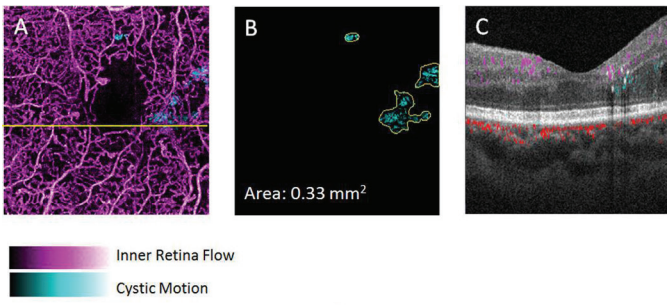
477 Clinical Applications of OCT Angiography
Wednesday, May 04, 2016 3:45 PM–5:30 PM
Exhibit/Poster Hall Poster Session
Program #/Board # Range: 5453–5510/C0057–C0114
Organizing Section: Multidisciplinary Ophthalmic Imaging Group
Contributing Section(s): Retinal Cell Biology

Program Number: 5453 **Poster Board Number:** C0057
Presentation Time: 3:45 PM–5:30 PM
Motion Signal Detected in Cystic Spaces on Optical Coherence Tomography Angiography
Monica Michelotti, Miao Zhang, Thomas S. Hwang, Steven T. Bailey, Christina J. Flaxel, Andreas Lauer, Phoebe Lin, J. Peter Campbell, David J. Wilson, David Huang, Yali Jia. Casey Eye Institute, Oregon Health And Science Univeristy, Portland, OR.
Purpose: To detect decorrelation signal within cystic spaces on optical coherence tomography (OCT) angiography.
Methods: Macular scans of participants with diabetic macular edema (DME) and neovascular aged related macular diseases (AMD) were taken using a spectral OCT system (RTVue-XR). The split-spectrum amplitude-decorrelation angiography (SSADA) algorithm was applied to detect flow. Semi-automated segmentation was used to identify the outer retina. The maximum flow projection in this slab was used for grading the decorrelation signal within cysts.
Results: 64 eyes of 37 patient with diabetic retinopathy and 57 eyes of 57 patients with neovascular AMD were analyzed. Of these, 5 eyes of 4 patients with diabetes had decorrelation signal within intraretinal cysts and no eyes with AMD. Patients with decorrelation signal had a mean central macular thickness of 341± 74.5 microns. Two patients had been treated with focal laser and anti-VEGF therapy. These cysts were sometimes associated with adjacent lipid and were most commonly in the parafoveal region. The decorrelation was noted in smaller cysts and not in large cystic spaces.
Conclusions: We present the first report of decorrelation signal within cysts. Previously all decorrelation signals had been attributed to flow within vessel or artifacts. The decorrelation signals within cysts likely originate from moving particles. These particles could be lipid or protein exudates, or cells. They tend to be present in smaller cysts in diabetic retinal edema, and not in fluids associated with choroidal neovascularization.



(A) En face OCT angiogram with cystic motion (B) Quantification of cystic spaces with detected decorrelation (C) Cross sectional angiogram showing intravascular flow in purple and cystic motion in blue.
Commercial Relationships: Monica Michelotti; **Miao Zhang**, None; **Thomas S. Hwang**, None; **Steven T. Bailey**, None; **Christina J. Flaxel**, None; **Andreas Lauer**, Oxford Biomedica (C); **Phoebe Lin**, None; **J. Peter Campbell**, None; **David J. Wilson**, None; **David Huang**, Optovue, Inc (P), Optovue, Inc (I), Optovue, Inc (F), Carl Zeis Meditec, Inc (P); **Yali Jia**, Optovue, Inc (P), Optovue, Inc (F)
Support: NIH grants DP3 DK104397, R01 EY02544, R01 EY023285, P30-EY010572, and an unrestricted grant from Research to Prevent Blindness

Program Number: 5454 **Poster Board Number:** C0058
Presentation Time: 3:45 PM–5:30 PM
Radial Peripapillary Capillary Network Visualized Using Wide-Field Montage Optical Coherence Tomography Angiography
Akihiro Ishibazawa, Taiji Nagaoka, Tomoko Mase, Akitoshi Yoshida. Ophthalmology, Asahikawa Medical University, Asahikawa, Japan.
Purpose: We quantitatively analyzed the features of a radial peripapillary capillary (RPC) network visualized using wide-field montage optical coherence tomography (OCT) angiography in healthy human eyes.
Methods: Twenty eyes of 20 healthy subjects were recruited. En-face OCT angiograms (3 × 3 mm) of multiple locations in the posterior pole were acquired using the RTVue XR Avanti, and wide-field montage images of the RPC were created. To evaluate the RPC density, the montage images were binarized and skeletonized. The correlation between the RPC density and the retinal nerve fiber layer (RNFL) thickness measured by an OCT circle scan were investigated.
Results: The RPC at the temporal retina was detected as far as 7.9 ± 0.5 mm from the edge of the optic disc but not around the perifoveal area within 0.9 ± 0.2 mm of the fovea. Capillary-free zones beside the second branches of the arterioles were significantly ($p<0.001$) larger than beside the third branches. The RPC densities at various distances from the optic disc edge were 13.1 ± 0.5% (0.5 mm), 11.5 ± 0.5% (2.5 mm), and 9.9± 0.5% (5 mm). The RPC density also was correlated significantly ($p<0.01$) with the RNFL thickness, with the greatest density in the inferior temporal region.
Conclusions: Montage OCT angiograms can visualize the expansion of the RPC network. The RPC is distributed to the superficial peripapillary retina in proportion to the RNFL thickness, suggesting that the RPC may be the vascular network primarily responsible for RNFL nourishment.
Commercial Relationships: Akihiro Ishibazawa, None; **Taiji Nagaoka**, None; **Tomoko Mase**, None; **Akitoshi Yoshida**, None

Program Number: 5455 **Poster Board Number:** C0059
Presentation Time: 3:45 PM–5:30 PM
High speed fundus photography or optical coherence tomography angiography – which one is better for non-invasive capillary perfusion maps and velocity measurements?
Chaitra Jayadev[1], Ashwin Mohan[1], Amiram Grinvald[3], Noel Bauer[2], Tos TJM Berendschot[2], Caroll Webers[2]. [1]Narayana Nethralaya, Bangalore, India; [2]Maastricht University, Maastricht, Netherlands; [3]Weizmann institute of science, Rehovot 76100, Israel.
Purpose: To compare the non-invasive capillary perfusion maps and velocity measurements between the Retinal Function Imager (RFI) and versus spectral domain optical coherence tomography angiography (OCTA) using the AngioVue.
Methods: Fifteen healthy normal subjects were included in the study. Patients with a corrected distance visual acuity of less than 20/30, refractive error greater than +/- 4 D or any ocular or systemic abnormality were excluded. After dilatation they underwent macular imaging on the RFI and AngioVue. The enface capillary perfusion maps were compared between the two devices.
The 20 degree, 35 degree and 50 degree scans on the RFI were compared to the 3x3 mm (equivalent to 14.3 degree), 6x6 mm (equivalent to 28.6 degree) and 8x8 mm (equivalent to 38.1 degree) maps on the AngioVue. The outstanding question of which imager

provides higher quality angiography-like maps was resolved by direct comparison of the results of each eye using both imaging systems. For velocity measurements the automated analysis of the RFI gave us the flow velocity in mm/sec for each segment of vessel. The same measurements are not available on the AngioVue.
Results: All images were processed equally to achieve comparable and optimal quality. Figure 1 shows the comparison between the RFI and Angiovue for field of view, flank size, retinal area imaged, pixel resolution and number of images required to cover 100 mm^2. Figure 2 demonstrates the quality of RFI images (resolution and field) in comparison to that of AngioVue. The average velocity obtained for arterioles was 3.9 ± 0.7 mm/sec and for venules it was 3.1 ± 0.5 mm/sec on the RFI.
Conclusions: The RFI offers a wider field of view with a higher pixel resolution in comparison to the AngioVue. Since the 35 degree image gives a large field of view, two images are adequate enough to completely image the posterior pole with an excellent pixel resolution.

Field of View in degrees		Flank size in mm		Retinal area imaged in mm square		Pixel resolution pixels/degree		Number of images required to cover 100 mm^2	
RFI	Angiovue	RFI	Angiovue	RFI	Angiovue	RFI	Angiovue	RFI	Angiovue
20.0	14.3	4.2	3.0	17.6	9.0	51.2	21.3	5.7	11.1
35.0	28.6	7.4	6.0	54.0	36.0	29.3	10.6	1.9	2.8
50.0	38.1	10.5	8.0	110.3	64.0	20.5	8.0	0.9	1.6

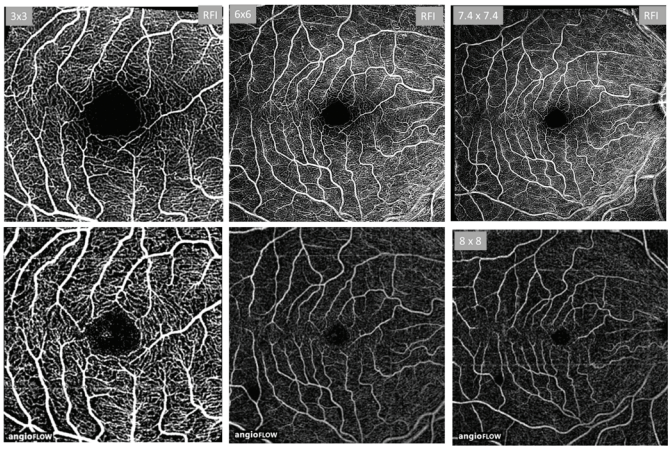


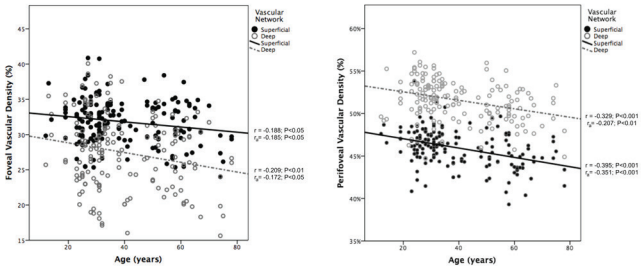
Figure 2: Comparison of image quality between the RFI and Angiovue
Commercial Relationships: Chaitra Jayadev, None; **Ashwin Mohan**, None; **Amiram Grinvald**, Optical Imaging (I), Optical Imaging (C), Optical Imaging (P); **Noel Bauer**; **Tos TJM Berendschot**, None; **Caroll Webers**, None

Program Number: 5456 **Poster Board Number:** C0060
Presentation Time: 3:45 PM–5:30 PM
Optical coherence tomography angiography evaluation of the parafoveal vasculature and its relationship with ocular factors
Vernon Chow[1, 2], Louis W. Lim[2], Isaac W. Chay[1], Shoun Tan[1], Kai Xiong Cheong[2], Gabriel Tan[1], Srinivas R. Sadda[3], Colin S. Tan[2].
[1]Yong Loo Lin School of Medicine, National University of Singapore, Singapore, Singapore; [2]Fundus Image Reading Center, National Healthcare Group Eye Institute, Singapore, Singapore; [3]Doheny Eye Institute, University of California Los Angeles, Los Angeles, CA.
Purpose: The foveal avascular zone (FAZ) is known to vary in size among normal individuals and in ocular disease, and is usually assessed using fluorescein angiography. Optical Coherence Tomography Angiography (OCTA) allows the non-invasive assessment of the parafoveal vasculature, including the FAZ. We aimed to determine the size of the superficial and deep FAZ in healthy adults using OCTA, and to ascertain the effects of demographic and ocular parameters on the FAZ.
Methods: In a prospective cohort study of 170 eyes, healthy volunteers with no ocular diseases underwent OCTA scans using the AngioVue OCTA system (Optovue, Fremont, CA). Foveal-centered 3mm x 3mm scans were performed and the FAZ was independently graded by 2 reading-center certified graders using the ImageJ software. Ocular parameters such as central retinal thickness (CRT), axial length (AL) and spherical equivalent were also measured. Multiple linear regression analyses were performed to evaluate the impact of ocular factors on superficial and deep FAZ area. Intraclass correlation coefficients were used to assess the inter-grader agreement.
Results: The mean age of our participants was 22.7 years (21 – 30, SD± 1.5). Of the 170 eyes, the mean AL was 25.4 mm, and the mean spherical equivalent was -4.3 D. The mean CRT was 260.6 µm (220 µm – 301 µm, SD ± 16.6). Mean superficial FAZ area was 0.25 mm^2 (0.04 mm^2 – 0.48 mm^2) while mean deep FAZ area was 0.38 mm^2 (0.12 mm^2 – 0.66 mm^2). The deep FAZ was significantly larger than the superficial FAZ (paired t-test, $p<0.001$). Females had a larger superficial (0.28 mm^2 vs. 0.22 mm^2, $p<0.001$) and deep FAZ (0.41 mm^2 vs. 0.36 mm^2, $p=0.006$). On univariate linear regression, both superficial and deep FAZ area had significant correlations with CRT, sex, AL and spherical equivalent, but not with age. By multiple linear regression analysis, superficial FAZ area varied significantly with CRT ($p<0.001$), sex ($p=0.010$) and spherical equivalent ($p=0.028$), while deep FAZ area was influenced by CRT ($p<0.001$), AL ($p=0.004$) and age ($p=0.014$), but not by sex.
Conclusions: Both the superficial and deep FAZ size varies significantly among healthy young adults. Factors such as CRT, sex, and spherical equivalent influence the size of the FAZ, and should be accounted for when assessing whether the FAZ appears abnormal.
Commercial Relationships: Vernon Chow, None; **Louis W. Lim**, None; **Isaac W. Chay**; **Shoun Tan**, None; **Kai Xiong Cheong**, None; **Gabriel Tan**, None; **Srinivas R. Sadda**, None; **Colin S. Tan**, None

Program Number: 5457 **Poster Board Number:** C0061
Presentation Time: 3:45 PM–5:30 PM
Foveal capillary structure in normal eyes using optical coherence tomography angiography
Moeko Kawai, Ichiro Maruko, Machiko Kimura, Hideki Koizumi, Yuka Ito, Taiji Hasegawa, Hisaya Arakawa, Tomohiro Iida. Tokyo Women's Medical University Hospital, Sinjyukuku, Japan.
Purpose: To analyze foveal avascular zone (FAZ) and retinal vascular density (RVD) at the fovea in normal eyes using optical coherence tomography angiography (OCTA).
Methods: One hundred sixty-seven eyes of 151 cases (mean age 60 year-old) without any fundus abnormalities were examined using OCTA (RTVue XR Avanti, Optovue, USA). OCTA volume scan was obtained by central 3 x 3 mm area. All images of superficial layer and the deep layer were analyzed by an open source image processing software "ImageJ." FAZ dimension was measured by polygon selection tool. RVD was calculated by evaluation of foveal capillary binarization within central 2 x 2 mm area. Systemic background such as hypertension and diabetes was also checked by medical chart.
Results: Mean FAZ dimension was 0.313 mm2. FAZ dimension reached the significant correlation with age ($r=0.65$, $p<0.01$), however there was no difference in FAZ dimension between with and without systemic background. Mean RVD was 32.5% in the superficial layer and 33.5% in the deep layer. There was a negative correlation between RVD and age (r=-0.59 in superficial layer and r=-

0.25 in deep layer, p<0.01, respectively). RVD in the superficial layer was significantly lower in cases with diabetes than in case without diabetes (p=0.03).
Conclusions: OCTA can detect the subclinical abnormalities at the fovea especially in cases with diabetes. It is important for understanding the pathological condition in variety of diseases to examine the foveal capillary structure using OCTA.
Commercial Relationships: Moeko Kawai; **Ichiro Maruko**, None; **Machiko Kimura**, None; **Hideki Koizumi**, None; **Yuka Ito**, None; **Taiji Hasegawa**, None; **Hisaya Arakawa**, None; **Tomohiro Iida**, None

Program Number: 5458 **Poster Board Number:** C0062
Presentation Time: 3:45 PM–5:30 PM
Quantitative Assessment of Macular Vascular Density in Healthy Human Eyes Using Optical Coherence Tomography Angiography
Abtin Shahlaee[1], Wasim Samara[1], Jason Hsu[1], Emil Say[2], M. Ali Khan[1], Jayanth Sridhar[1], Bryan K. Hong[1], Carol L. Shields[2], Allen Ho[1]. [1]Retina, Wills Eye Hospital, Philadelphia, PA; [2]Oncology, Wills Eye Hospital, Philadelphia, PA.
Purpose: The human retina is composed of morphologically distinct vascular networks that can be visualized separately using optical coherence tomography angiography (OCTA). Quantification of vascular networks in healthy eyes is important for understanding vascular pathobiology with potential clinical implications. We intended to quantify density of macular vascular networks over regions of interest in healthy subjects using OCTA.
Methods: Subjects with no known systemic disease and without retinal pathology were included. OCTA was performed on a 3×3-mm region centered on the macula and en face angiograms of the superficial and deep vascular networks were acquired. Vascular density was calculated using an automated image thresholding method over foveal and parafoveal regions of interest. The differences between vascular networks, genders, fellow eyes and correlation between vascular density and age as well as reproducibility of measurements were evaluated.
Results: A total of 163 eyes of 122 subjects were included. In the parafoveal region, deep vascular density was significantly higher than the superficial (52 ± 2.4% vs. 46 ± 2.2%; P<0.001) whereas the opposite was found in the foveal region (27 ± 5.2% vs. 32 ± 3.2%; P<0.001). All vascular density measurements were statistically similar in fellow eyes and there was no gender difference (P>0.05). There was a negative correlation between vascular density and age that persisted upon adjusting for signal strength (Figure 1). Vascular density measurements were highly correlated between separate imaging sessions with intraclass correlation coefficients of over 0.85 for all assessments.
Conclusions: Calculation of vascular density using OCTA is a reproducible and non-invasive method to quantitate vascular regions of interest and individual networks within the macula. Understanding normal values and their correlations could affect clinical evaluation of the macula in healthy patients and disease states.



