CASE REPORTS

Optical Coherence Tomography Angiography in Common Retinal Diseases: A New Diagnostic Modality

Abstract
Optical Coherence Tomography Angiography (OCT-A) is a technology in which vascular flow is visualized in an non-invasive manner. Here we report three cases in which OCT-A provides details about retinal pathology that are comparable to traditional retinal imaging methods.

Key Words
OCT-A, AngioPlex™, non-invasive ophthalmic vascular imaging

Introduction
We live in a world in which new technology is constantly changing the diagnostic capability in the assessment of retinal disease. With the advent of Optical Coherence Tomography Angiography (OCT-A) we now have an imaging technique that gives new information of vascular flow of retinal and choroidal vessels without the need for an intravenous dye injection.

Herein we describe three cases of common retinal vascular disease, neo-vascular age-related macular degeneration (nvAMD), proliferative diabetic retinopathy (PDR), and branch retinal vein occlusion (BRVO) using multi-modal imaging methods.

Methods
We performed multimodal imaging using fluorescein angiography (FA), indocyanine green angiography (ICG), spectral domain optical coherence tomography (SD-OCT), and OCT-A (Zeiss Cirrus 5000 Angioplex™ OCT).

Angioplex™ uses 68,000 A-scans per second speed OCT scanning engine and a Zeiss proprietary algorithm called OMAGC (optical micro-angiography algorithm to the power of complex) to detect light reflectivity along each repeated scanned data point (voxel), defining motion of red blood cells. It also utilizes FastTrac™, real-time tracking, eye tracking to ensure scanning registration, decreased motion artifacts and rescan areas to account for patient blinking.1

Figure 1: OCT-A Illustration from Zeiss.

Figure 1: AngioPlex Optical Coherence Tomography. A. Acquisition of Data and Processing: B. Superficial, Deep and Avascular Maps from Sequential Scans With B-scans Showing Layers that Define the Maps and a Schematic of the Vasculature of the Eye.

References
CASE REPORT 1:  
NEOVASCULAR AGE RELATED MACULAR DEGENERATION

A 60 year old female presents with decreased vision in the left eye. Examination revealed a visual acuity of 20/20 and 20/60 in the right and left eyes respectively with normal pupils, extraocular motility, and intraocular pressure. The right eye exam was significant for macular drusen. On dilated fundus exam of the left eye, the macula showed retinal thickening with a grey-white discoloration consistent with choroidal neovascularization (CNV) with surrounding subretinal hemorrhages (Figure 2a). Fundus autofluorescence showed multiple areas of hypoautofluoresce (Figure 2b). On SD-OCT there was a subretinal hyper-reflectivity with intraretinal edema (Figure 2C). The fluorescein angiogram (Figures 2d and 2e) shows leakage within the macula with blocking of the subretinal hemorrhages and ICG angiography (Figures 2f and 2g) shows no evidence of polypoidal choroidal vasculopathy. The OCT-A (Figure 2h) displays a complex vascular network that corresponds to the area of retinal thickening on fundus photography and leakage on FA. The en face imaging shows the structure detail (Figure 2i). There is increased flow as noted by the corresponding B-scan in the area of the CNV (Figure 2j). This patient was diagnosed with NVAMD in the left eye and was entered into a clinical trial for Anti-VEGF therapy.
Figure 2f: Indocyanine green angiography (early phase).

Figure 2h: OCT-A Zeiss Cirrus 5000 AngioPlex – Choriocapillaris Sub Retinal above RPE 6x6.

Figure 2g: Indocyanine green angiography (late phase).

Figure 2i: OCT-A Zeiss Cirrus 5000 AngioPlex – Structure En Face 3x3.

Figure 2c: SD-OCT Line Scan from Heidelberg Spectralis with ICG.
CASE REPORT 2: PROLIFERATIVE DIABETIC RETINOPATHY

A 45 year old male with a past medical history of Type II Diabetes presents with decreased vision in the left eye. Examination revealed a visual acuity of 20/25 in the right eye and 5/200 in the left eye with normal pupils, extraocular motility, and intraocular pressure. On dilated fundus exam in the right eye, there was 360 degrees neovascularization of the optic disk. In the left eye there was no view of the posterior pole secondary to a vitreous hemorrhage. On fundus photography there is notable neovascularization of the optic nerve (Figure 3a) in the right eye. The FA shows leakage of the neovascular vessels (Figures 3b and 3c). The OCT-A reveals abnormal vasculature on the temporal optic nerve with the outline of the neovascularization that is extending into the vitreous (Figures 3d and 3e).

Figure 3a: Color Fundus Photo – Proliferative Diabetic Retinopathy (NVD).

Figure 3b: Fluorescein Angiogram (early phase).

Figure 3c: Fluorescein Angiogram (late phase).

Figure 3d: OCT-A Zeiss Cirrus 5000 AngioPlex – Retinal 6x6.

Figure 3i: OCT-A Zeiss Cirrus 5000 AngioPlex – Superficial 6x6.
**Case Report 3: Branch Retinal Vein Occlusion**

An 85 year old female with a past medical history of hypertension presents to clinic with blurry vision in the left eye. On examination her visual acuity was 20/25 in the right eye and 20/30 in the left eye with normal intraocular pressure. Anterior segment was normal in both eyes with a normal posterior segment in the right eye. Dilated fundus examination revealed diffuse intraretinal hemorrhages in the supranasal macula with cotton wool spots and central cystoid macula edema in the left eye. Temporally there were scattered small drusen (Figure 4a). Fluorescein angiography shows blocking in the region of the intraretinal hemorrhage with a small amount of leakage at the fovea (Figures 4b and 4c). OCT-A highlights the capillary dropout and the vascular changes that are not well visualized on FA (Figure 4d).

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**Figure 4a:** Color Fundus Photo – Branch Retinal Vein Occlusion (BRVO).

**Figure 4b:** Fluorescein Angiogram (early phase).

**Figure 4c:** Fluorescein Angiogram (late phase).

**Figure 4d:** OCT-A Zeiss Cirrus 5000 AngioPlex 6x6.

**Figure 5:** OCT-A Zeiss Cirrus 5000 AngioPlex – Vascular Occlusion, Optic Atrophy 6x6.
CONCLUSIONS

In the patient with NVAMD OCT-A offers more enhanced detail of the CNV membrane than the corresponding FA and ICG. Future studies need to be performed to define the CNV response to treatment so that OCT-A can direct therapy more effectively. For the proliferative diabetic retinopathy patient, the OCT-A complements the FA images. While OCT-A was not able to show leakage, it does confirm the abnormal growth of vessels. Lastly, in the BRVO case, OCT-A gave details about vascular flow that were not visualized on FA.

OCT-A is a non-invasive technique that can be used to diagnose retinal disease with image acquisition performed in less than one minute. In addition, the images can provide details about vascular flow that were not otherwise visualized on traditional FA and ICG. Zeiss Angioplex produces images at various segmentations which gives detail about flow in different retinal and choroidal layers. OCT-A may offer patients an alternative to imaging in which an invasive technique is less desirable, such as young patients, pregnancy, diabetic patients in which venous access is difficult, and especially for patients with known adverse reactions and/or allergies to FA/ICG dye. Lastly, there is increased patient satisfaction with OCT-A given far less time to acquire an image and improve patient comfort due to decreased illumination. This novel technology will continue to evolve and improve to provide new insights into disease pathogenesis.

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REFERENCES