Journal Article Review

Distinct retinal capillary plexuses identified with SPECTRALIS OCT-angiography

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Background and Purpose

In order to visualize the retinal microvasculature with optical coherence tomography angiography (OCTA), earlier studies have analyzed the OCTA signal profile over retinal depth. Based on these findings, distinct retinal vascular anatomic plexuses that are known from histology were identified and parameters for their optimal separation and display as *en face* projections were derived.[1] However, these results relied on an OCTA algorithm that sacrifices depth resolution to reduce noise in the resulting flow signal by a technique called 'split-spectrum amplitude decorrelation angiography' (SSADA). Because this tradeoff could have a profound impact on the resulting angiography depth profile and subsequent identification of retinal vascular layers by OCTA, the current study investigated the retinal vasculature in normal eyes using the OCT Angiography Module of SPECTRALIS®, which preserves the original depth resolution of OCT for OCTA imaging.

Methods

This study included right eyes of 22 healthy subjects, age 34 ± 6.9 years, who had no significant refractive errors (≤ -6.00 D or ≥ +3.00 D). SPECTRALIS OCTA is unique in that it relies on an algorithm that calculates the probability of flow at each tissue location to produce high-contrast OCTA images. To ensure consistent scan placement, OCTA scans were obtained along the fovea to Bruch's membrane opening center axis using the Anatomic Positioning System. Large vessels were excluded from the depth profile analysis in order to study microvascular flow. Flow signals were precisely aligned in depth across retinal locations and individuals before statistical analysis.

Results

- Vascular layers are present at relatively consistent depths in the retina across individuals; four capillary plexuses can be distinguished – two superficial vascular plexuses and two deep vascular plexuses.
- In the parafoveal area, the superficial vascular plexus (SVP) can be separated in depth into two distinct vascular networks. Their separating boundary is located near the nerve fiber layer – ganglion cell layer junction and extends between 3° and 5° around the fovea. In the perifoveal area, the SVP is not comprised of two clearly distinct capillary layers.
- Towards the temporal periphery, the two deeper vascular layers, intermediate capillary plexus (ICP) and deep capillary plexus (DCP), move closer together in depth, yet remain clearly separated using full-spectrum OCTA with preserved depth resolution.
- 3D projection artifact removal (3D-PAR) was applied to ensure direct comparability to Campbell *et al*.[1] However, the study results indicated that 3D-PAR was not mandatory for the reliable separation of different distinct vascular layers in depth. This particular variant of 3D-PAR will not be implemented into SPECTRALIS OCTA.
- High lateral resolution OCTA *en face* projections (6 µm/ pixel) of the ICP and DCP show different geometric vessel features in the individual networks. The DCP exhibits distinct vortex-like configurations of vascular loops surrounding a central seed point, not seen in the ICP.

Conclusions

- The full-spectrum, probabilistic OCTA algorithm provides consistent visualization of the SVP, ICP, and DCP.
- In the parafoveal area, the SVP can be separated into two distinct plexuses whereas this separation is not seen using the split-spectrum based analysis with SSADA – this may have clinically significant implications.
- The findings indicate that a constant offset from the outer boundary of the inner plexiform layer can be used to define a reliable separating interface between SVP and ICP, as well as ICP and DCP.
- For precise 3-D reconstruction and anatomically correct visualization of retinal microvasculature in healthy eyes, axial vascular density analysis of the high-resolution signal from full-spectrum OCTA is critical.

1. Campbell JP, Zhang M, Hwang TS, *et al*. Detailed vascular anatomy of the human retina by projection-resolved optical coherence tomography angiography. *Scientific reports*. 2017;7:42201.