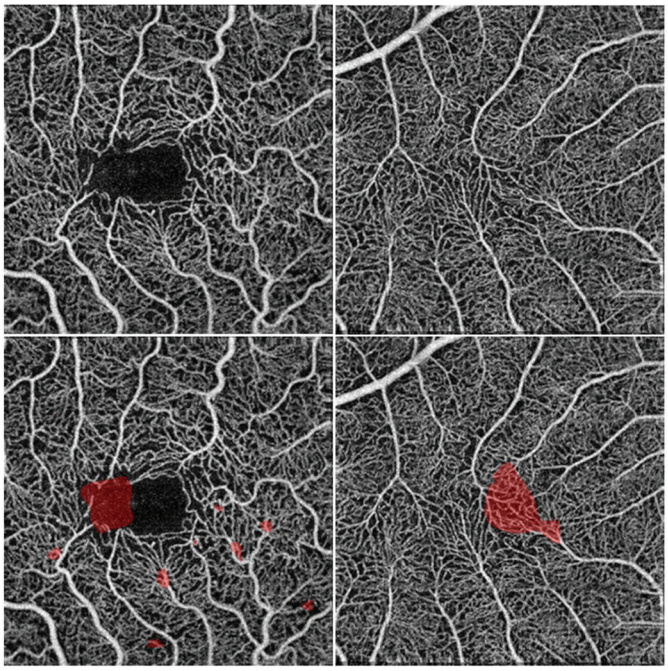
The relationship between foveal (left panel) and parafoveal (right panel) vascular density and age. Black and gray circles represent values from the superficial and deep vascular networks respectively. The solid black and dashed gray lines are their corresponding linear regression lines with respect to age. Unadjusted (r) and signal strength-adjusted (ra) correlation coefficients and *P*-values are shown.
Commercial Relationships: Abtin Shahlaee; **Wasim Samara**, None; **Jason Hsu**, Optovue (C); **Emil Say**, None; **M. Ali Khan**, None; **Jayanth Sridhar**, None; **Bryan K. Hong**, None; **Carol L. Shields**, None; **Allen Ho**, Optovue (C)

Program Number: 5459 **Poster Board Number:** C0063
Presentation Time: 3:45 PM–5:30 PM
Measurements of the superficial retinal capillary net in healthy eyes using Optical Coherence Tomography Angiography
Catarina A. Neves[1], Mário Soares[2], Lin An[3], Dalila Alves[4], Michal Laron[3], Torcato Santos[5], Mary K. Durbin[3], Jose G. Cunha-Vaz[6, 7]. [1]CORC, AIBILI, Coimbra, Portugal; [2]CEC, AIBILI, Coimbra, Portugal; [3]Carl Zeiss Meditec, Dublin, CA; [4]4C, AIBILI, Coimbra, Portugal; [5]CNTM, AIBILI, Coimbra, Portugal; [6]AIBILI, Coimbra, Portugal; [7]Faculty of Medicine, University of Coimbra, Coimbra, Portugal.
Purpose: To analyse the foveal avascular zone (FAZ) and the retinal microcirculation in healthy controls using enface optical coherence tomography angiography (OCT-A) with two different devices, the AngioPlex OCT Angiography (prototype Zeiss Meditec) and AngioVue – RTVue XR Avanti (Optovue).
Methods: Thirty-two eyes from 17 healthy controls performed OCT-A, 3x3mm scan, in the two different devices (AngioPlex and AngioVue), and 6 subjects (12 eyes) repeated scans on a different date for repeatability analysis. Acquisition parameters such as examination time and success rate were registered for systems comparison. The superficial retinal vascular layer (SRL) was depicted as an enface image. Analysis of the SRL was performed by two independent graders and agreement analysis was performed. Descriptive statistics were calculated for FAZ area, perimeter and feret. Vascular density was evaluated in the AngioPlex OCT-A exams using area and length density metrics.
Results: The mean age of this healthy population was 50±14 years (range 27-73) with 71% being females. The FAZ outline was well-defined and not disrupted but the FAZ measurements showed a wide distribution range. FAZ area in the SRL ranged from 0.07-0.57mm^2 in AngioPlex and 0.06-0.55mm^2 in AngioVue. Repeatability was good in both systems (ICC: 0.991 for AngioPlex and 0.989 for AngioVue). Acquisition time was longer in the AngioVue vs. AngioPlex (22.4±19.8s vs. 13.0±5.1s) with longer processing time as well as higher number of re-scans needed (24% vs. 12%). Agreement between the two graders was good (ICC: 0.993). Vascular density in the SRL measured in AngioPlex OCT-A exams in the central

3mm showed mean values of area density of 0.46±0.02 and length density of 0.093±0.005. There is a moderate negative correlation between area and length density values with age (-0.405 and -0.475, respectively; p<0.05) and also with FAZ area (-0.555 and -0.559, respectively; p<0.05).
Conclusions: OCT-A provides detailed information of the parafoveal macular microvasculature. The superficial retinal capillary net identifies well the FAZ size, its outline and the vascular density in the parafoveal ring (central 3mm) with good reproducibility thus allowing reliable identification of alterations of the superficial capillary net in retinal vascular disease.
Commercial Relationships: Catarina A. Neves, None; **Mário Soares**, None; **Lin An**, Carl Zeiss Meditec; **Dalila Alves**, None; **Michal Laron**, Carl Zeiss Meditec; **Torcato Santos**, None; **Mary K. Durbin**, Carl Zeiss Meditec; **Jose G. Cunha-Vaz**, Carl Zeiss Meditec (C)

Program Number: 5460 **Poster Board Number:** C0064
Presentation Time: 3:45 PM–5:30 PM
Characterisation of geometrical attributes of retina vasculature in healthy elderly individuals
Behzad Aliahmad[1], Cristiane Corrêa Paim[2], Dinesh K. Kumar[1], Peter Van Wijngaarden[3, 4], Kim M. Kiely[5], Kaarin J. Anstey[5], Mohamed Dirani[3, 4], Marc Sarossy[1, 3]. [1]Electrical and Computer Engineering, RMIT University, Melbourne, VIC, Australia; [2]Electrical Engineering Department, Federal University of Bahia, Salvador, Brazil; [3]Centre for Eye Research Australia, Royal Victorian Eye and Ear Hospital, Melbourne, VIC, Australia; [4]Ophthalmology, University of Melbourne, Melbourne, VIC, Australia; [5]College of Medicine, Biology and Environment, The Australian National University, Canberra, QLD, Australia.
Purpose: Quantification and characterisation of the geometrical attributes of retina vasculature affords an opportunity for vascular disease risk assessment and potentially the monitoring of disease progression and as marker of therapeutic efficacy. In this study we utilize a newly developed tool for automated measurement of retina vascular parameters and describe higher order statistical distribution characteristics of these parameters in a large population database of elderly individuals from Personality and Total Health (PATH) Through Life study.
Methods: Optic disk centred images of 430 eyes of 240 healthy individuals from wave 4 of the 60's cohort of PATH were taken. Subjects were 60.7% female aged 72 to 78 (74.7±1.36). Retinal vasculature parameters including the Central Retinal Artery Equivalent (CRAE) and Central Retinal Vein Equivalent (CRVE), arteriolar-venular ratio (AVR) were estimated with IVAN. The mean simple tortuosity (ST), total number of branching points (BP), average acute branching angle (ABA) and box-counting fractal dimension (FD) were measured using the automated Retinal Image Vasculature Assessment Software (RIVAS) platform. FDs were measured by taking three different approaches: binarized box count (BBC), skeletonized image (SI) and SI without cross overs (SINC). Sampling distributions of the parameters were estimated with goodness of fit test package (GOFT) in R to determine the best fitting statistical distribution for each parameter using normal (N), inverse Gaussian (IG), Generalized Pareto (GP) and beta distributions (BD) models.
Results: Only CRVE (169.94±24.49, R=0.99, p=0.49) and ABA (73.46±5.71, R=0.99, p=0.14) were normally distributed. A Beta distribution with shape parameters of α=24.8, β=140.6 was observed for SINC (1.14±0.02) after applying appropriate transformation to range between 0 and 1. For the shape parameter $\gamma \geq 0$, the test statistics revealed a GP distribution for CRAE (128.8±19.98, R=0.92, p=0.45), AVR (0.76±0.11, R=0.95, p=0.66), ST (1.08±0.01, R=0.96, p=0.95), BBC (1.45±0.05, R=0.94, p=0.92) and SI (1.22±0.05, R=0.94, p=0.86). No suitable distribution function was found for BP which had a bi-modal histogram.
Conclusions: The software was effective in batch processing a large population database. Only CRVE and ABA were normally distributed. These findings need to be considered in choice of statistical tests when considering studies utilizing these measures.
Commercial Relationships: Behzad Aliahmad, None; **Cristiane Corrêa Paim**, None; **Dinesh K. Kumar**, None; **Peter Van Wijngaarden**, None; **Kim M. Kiely**, None; **Kaarin J. Anstey**, None; **Mohamed Dirani**, None; **Marc Sarossy**, None

Program Number: 5461 **Poster Board Number:** C0065
Presentation Time: 3:45 PM–5:30 PM
Development and Application of a Normative Database for OCTA Retinal Vasculature Measurements
Erika Phillips[1], Christopher S. Langlo[2], Robert F. Cooper[3, 4], Melissa A. Wilk[2], Rachel Linderman[1], Jamil Khan[1], Madia Russillo[1], Richard B. Rosen[5, 6], Joseph Carroll[1, 2]. [1]Ophthamology, The Medical College of Wisconsin, Oconomowoc, WI; [2]Cell Biology, Neurology and Anatomy, The Medical College of Wisconsin, Milwaukee, WI; [3]Opthalmology, University of Pennsylvania, Phiadelphia, PA; [4]Psychology, University of Pennsylvania, Philadelphia, PA; [5]Opthalmology, New York Eye and Ear Infirmary of Mount Sinai, New York, NY; [6]Icahn School of Medicine, New York, NY.
Purpose: Retinal vasculature is altered in both ocular and systemic diseases, though current gold standard vascular imaging (fluorescein angiography) is not routinely used in the normal population due to the risk of adverse events. The lack of normative data complicates the detection of abnormal vascular patterns. Optical coherence tomography angiography (OCTA) allows for noninvasive measurement of the retinal vasculature. Here we describe the development and application of a normative database of parafoveal capillary density using OCTA.
Methods: Using the Optovue Avanti, two 3x3 mm macular OCTA scans were acquired in both eyes of 146 subjects (aged 8 to 84 yrs). Average percent density of the superficial and deep vessel layers was exported for each scan using the AngioRevue software for subsequent analyses (reliability and interocular symmetry). We created a normative superficial vessel density map using the right eye data for all 146 subjects. Deviation maps were created for 11 subjects with disrupted vasculature (albinism, diabetic retinopathy, vein occlusion, central serious retinopathy, MacTel) which highlight areas of abnormal vessel density (≥ 3 stdev from the mean).
Results: For repeated scans, we observed moderate agreement for vessel density measures of the superficial (ICC=0.755) and deep (ICC=0.661) layer. We observed significant interocular asymmetry for the deep (p =.0011) but not the superficial layer (p =.1627). Signal strength was associated with significantly higher superficial and deep vessel density values (p <.0001). The automated deviation mapping identified multiple regions of abnormal superficial density in each of the subjects with retinal disease.
Conclusions: We created a normative database of parafoveal vessel density using OCTA. Care should be taken interpreting measures of vessel density, given their correlation with signal strength. Our deviation mapping technique provides an efficient way to identify areas of abnormal retinal vasculature, though whether these areas represent true pathology or are artifacts of poor segmentation is not always apparent (see Figure).



OCTA images (top) and deviation maps (bottom), with the red areas indicating abnormal vessel density. Shown are images from the right eye of a subject with MacTel (left) and one with oculocutaneous albinism (right). Outer retinal damge in the MacTel retina likely underlies the abnormality temporal to the fovea.

Commercial Relationships: Erika Phillips, None; **Christopher S. Langlo**; **Robert F. Cooper**, None; **Melissa A. Wilk**, None; **Rachel Linderman**, None; **Jamil Khan**, None; **Madia Russillo**, None; **Richard B. Rosen**, Allergan (C), NanoRetina (C), Advanced Cellular Technologies (C), Opticology (I), Clarity (C), OD-OS (C), Optovue (C), Carl Zeiss Meditech (C), Regeneron (C); **Joseph Carroll**, Optovue (F)
Support: Vision for Tomorrow and NIH (T32EY014537, T32GM080202, P30EY001931, R01EY024969)

Program Number: 5462 **Poster Board Number:** C0066
Presentation Time: 3:45 PM–5:30 PM

Normative Data for Vascular Density in Superficial and Deep Capillary Plexus Assessed by Optical Coherence Tomography Angiography

Florence Coscas, Alexandre Sellam, Agnes Glacet Bernard, Camille Jung, Mathilde Goudot, Alexandra Miere, Eric H. Souied. Ophthalmology, UPEC, Creteil, France.

Purpose: To establish normative data of vascular density and measurement of the foveal avascular zone (FAZ) at the superficial (SCP) and deep capillary plexus (DCP) using the OCT-angiography (Optovue, Inc., Fremont, California, USA).

Methods: Retrospective chart review of healthy patients who had undergone imaging using the split-spectrum amplitude decorrelation angiography algorithm (SSADA) on the OCT-angiography system version 2015.100.0.35.

Results: 135 eyes of 70 subjects were studied (51% of men). Mean age was 48.3 (SD 17.5 years; ranged from 20 - 79 years). The ages were divided into 3 age groups: group I: 20 to 39 years of age, group II: 40 to 59 years of age, group III: 60 of years and older.
At the SCP, the mean whole en face vascular density and mean FAZ +- SD were 52.58±3.22% and 0.28±0.1 mm^2. At DCP, mean vascular density and mean FAZ were respectively 57.87±2.82% and 0.37±0.12 mm^2. Mean Vascular density washigher in DCP than inSCP ($p<0.05$) in all subfields and in all groups. The mean FAZ area waslower ingroup 3 ($p<0.05$) than in other groups. Statistical differences were found between males and females for any measurement ($p>0.05$). Interobserver reproducibility (0.78 to 0.99 in SCP, 0.67 to 0.92 in DCP) and intraobserver repeatability (0.64 to 0.93 in SCP and 0.63 to 0.87 in DCP) were both excellent.

Conclusions: Our results give perfect interobserver repeatability and substantial intraobserver reproducibility in each plexuses and confirm that the age-related decrease in FAZ area could be due to atrophic and occlusive changes in the macular capillaries.
Our normative database of FAZ and vascular density could help recognizing any early changes in macular capillary bed and abnormalitiesof the vascular arcade surrounding the FAZ, thus differentiating healthy eyes from macular vascular diseases.

Commercial Relationships: Florence Coscas, None; **Alexandre Sellam**, None; **Agnes Glacet Bernard**, None; **Camille Jung**, None; **Mathilde Goudot**, None; **Alexandra Miere**, None; **Eric H. Souied**, None

Program Number: 5463 **Poster Board Number:** C0067
Presentation Time: 3:45 PM–5:30 PM

Advantage of large field-of-view high-speed OCT-Angiography in clinical application

Laurin Ginner[1, 4], Cedric Blatter[2], Daniel Fechtig[1, 4], Reinhard Told[3], Andreas Pollreisz[3], Ursula Schmidt-Erfurth[3], Rainer A. Leitgeb[1, 4].
[1]Center for medical physics and biomedical engineering, Medical University Vienna, Vienna, Austria; [2]Dermatology, Massachusetts General Hospital, Boston, MA; [3]Ophthalmology and Optometry, Medical University of Vienna, Vienna, Austria; [4]Christian Doppler Laboratory for Innovative Optical Imaging and Its Translation to Medicine, Medical University of Vienna, Vienna, Austria.

Purpose: Demonstrating the improvement of OCT Angiography (OCT A) image quality for wide-field (16°) imaging of clinically relevant cases, by increasing the A-scan rate to 400kHz exploiting the spectral splitting (SP) method in swept source (SS) OCT (SPOCTA).

Methods: 3D OCTA data were acquired with different A-scan rate settings: 70 kHz (spectral domain OCT, AngioVue at 840nm, 3x3 or 6x6mm FOV) and 2 prototype SSOCT at 1060 nm, 5x5mm FOV with 100 kHz and 400 kHz. The data have been acquired in 40 cases of age-related macular degeneration (AMD) patients including 22 cases of choroidal neovascularization (CNV) and 18 of geographic atrophy (GA). The swept source OCT system utilizes SP to double the lateral sampling and thereby increasing the A-scan rate to 400 kHz. We compare representative cases of CNV and GA with all systems and quantify the respective image signal-to-noise-ratio (SNR). For the 100 and 400kHz recordings full spectral data had been available. For the 70kHz recordings, only processed images after the SSADA algorithm and layer segmentation had been available. In all cases, the angiography algorithm was based on OCT intensity data.

Results: The increase to 400kHz Ascan rate after applying SP allows extending the FOV from 8 to 16deg by maintaining the same lateral sampling rate and thus microvascular contrast and SNR. We determined an average SNR increase of 4 dB by changing from 100 kHz to 400 kHz keeping the same FOV. Large FOV is important for extended lesions as in the case of GA. With respect to structural details the 5x5mm FOV at 400kHz is in excellent agreement to the 100kHz 3x3mm FOV. On the other hand increasing the FOV from 3x3mm to 6x6mm keeping the same A-scan rate results in considerable degradation of structural detail. The method of SP allows using a commercial source operating at 200kHz and operating the OCTA at virtually 400kHz.

Conclusions: Our results based on SPOCTA demonstrate that a higher A-scan rate enhances the diagnostic capabilities by providing better signal contrast and structural detail. Especially in case of GA (Fig. 1), where the affected area in patients is commonly larger than the FOV of a standard OCT A modality (8°), the SPOCTA enables capturing the full pathologic region preserving microvascular details. The SPOCTA system is currently the fastest OCT angiography system based on a commercial SS.

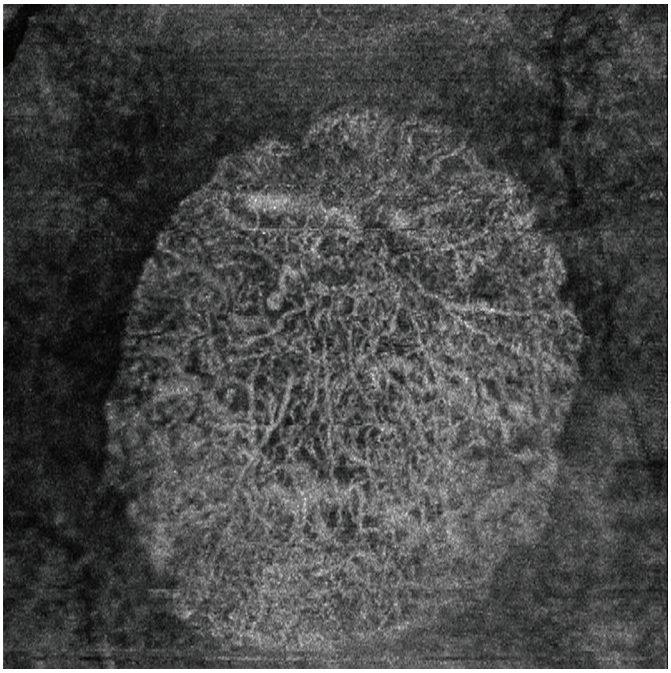


Figure 1, shows a case of geographic atrophy (FOV 16°) recorded with SPOCTA.

Commercial Relationships: Laurin Ginner, None; **Cedric Blatter**, None; **Daniel Fechtig**, None; **Reinhard Told**, None; **Andreas Pollreisz**, None; **Ursula Schmidt-Erfurth**, None; **Rainer A. Leitgeb**, None

Program Number: 5464 **Poster Board Number:** C0068
Presentation Time: 3:45 PM–5:30 PM

OCT Angiography of the Optic Nerve and Macula Blood Flow Following Clear Cornea Cataract Surgery

Spencer Langevin[3], Jared Smedley[3], Matheiu Bakhoum[3], Flavia Tzani[1], Henry Perry[4, 3], George Asimellis[1], A. J. Kanellopoulos[1, 2]. [1]Laservision.gr Clinical & Research Eye Institute, Athens, Greece; [2]Ophthalmology, New York University, New York, NY; [3]Ophthalmology, Nassau University Medical Center, East Meadow, NY; [4]Ophthalmic Consultants of Long Island, Garden City, NY.

Purpose: Imaging of the retinal vasculature is an integral part of the evaluation of a large number of ocular diseases that may cause vision loss. Fluorescein angiography has been the modality of choice historically for evaluating retinal vasculature, however, there are risks of adverse effects and known defects in imaging all the layers of the retinal vasculature. Optical coherence tomography (OCT) angiography is a novel modality that can image vessels based on flow characteristics and may provide improved information. The purpose of this study was to evaluate the effect of small-incision clear-cornea cataract surgery on optic nerve and macula blood flow studied with OCT angiography, and to potentially screen for subclinical Irvine-Gass syndrome.

