Comparison of microaneurysm detectability between MHz WF-OCTA and kHz WF-OCTA in advanced diabetic retinopathy

Kim Lien Huber1, Heiko Stino1, Thomas Schlegl2, Michael Niederleithner3, Wolfgang Drexler4, Rainer A. Leitgeb3, Ursula Schmidt-Erfurth3, Tilman Schmölz3, Andreas Pölleisz2
1Department of Ophthalmology, Medical University of Vienna, Austria; 2Center for Medical Physics and Biomedical Engineering, Medical University Vienna, Austria; 3Carl Zeiss Meditec, Inc., Dublin, CA

PURPOSE
To compare the difference in diabetic microaneurysm (MA) detection between an ultrafast megahertz (MHz) widefield optical coherence tomography angiography (WF-OCTA) device and a commercially available kilohertz (kHz) WF-OCTA device.

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 1.7 MHz; 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; ultrawide-field fluorescence angiography (FA) and color fundus (CF) imaging).

Microaneurysms (MAs) were manually 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 in combination with DL-based image denoising techniques outperformed kHz WF-OCTA in the detection of diabetic MAs, which was pronounced in the extra-macular and peripheral regions of an extended ETDRS grid.

RESULTS
Thirty-four eyes of 34 patients with severe non-proliferative DR (n=11) and proliferative DR (n=23) were included in this study. A mean number of 160±45 (± standard deviation) MAs per eye were detected from the gold standard FA images. MHz WF-OCTA and kHz WF-OCTA detected 55% and 44% of MAs, respectively. Significantly more MAs in total were detected on MHz WF-OCTA compared to kHz WF-OCTA (p=0.007). MHz WF-OCTA outperformed kHz WF-OCTA in MA detection in the outer (p=0.006) and extended ETDRS ring (p=0.031). CF showed the lowest detection rate with 34% of MAs. Details of MA numbers in specific ETDRS rings are shown in Table 1.

Table 1: Number of MAs detected per modified ETDRS grid

<table>
<thead>
<tr>
<th></th>
<th>MHz WF-OCTA</th>
<th>kHz WF-OCTA</th>
<th>FA</th>
<th>CF</th>
</tr>
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<tbody>
<tr>
<td>Central disc</td>
<td>28</td>
<td>25</td>
<td>54</td>
<td>15</td>
</tr>
<tr>
<td>Inner ring</td>
<td>199</td>
<td>174</td>
<td>346</td>
<td>129</td>
</tr>
<tr>
<td>Outer ring</td>
<td>839</td>
<td>641</td>
<td>1359</td>
<td>475</td>
</tr>
<tr>
<td>Extended ring</td>
<td>1954</td>
<td>1538</td>
<td>3685</td>
<td>1227</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3020</strong></td>
<td><strong>2378</strong></td>
<td><strong>5444</strong></td>
<td><strong>1846</strong></td>
</tr>
</tbody>
</table>

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. Images 1-3. show examples of MAs on OCTA en face images