Performance of an ultrafast megahertz widefield OCTA device in the detection of microvascular lesions in advanced diabetic retinopathy

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PURPOSE

- To compare the detection rate of microvascular lesions between an ultrafast Megahertz widefield optical coherence tomography angiography (MHz WF-OCTA) device and commercially available kHz WF-OCTA, fluorescein angiography (FA) and color fundus (CF) imaging.
- Improvements of OCTA imaging have led to an increased usage of OCTA in diabetic retinopathy (DR) diagnosis, pathing the way for a wider applicability.

METHODS

- Diabetic patients with DR were recruited from the Department of Ophthalmology at the Medical University of Vienna.
- MHz WF-OCTA 3D data were acquired with a custom-built swept-source (SS) OCT prototype: A-scan rate 1.7MHz; FOV 18mm in diameter; 1060nm central wavelength and lateral resolution of 20 µm. Data was further processed with deep learning (DL) based 3D denoising.
- Corresponding images were obtained with PLEX® Elite 9000 (ZEISS, Dublin, CA; A-scan rate 200 kHz; FOV 12x12mm) and Optos® California (Optos; ultrawidefield FA and CF imaging).
- Microaneurysms (MAs) and intraretinal microvascular abnormalities (IRMAs) were evaluated on en face OCTA/FA/CF images within an extended ETDRS grid consisting of a central 1 mm diameter disc, inner (0.5–1.5mm), outer (1.5–3.0mm) and extended ring (3.0-6.0mm).

CONCLUSIONS

- MHz WF-OCTA imaging in combination with DL-based image quality improvement techniques show accurate performance in MA detection and outperforms FA in the detection of IRMAs in advanced stages of DR, potentially simplifying correct DR staging and disease monitoring in diabetic patients.

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RESULTS

Thirty-four eyes of 34 patients with severe non-proliferative DR (n=11) and proliferative DR (n=23) were included.
MHz WF-OCTA, WF-OCTA and CF imaging detected 55%, 44% and 34% of MAs, respectively. Significantly more MAs in total were detected on MHz WF-OCTA compared to WF-OCTA (p=0.007). Both OCTA devices detected IRMAs in all 34 eyes. Rate of IRMA detection was higher in the inner and outer ring using MHz WF-OCTA compared to WF-OCTA (47% vs. 24% and 91% vs. 65%, respectively). MHz WF-OCTA outperformed FA in IRMA detection in the inner (47% vs. 26%), outer (91% vs. 71%) and extended rings (100% vs. 97%). Details of MA and IRMA detection rates with different imaging modalities in specific ETDRS rings are shown in Table 1 and Table 2.

Table 1: Mean number of MAs per eye (± SD)

	MHz WF-OCTA	WF-OCTA	FA	CF
Central disc	0.8 ± 1	0.7 ± 1	2 ± 2	0.4 ± 0.8
Inner ring	6 ± 4	5 ± 5	10 ± 9	4 ± 5
Outer ring	25 ± 23	19 ± 20	40 ± 40	14 ± 13
Extended ring	57 ± 55	45 ± 40	108 ± 99	36 ± 32
Total	89 ± 80	70 ± 63	160 ± 145	54 ± 48

Table 2: Rate of IRMA detection in percentage (number of eyes with IRMAs)

	MHz WF-OCTA	WF-OCTA	FA	CF
Central disc	0	0	0	0
Inner ring	47% (16)	24% (8)	26% (9)	0
Outer ring	91% (31)	65% (22)	71% (24)	29% (10)
Extended ring	100% (34)	100% (34)	97% (33)	76% (26)

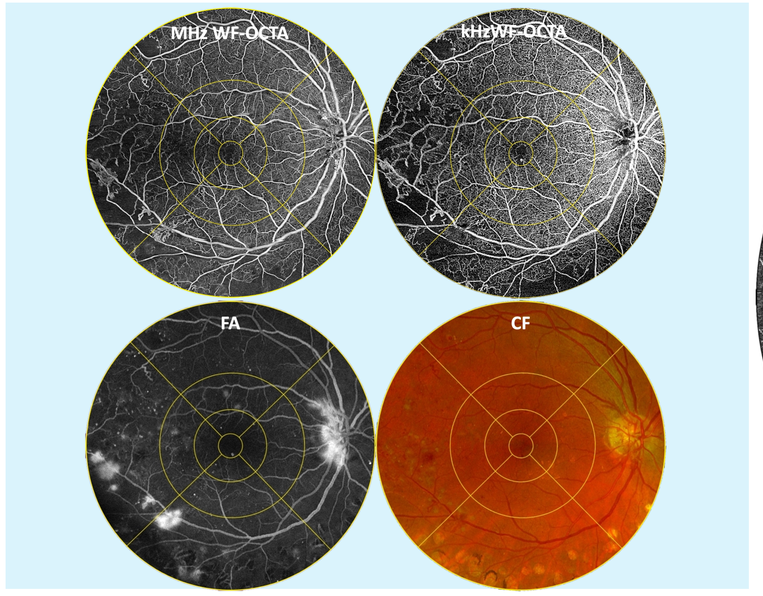

Figure 1: 57-year-old patient with proliferative DR, MAs, IRMAs and NVs visible on MHz-WF-OCTA, WF-OCTA, FA and CF imaging

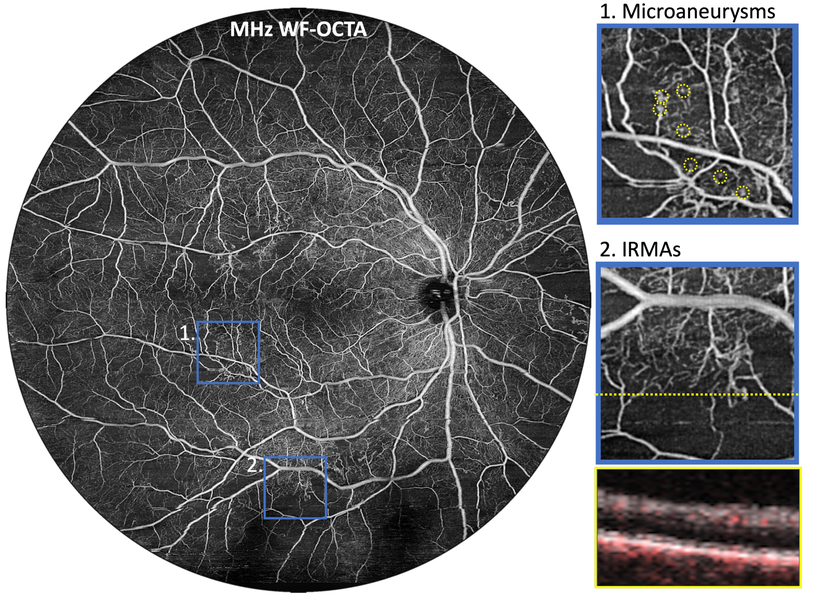

Figure 2: MHz-WF OCTA of a 55-year-old with severe non-proliferative DR, 1. IRMA with no breaching of the inner limiting membrane on WF-OCTA B-Scan, 2. MAs