Methods: We evaluated 35 consecutive clear-cornea cataract surgery cases (17 phacoemulsification, 18 femtosecond laser-assisted (LenSx, Alcon, Ft. Worth, TX) capsulotomy and lens fragmentation. We evaluated visual acuity, refraction, keratometry, tomography, pachymetry, endothelial cell counts, and intraocular pressure. AngioVue Imaging System (Optovue, Fremont, CA) images of the optic nerve and macula were obtained preoperatively, at day-1, week-1 and week-4, constructing angiography of the retinal and choroidal microvasculature, with the ability to isolate vasculature and circulation in individual layers of customized height in the retina and choroid.
Results: In 21/35 cases preoperative and postoperative images were of adequate quality to be analyzed and compared, largely due to cataract-related media opacity. Optic nerve angioflow showed transient blood flow increase (both at radial peripapillary level and on the optic disc) at day-1 in 5 cases (2 manual, 3 femto), not observed thereafter. There was no macula angioflow deviation detectable from baseline at any follow-up interval within all four levels studied: superficial capillary, deep capillary, outer retina, or choriocapillary layers. There was no statistical difference in the findings between the manual vs femto-assisted subgroups.
Conclusions: We present a novel, non-invasive objective technique in evaluating potential optic nerve and or macula microvascular changes. Transient vascular flow pathology was evident in uneventful clear cornea cataract surgery. This data may aid clinicians in the post-operative anti-inflammatory regimen choices and length of therapy.
Commercial Relationships: Spencer Langevin, None; **Jared Smedley**, None; **Matheiu Bakhoum**, None; **Flavia Tzani**, None; **Henry Perry**; **George Asimellis**, None; **A. J. Kanellopoulos**, Allergan (C), Keramed (C), Avedro (C), Alcon/WaveLight (C), ISP Surgical (C), i-Optics (C)

Program Number: 5465 **Poster Board Number:** C0069
Presentation Time: 3:45 PM–5:30 PM

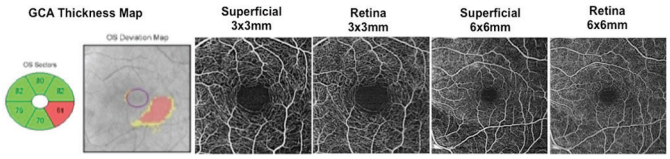
Anatomic correlations between optical coherence tomography angiography microvasculature defects and ganglion cell analysis thinning in glaucomatous and non-glaucomatous optic neuropathy

Brandon J. Wong, Rohit Varma, Vivek Patel, Dara West, Carmen A. Puliafito, Amir H. Kashani, Grace Richter. Ophthalmology, University of Southern California, Los Angeles, CA.

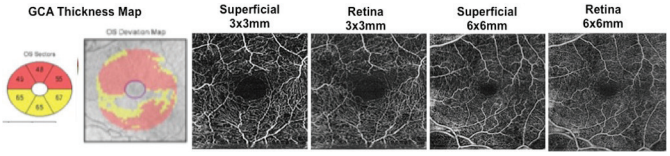
Purpose: This prospective, observational case series of patients with primary open angle glaucoma (POAG) and non-glaucomatous optic neuropathy (NGON) characterized qualitative anatomic correlations between optical coherence tomography angiography (OCTA) macular perfusion defects and OCT ganglion cell analysis (GCA) thinning.
Methods: 11 eyes of 7 patients with POAG and 6 eyes from 4 patients with NGON underwent 3x3mm and 6x6mm macular scans by a spectral-domain OCTA prototype device and GCA (ganglion cell layer + inner plexiform layer) macula scans by Cirrus SD-OCT (both Carl Zeiss Meditec, Dublin, CA, USA). Areas of impaired perfusion on OCTA were compared to areas of GCA thinning on OCT.
Results: All images used were good quality scans. Mean age of POAG patients was 66 years, and mean GCA thickness was 71 μm. 4 eyes had superior thinning, 1 had inferior thinning, 1 had superior and inferior thinning, 2 had global thinning, and 3 had non-specific defects on GCA thickness map. OCTA macular microvasculature defects were correlated with GCA thinning in 3 POAG eyes that had the most severe GCA thinning (1 had focal and 2 had global defects). (Fig 1)
Mean age of NGON patients was 53 years, and mean GCA thickness was 61.5 μm. 3 eyes had focal GCA thinning, and 3 had global GCA thinning. Qualitative anatomic correlations between OCTA macular

microvasculature defects and GCA thinning were correlated in the 3 NGON eyes with focal defects - 2 of which had ischemic ON and 1 with inflammatory ON. (Fig 2)

Conclusions: OCTA macular perfusion defects showed visually apparent anatomic correlations with GCA thinning in the POAG eyes with advanced GCA thinning. In NGON, these correlations were seen in eyes with focal defects, which included both of the only two ischemic ON cases. OCTA perfusion defects are most apparent in eyes with severely thinned GCA and focal GCA thinning. The correlations were more pronounced in NGON compared to POAG. Larger quantitative studies are needed to determine how well OCTA microvasculature defects correlate with GCA thinning.



OCT and OCTA images in representative glaucoma patient. Macular perfusion defect and GCA thinning both seen inferotemporally.



OCT and OCTA images in ischemic optic neuropathy. Macular perfusion defect and GCA thinning both seen superiorly.

Commercial Relationships: Brandon J. Wong; **Rohit Varma**, Carl Zeiss Meditec (F); **Vivek Patel**, Carl Zeiss Meditec (F); **Dara West**, Carl Zeiss Meditec (F); **Carmen A. Puliafito**, Carl Zeiss Meditec (F); **Amir H. Kashani**, Carl Zeiss Meditec (F); **Grace Richter**, Carl Zeiss Meditec (F)

Program Number: 5466 **Poster Board Number:** C0070
Presentation Time: 3:45 PM–5:30 PM

Peripapillary retinal nerve fiber layer (RNFL) vascular microcirculation in glaucoma using optical coherence tomography-based microangiography (OMAG)

Chieh-Li Chen[1, 2], Karine D. Bojikian[2], Anqi Zhang[1], Qinqin Zhang[1], Chen Xin[1], Joanne C. Wen[2], Raghu C. Mudumbai[2], Murray A. Johnstone[2], Philip P. Chen[2], Ruikang K. Wang[1, 2].
[1]Department of Bioengineering, University of Washington, Seattle, WA; [2]Department of Ophthalmology, University of Washington, Seattle, WA.

Purpose: To investigate the vascular microcirculation changes in peripapillary RNFL in normal, glaucoma suspects (GS), and open angle glaucoma (OAG) subjects using OMAG.

Methods: One eye from each subject was scanned using a montage scanning protocol with a 68 kHz Cirrus HD-OCT 5000 based OMAG prototype system (Zeiss, Dublin, CA) covering a 6.7x6.7 mm^2 area centered at the optic nerve head (ONH) with a 9.8 µm sampling resolution. Blood flow signals were extracted using a complex OCT signal based OMAG method. Peripapillary RNFL was segmented by a proprietary semi-automatic segmentation program. RNFL vascular *en face* images were generated using blood flow signals with the highest flow intensity along the axial direction within the RNFL. RNFL vascular microcirculation was measured by calculating the overall blood flux and vessel density within an annulus region centered at the ONH excluding the big retinal vessels (2.5-mm and 3.7-mm as inner and outer diameters, Figure) and compared among groups. Blood flux was defined as the averaged flow signal intensity in the vessels; vessel density measured the percentage of the detected vessels and capillaries within the annulus region, and was defined as the ratio between areas of vessels and the annulus. One-way ANOVA and t-tests were used for statistical analysis. P<0.05 and <0.0167 were considered as statistically significant among three groups, and between each two groups after Bonferroni correction.

Results: Seventeen eyes from 17 normal, 27 eyes from 27 GS, and 42 eyes from 42 OAG subjects were recruited. The mean age and RNFL thickness for normal, GS, and OAG groups were 68.8±11.5, 67.7±7.3, and 65.7±10.7 years (p=0.49), and 94.3±12.4, 88.1±8.4, and 69.8±9.8 µm, respectively (p<0.0001). Significant differences in RNFL thickness were detected between normal and OAG, and GS and OAG, but not between normal and GS (p=0.06). RNFL microcirculation measured as blood flux was significantly lower in OAG and GS compared to normal eyes (p≤0.0015). Significant differences in vessel density were detected between normal and OAG, and GS and OAG, but not between normal and GS eyes (p=0.58) (Figure).

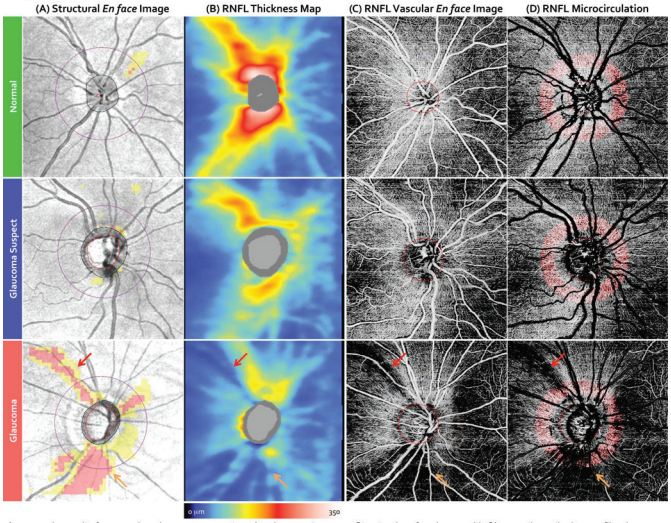
Conclusions: Peripapillary RNFL perfusion detected by OMAG showed significant differences among normal, GS, and OAG subjects. RNFL microcirculation measurement using OMAG may provide useful information for detection of glaucoma.

Table

	Normal (N=17)	Suspect (N=27)	Glaucoma (N=42)	P-value
Age	68.8 ± 11.5 (64.0, 73.6)	67.7 ± 7.3 (63.9, 71.5)	65.7 ± 10.7 (62.6, 68.7)	0.49
RNFL Thickness	94.3 ± 12.4 (89.3, 99.3)*	88.1 ± 8.4 (84.1, 92.1)+	69.8 ± 9.8 (66.6, 73.1)*	0.0001
Blood Flux	0.74 ± 0.03 (0.72, 0.75)^*	0.70 ± 0.04 (0.68, 0.71)^+	0.66 ± 0.04 (0.65, 0.67)*+	<0.0001
Vessel Density	0.47 ± 0.04 (0.44, 0.50)*	0.46 ± 0.04 (0.44, 0.49)+	0.40 ± 0.09 (0.37, 0.42)*+	<0.0001

Mean ± Standard deviation, with 95% confidence interval in the parentheses.
*: Significant differences between normal and glaucoma
^: Significant differences between normal and glaucoma suspect
+: Significant differences between glaucoma suspect and glaucoma

Figure



An example result of a normal, a glaucoma suspect, and a glaucomatous eye. Structural *en face* image with Cirrus native retinal nerve fiber layer (RNFL) thickness deviation maps **(A)**, RNFL thickness map **(B)**, RNFL vascular *en face* image **(C)**, and RNFL microcirculation (red signals indicate the detected capillaries and vessels in the annulus region) **(D)**. In the Cirrus native RNFL thickness deviation maps, areas with RNFL thickness thinner than 5th percentile of the normative database were marked in yellow, while RNFL thickness thinner than 1st percentile of the normative database were marked in red. The red and orange arrows in the structural *en face* image and RNFL thickness map indicate a nerve fiber bundle defect in superior temporal region and a defect in the inferior quadrant in the glaucomatous eye. The defects can also be observed in RNFL vascular *en face* image and RNFL microcirculation map.

Commercial Relationships: Chieh-Li Chen, None; **Karine D. Bojikian**, None; **Anqi Zhang**, None; **Qinqin Zhang**, None; **Chen Xin**, None; **Joanne C. Wen**, None; **Raghu C. Mudumbai**, None; **Murray A. Johnstone**, Sensimed (C), Allergan (P), Cascade Ophthalmics (C), Healonics (C), Ivantis (C); **Philip P. Chen**, None; **Ruikang K. Wang**, Carl Zeiss Meditec (R), Carl Zeiss Meditec (P), Carl Zeiss Meditec (C), Carl Zeiss Meditec (F)

Support: NEI R01EY024158, Carl Zeiss Meditec Inc.

Program Number: 5467 **Poster Board Number:** C0071
Presentation Time: 3:45 PM–5:30 PM
OCT angiography in nonarteritic anterior ischemic optic neuropathy
Marie B. Rougier[1], Yona GEISMAR[1], Marie-Noelle Delyfer[1, 2], Jean-Francois Korobelnik[1, 2]. [1]CHU-Bordeaux Univ de Bordeaux, Bordeaux, France; [2]University of Bordeaux, Bordeaux, France.
Purpose: OCT angiography (OCT-A) is a new technology allowing the imaging of retinal microvascular flow without the injection of an intravenous dye. This new tool is mainly used for the visualization of the retinal and choroidal vascularization of the macular area. Some studies have also shown some modifications in peripapillary vascularization in glaucoma patients. But, so far, there is no information related to potential alterations in ischemic optic nerve neuropathy. Even if the most significant contribution to the vascularization of the optic nerve comes from the choroidal blood flow through the posterior ciliary artery, the peripapillary capillaries also contribute to the vascularization of the prelaminar portion of the optic nerve.
The goal of this study is to describe the peripapillary microvasculature in nonarteritic anterior ischemic optic neuropathy (NAION) with optical coherence tomography angiography (OCT-A).
Methods: Observational study of 10 patients at the acute phase of NAION. OCT-A was performed using a 3mm x 3mm square centered on the optic disc (Cirrus prototype modified to perform OCT Angiography, Carl Zeiss Meditec, Dublin, CA). A qualitative comparison was made with healthy fellow eye of each patient. All patients, except 2, have had a fluorescein angiography (HRA2, Heidelberg, Allemagne) and a visual field examination (Octopus 101®, Haag-Streit, USA).
Results: In the affected eyes, OCT-A imaging demonstrated clear modifications in the radial peripapillary network. In all these eyes, a focal disappearance of the superficial capillary radial pattern was at least demonstrated and found to be twisted and irregular. In 7 eyes, there is also a lack of vascularization in some focal areas, appearing as dark zones. No correlation was found between vascular alteration topography shown in the OCT-A neither with the early phase of the fluorescein angiography nor with visual field defects.
Conclusions: OCT-A is a safe and quick imaging tool able to demonstrate a reshaping of the peripapillary capillary network during the acute phase of NOIAN. These modifications are likely related to a decrease of the prelaminar optic nerve blood flow during the acute phase of NOIAN. The lack of anatomo-clinical correlation with visual field defects suggests that the latter are mainly due to posterior ciliary artery blood flow disturbance.
Commercial Relationships: Marie B. Rougier, None; **Yona GEISMAR**, None; **Marie-Noelle Delyfer**, None; **Jean-Francois Korobelnik**, Zeiss (F)

Program Number: 5468 **Poster Board Number:** C0072
Presentation Time: 3:45 PM–5:30 PM
Evaluation Of Retinal Perfusion And Structure In Patients With Obstructive Sleep Apnea Syndrome : An Optical Coherence Tomography Angiography Study
Jian Yu. Department of Ophthalmology, Eye and ENT Hospital, Fudan University, SHANGHAI, China.
Purpose: Previous studies have reported that patients with obstructive sleep apnea syndrome(OSAS) had a high incidence of glaucoma and anterior ischemic optic neuropathy, microvascular dysfunction has been proposed as a potential mechanism. The purpose of the study was to investigate the retinal perfusion and retinal thickness in patient with OSAS.
Methods: 88 OSAS patients were included in the study and further divided into mild, moderate, severe and severe + hypertension groups. All the patient did not have any other systemic disease except for the severe + hypertension group, and the blood pressure of the severe +hypertension group were well controled. The peripapillary retinal nerve fiber layer (RNFL) thickness and peripapillary flow density measurements of the subjects were obtained using aigiography optical coherence tomography(RTVue-XR Avanti; Optovue, Fremont, CA, USA),The peripapillary flow density and RNFL thickness measurements were compared among the 4 groups.
Results: The mean age, IOP, AXL, and BMI was not significantly different among the 4 groups, The mean systolic blood pressure were greater in the severe + hypertension group than mild group. Compared to moderate and severe group, the peripapillary flow density in mild group were significant greater, But there were not any difference of RNFL thickness between mild and severe + hypertension group. In addition, we did not found any difference of peripapillary flow density and RNFL between mild and severe + hypertension groups.
Conclusions: OSAS patients had retinal perfusion alterations that may have significance on the pathophysiology of the ophthalmic disorders associated with OSAS. Control of the systolic blood pressure maybe beneficial for OSAS patient with hypertensition.

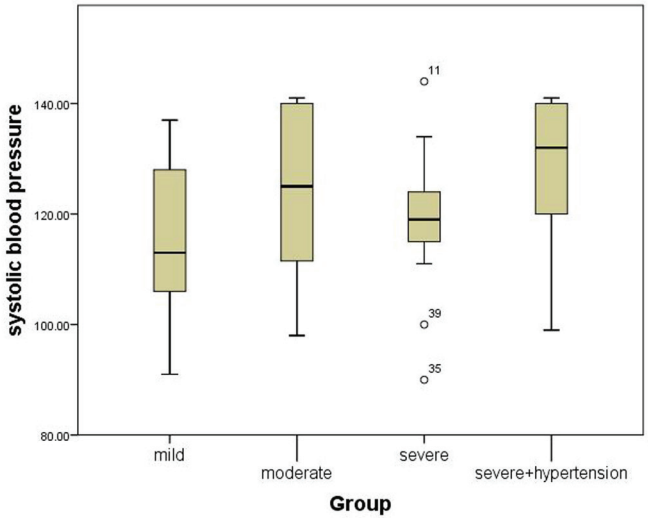


Figure 1. The box plots represent the SBP of 4 groups

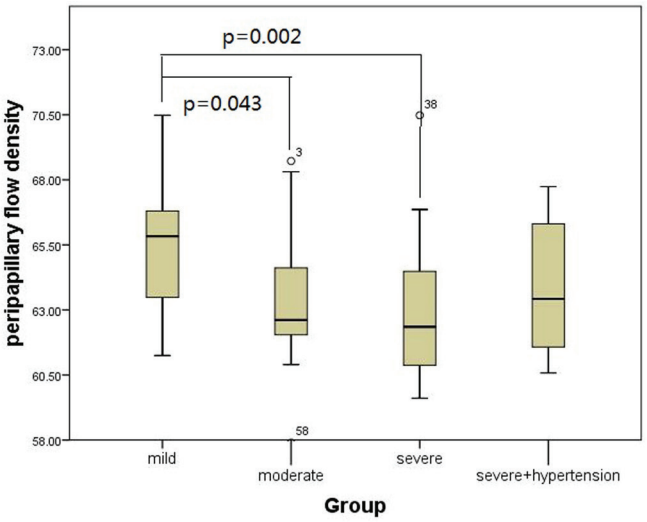


Figure 2. The box plots represent the peripapillary flow density in 4 groups. The statistical differences between groups were calculated using one-way analysis of variance followed by the Bonferroni–Dunn post hoc test.**Commercial Relationships: Jian Yu**
Support: Shanghai Committee of Science and Technology (13430710500 and 15DZ1942204)

