Ultra-Widefield Steering-Based SD-OCT Imaging of the Retinal Periphery

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OBJECTIVE To describe the spectral-domain optical coherence tomography (SD-OCT) features of peripheral retinal findings using an ultra-widefield (UWF) steering technique to image the retinal periphery.

PURPOSE To demonstrate successful imaging and evaluation of a steered approach using an SD-OCT of peripheral retinal pathologies.

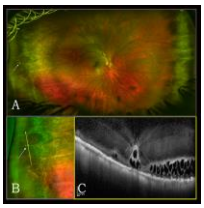
METHODS Nineteen peripheral retinal features including: vortex vein, congenital hypertrophy of the retinal pigment epithelium (CHRPE), pars plana, ora serrata pearl, typical cystoid degeneration (TCD), cystic retinal tuft, meridional fold, lattice and cobblestone degeneration, retinal hole, retinal tear, rhegmatogenous retinal detachment (RRD), typical degenerative senile retinoschisis, peripheral laser coagulation scars, ora tooth, cryopexy scars (retinal tear and treated retinoblastoma scar), bone spicules, white without pressure, and peripheral drusen were identified by peripheral clinical examination. Near infrared (NIR) scanning laser ophthalmoscopy (SLO) images and SD-OCT of these entities were registered to UWF color photographs.

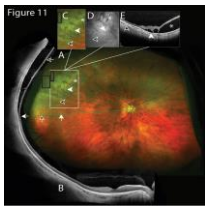
RESULTS SD-OCT resolved structural features of all peripheral findings. Dilated hyporeflective tubular structures within the choroid were observed in the vortex vein. Loss of retinal lamination, neural retinal attenuation, RPE loss or hypertrophy were seen in several entities including CHRPE, ora serrata pearl, TCD, cystic retinal tuft,

meridional fold, lattice and cobblestone degenerations. Hyporeflective intraretinal spaces, indicating cystoid or schitic fluid, were seen in ora serrata pearl, ora tooth, TCD, cystic retinal tuft, meridional fold, retinal hole, and typical degenerative senile retinoschisis. The vitreoretinal interface, which often consisted of lamellae-like structures of the condensed cortical vitreous near or adherent to the neural retina, appeared clearly in most peripheral findings, confirming its association with many low-risk and vision-threatening pathologies such as lattice degeneration, meridional folds, retinal breaks, and RRDs.

CONCLUSION UWF steering technique-based SD-OCT imaging of the retinal periphery is feasible with current commercially available devices, and provides detailed anatomical information of the peripheral retina, including benign and pathological entities, not previously imaged.

TAKE HOME MESSAGE UWF steering technique-based SD-OCT imaging of the retinal periphery is feasible with current commercially available devices, and provides detailed anatomical information of the peripheral retina.





HUMAN RESEARCH This study involves human research.
IRB Approval Status: Approval waived

Lessons for the High Volume Clinic From an Initial Experience of Optical Coherence Tomography Angiography (OCTA)

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OBJECTIVE What is the role of OCT angiography in the diagnosis and management of diabetic retinopathy?

PURPOSE Optical coherence tomography angiography (OCTA) is a new imaging technology that allows high-resolution mapping of the retinal and choroidal vasculature without the need for injection of an exogenous contrast agent. The first commercial OCTA systems became available near the end of 2014. We describe our initial experiences with, OCTA imaging of patients with diabetic retinopathy at a large tertiary care facility.

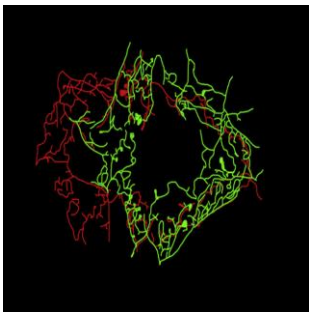
METHODS A commercial OCTA system (AngioVue, Optovue, Inc. Fremont, CA, USA) was installed at Moorfields Eye Hospital from late October 2014. Patients attending retinal clinics underwent OCTA imaging as part of their routine clinical care. Indications for OCTA imaging were recorded up to November 2015. The accuracy and reproducibility of OCTA image grading was assessed.

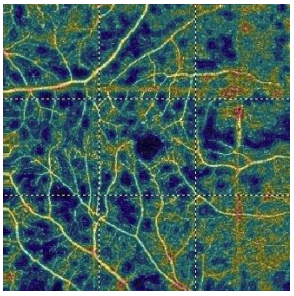
RESULTS OCTA imaging was performed in 1020 patients over a 12-month period. Retinal indications for imaging included: diabetic retinopathy 218 (21%), retinal vascular occlusion 105 (10%), other retinal vascular disease 193 (19%), age-related macular degeneration 64 (6%), high myopia 28 (3%), inherited retinal disease 46 (5%), and uveitis 77 (8%). OCTA imaging was also performed in patients attending glaucoma (26, 3%), neuro-ophthalmology (29, 3%), and corneal clinics (134, 13%). In patients

with diabetic retinopathy, good agreement was seen between OCTA imaging and fluorescein angiography (FA) for the grading of retinal capillary non-perfusion (e.g., intraclass correlation coefficient 0.825 for 3x3 mm OCTA scans in retinal vein occlusion). Motion artifacts and failures of automated image segmentation often limited assessment of OCTA images of choroidal neovascularization. Finally, OCTA imaging allowed the accurate and repeatable assessment of anterior segment vasculature.

