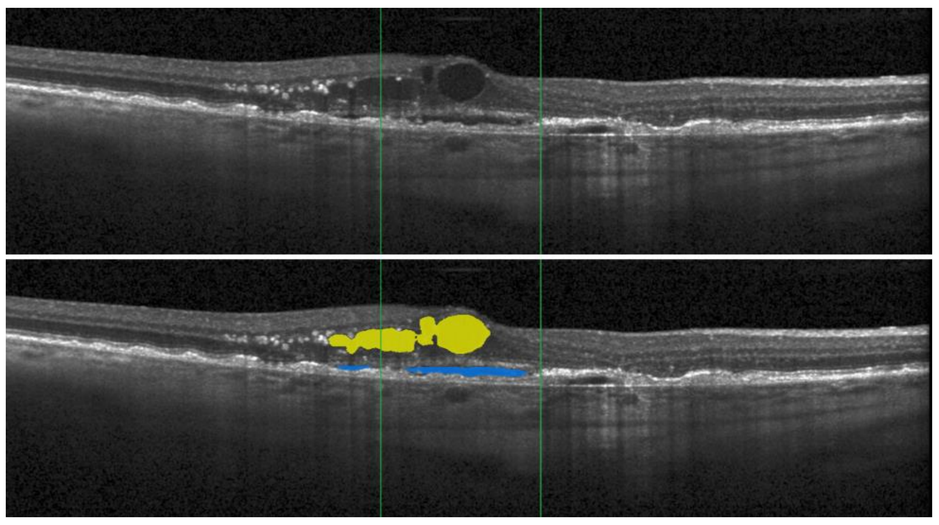

Figure 1. Native (top) and AI-supported (bottom) OCT assessment in neovascular AMD. Both intraretinal fluid (IRF, yellow) and subretinal fluid (SRF, blue) are present in the central 1 mm and the 6 mm area.

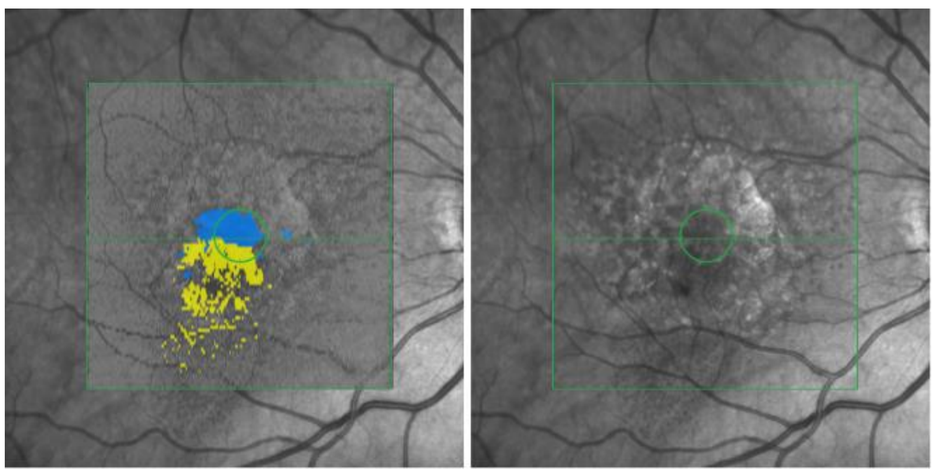

Figure 2. En face visualization of the macular fluid seen in Figure 1 with AI support (left) and native (right). Both intraretinal fluid (yellow) and subretinal fluid (blue) are present in the central 1 mm and the 6 mm area.

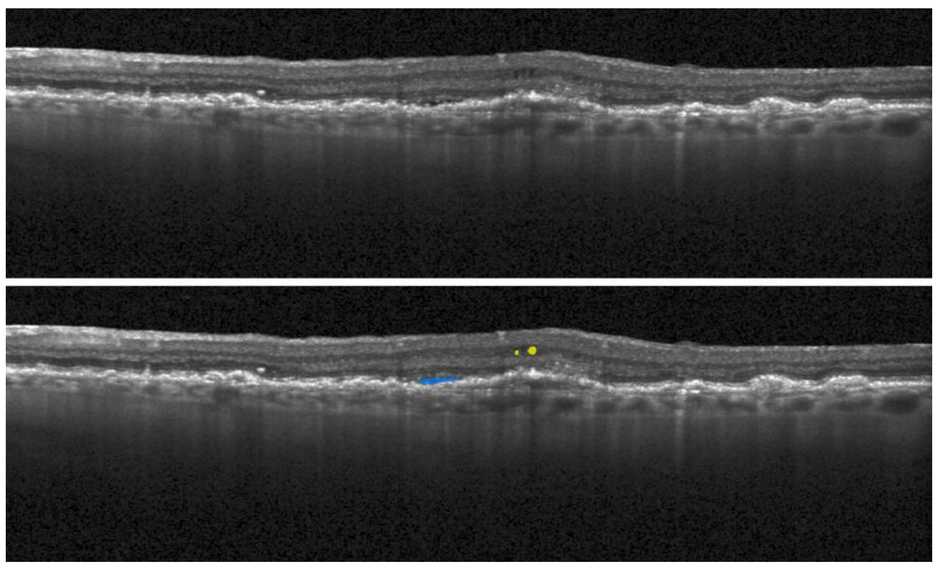

Figure 3. Native (top) and AI-supported (bottom) OCT assessment in neovascular AMD. Intraretinal fluid (yellow) is only present outside the central 1 mm, but subretinal fluid (blue) is present in the central 1 mm and the 6 mm area (see also Figure 4).

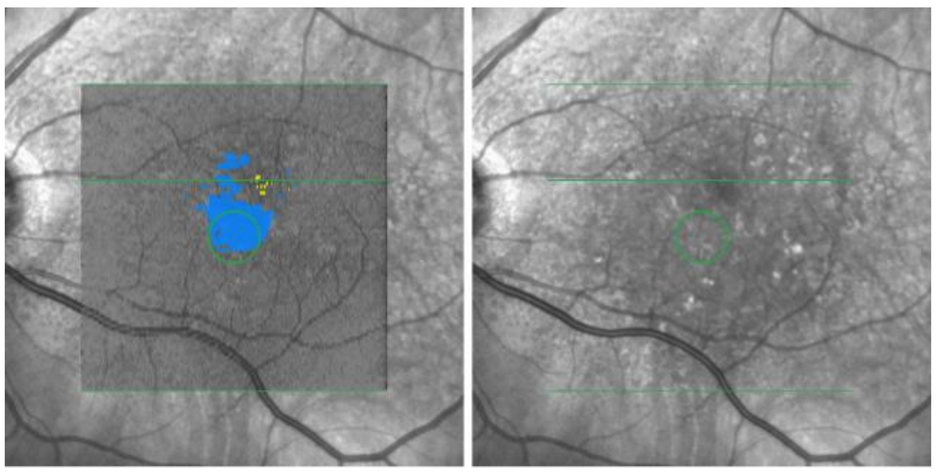

Figure 4. En face visualization of the macular fluid seen in Figure 3 with AI support (left) and native (right). Intraretinal fluid (yellow) is only present outside the central 1 mm, but subretinal fluid (blue) is present in the central 1mm and the 6mm area.

References

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