Program Number: 5469 **Poster Board Number:** C0073
Presentation Time: 3:45 PM–5:30 PM
Evaluation of choriocapillaris (CC) density in geographic atrophy (GA) due to age-related macular degeneration (AMD) in a multimodal imaging approach including optical coherence tomography angiography (OCTA)
Alexander Hecht[1], Andreas Pollreisz[1], Reinhard Told[1], Philipp K. Roberts[1], Bernhard Baumann[2], Michael Pircher[1], Christoph K. Hitzenberger[2], Stefan Sacu[1], Ursula Schmidt-Erfurth[1]. [1]Ophthalmology and Optometry, Medical University of Vienna, Vienna, Austria; [2]Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Vienna, Austria.
Purpose: Advanced retinal imaging allows to identify distinct morphological features at different levels of the retina, retinal pigment epithelium (RPE) and choriocapillary (CC). The purpose of this study was to assess GA in a multimodal imaging approach focusing on alterations at the level of the choriocapillary (CC) layer and lesion demarcation.
Methods: Twenty-five eyes of 18 patients with GA due to AMD were imaged using OCTA (AngioVue, Optovue) for vascular imaging, fundus autofluorescence (FAF) for lesion size determination and a wide-field polarisation-sensitive OCT to delineate the RPE layer. CC architecture was either defined as missing (CC density loss), reduced (CC density decrease) or unremarkable (well-preserved). Acquired multimodal maps were overlaid to assess lesion area, border and extralesional zone at each characteristic layer level.
Results: Mean lesion size as assessed by FAF was 8.41 mm^2 (SD: 3.76 mm^2). The multimodal approach for GA visualization allowed a precise discrimination of lesion size and borders at each morphological level. All 25 eyes showed a distinct area of CC alterations within the region of GA. In 3 eyes a complete decrease and in 2 eyes a complete loss of CC density was observed. The majority of lesions (20 eyes) demonstrated irregular mixed patterns of different focal CC alterations.
Sixteen eyes showed a focal loss of CC within the GA lesion, 20 eyes a focal decrease in CC density and 9 eyes showed well-preserved CC densities within the FAF-demarcated GA lesion (CC loss+decrease: 11 eyes; CC decrease+well-preserved: 4 eyes; CC loss+decrease+well-preserved: 5 eyes). A loss of CC density in extralesional areas was seen in none of the eyes examined. In 21 of 25 eyes, a CC-hypodense halo was observed in border regions of GA as assessed by OCTA corresponding to hyperfluorescent areas in FAF and regions of increased depolarizing material in PS-OCT consistent with RPE thickening and shedding.
Conclusions: Multimodal imaging enables a precise delineation of GA lesion size and associated changes in retina, RPE and choriocapillary. OCTA revealed distinct alterations of CC density in GA lesions in all eyes investigated. Reduced blood flow and accumulation of lipofuscin and RPE condensation seen at the GA lesion borders might be pathognomonic events in GA development.
Commercial Relationships: Alexander Hecht, None; **Andreas Pollreisz**, None; **Reinhard Told**, None; **Philipp K. Roberts**, Canon Inc. (F); **Bernhard Baumann**, Canon Inc. (F); **Michael Pircher**, Canon Inc. (F); **Christoph K. Hitzenberger**, Canon Inc. (F); **Stefan Sacu**, None; **Ursula Schmidt-Erfurth**

Program Number: 5470 **Poster Board Number:** C0074
Presentation Time: 3:45 PM–5:30 PM
Macular Microvascular Abnormalities Associated with Birdshot Chorioretinopathy
Kimberly E. Stepien[1], Lynn W. Sun[1], Erika Phillips[1], Rebecca Mastey[1], Joseph Carroll[1, 2], Wanda Martinez[3]. [1]Ophthalmology, Medical College of Wisconsin, Milwaukee, WI; [2]Cell Biology, Neurobiology and Anatomy, Medical College of WI, Milwaukee, WI; [3]Malcom Randall VAMC, Gainesville, FL.
Purpose: To characterize retinal macular microvascular changes and density in individuals with birdshot chorioretinopathy.
Methods: Fourteen eyes of 7 patients ages 36-69 years, average 57.5 years, diagnosed with HLA-A29 + birdshot chorioretinopathy underwent comprehensive retinal exam and retinal imaging using OCT-angiography (OCT-A) (AngioVue; Optovue, Inc.) where both 3 x3 mm and 6 x 6 mm scans of the macula were acquired. Foveal avascular zone (FAZ) area and vascular density were calculated and compared to an in-house normative OCT-A database of 146 subjects. Vascular density data was then overlaid onto 3x 3 mm superficial macular scans, and areas greater than 2 standard deviations from normative date were highlighted. OCT-A images were also reviewed for microvascular changes in the posterior pole.
Results: Visual acuity ranged from 20/20 to 20/50 for all eyes. All individuals were on immunosuppressive agents for birdshot chorioretinopathy. Seven of 14 eyes had an epiretinal membrane(ERM) involving the macula, with 5 eyes having only trace ERM. A lamellar hole/ERM was present in one eye and ERM traction of the macula was present in one eye, excluding these eyes from further FAZ area and vascular density analysis. Four eyes had a history of previous cystoid macular edema, although resolved at the time of image acquisition. OCT-A demonstrated irregularities of the FAZ in all eyes, with 12 eyes having irregular shaped and/or enlarged FAZ and 2 eyes of one patient having no defined FAZ. Mean FAZ area of 10 of 14 eyes (0.35mm^2) was significant larger when compared to mean FAZ area in the normative database (0.27 mm^2 p= 0.02, Mann-Whitney test). Macular vascular density was calculated for 6 of 14 eyes, and showed multiple areas throughout the 3x3 mm image where density was greater than 2 standard deviations from normal. Review of OCT-A images showed capillary dilation and vascular looping in all 14 eyes. Additionally, anomalous vessels were present in 2 eyes.

Conclusions: Significant retinal microvascular anomalies exist in the macula of patients with birdshot chorioretinopathy that are not appreciated with conventional clinical imaging, even when visual acuity is preserved and inflammation is well controlled.
Commercial Relationships: Kimberly E. Stepien, None; **Lynn W. Sun**, None; **Erika Phillips**, None; **Rebecca Mastey**, None; **Joseph Carroll**; **Wanda Martinez**, None
Support: AngioVue OCT –angiography system provided by Optovue. This investigation was conducted in a facility constructed with support from the Research Facilities Improvement Program, grant number C06 RR016511, and grant number P30 EY 001931 from the National Center for Research Resources, National Institutes of Health

Program Number: 5471 **Poster Board Number:** C0075
Presentation Time: 3:45 PM–5:30 PM
Macular retinal vascular flow characteristics in birdshot chorioretinopathy using optical coherence tomography angiography
Mohamed Saleh[1, 2], Liang Liu[1], Yali Jia[1], David Huang[1], James T. Rosenbaum[1], Eric B. Suhler[1], Phoebe Lin[1]. [1]Casey eye institute, Oregon health and Science University, Portland, OR; [2]Ophthalmology department, Assiut University, Assiut, Egypt.
Purpose: Birdshot chorioretinopathy (BSCR) is characterized by classic deep choroidal lesions, occasional retinal vascular or optic nerve leakage, and eventual choroidal and outer retinal atrophy. The purpose of this study was to quantify retinal vascular changes in the macular area in patients with BSCR using optical coherence tomography angiography (OCTA).
Methods:
This was a prospective case series of 11 eyes of 6 patients with BSCR and 8 eyes from 8 normal age-similar subjects imaged with a 3x3 mm scan by a high-speed (70 kHz) 840 nm spectrometer-based OCT system SD-OCT (Optovue RTVue XR Avanti). The split-spectrum amplitude decorrelation angiography (SSADA) algorithm was used to compute angiograms from the internal limiting membrane to the outer plexiform layer. The parafoveal retinal flow index and vessel density were determined in a 2.5 mm wide annulus centered on the fovea. The retinal vessel density was defined as the percentage area occupied by vessels on the en face angiogram. The flow index is a measure that includes the SSADA-derived flow velocity in capillaries and the area of large vessels on the en face angiogram. A Mann–Whitney U test was used to compare these flow characteristics between BSCR patients and normal subjects.
Results: Mean age of BSCR subjects was 60.8 years (range 34-70) compared to mean age of 60.3 years in normal subjects (range 32-72) (p=1.0). All BSCR subjects were positive for HLA-A29. The parafoveal retinal vessel density via OCTA was significantly lower in BSCR patients compared to normal subjects (mean parafoveal vessel density 80.2% vs. 91.7%, p=0.003). The parafoveal retinal flow index was also significantly lower in BSCR subjects compared to normal subjects (mean flow index 0.06 vs. 0.08, p<0.0001).
Conclusions: Retinal blood flow in the parafoveal area of patients with BSCR is reduced compared to age-similar subjects suggesting possible disruption of the blood retinal barrier.
Commercial Relationships: Mohamed Saleh, None; **Liang Liu**; **Yali Jia**, Optovue, Inc (F), Optovue,Inc (P); **David Huang**, Optovue,Inc (I), Optovue,Inc (P), Optovue,Inc (F), Carl zeiss Meditec,Inc (P), Optovue,Inc (R); **James T. Rosenbaum**, None; **Eric B. Suhler**, None; **Phoebe Lin**, None

Program Number: 5472 **Poster Board Number:** C0076
Presentation Time: 3:45 PM–5:30 PM
Microvascular abnormalities on optical coherence tomography angiography in macular edema associated with branch retinal vein occlusion
Norihiro Suzuki, Yoshio Hirano, Munenori Yoshida, Taneto Tomiyasu, Akiyoshi Uemura, Tsutomu Yasukawa, Yuichiro Ogura. Department of Ophthalmology and Visual Science, Nagoya City University Graduate School of Medical Sciences, Nagoya, Japan.
Purpose: To determine the ability of optical coherence tomography (OCT) angiography to image the microvascular structures compared with FA in patients with macular edema associated with branch retinal vein occlusion (BRVO).
Methods: Twenty–eight eyes of 27 patients (14 men, 13 women; mean age, 68.4 years) with macular edema associated with BRVO were enrolled. Simultaneous OCT angiography and FA were performed in all patients to evaluate the microvascular abnormalities and non–perfused areas. Patients whose OCT angiography images were of inadequate quality for evaluation because of eye movement, cataract or who had not undergone FA because of renal and/or liver dysfunction or allergy to fluorescein were excluded.
Results: OCT angiography detected non–perfused areas in 28 eyes and FA in 18 eyes. The respective findings of superficial capillary telangiectasias by OCT angiography and FA were 13 and 11 eyes, for deep capillary telangiectasias 28 eyes and 11 eyes, for collateral vessels 18 eyes and 16 eyes, and for microaneurysms 13 eyes and 14 eyes. OCT angiography facilitated differential layer analysis of microaneurysms and collaterals as well as capillary telangiectasias in the retina.
Conclusions: OCT angiography can visualize microvascular abnormalities equally well or better than FA in eyes with BRVO. Multimodal imaging using OCT angiography and FA can be a powerful tool to evaluate the pathology in BRVO.
Commercial Relationships: Norihiro Suzuki, None; **Yoshio Hirano**, None; **Munenori Yoshida**, None; **Taneto Tomiyasu**; **Akiyoshi Uemura**, None; **Tsutomu Yasukawa**, None; **Yuichiro Ogura**, None

Program Number: 5473 **Poster Board Number:** C0077
Presentation Time: 3:45 PM–5:30 PM
Comparison of OCT Angiography and Conventional Fluorescein Angiography in the Evaluation of Collateralization in Acute versus Chronic Branch or Hemi Retinal Vein Occlusion
Bryan P. Jones[7], Michael H. Chen[6], Jesse J. Jung[1], Quan V. Hoang[2], Maiko Inoue[3, 4], Chandra Bala[3], K Bailey Freund[3, 4], Lawrence A. Yannuzzi[3, 4], Soraya Rofagha[1, 5], Scott Lee[1]. [1]East Bay Retina Consultants, Inc., Oakland, CA; [2]Department of Ophthalmology, Edward S. Harkness Eye Institute, Columbia University College of Physicians and Surgeons, New York, NY; [3]Vitreous Retina Macula Consultants of New York, New York, NY; [4]The LuEsther T. Mertz Retinal Research Center, Manhattan Eye, Ear and Throat Hospital, New York, NY; [5]Department of Ophthalmology, University of California, San Francisco, San Francisco, CA; [6]Silicon Valley Eyecare, Santa Clara, CA; [7]Department of Ophthalmology, New York University School of Medicine, New York, NY.
Purpose:
To describe the role of optical coherence tomography angiography (OCTA) in identifying collateralization in acute versus chronic branch retinal vein occlusion (BRVO) or hemi-retinal vein occlusion (HRVO).
Methods:
This retrospective cohort study reviewed 32 patients with BRVO/HRVO who were imaged with spectral-domain (RTVue XR

Avanti, Optovue, Inc.; Cirrus AngioPlex, Carl Zeiss Meditec) or swept-source OCTA (Prototype, Carl Zeiss Meditec) at two retinal practices. Medical charts were reviewed for collateral vessels seen during clinical exam. *En-face* OCTA images of the superficial (SCP) and deep capillary plexuses (DCP) were generated and reviewed. Patients were categorized according to chronicity, with acute defined as < 6 months vs. chronic (≥ 6 months) from initial diagnosis. The likelihood of collateral vessels on OCTA in acute versus chronic groups was compared. Fisher exact test was used to assess agreement regarding identification of collaterals on OCTA, fluorescein angiography (FA) and clinical exam. Statistical significance was defined as $p<0.05$.

Results:

The 32 patients (19 female) had a mean age of 65 (range 42-93). Of the patients, 41% had acute and 59% had chronic BRVO/HRVO. Best-correct visual acuity was 20/56 (range 20/20–CF@6', 0.45+/-0.43, mean+/-SD in logMAR). OCTA identified collateral vessels in 22/32 (69%) of cases (2 (9%) in SCP, 5 (23%) in DCP and 15 (68%) in both). Of the 17 patients that underwent both FA and OCTA, collateral vessels were identified by clinical exam in 9 (28%), by FA in 11 (34%) and OCTA in 11 (34%). OCTA and clinical examination for collaterals were in good agreement ($p=0.002$), with both FA and OCTA identifying collaterals in two cases not noted on clinical exam alone. There was perfect agreement between OCTA and FA in all 17 cases ($p=0.000$). Overall on OCTA, collateral vessels were significantly more likely found (t-test, $p=0.024$) in chronic (14/19, 74%) than acute cases (5/13, 38%).

Conclusions:

OCTA has depth-encoded information and is able to reliably identify collateral vessels in patients with BRVO/HRVO in perfect agreement with FA. Collateral vessels are seen within both capillary plexuses. Identifiable collateralization typically occurs after ≥ 6 months from the initial diagnosis of BRVO/HRVO.

Commercial Relationships: Bryan P. Jones; **Michael H. Chen**, Carl Zeiss Meditec (C); **Jesse J. Jung**, Optos (C), Carl Zeiss Meditec (C); **Quan V. Hoang**, None; **Maiko Inoue**, None; **Chandra Bala**, None; **K Bailey Freund**, REGENXBIO (C), Genentech (C), Ohr Pharmaceutical (C), Optos (C), Optovue (C), Heidelberg Engineering (C), ThromboGenics (C); **Lawrence A. Yannuzzi**, None; **Soraya Rofagha**, Carl Zeiss Meditec (C); **Scott Lee**, Carl Zeiss (C)

Program Number: 5474 **Poster Board Number:** C0078
Presentation Time: 3:45 PM–5:30 PM

Qualitative and quantitative follow-up of patients with retinal vein occlusion using Optical Coherence Tomography Angiography

Alexandre Sellam, Florence Coscas, Agnes Glacet-Bernard, Alexandra Miere, Gabriel J. Coscas, Eric H. Souied. Regulatory Science, Creteil University, Paris, France.

Purpose: To evaluate qualitatively and quantitatively the results using Optical Coherence Tomography Angiography (OCTA) in the follow-up of patients treated with intravitreal injections for a macular edema secondary to retinal vein occlusion (RVO).

Methods: Retrospective study of RVO patients treated with intravitreal injections for a macular edema. Before and after injection, following data were recorded: best-corrected visual acuity (BCVA), Spectral Domain-Optical Coherence Tomography (SD-OCT), fluorescein angiography and OCT A (Optovue, Inc., Fremont, California, USA). Automatic measurement of vascular density of the superficial (SCP) and deep capillary plexus (DCP) was also done before and after treatment and compared to healthy subjects, matched for age and gender.

Results: 35 eyes of 34 patients (mean age, 68 years, male 64%) were retrospectively analyzed, including 16 central RVO, 15 branch RVO and 4 hemicentral RVO. After treatment, central macular thickness significantly decreased from 623µ to 326µ in average and BCVA increased from 20/100 to 20/63 ($p<0.01$ for both). On OCTA, a significant decrease of perifoveal capillary disruption was observed after treatment ($p=0.02$) as well as a decrease of vascular dilation in the SCP and the DCP ($p=0.001$ and 0.016 respectively) and of the number of cysts in the SCP and DCP ($p<0.001$ for both). At the SCP, the mean whole en face vascular density slightly decreased during follow-up from 45.7 to 44.5%, and the density in the parafoveal zone decreased from 47.2 to 45.8% (non-significant difference for both). These densities were largely inferior to those observed in control subjects (50.8% and 52.6% respectively, $p<0.001$ for both).

Conclusions: Along with the disappearance of macular edema and of macular cysts, OCTA visualized a slight decrease in macular vascular density with time and despite treatment. This technique allows a quantitative and qualitative evaluation of the follow-up of RVO patients, useful to analyze both macular edema and vascular perfusion.

Commercial Relationships: Alexandre Sellam; **Florence Coscas**, None; **Agnes Glacet-Bernard**, None; **Alexandra Miere**, None; **Gabriel J. Coscas**, None; **Eric H. Souied**, None

Program Number: 5475 **Poster Board Number:** C0079
Presentation Time: 3:45 PM–5:30 PM

Measurement of Foveal Avascular Zone and Macular Vascular Density in Eyes with Branched Retinal Vein Occlusion Using Optical Coherence Tomography Angiography

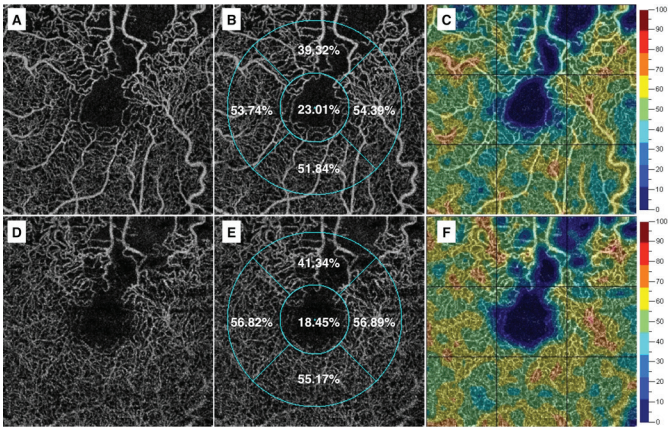
Wasim Samara, Abtin Shahlaee, Jayanth Sridhar, M. Ali Khan, Jason Hsu, Allen Ho. Ophthalmology & Visual Sciences, Wills Eye Hospital, Philadelphia, PA.

Purpose: To measure the vascular density and foveal avascular zone (FAZ) area in the deep and superficial retinal capillary networks using optical coherence tomography angiography (OCTA) in patients with branched retinal vein occlusion (BRVO) and to study the correlation with visual function.

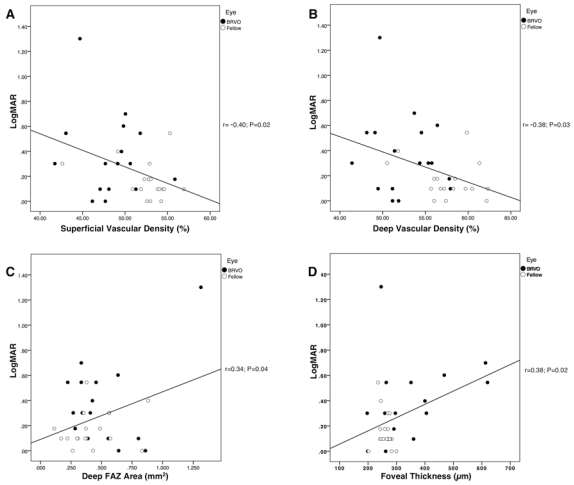
Methods: Seventeen patients (9 females, 8 males; mean age, 64 years) with unilateral BRVO involving the macula were enrolled. OCTA was performed for the BRVO eyes and the fellow eyes. Macular vascular density, foveal thickness, and FAZ area were measured in all eyes.

Results: The mean vascular density measured in the entire scan was significantly lower in the BRVO eyes when compared to the fellow eyes in both the superficial (48.07% vs 52.60%; $P<0.001$) and the deep (52.60% vs 57.67%; $P<0.001$) capillary networks. There was a significant negative correlation between the vascular density in both networks and the logarithm of the minimum angle resolution (LogMAR) of best corrected visual acuity (BCVA). The mean FAZ area in BRVO eyes was significantly lower only at the level of the deep capillary network when compared to the fellow eyes (0.519 mm^2 vs 0.410 mm^2; $P<0.001$) and correlated positively with logMAR.

Conclusions: OCTA is useful to quantify the vascular density and FAZ area in eyes with BRVO. In these eyes, vascular density and FAZ area appear to correlate with visual function. Eyes with lower vascular density and bigger FAZ areas are noted to have worse visual function.