CONCLUSION OCTA is a promising new imaging technology. Due to the presence of motion artifacts, errors in image segmentation, and small sampling areas, it is not yet a complete replacement for FA imaging. However, it may be particularly useful for assessment of macular ischaemia in patients with diabetic retinopathy. Novel clinical applications for OCTA are emerging.

TAKE HOME MESSAGE Diabetic macular ischaemia DMI is an important baseline parameter with implications for visual prognosis and treatment pathways in high volume settings. OCT angiography improves DMI detection.





Will Optical Coherence Tomography Angiography Shine When Traditional Ophthalmic Imaging Failed?

- Ching J. Chen, MD
- Matthew Olson, CRA
- Jordan Burnham, MD

OBJECTIVE To explore the capability of Optical Coherence Tomography Angiography (OCTA) in detection of retinal pathologies failed to be identified by traditional ophthalmic imaging.

PURPOSE To investigate the capability of OCTA in detecting retinal pathologies failed to be identified by traditional ophthalmic imaging including FA and SD-OCT.

METHODS This is a retrospective comparative observational study. Split Spectrum Amplitude Decorrelation Angiography (SSADA) based OCTA images were used to compare to the images obtained by traditional FA and SD-OCT.

RESULTS OCTA successfully detected the deep vascular changes in 9 eyes (7 with stage 1 and 2 with stage 5) of type 2 macular telangiectasia, 1 eye with active choroidal neovascular membrane (CNV) in central serous choroidopathy, 1 eye with silent CNV in ocular histoplasmosis, 9 eyes with silent CNV and 14 eyes with treated and quiescent CNV in neovascular age-related macular degeneration. FA and SD-OCT failed to identify definite vascular pathologies on all these cases.

CONCLUSION SSADA based OCTA with its 3D nature allows for *en face* segmentation to determine the depth of vascular pathology relative to retinal anatomic layers. It can

highlight findings which are not as obvious or even visible by traditional ophthalmic imaging.

TAKE HOME MESSAGE SSADA based OCTA can highlight findings which are not as obvious or even visible by FA or SD-OCT. Its 3D nature allows for *en face* segmentation for better imaging of the deeper vascular pathology.

HUMAN RESEARCH This study involves human research.
IRB Approval Status: Approved by institutional review board

Computerized Automated Characterization of Ultra-Widefield Fluorescein Angiography Features

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OBJECTIVE To develop and evaluate an automated algorithm for identification and quantification of angiographic features on ultra-widefield fluorescein angiography (UWFA).

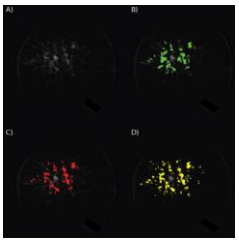
PURPOSE UWFA allows clinicians to visualize pathology in the posterior pole and the retinal periphery. Integration of the complex findings in UWFA, including microaneurysms (MA), leakage, and ischemia, is limited to subjective interpretation. This study was performed to develop and evaluate a novel automated assessment tool for UWFA features to facilitate objective and rapid UWFA evaluation.

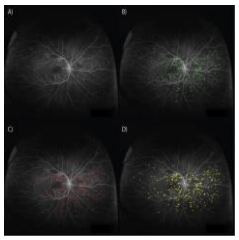
METHODS An automated unsupervised algorithm was developed for multiple vascular parameters, including MA, ischemia and leakage. A validation dataset consisted of UWFA obtained on the Optos 200Tx from subjects with retinal vascular disease. Comparative assessment of both native and dewarped images was performed. The tool utilized one early and late image for analysis. Early-late image registration and normalization was performed for leakage assessment. The early image was utilized for MA and ischemia analysis. Two independent expert graders manually assessed all parameters in ImageJ (NIH Freeware) and utilized the region of interest tool for direct comparisons between each reader and the algorithm.

RESULTS The algorithm successfully identified MA, ischemia and leakage on UWFA. The algorithm performed similarly to the two expert readers for all features. Dewarping images also resulted in changes to both manual and algorithm-based grading. Generally, dewarping resulted in a decrease in both detection of pathology and area of involvement for both manual and computerized grading. Time for image processing and analyzing was approximately 3-5 seconds for the automated tool compared to > 60 minutes for more complex manual grading. An automated zonal measurement system was successfully implemented with concentric zones around the optic nerve. This zonal measurement system facilitated a more refined approach to peripheral artifacts, such as lashes or media opacities. Preliminary assessment of longitudinal performance was completed utilizing prospective clinical trial data confirming algorithm performance and characterization of alterations in disease burden.

CONCLUSION Automated UWFA assessment provided rapid assessment of angiogram features, performing similarly to expert graders. Objective, quantitative evaluation of UWFA features may provide enhanced information related to disease state, prognosis and therapeutic response. Additionally, integrative pattern analysis of angiographic patterns may identify critical imaging biomarkers for individualizing care.

TAKE HOME MESSAGE Automated objective assessment of ultra-widefield fluorescein angiography is feasible and provides novel information related to quantitative metrics for various features (e.g., ischemia, leakage).





HUMAN RESEARCH This study involves human research.
IRB Approval Status: Approved by institutional review board