3x3 mm OCTA scan of the macula at the level of the superficial (A) and deep (D) capillary networks showing an area of non-perfusion superiorly. The vascular density in the superficial (B) and deep (E) capillary networks was measured in the whole scan and in each sector of the ETDRS map. Color-coded vascular density map is shown for the superficial (C) and deep (F) networks with dark blue areas corresponding to areas of non-perfusion.



Using Pearson Correlation Coefficient, the vascular density measured in the whole en face scan correlated negatively with logMAR in the superficial (A) and the deep (B) capillary networks. A significant positive correlation was found between the area of deep FAZ and logMAR (C). A positive correlation was also found between foveal thickness and logMAR.

Commercial Relationships: Wasim Samara; **Abtin Shahlaee**, None; **Jayanth Sridhar**, None; **M. Ali Khan**, None; **Jason Hsu**, Optovue (C); **Allen Ho**, Optovue (C)

Program Number: 5476 **Poster Board Number:** C0080
Presentation Time: 3:45 PM–5:30 PM

Optical Coherence Tomography Angiography Imaging and Ultra Wide-field Multi-wavelength Imaging after Transcleral Drainage of Subretinal Fluid, Anti-Vascular Endothelial Growth Factor, and Wide-Field Imaging-Guided Laser in Coats' Exudative Retinal Detachment

Katarzyna M. Chwiejczak[1], ALESSANDRO PAPAYANNIS[1], Francesco Stringa[1], EMMANOUIL TSAMIS[1, 2], Susmito Biswas[1, 2], Assad Jalil[1], Paulo E. Stanga[1, 2]. [1]Manchester Vision Regeneration (MVR) Lab at Manchester Royal Eye Hospital & NIHR/Wellcome Trust Manchester CRF and Manchester Royal Eye Hospital, Central Manchester University Hospitals NHS Foundation Trust, Manchester, United Kingdom; [2]Institute of Human Development, Faculty of Medical and Human Sciences, University of Manchester, Manchester, United Kingdom.

Purpose: To determine whether Swept-Source Optical Coherence Tomography Angiography (SS OCT-A) can detect additional vascular changes in the posterior pole of patients that have undergone transcleral drainage of subretinal fluid, anti-vascular endothelial growth factor, and wide-field imaging-guided laser in Coats'exudative retinal detachment(RD).

Methods: Serial case report: 8 patients aged 4 years to 15 years, with either total or subtotal RD (Stage 3 Coats' disease) at the onset of treatment. Patients were imaged with Optos California® Ultra Wide-field Multi-wavelength Imaging (UWF MWI) and SS OCT-A with Topcon DRI OCT-1®, both Atlantis® and Triton®. Automatic segmentation of the retinal layers was used for displaying characteristics of the superficial and deep neuro-vascular plexuses and choriocapillaris. When necessary, segmentation was modified manually. Images were analysed by two independent retina specialists.

Results: UWF MWI confirmed the absence of active disease (Fig.1). SS OCT-A showed fine collaterals drop-out and irregularity of the capillary network in the posterior pole (Fig.2a). The deep retinal plexus displayed rarefaction of fine vascular branches, with irregular course and segmental dilatation, contributing to the foveal avascular zone enlargement (Fig.2b). Neovascular and fibrotic changes were also observed. Optical shadowing was noted at the level of the chorocapillaris in cases with macular fibrosis. Fifty-percent of fellow eyes showed telangiectatic-like changes in the posterior pole that were not visible on biomicrscopy (Fig.3).

Conclusions: UWF MWI is essential to confirm absence of active peripheral disease. SS OCT-A showed additional vascular information in the posterior pole not only of treated eyes but also of the fellow eyes. This additional vascular information could be potentially considered as a biomarker of prognosis. Further imaging studies are being carried out.

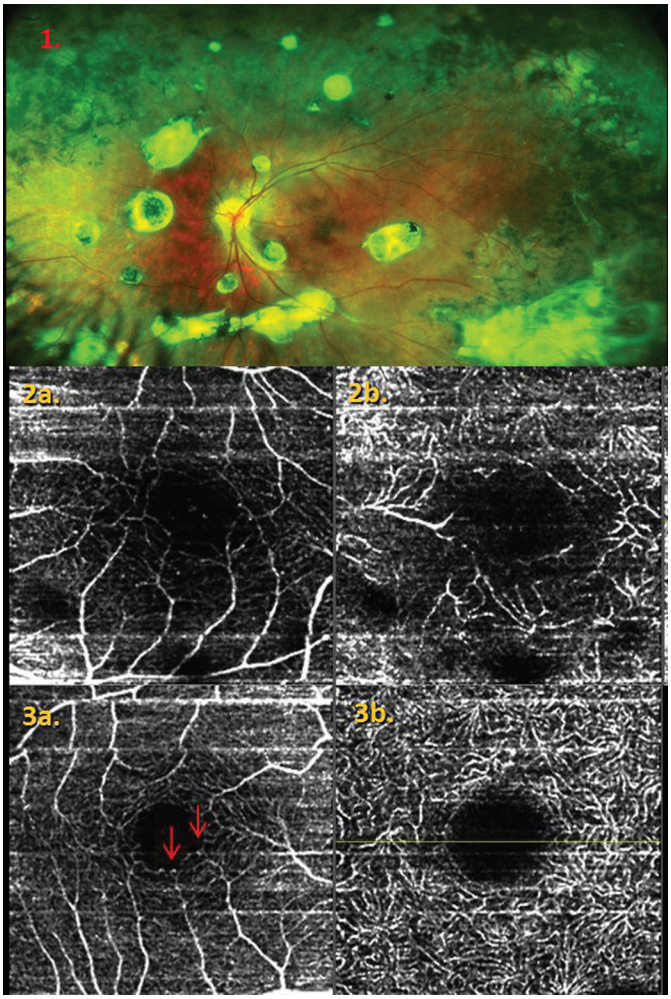


Figure 1: Post-treatment UWF MWI showing inactive disease.
Figure 2: Post-treatment Topcon DRI OCT-1 Atlantis® OCT-A imaging of neurovascular plexuses:(a) superficial,(b) deep.
Figure 3: Fellow eye: superficial(a) and deep(b) neurovascular plexuses. Red arrows: telangiectatic changes and pruning at the edge of the foveal avascular zone.
Commercial Relationships: Katarzyna M. Chwiejczak, None; **ALESSANDRO PAPAYANNIS**, None; **Francesco Stringa**, None; **EMMANOUIL TSAMIS**, None; **Susmito Biswas**, None; **Assad Jalil**, None; **Paulo E. Stanga**, Topcon Corp. (F), Optos Plc. (R), Topcon Corp. (C), Topcon Corp. (R), Optos Plc. (C), Optos Plc. (F)

Program Number: 5477 **Poster Board Number:** C0081
Presentation Time: 3:45 PM–5:30 PM
Optical coherence tomography angiography features in retinal artery occlusion
Nikoly T. Fares, Joao R. Dias, Marina P. Neder, Claudio Z. Lobos, Eduardo A. Novais, Belfort Rubens. Federal University of Sao Paulo, Sao Paulo, Brazil.
Purpose: To describe the retinal microvasculature of the eyes with nonarteritic retinal artery occlusion (RAO) based on optical coherence tomography angiography (OCT-A).
Methods: Cross-sectional, prospective, observational study. Patients with artery occlusion – central, branch or cillioretinal – were prospectively recruited to be imaged on spectral-domain OCT-A (RTVue XR Avanti; Optovue, Inc, Fremont, California, USA), FA (Spectralis HRA Heidelberg Engineering, Heidelberg, Germany) and color fundus phtograph on the same day. Qualitative analysis of the morphology of the superficial and deep retinal capillary plexuses, and radial peripapillary capillaries was performed. Retinal vasculature images using optical coherence tomography angiography were correlated with fluorescein angiography images. All patients were referred to a clinical evaluation for the investigation of systemic diseases.
Results: Ten patients with retinal artery occlusion were included in this study. OCT-A findings were similar to FA finding for the demonstration of retinal ischemia and neovascularization. Distinct differences in the distribution of zones of decreased vascular perfusion between the superficial and deep retinal capillary plexus corresponding to areas of delayed dye perfusion on fluorescein angiography were demonstrated using OCT angiogram. However, OCT-A was not able to evaluate peripheral retina due to restrict scanning field.
Conclusions: OCT-A imaging can accurately discern retinal capillary plexuses at different levels in the eyes with retinal artery occlusion and may be sensitive for more precisely characterizing the extent of macular ischemia and monitoring vascular flow changes during the course of the disease. However, because this exam is restricted to the posterior pole, AF still remains the gold standard exam for peripheral retina imaging.
Commercial Relationships: Nikoly T. Fares, None; **Joao R. Dias**, None; **Marina P. Neder**, None; **Claudio Z. Lobos**, None; **Eduardo A. Novais**, None; **Belfort Rubens**, None

Program Number: 5478 **Poster Board Number:** C0082
Presentation Time: 3:45 PM–5:30 PM
Evaluation of Retinal Artery Occlusions with Ocular Coherence Tomography Based Microangiography
Narae Ko, Aaron Y. Lee, Qinqin Zhang, Kasra Attaran-Rezaei, Raghu C. Mudumbai, Cecilia S. Lee, Ruikang K. Wang. Ophthalmology, University of Washington, Seattle, WA.
Purpose: Central retinal artery occlusion (CRAO) is an important vascular cause of profound vision loss. Visualization of retinal vasculature using fluorescein angiography is limited. We report the results of ocular coherence tomography (OCT) based microangiography (OMAG) imaging of a patient who suffered sequential CRAO in both eyes.
Methods: Fundus photographs, spectral-domain OCT, and OMAG (67 kHz Cirrus HD-OCT prototype system, Carl Zeiss Meditec, Dublin, CA) images were obtained prior to the CRAO in the left eye and on multiple visits after the CRAO in both eyes. The retinal images were segmented into inner, middle, outer retinal layers using a semi-automated algorithm. The macula was divided in 9 zone Early Treatment Diabetic Retinopathy Study (ETDRS) grids. Perfusion index, defined as the percent coverage of the area by retinal vessels with flow, was calculated in each zone.
Results: After the resolution of initial macular edema, the involved retina became atrophic during a period of 1-2 months following the CRAO in the right eye. OMAG images obtained on months 1 and 3 after the onset of CRAO in the right eye demonstrated visible absence of retinal vasculature except for the nasal macula, which was perfused by intact cilioretinal artery. The perfusion index in the nasal macula of the right eye was comparable to that of the left eye prior to CRAO. No significant change in perfusion index was observed in the right eye between months 1 and 3. Compared to the images prior to CRAO, OMAG images obtained on month 1 after CRAO in the left eye revealed diffuse loss of retinal capillary plexus and significant reduction in perfusion index in all 9 zones. Last recorded visual acuity 5 months after bilateral CRAOs were 20/25 eccentrically in the right eye and 20/400 in the left eye.

Conclusions: Extensive loss of retinal vasculature sparing the fovea was demonstrated using OMAG in CRAO of the right eye. Perfusion index after the onset showed minimal change over 3 months after the onset of CRAO. A significant reduction in perfusion index in all 9 ETDRS zones were noted in the left eye after the CRAO.

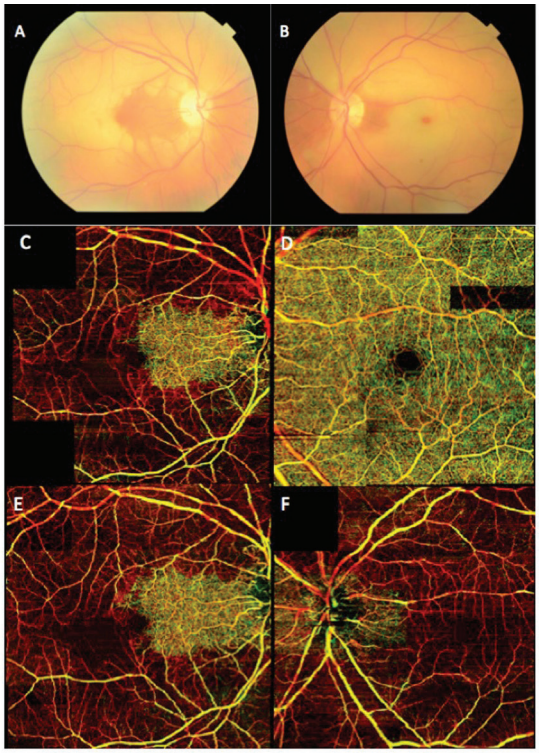


Figure 1. A-B, fundus photographs: week 1 (A) and day 4 (B) after central retinal artery occlusion (CRAO). C-F, ocular coherence tomography based microangiography (OMAG) images: month 1 (C) and month 3 (E) after CRAO right eye, before (D) and 1 month (F) after CRAO left eye.

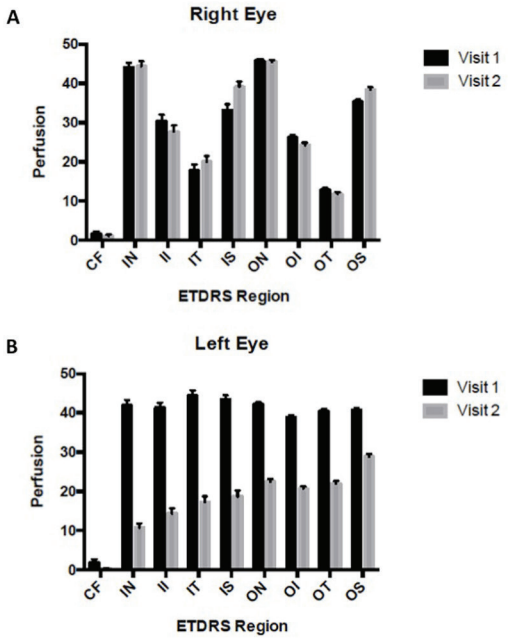


Figure 2. A, bar graphs of perfusion index in 9 ETDRS subfields on month 1 (visit 1) and month 3 (visit 2) after CRAO right eye. B, bar graphs of perfusion index before (visit 1) and 1 month (visit 2) after CRAO left eye.

Commercial Relationships: Narae Ko, None; **Aaron Y. Lee**, None; **Qinqin Zhang**, None; **Kasra Attaran-Rezaei**, None; **Raghu C. Mudumbai**, None; **Cecilia S. Lee**, None; **Ruikang K. Wang**
Support: K23EY024921, R01EY024158, and Carl Zeiss Meditec Inc

Program Number: 5479 **Poster Board Number:** C0083
Presentation Time: 3:45 PM–5:30 PM

En-face optical coherence tomography angiography in central serous corioretinopathy

Roberta Farci, Pietro Emanuele Napoli, Maurizio Fossarello. Eye Clinic, Surgery Department, University of Cagliari, Cagliari, Italy.

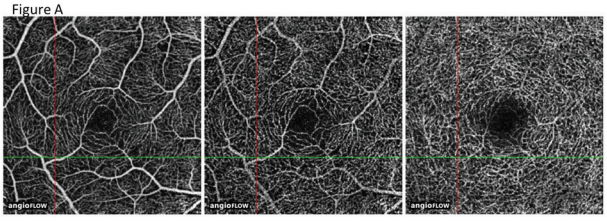
Purpose: To analyze retinal layers and vascular plexus changes using optical coherence tomography angiography (OCT-A) in patients with acute and chronic central serous corioretinopathy (CSC).
Methods: Twenty-eyes of 20 patients with central serous corioretinopathy (ascertained by spectral domain optical coherence tomography OCT), fluorescein angiography (FA), and indocyanine green angiography (ICGA), were enrolled for en-face angio OCT examination, and studied in comparison to 20 controls using a spectral-domain OCT device (AngioVue RTVue XR Avanti, Optovue).
Results: In patients with CSC, OCT angiography revealed the depletion of main vessels in the superficial capillary plexus and in the avascular foveal zones borders and the reduction of vascular flow in the superficial and the deep vascular network, as quantified by the software OCT (thickness ILM-EPR flow density and grid based flow density). Moreover, en-face OCT imaging permitted to describe three different chorocapillaris morphological patterns: a) marbled pattern, b) rough grain pattern and, c) fine grain pattern.

Conclusions: En face OCT-A imaging is an easy, reproducible, non-invasive and effective tool to visualise retinal and choroidal changes in patients affected by CSC. It provides complementary morphological and blood flow quantitative information, and reveals peculiar imaging patterns at the level of choriocapillaris/choroid layer which deserve further studies.
Commercial Relationships: Roberta Farci; **Pietro Emanuele Napoli**, None; **Maurizio Fossarello**, None

Program Number: 5480 **Poster Board Number:** C0084
Presentation Time: 3:45 PM–5:30 PM
Optical Coherence Tomography angiography of Flat Irregular Pigment Epithelium Detachment in Central Serous Chorioretinopathy
Elodie Bousquet[1, 2], Valerie Krivosic[2], Ramin Tadayoni[2], Alain Gaudric[2]. [1]OPHTHALMOLOGY, HOTEL DIEU COCHIN HOSPITAL, PARIS DESCARTES UNIVERSITY, PARIS, France; [2]OPHTHALMOLOGY, LARIBOISIERE HOSPITAL, PARIS DIDEROT UNIVERSITY, PARIS, France.
Purpose: Retinal pigment epithelium detachments (PED) are found in most of the cases of central serous chorioretinopathy (CSCR) with variable aspects. A "dome-shaped" PED is present in acute CSCR and "flat irregular" PED is more likely observed in chronic CSCR. Type 1 choroidal neovascularization (CNV) may complicate chronic CSCR and the distinction between both entities can be complex because of overlapping imaging features.
This study evaluates the rate of CNV in eyes with "flat irregular" PED using optical coherence tomography angiography (OCT-A).
Methods: Retrospective observational case series study of patients with CSCR. Multimodal imaging including OCT, indocyanine green (ICG-A)/fluorescein angiography (FA) and OCT-A (Avanti RTVue, Optovue, California, USA) were reviewed. Macular cubes (3X3mm and 6X6mm) centered on the fovea were analyzed by two masked graders for the detection of choroidal neovascularisation and flat irregular PED, which was defined as an irregular elevation of RPE allowing the visualization of Bruch's membrane.
Results: Eighty seven eyes of 59 patients with CSCR were included. Patients' mean age was 52 years (range, 30-84). Forty six patients (78%) were male. Flat irregular PED were present in 55 eyes (63.2%). OCT-A allowed the detection of CNV in 11 eyes (20%) with flat irregular PED. CNV were not associated with retinal hemorrhage or hard exsudates. They did not display a neovascular network on FA nor ICG-A. This proportion is very close from the rate found in a previous study evaluating the presence of CNV based on FA/ICGA/SD OCT in chronic CSCR (Hage et al, AJO 2015).
Conclusions: OCT-angiography can detect the presence of CNV in 20% of eyes with flat irregular PED in CSCR patients. Further studies with large sample size are needed to evaluate the sensitivity and specificity of CNV detection on OCT-A compared with FA/ICGA in chronic CRSC.
Commercial Relationships: Elodie Bousquet; **Valerie Krivosic**, None; **Ramin Tadayoni**, None; **Alain Gaudric**, None

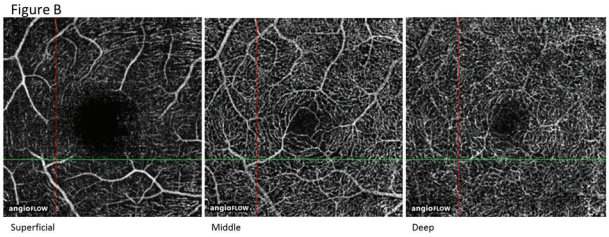
Program Number: 5481 **Poster Board Number:** C0085
Presentation Time: 3:45 PM–5:30 PM
Optical Coherence Tomography Angiography of Three Retinal Capillary Networks
Justin Park[1], Brian Soetikno[1, 2], Peter L. Nesper[1], Amani A. Fawzi[1]. [1]Ophthalmology, Feinberg School of Medicine, Northwestern University, Chicago, IL; [2]Biomedical Engineering, Functional Optical Imaging Laboratory, Northwestern University, Evanston, IL.
Purpose: Optical Coherence Tomography Angiography (OCTA) is an effective modality to obtain three-dimensional angiograms of the retinal vasculature. However, current software limits analysis to the superficial and deep capillary plexuses (SCP and DCP) and does not account for the middle capillary plexus (MCP) as a separate entity. We performed a prospective imaging study of both healthy controls and diseased eyes to assess the feasibility of imaging the MCP apart from the SCP and DCP.
Methods: Ten healthy eyes and twelve eyes from nine diabetic patients were imaged using OCTA (RTVue XR, Optovue, Inc with SSADA software). To visualize the three networks, we obtained *en face* OCT angiograms using two different segmentation approaches. The first approach used pre-set segmentation for the SCP and DCP, while the MCP was set by placing a thin slab at its anatomic location of the inner border of the inner nuclear layer (INL). The second approach used customized segmentation to set the boundaries for each capillary plexus according to its known anatomical location, setting the SCP to capture the nerve fiber and ganglion cell layers, and the MCP and DCP at the inner border and outer borders of the INL respectively.
Results: Both approaches to segment *en face* OCT angiograms into three capillary plexuses showed significant limitations, with difficulty in discerning three separate networks, and shadow artifacts were observed as the superficial vessels cast shadows on deeper capillary layers. Figure A shows results for approach 1 and Figure B shows results for approach 2.
Conclusions: Current segmentation software of OCTA does not allow for the ability to distinguish the MCP from the SCP and DCP. Our attempts to manually segment the capillary plexus layers according to their anatomical locations show the limitations in isolating the MCP with current methods. Further work and software modifications in the future will enable improved ability to visualize the three separate capillary plexuses, including removal of shadow artifacts from the inner vascular networks that confound the deeper networks.

Figure A



Approach 1 shows significant artifacts as superficial vessels cast shadows on all deeper capillary layers. The SCP and MCP are difficult to distinguish despite the MCP segmentation confined to a thin area above the INL.

Figure B



Approach 2 shows a higher degree of separation but superficial vessels still cast shadow artifacts on deeper capillary layers.
Commercial Relationships: Justin Park, None; **Brian Soetikno**, None; **Peter L. Nesper**, None; **Amani A. Fawzi**, None
Support: NIH/NIDDK 1DP3DK108248 (AAF)

Program Number: 5482 **Poster Board Number:** C0086
Presentation Time: 3:45 PM–5:30 PM
Imaging the perifoveal retinal capillary vasculature of patients with diabetic retinopathy with Swept Source Optical Coherence Tomography Angiography (SS-OCTA)
Alberto La Mantia, Rengin A. Kurt, Samantha Mejor, Dawn A. Sim, Catherine A. Egan, Adnan Tufail, Pearse A. Keane. Medical Retina, Moorfields Eye Hospital, London, United Kingdom.
Purpose: SS-OCTA is a novel, non-invasive imaging technique that may be useful in the clinical management of retinal vascular disease. The aim of this observational study was to report SS-OCTA features of the perifoveal retinal capillary plexes of patients with diabetic retinopathy as well as to test potential applications of this technique in a clinical setting.
Methods: Twelve patients (twenty-two eyes) were enrolled. Inclusion criteria were the presence of diabetic retinopathy, with or without maculopathy. Exclusion criteria were: presence of significant media opacity or other concurrent retinal disease and history of previous endovitreal surgery. SS-OCTA was performed using the DRI OCT Triton Plus® (Topcon Corp., Tokyo, Japan). The imaged area was 3mm x 3mm, centered on the fovea. The SS-OCTA images of the superficial (SP) and deep (DP) perifoveal plexes were analysed quantitatively and qualitatively. Manual segmentation was performed for each scan.
Results: Our quantitative analysis showed that the mean Foveal Avascular Zone area in the SP was 0.466 ± 0.23 mm^2 and 0.519 ± 0.19 mm^2 in the DP. Image quality was graded as excellent (group A) 4/22 (18%), good (group B) 7/22 (31.8%), poor but gradable (group C) 9/22 (40.9%) and ungradable (group D) 2/22 (9.1%). The most common cause of poor image quality were motion artifacts, the most frequent being “white lines” (Fig.1) with associated “vessel displacement” (86,4%) followed by “projection artifacts” (27,3%) and “gap defects” (13%). SS-OCTA highlighted some of the features of diabetic maculopathy such as capillary drop-out (Fig.2), intraretinal microvascular abnormalities and cystoid cavities.
Conclusions: SS-OCTA is a promising imaging technique for the assessment of macular perfusion. This small pilot study demonstrated its potential use as an adjunct to traditional Fluorescein Angiography. The absence of dye allows visualisation of structures that would otherwise be masked by fluorescein leakage or staining. The primary drawback of SS-OCTA was the degradation of image quality due to motion artifacts. However, we observed that most images were of sufficient quality to allow for both qualitative and quantitative grading of diabetic maculopathy.

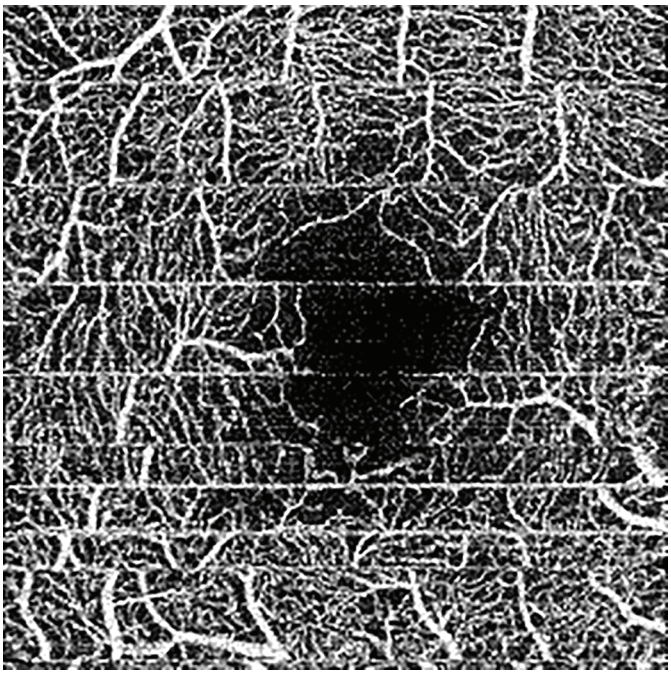


Fig.1 Example of multiple “white lines” and “vessel displacement” artifacts.

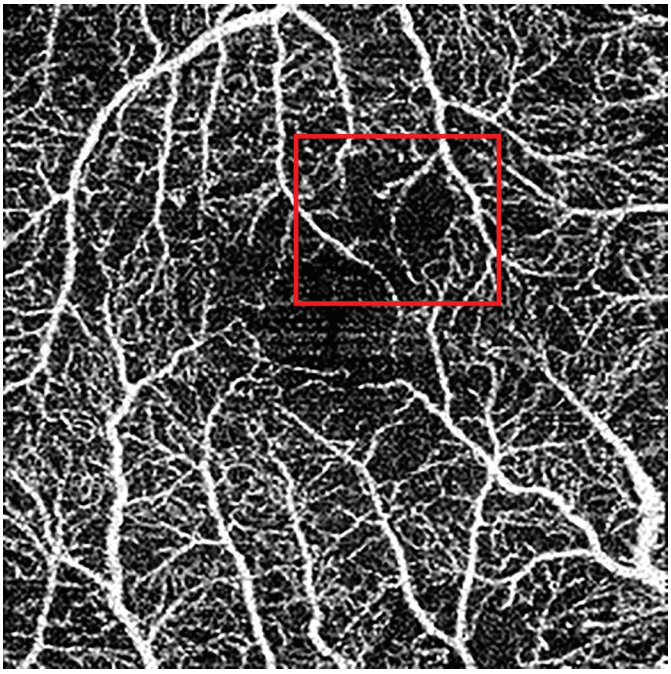


Fig.2 Example of areas of capillary drop-out in the superficial plexus.
Commercial Relationships: Alberto La Mantia; **Rengin A. Kurt**, None; **Samantha Mejor**, None; **Dawn A. Sim**, Allergan (F), Fight for Sight UK (F); **Catherine A. Egan**, None; **Adnan Tufail**, Pfizer (C), Allergan (C), GSK (C), Bayer (C), Thrombogenics (C), Novartis (C); **Pearse A. Keane**, None

Program Number: 5483 **Poster Board Number:** C0087
Presentation Time: 3:45 PM–5:30 PM
Correlation between OCT-based Microangiography Flow Indices and Diabetic Retinopathy Severity
Alexander Lin, Qinqin Zhang, Aaron Y. Lee, Kasra Attaran-Rezaei, James L. Kinyoun, Cecilia S. Lee, Ruikang K. Wang. Ophthalmology, University of Washington, Seattle, WA.
Purpose: To examine microvascular changes of patients with diabetes and diabetic retinopathy using Optical Coherence Tomography based Microangiography (OMAG).
Methods: A total 68 patients (136 eyes) with a history of diabetes underwent OMAG imaging, 67 kHz Cirrus HD-OCT prototype system (Carl Zeiss Meditec, Dublin, CA) at University of Washington, Seattle. The demographics and clinical data including past medical and ocular history were collected. All patients were divided into 5 separate groups based on the severity of their diabetic retinopathy (DR). Flux index was defined as the average OMAG value within an independent subsampled area of the retina, Perfusion index was defined as the percent coverage of the area by retinal vessels with flow. The analysis of flow indices was performed in a total of 21 patients (5, 3, 6, 4, and 3 with no DR, mild NPDR, moderate NPDR, severe NPDR, and PDR respectively). Multivariate linear regression models were used to determine the correlation of flow indices with diabetic retinopathy severity after adjustment of clinical variables using R (http://www.r-project.org).
Results: There were statistically significant inverse correlations between the flow indices (flux and perfusion) and the severity of diabetic retinopathy. Representative images of each stage of diabetic retinopathy are shown in Figure. The flux index (raw scores) decreased by 6.74 (95% CI 5.88, 7.59, $p < 2x10^{-16}$) with each increase in score of DR after multivariate adjustment for age, gender, logMAR visual acuity, type of diabetes, same subject intercorrelation, and the ETDRS subfields. The perfusion index decreased by 1.63% (95% CI 1.33, 1.94, $p<2x10^{-16}$) after adjusting for the aforementioned covariates.
Conclusions: The flow indices based on OMAG imaging allows quantitative evaluation of the microvascular changes seen in diabetic retinopathy and there is an inverse correlation with the severity of DR. The flow indices may be an important non-invasive tool to diagnose and monitor the presence and progression of diabetes related retinal microvascular disease.

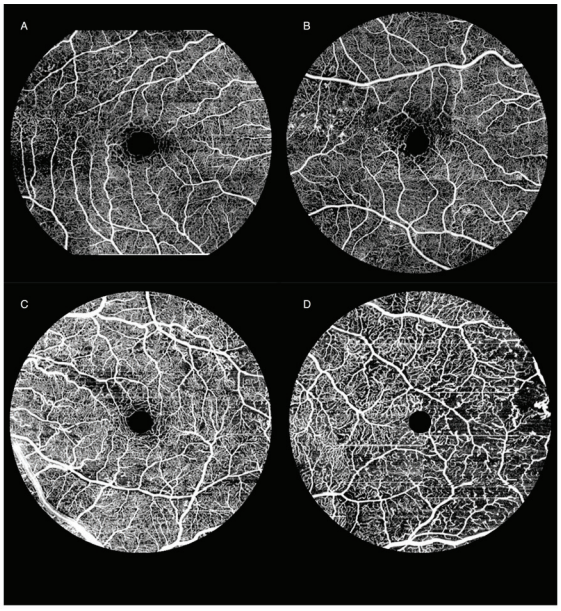
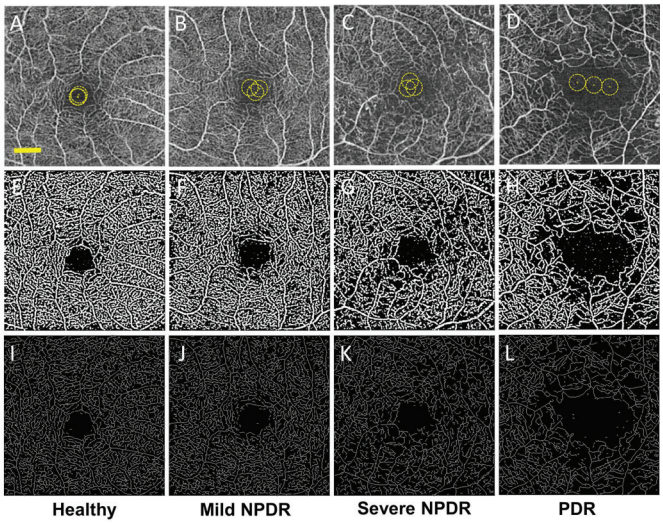


Figure 1:
Optical Coherence Tomography based Microangiography imaging demonstrating microvascular changes in Mild Non-Proliferative Diabetic retinopathy (A), Moderate Non-Proliferative Diabetic retinopathy (B), Severe Non-Proliferative Diabetic retinopathy (C) and Proliferative Diabetic retinopathy (D)

Commercial Relationships: Alexander Lin, None; **Qinqin Zhang**, None; **Aaron Y. Lee**, None; **Kasra Attaran-Rezaei**, None; **James L. Kinyoun**, None; **Cecilia S. Lee**, None; **Ruikang K. Wang**, Carl Zeiss Meditec (F), Carl Zeiss Meditec (C), Carl Zeiss Meditec (P), Carl Zeiss Meditec (R)
Support: NIH Grant K23EY024921, R01EY024158, and Carl Zeiss Meditec Inc.

Program Number: 5484 **Poster Board Number:** C0088
Presentation Time: 3:45 PM–5:30 PM
Quantification of retinal microvascular changes in diabetic retinopathy using spectral domain optical coherence tomography angiography (SD-OCTA)
Alice Y. Kim[1], Zhongdi Chu[2], Anoush Shahidzadeh[1], Ruikang K. Wang[2], Carmen A. Puliafito[1], Amir H. Kashani[1].
[1]Ophthalmology, University of Southern California Eye Institute, Los Angeles, CA; [2]Bioengineering and Ophthalmology, University of Washington, Seattle, WA.
Purpose: To quantify changes in density and morphology of retinal microvasculature in diabetic retinopathy (DR) using SD-OCTA.
Methods: Retrospective, cross-sectional, observational study of healthy and diabetic adult subjects with and without DR. Retinal microvascular changes were assessed using a prototype SD-OCTA (Cirrus, Carl Zeiss Meditec, Dublin, CA) and intensity-based optical microangiography (OMAG) algorithm. A semi-automated program was used to calculate indices of microvascular density and morphology in non-segmented and segmented 3x3 mm SD-OCTA images centered on the fovea. Microvascular density was quantified using skeleton density (SD) and vessel density (VD), while vessel morphology was quantified as fractal dimension (FD) and vessel diameter index (VDI). Statistical analyses were performed using the Student's *t*-test or analysis of variance (ANOVA) with post hoc Tukey Honest Significant Difference (HSD) tests for multiple comparisons.
Results: Eighty four eyes of 50 patients with DR and 14 eyes of 8 healthy subjects were studied. All subjects were age- and gender-matched. Spearman's rank test demonstrated a negative correlation

between DR severity and SD, VD, and FD, and a positive correlation with VDI (rho = -0.767, -0.7166, -0.768, and +0.5051, respectively; $P < 0.0001$). All parameters showed high reproducibility between graders (ICC = 0.971, 0.962, 0.937, and 0.994 for SD, VD, FD, and VDI respectively). Repeatability (κ) was 0.997, 0.996, 0.996, and 0.999 for SD, VD, FD, and VDI, respectively.
Conclusions: Vascular changes in DR can be objectively characterized using SD, VD, FD and VDI. In general, decreasing capillary density (SD and VD), branching complexity (FD), and increasing vascular caliber (VDI) were associated with worsening DR. Capillary density and morphology were significantly correlated with diabetic macular edema.



Non-segmented SD-OCTA images with quantitative image outputs of representative subjects in 3x3 mm areas around the fovea. En face representations of retinal perfusion can be viewed as (A-D) 2D grayscale SD-OCTA images, with selection of noise thresholding marked with *yellow* in the foveal avascular zone. Contrast-enhanced (E-H) binarized and (I-L) skeletonized images of retinal perfusion around the macula corresponding to the group labeled in each column. *Yellow scale bar* (A) shows a distance of 500 µm.
Commercial Relationships: Alice Y. Kim; **Zhongdi Chu**, Carl Zeiss Meditec, Inc. (F); **Anoush Shahidzadeh**, Carl Zeiss Meditec, Inc. (F); **Ruikang K. Wang**, Carl Zeiss Meditec, Inc. (P), Carl Zeiss Meditec, Inc. (R), Carl Zeiss Meditec, Inc. (C), Carl Zeiss Meditec, Inc. (F); **Carmen A. Puliafito**, Carl Zeiss Meditec, Inc. (F); **Amir H. Kashani**, Carl Zeiss Meditec, Inc. (R), Carl Zeiss Meditec, Inc. (C), Carl Zeiss Meditec, Inc. (F)
Support: Research To Prevent Blindness, University of Southern California Dean's Scholars Fund, National Eye Institute (R01EY024158)

Program Number: 5485 **Poster Board Number:** C0089
Presentation Time: 3:45 PM–5:30 PM
Comparison of Retinal Vascular Imaging between Optical Coherence Tomography Angiography and En-Face Optical Coherence Tomography in Diabetic Retinopathy
Yuko Miwa, Tomoaki Murakami, Kiyoshi Suzuma, Akihito Uji, Shin Yoshitake, Masahiro Fujimoto, Tatsuya Yoshitake, Nagahisa Yoshimura. Ophthalmology and Visual Sciences, Kyoto University Graduate School of Medicine, Kyoto, Japan.
Purpose: Optical coherence tomography angiography (OCTA), in which the movement of blood cells is accentuated, can visualize retinal vessels accompanied with blood flow, whereas the vascular imaging on optical coherence tomography (OCT) images is based on the reflectance intensity of vascular walls. We compared retinal vessels on fluorescein angiography (FA), OCTA, and en-face OCT images, representing plasma, blood cells, and vascular walls, in diabetic retinopathy (DR).
Methods: Consecutive 33 eyes of 17 DR patients were retrospectively reviewed. FA images were obtained using HRA2 (Heidelberg Engineering), and OCTA and OCT images (3x3mm centered on the fovea) were simultaneously acquired using Optovue RTVue XR Avanti (Optovue, Inc.). We qualitatively evaluated the OCTA and en face OCT findings corresponding to the microaneurysms on FA images, and quantified the areas of the foveal avascular zone (FAZ) on three imaging systems using ImageJ (NIH), followed by the comparison between them.
Results: Microaneurysms on FA images corresponded to saccular, fusiform, coiled, or curved capillaries on OCTA images and round, oval, or ringed hyperreflective lesions on en face OCT images. 36.7±16.5% and 38.2±16.2% of microaneurysms on FA images were observed on OCTA and en face OCT images, respectively. The number of microaneurysms on either OCTA or OCT images were correlated to that on FA images (R=0.862, P<0.001). Additionally, the nonperfused areas on FA images corresponded almost to those on OCTA images, although en face OCT often detected capillaries in such areas. Further quantification showed that the areas of the FAZ on FA and OCTA images in the superficial layer were almost the same (intraclass correlation coefficient=0.984). The FAZs on en face OCT images were significantly smaller than those on OCTA images in both the superficial and deep layers (P<0.001 and P<0.001).
Conclusions: The comparative study might show the structural-functional gap, i.e., vascular walls and blood flow, in retinal vasculature in DR, suggesting the feasibility of multi-modal evaluation of diabetic retinal vessels.
Commercial Relationships: Yuko Miwa, None; **Tomoaki Murakami**, None; **Kiyoshi Suzuma**, None; **Akihito Uji**, None; **Shin Yoshitake**, None; **Masahiro Fujimoto**, None; **Tatsuya Yoshitake**, None; **Nagahisa Yoshimura**

Program Number: 5486 **Poster Board Number:** C0090
Presentation Time: 3:45 PM–5:30 PM
Optical Coherence Tomography Angiography Assessment of the Deep Retinal Capillary Plexus in Patients With Diabetic Retinopathy
Roberto Gallego-Pinazo[1, 2], LAURA MONJE-FERNANDEZ[1, 3], María Andreu-Fenoll[1, 4], Nestor Garcia-Marin[1, 4], Rosa Dolz-Marco[4, 1]. [1]Unit of Macula. Ophthalmology Department, Univ & Polytechnic Hosp La Fe, Valencia, Spain; [2]Retics Oftared (RD12/0034), Prevention, Early Detection And Treatment Of The Prevalent Degenerative And Chronic Ocular Pathology, Institute of Health Carlos III, Madrid, Spain; [3]Ophthalmology department, University Hospital Complex of León, Leon, Spain; [4]Institute for Health Research, University and Polytechnic Hospital La Fe, Valencia, Spain.
Purpose: To describe the correlation between conventional high-definition optical coherence tomography (OCT) and optical coherence tomography angiography (OCT-A) in patients with diabetic retinopathy and deep retinal capillary ischemia.
Methods: Patients with diabetic retinopathy were analyzed by OCT and OCT-A (Heidelberg Engineering) macular scan and those showing any degree of deep retinal capillary plexus dropout were included in the present study. A qualitative correlation between areas of preserved and damaged deep capillary plexus as observed with OCT-A, and the morphometric appearance of them in the corresponding OCT scans was performed. Patients with cystoid

retinal changes were excluded from the analysis in order to avoid possible bias induced by the disrupted retinal anatomy in such cases.
Results: A total number of 20 eyes of 10 diabetic patients (7 men and 3 women; age range: 25-72 years). A robust and constant qualitative association was evidenced between areas of deep retinal capillary ischemia and focal thinning of the INL. Deep capillary ischemic changes were evidenced to show a honeycomb distribution in the OCT-A images that was translated into a wreath-like contour of the INL in the corresponding sectional OCT scan.
Conclusions: The advent of OCT-A is one of the most exciting advances within the field of macular diseases. For the first time we are able to clearly differentiate and visualize both the superficial and deep retinal capillary plexi. Patients with retinal vascular diseases may benefit from this new imaging modality as changes at the level of the deep plexus have an increasing role in their prognosis. We have found a consistent correlation between areas of INL thining in the conventional OCT scans with the deep capillary dropout in the OCT-A images, suggesting that the OCT changes may constitute an indirect sign of those ischemic changes.
Commercial Relationships: Roberto Gallego-Pinazo, Novartis (F), Alcon (F), Novartis (C), Bayer (F), Heidelberg Engineering (F); **LAURA MONJE-FERNANDEZ**, None; **María Andreu-Fenoll**, None; **Nestor Garcia-Marin**, None; **Rosa Dolz-Marco**, Novartis (F), Alcon (F), Heidelberg Engineering (F)

Program Number: 5487 **Poster Board Number:** C0091
Presentation Time: 3:45 PM–5:30 PM
Comparison of Diabetic Retinopathy Classification using Fluorescein Angiography and Optical Coherence Tomography-Angiography
Mario Soares[1], Catarina A. Neves[2], Christian Schwartz[2], Dalila Alves[3], Torcato Santos[4], Jose G. Cunha-Vaz[5, 6]. [1]CEC, AIBILI, Coimbra, Portugal; [2]CORC, AIBILI, Coimbra, Portugal; [3]4C, AIBILI, Coimbra, Portugal; [4]CNTM, AIBILI, Coimbra, Portugal; [5]AIBILI, Coimbra, Portugal; [6]Faculty of Medicine, University of Coimbra, Coimbra, Portugal.
Purpose: To analyse and compare the classification of eyes with Diabetic Retinopathy (DR) using Fluorescein Angiography (FA) and Optical Coherence Tomography-Angiography (OCT-A), with either AngioPlex or AngioVue.
Methods: Twenty nine eyes (29) eyes from 15 diabetic subjects underwent FA (HRA Spectralis), color fundus photography (CFP) and OCT-A, 3x3mm scan, using two different devices (Zeiss AngioPlex prototype and Optovue AngioVue OCTA system). ETDRS DR levels were obtained from CFP. From OCT-A the superficial retinal vascular layer (SRL) were depicted as an *en-face* image and exported as image file. For FA, 20 degrees images from field 2 of the initial stage of the procedure were also exported. Two independent graders (CAN and MS) classified the FA using the ETDRS Report 11, and a similar evaluation was performed for OCT-A. Foveal avascular zone (FAZ) was also measured using an image processing program (ImageJ) and the free hand selection tool. Descriptive statistics were calculated.
Results: The mean age of the diabetic patients was 66.1±7.8 years (range 52-76) and 34.5% were females. The FAZ size varied widely (from 0.146 to 0.670 mm^2 for Zeiss AngioPlex, from 0.113 to 0.816 mm^2 for AngioVue OCTA system and from 0.092 to 0.741 mm^2 for FA). Outline of FAZ, capillary loss, arteriolar abnormalities and capillary dilatation showed a higher percentage of ungradable features using FA in comparison with both OCT-A devices. Gradable images for outline of FAZ in central subfield (CSF) were 70.0% with FA, 86.2% with AngioPlex, and 75.9% with AngioVue (FA vs AngioPlex p=0.006; FA vs AngioVue p=0.100). For capillary loss, gradable images in the inner ring were 56.9% with FA, 69.8% with AngioPlex, and 64.7% with AngioVue (FA vs AngioPlex p=0.169; FA vs AngioVue p=0.732).
Conclusions: The OCT-A allows better discrimination of the CSF and parafoveal macular microvasculature than FA, especially for FAZ rupture and capillary loss, without the need of an intravenous injection of fluorescein. In addition, FA had also a higher number of ungradable features. The OCT-A can replace with advantage the FA as a non-invasive and more sensitive procedure for detailed morphological evaluation of retinal vascular changes.
Commercial Relationships: Mario Soares, None; **Catarina A. Neves**, None; **Christian Schwartz**, None; **Dalila Alves**, None; **Torcato Santos**, None; **Jose G. Cunha-Vaz**, Carl Zeiss Meditec (C)
Clinical Trial: NCT02391558

Program Number: 5488 **Poster Board Number:** C0092
Presentation Time: 3:45 PM–5:30 PM
Linking retinal microvasculature changes to severity of non-proliferative diabetic retinopathy using Optical coherence tomography angiography
Neha S. Anegondi, Devanshi Bhanushali, Lavanya Chidambara, Santosh G. Gadde, Priya B V, Naresh Kumar Yadav, Rohit Shetty, Abhijit Sinha Roy. Narayana Nethralaya, Bangalore, India.
Purpose: To correlate retinal microvasculature changes with severity and systemic indicators of non proliferative diabetic retinopathy (NPDR) using Optical coherence tomography angiography(OCTA)
Methods: 187 eyes of 122 type 2 diabetes patients with NPDR (age 29-84, female/male = 40/82) and 60 eyes of 31 normal subjects(age 24-60, female/male =14/17) were imaged with OCTA system(Optovue Inc.,Fremont, USA). The NPDR patients were graded into mild, moderate and severe. Local fractal analysis was applied to the 3mm x 3mm OCTA images of the superficial and deep retinal layers. Foveal avascular zone area(FAZ in mm^2) was calculated. Vessel density, spacing between large and small vessels were quantified as percentage of the total area (9 mm^2) to compare between normals and grades of NPDR. Levels of Human Hemoglobin A1c protein (HbA1c), blood pressure, low density lipoprotein(LDL), high density lipoprotein(HDL), triglycerides, fasting blood sugar(FBS) and post-prandial blood sugar(PPBS) were compared with vascular parameters
Results: Normals had significantly lower FAZ area($p<0.001$), higher vessel density($p<0.001$), lower spacing between large($p<0.001$) and small vessels ($p<0.001$) as compared to NPDR grades. Among the NPDR grades, FAZ area and vessel density were similar in superficial ($p=0.29$ and 0.99, respectively) and deep retinal($p=0.32$ and 0.80, respectively) layers. In the superficial layer, severe NPDR had higher spacing between large vessels ($p=0.045$) as compared to mild and moderate. However, mild NPDR had higher spacing between small vessels($p=0.001$) as compared to moderate and severe. In deep retinal layer, spacing among large vessels($p=0.34$) and spacing among small vessels($p=0.13$) were similar between the NPDR grades. Spacing between large vessels in the superficial retinal layer showed a positive correlation with HbA1c ($r=0.25$, $p=0.03$),FBS($r=0.23$,$p=0.03$) and PPBS($r=0.26$,$p=0.02$). Spacing between small vessels in the superficial retinal layer had no correlation ($p>0.05$) with systemic indicators. Vascular parameters in deep retinal layer showed no correlation ($p>0.05$) with systemic indicators.$p<0.05$ was considered statistically significant
Conclusions: Spacing between large vessels in the superficial layer showed a positive correlation with HbA1c, FBS, PPBS and severity of NPDR. This may be used in combination with other indicators for diagnosis and grading of NPDR.

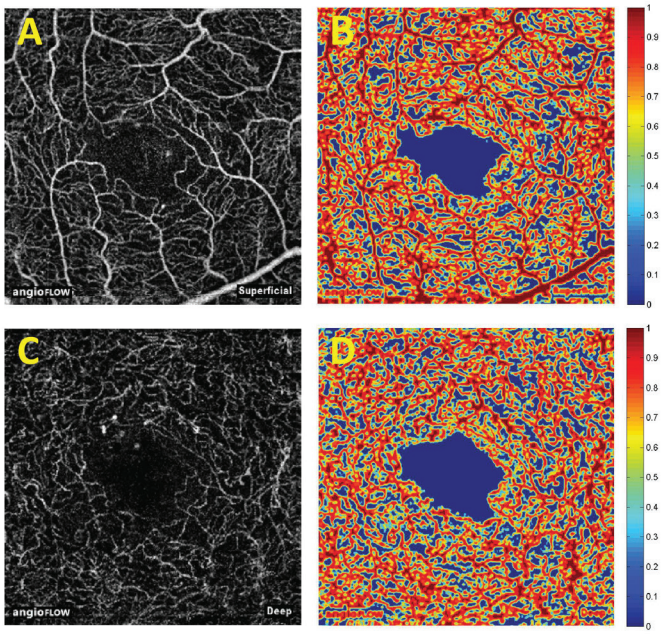


Figure 1: OCTA images of superficial and deep retinal layers and their respective "heat" maps developed using local fractal method showing probability index of presence of vessels. Index value closer to 1 indicates vessel and closer to 0 indicates non-vessel region.

		Superficial retinal vascular plexus			
Vascular parameters	Normals	Mild NPDR	Moderate NPDR	Severe NPDR	p-value
FAZ (mm^2)	0.38 [0.01]	0.45 [0.03]	0.45 [0.01]	0.46 [0.02]	<0.001
Vessel density (%)	49.6 [0.55]	39.2 [1.21]	39.1 [0.59]	38.5 [0.76]	<0.001
Spacing between large vessels (%)	10.6 [0.38]	21.1 [1.01]	21.9 [0.56]	24.13 [0.91]	<0.001
Spacing between small vessels (%)	34.9 [0.22]	39.6 [0.55]	37.9 [0.21]	37.3 [0.43]	<0.001
		Deep retinal vascular plexus			
FAZ (mm^2)	0.51 [0.01]	0.68 [0.04]	0.68 [0.02]	0.69 [0.03]	<0.001
Vessel density (%)	53.1 [0.73]	39.7 [1.57]	39.16 [0.46]	38.9 [0.69]	<0.001
Spacing between large vessels (%)	7.7 [0.41]	23.1 [1.38]	23.9 [0.59]	24.5 [079]	<0.001
Spacing between small vessels (%)	32.9 [0.35]	38.1 [0.72]	36.9 [0.29]	36.52 [0.51]	<0.001

Table 1: Mean [SEM] of retinal vascular parameters. p-value shows statistical difference between normals and grades of NPDR.

Commercial Relationships: Neha S. Anegondi, None; **Devanshi Bhanushali**, None; **Lavanya Chidambara**, None; **Santosh G. Gadde**, None; **Priya B V**, None; **Naresh Kumar Yadav**, None; **rohit shetty**, Carl Zeiss (F), Narayana Nethralaya (P), Allergan (F); **Abhijit Sinha Roy**

Program Number: 5489 **Poster Board Number:** C0093
Presentation Time: 3:45 PM–5:30 PM

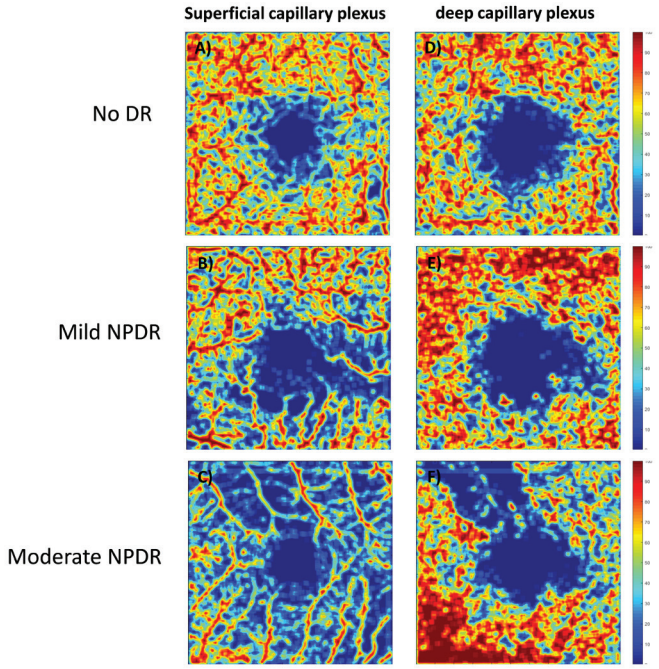
Quantitative Assessment of Retinal Capillary Network in Diabetic Retinopathy with Optical Coherence Tomography Angiography

Carol Y. Cheung[1], Fang Yao Tang[1], Danny Ng[1], Alexander Lam[1], Fiona Luk[2], Raymond Wong[2], Frank Lai[1], Karen Chan[1], Marten Brelen[1], Clement C. Tham[1]. [1]Ophthalmology and Visual Sciences, The Chinese University of Hong Kong, Hong Kong, Hong Kong; [2]Hong Kong Eye Hospital, Hong Kong, Hong Kong.

Purpose: A couple of publications have reported case series of diabetic retinopathy (DR) examined by optical coherence angiography (OCT-A). However, automated method for quantitative assessment of capillary bed is still lacking. We developed a prototype automated analysis system to quantify and measure retinal capillary network from OCT-angiograms, and examined the associations of the OCT-A measures with different DR severity and hyperglycemia in a cohort with diabetes (DM).

Methods: We conducted a prospective, observational clinical study of Chinese patients with DM. Dilated fundus examination

was accessed for DR severity. All patients underwent OCT-A with a swept-source-OCT (DRI-OCT Triton, Topcon) with a scan area of 3mmx3mm containing 256×256 A-scans. En face images for superficial and deep capillary plexus were generated by the Triton build-in software. Foveal avascular zone area, total capillary dropout area and microvascular density for each capillary plexus image were automatically measured by our customized image analysis program. We used analyses of covariance and test of trend to determine the associations of DR severity with OCT-A measures.
Results: A total of 50 eyes from 50 patients with DM were included. The mean (SD) age was 65.9 (12.4) years and duration of DM was 13.4 (9.54) years, respectively. Increased DR severity level was significantly associated with larger total capillary dropout area (p-trend=0.020), larger foveal avascular zone area (p-trend=0.046) and lower microvascular density (p-trend=0.020) in the superficial capillary plexus, and larger total capillary dropout area (p-trend=0.017) and lower microvascular density (p-trend=0.017) in the deep capillary plexus, while controlling for age, gender, HbA_{1c}, duration of DM, body mass index, blood pressure and hypercholesterolemia. In the multiple linear regression analysis, each 1% increase in HbA_{1c} level was associated with 0.079mm^2 of total capillary area enlargement (p=0.047) and 0.081% microvascular density decrease (p=0.047) in the superficial capillary plexus.
Conclusions: Loss of macular capillary bed can be quantitatively measured from OCT-angiograms and shows association with retinopathy severity and hyperglycemia in patients with DM.



Microvascular density maps generated by a customized program in no DR, mild and moderate NPDR in superficial (A-C), and in deep capillary plexus (D-F), respectively.
Commercial Relationships: Carol Y. Cheung, None; **Fang Yao Tang**, None; **Danny Ng**, None; **Alexander Lam**, None; **Fiona Luk**, None; **Raymond Wong**, None; **Frank Lai**, None; **Karen Chan**; **Marten Brelen**, None; **Clement C. Tham**, None

Program Number: 5490 **Poster Board Number:** C0094
Presentation Time: 3:45 PM–5:30 PM

ULTRA-WIDE FIELD SWEPT-SOURCE OPTICAL COHERENCE TOMOGRAPHY ANGIOGRAPHY (UWF SS OCT-A) IN DIABETIC RETINOPATHY

Alessandro Papayannis[1], EMMANOUIL TSAMIS[1, 2], Francesco Stringa[1], Katarzyna M. Chwiejczak[1], Tim Cole[3], Yvonne D'Souza[1], Assad Jalil[1], Paulo E. Stanga[1, 2]. [1]Manchester Vision Regeneration (MVR) Lab at Manchester Royal Eye Hospital & NIHR/Wellcome Trust Manchester CRF and Manchester Royal Eye Hospital, Central Manchester University Hospitals NHS Foundation Trust, Manchester, United Kingdom; [2]Institute of Human Development, Faculty of Medical and Human Sciences, University of Manchester, Manchester, United Kingdom; [3]Imaging Product Manager, Topcon (GB) Ltd, Manchester, United Kingdom.
Purpose: To describe the Ultra Wide-field Swept-Source Optical Coherence Tomography Angiography (SS OCT-A) (UWF SS OCT-A) features of Diabetic Retinopathy (DR).
Methods: We describe features of DR in patients undergoing routine examination in a serial case report. Eighty six eyes (43 consecutive patients) underwent full ophthalmological evaluation, 45° Colour Fundus Photography (CFPh), Optos California® Ultra Wide-field Colour Fundus Photography (UWF CFPh) and SS OCT-A with both Topcon DRI OCT-1 Atlantis® and Topcon DRI OCT Triton® of the posterior pole and the mid peripheral retina. Where clinically necessary, Ultra Wide field Optos California® Fluorescein Fundus Angiography (UWF FFA) was performed (Figure a). Individual SS OCT-A images were montaged to create an UWF SS OCT-A image (Figure b). Two independent reviewers compared images as follows: CFPh vs UWF SS OCT-A, UWF CFPh vs UWF SS OCT-A, and UWF FFA vs UWF SS OCT-A.
Results: Diabetic Macula Oedema (DMO), posterior pole and mid-peripheral retinal non-perfusion and Neovascularization of the Disc (NVD) and elsewhere (NVE) were identified on UWF SS OCT-A with 100% inter-reviewer agreement. Microvascular lesions observed on CFPh and UWF CFPh were also observed on UWF SS OCT-A in 86/86 eyes. An enlarged Foveal Avascular Zone (eFAZ) was observed on both UWF FFA and UWF SS OCT-A in 36/36 eyes. Microvascular lesions, DMO, NVD and NVE were observed on UWF FFA and UWF SS OCT-A in 28/28 eyes. Within the central 100°, there was good correlation between sensitivity of both UWF FFA and UWF SS OCT-A in detecting NVE in 9/10 eyes.
Conclusions: UWF SS OCT-A is a sensitive and non-invasive imaging technique that can offer additional topographic information regarding the localization and the morphology of the vascular lesions in DR, not only within the posterior pole but also up to the mid-periphery.

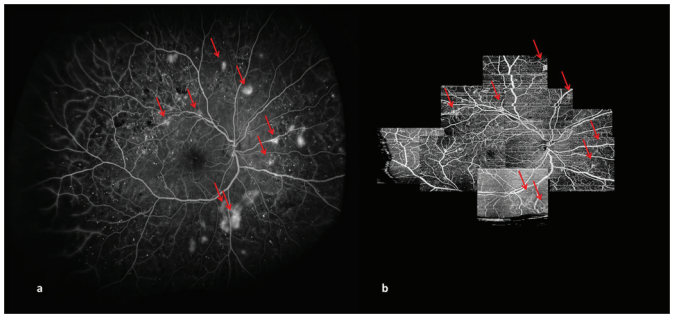
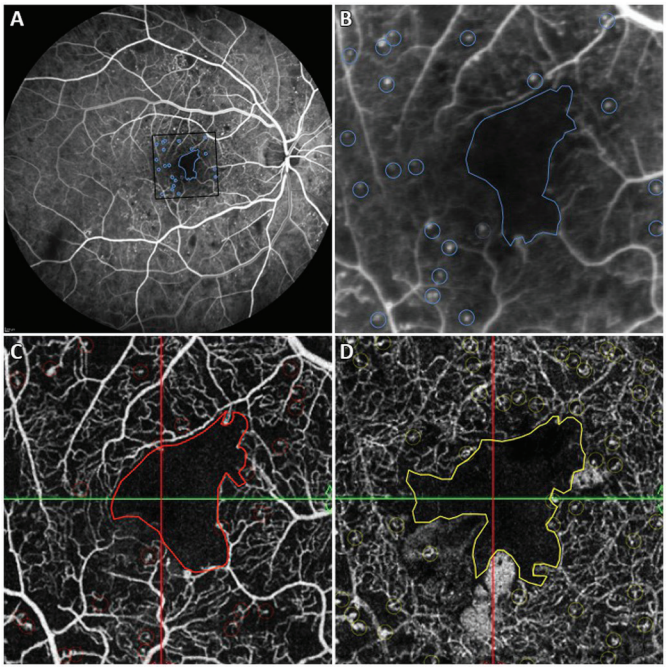


Figure a. OPTOS California® ultra wide-field FFA imaging. Red arrows indicate neovascularization elsewhere (NVE).
Figure b. UWF SS OCT-A composite image of the posterior pole and mid periphery. Red arrows indicate neovascularization elsewhere (NVE).
Commercial Relationships: Alessandro Papayannis, None; **EMMANOUIL TSAMIS**, None; **Francesco Stringa**, None; **Katarzyna M. Chwiejczak**, None; **Tim Cole**, Topcon (GB) Ltd; **Yvonne D'Souza**, None; **Assad Jalil**, None; **Paulo E. Stanga**, Second Sight Medical Products, Inc (C), Second Sight Medical Products, Inc (R), Second Sight Medical Products, Inc (F), Topcon Corp (F), Topcon Corp (R), Optos Plc (F), Topcon Corp (C), Optos Plc (R), Optos Plc (C)

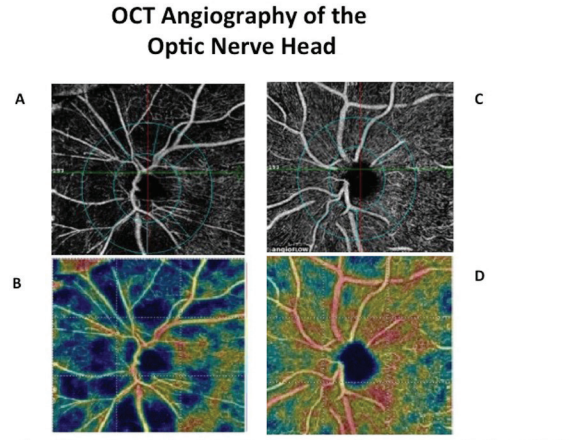
Program Number: 5491 **Poster Board Number:** C0095
Presentation Time: 3:45 PM–5:30 PM
Comparative features on same-day optical coherence tomography angiography (OCTA) and fluorescein angiography (FA) in diabetic macular edema (DME)
Murilo B. Peres[1], Renata Tiemi Kato[1], Vinícius Kniggendorf[1], Ricardo N. Louzada[3, 2], Emily Cole[2], Belfort Rubens[1], Eduardo A. Novais[1, 2], Caio Regatieri[1, 2]. [1]Ophthalmology, Federal University of São Paulo (UNIFESP), São Paulo, Brazil; [2]Opthalmology, New England Eye Center, Boston, MA; [3]Ophthalmology, Federal University of Goiás (UFG), Goiânia, Brazil.
Purpose: To compare visualization of microaneurysms (MA) and the foveal avascular zone (FAZ) area using OCTA and FA in patients with DME.
Methods: Patients with DME were prospectively recruited for same-day imaging on spectral-domain OCTA (Avanti; Optovue) and FA (HRA; Heidelberg Engineering). OCT angiograms were automatically segmented into superficial (OCTAs) and deep (OCTAd) capillary plexuses, and early-phase FA was used. A quantitative analysis was performed comparing the number of visible MAs and the FAZ area between the two imaging modalities using Image J. MA counts and FAZ area were performed by two masked readers, and intraclass correlation coefficient (ICC) was calculated. A paired Student T-test was used to compare the mean FAZ area and the mean MA count between FA and the two OCTA vascular plexuses.
Results: Nineteen eyes from 10 patients were included in this study. A strong ICC was established for MA count and FAZ area between the two readers (Range 0.91–0.99). The mean MA count on the FA, OCTAs and OCTAd were 18.4 ± 13.5, 12.5 ± 9.8, 24.9 ± 12.2, respectively. There was a statistically significant difference between FA vs. OCTAd (p=0.03), which was not found between FA vs. OCTAs (p=0.09). The OCTAd identified a greater number of MAs compared to OCTAs (p<0.001). The mean FAZ area measured on the FA, OCTAs and OCTAd were 0.39 ± 0.17mm^2, 0.28 ± 0.23mm^2, and 0.39 ± 0.23mm^2, respectively. There was no statistically significant difference between FA vs. OCTAs (p=0.08), and FA vs. OCTAd (p=0.94). However, the OCTAd demarcated a greater FAZ area compared to the OCTAs (p=0.005).
Conclusions: OCTA is a noninvasive, dye-less, fast acquisition imaging technique that enables visualization of MA and the FAZ as an alternative to traditional dye-based.



Multimodal imaging of patient with DME. (A) FA with corresponding OCTA 3x3mm area centered in the fovea. (B) FA 3x3mm area showing FAZ area outlined in blue (0.539 mm^2), and 21 MA circled in blue. (C) OCTA of superficial capillary plexus showing FAZ area outlined in red (0.794mm^2), and 25 MA circled in red. (D) OCTA of deep capillary plexus showing FAZ area outlined in yellow (0.943mm^2), and 44 MA circled in yellow.
Commercial Relationships: Murilo B. Peres, None; **Renata Tiemi Kato**, None; **Vinícius Kniggendorf**, None; **Ricardo N. Louzada**, None; **Emily Cole**, None; **Belfort Rubens**, None; **Eduardo A. Novais**, None; **Caio Regatieri**

Program Number: 5492 **Poster Board Number:** C0096
Presentation Time: 3:45 PM–5:30 PM
Optic Nerve Head Perfusion Changes in Diabetic Retinopathy Assessed by OCT Angiography Perfusion Density Mapping
Fatoumata Yanoga, Patricia Garcia, Richard B. Rosen. Ophthalmology, New York Eye and Ear Infirmary, New York, NY.
Purpose: To investigate optic disc perfusion changes in diabetic patients in relation to severity of the diabetic retinopathy using OCT Angigraphy Perfusion Density Mapping.
Methods: A prospective observational study of 19 eyes with diabetic retinopathy with no history of glaucoma and 19 age-matched normal eyes was performed at the New York Eye and Ear Infirmary of Mount Sinai. Optic disc regions was imaged using spectral domain optical coherence tomography (OCT) (Optovue XR Avanti, Fremont, CA) and analyzed with the split-spectrum amplitude decorrelation angiography(SSADA) algorithm. Capillary perfusion density was calculated inside the optic nerve head and in the peripapillary region (defined as the 0.75mm width ring extending from the margins of the optic disc). The Wilcoxon–Mann–Whitney test was used to analyze the data and to compare the different groups.

Results: Diabetic retinopathy patients were grouped according to severity, 10 patients had non-proliferative diabetic retinopathy (NPDR) and 9 patients had proliferative diabetic retinopathy (PDR). Capillary perfusion density values, both peripapillary and inside the disc, were significantly lower in nearly all patients with diabetic retinopathy compared to the normal controls. This was statistically significant with a p-values of 0.00466 and 0.0002 respectively using the Wilcoxon–Mann–Whitney test. This was also visible on the OCT angiography as there were significant capillary drop outs in the vascular network around the discs in the study patients compared to the controls. In addition, the NPDR group had a statistically significant higher perfusion density in the peripapillary region than the PDR group, but there was no difference in the perfusion density inside the optic nerve head. The p-values are 0.00614 and 0.72634 respectively.
Conclusions: Diabetic retinopathy patients appear to have a lower optic nerve perfusion both inside the nerve head and in the peripapillary region compared to healthy controls. The observed correlation between the severity of the diabetic retinopathy and the optic nerve head perfusion which may explain the development of disc neovascularization. Additional studies with larger numbers may help clarify this relationship.

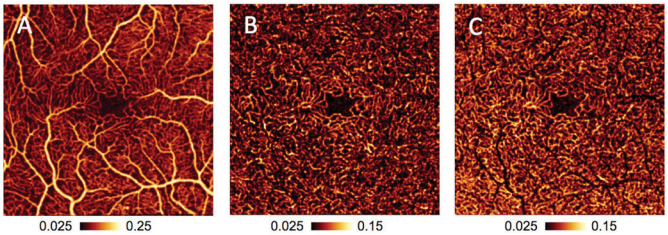


OCT angiopgraphy of the optic nerve head showing areas of capillary non-perfusion in a patient with diabetic retinopathy A & B , and a normal capillary network in a healthy control with C & D.

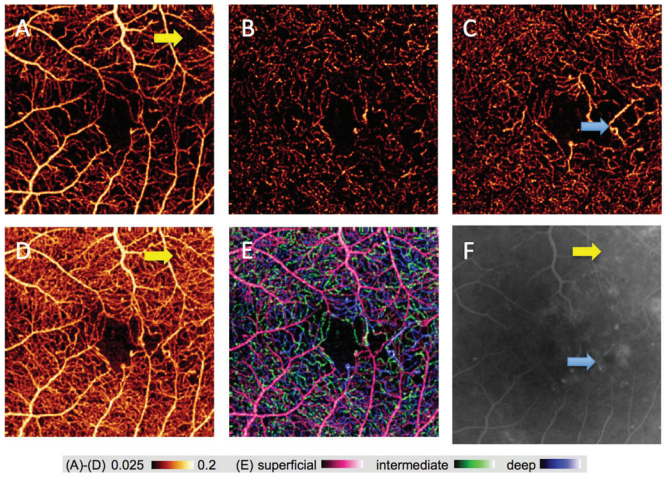
Commercial Relationships: Fatoumata Yanoga; **Patricia Garcia**, None; **Richard B. Rosen**, None

Program Number: 5493 **Poster Board Number:** C0097
Presentation Time: 3:45 PM–5:30 PM
Evaluation of radial peripapillary capillaries in diabetic retinopathy using optical coherence tomography angiography – looking beyond macular ischemia
Maria Gkika[1], Jibran Mohamed-Noriega[1], Lei Liu[2], Pearse A. Keane[1], Catherine A. Egan[1], Adnan Tufail[1], Dawn Sim[1]. [1]Moorfields Eye Hospital NHS Foundation Trust, London, United Kingdom; [2]Ophthalmology, University of Bristol, Bristol, United Kingdom.
Purpose: To evaluate the integrity of radial peripapillary capillaries (RPC) of the retinal nerve fibre layer (RNFL) in different severity grades of diabetic retinopathy (DR) and examine its relationship to visual acuity (VA).
Methods: Patients with evidence of DR were included. Optical coherence tomography angiography (OCTA) images (AngioVue, Optovue, Inc. Fremont, CA, USA) were acquired over a 3x3mm area and centered on the optic disc. RPC density were analyzed using using ImageJ with automated thresholding and presented as percentages.
Results: 86 eyes of 43 patients were included. 11 eyes (14.0%) were excluded from analysis as images were of poor quality. The mean age as 55.8 years (sd=16.6) and mean VA was 93.9 ETDRS letters (sd=13.4). 30/74 (40.5%) had mild to moderate non proliferative diabetic retinopathy (NPDR), 22/74 (29.7%) severe NPDR, 15/74 (20.3%) stable PDR, and 7/74 (9.5%) active PDR. In 61/74 (82%) maculopathy was absent, and 13/74 (17.6%) present. The mean RPC density in all patients was 28.8% (sd=4.30). Eyes with a RPC density of great or equal to 30% had a better VA (98.1 letters [sd=9.0]) compared to an RPC of less than 30% (89.7 letters [sd=16.1]) (p=0.02). RPC density was further correlated to visual acuity (r=0.34, p=0.004). No difference was observed in RPC density and retinopathy or maculopathy severity grades.
Conclusions: OCTA has for the first time, allowed detailed analysis of the RPC in RNFL of patients with diabetic retinopathy. In a cohort of patients with established diabetic retinopathy, the relationship poor VA and low RPC density observed in this study suggests that ischemia within the papillomacular and peripapillary RNFL may be of clinical and visual significance, and warrants further investigation.
Commercial Relationships: Maria Gkika, None; **Jibran Mohamed-Noriega**, None; **Lei Liu**, None; **Pearse A. Keane**, None; **Catherine A. Egan**, None; **Adnan Tufail**, None; **Dawn Sim**, None

Program Number: 5494 **Poster Board Number:** C0098
Presentation Time: 3:45 PM–5:30 PM
Projection Resolved Optical Coherence Tomography Angiography Visualizes Three Distinct Retinal Plexuses in Diabetic Retinopathy
Thomas S. Hwang, Miao Zhang, J. Peter Campbell, Christina J. Flaxel, Andreas Lauer, Steven T. Bailey, David J. Wilson, Phoebe Lin, David Huang, Yali Jia. Ophthalmology, Oregon Health and Science University, Portland, OR.
Purpose: To describe features of diabetic retinopathy (DR) in projection resolved optical coherence tomography angiography (OCT-A)
Methods: Using a commercial spectral-domain 70kHz OCT instrument (RTVue-XR, Optovue) and the Split-Spectrum Amplitude-Decorrelation Angiography (SSADA) algorithm, 3x3 mm macular scans were obtained in diabetic and normal study participants. A novel algorithm suppressed projection artifacts that blur the retinal vascular layers. A semi-automated algorithm separated this angiogram into superficial, intermediate, and deep retinal plexuses. *En face* angiograms of each layer, composite-color-coded inner retinal angiograms, and cross sectional angiograms were examined qualitatively.
Results: 19 normal and 35 DR participants were imaged. Projection-resolved OCT-A showed 3 distinct vascular plexuses in the inner retina. In normal eyes, the intermediate and deep plexuses are capillary networks of uniform density and caliber. The superficial plexus contains large and small vessels in a centripetal branching pattern. In DR eyes, areas of capillary nonperfusion were present in all three plexuses. Areas of nonperfusion detected on individual layers can be missed on combined inner retinal angiogram. Dilated vessels of the deeper plexuses, associated with superficial non-perfusion, can often be seen on fluorescein angiogram (FA).
Conclusions: Projection-resolved OCT-A, by presenting 3 retinal vascular plexuses distinctly, reveals pathologies not previously visible on OCT-A and FA.



Projection-resolved OCT-A of a normal eye shows 3 distinct plexuses: (A) superficial, in the nerve fiber and ganglion cell layers, (B) intermediate, concentrated between the inner plexiform and inner nuclear layer (INL) and (C) deep, concentrated between the INL and outer plexfiform layer. The plexuses merge at the edge of the foveal avascular zone.



In this diabetic eye, incongruent areas of capillary nonperfusion are present in the superficial (A), intermediate (B), and deep (C) plexuses, shown in yellow, blue, and red respectively in composite angiogram (E). The two deeper slabs show greater variance of vessel caliber compared to the normal eyes. The yellow arrows point to an area of nonperfusion in superficial slab not evident on the combined inner retinal OCT-A (D) or FA (F). The blue arrows show a dilated vessel in the deep plexus that is evident on FA.

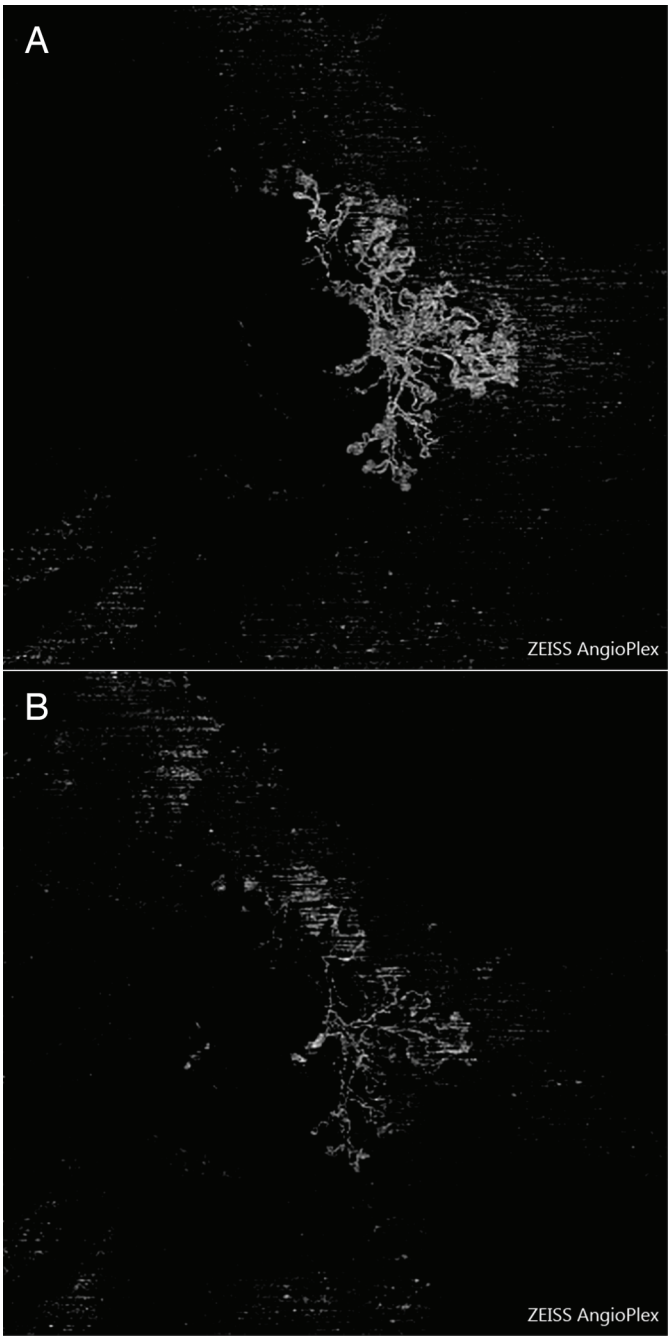
Commercial Relationships: Thomas S. Hwang, None; **Miao Zhang**, None; **J. Peter Campbell**, None; **Christina J. Flaxel**, None; **Andreas Lauer**, Oxford Biomedica (C); **Steven T. Bailey**, None; **David J. Wilson**, None; **Phoebe Lin**, None; **David Huang**, Carl Zeiss Meditec, Inc (P), Optovue, Inc (P), Optovue, Inc (F), Optovue, Inc (I); **Yali Jia**, Optovue, Inc (P), Optovue, Inc (F)
Support: NIH grants DP3 DK104397, R01 EY024544, R01 EY023285, P30-EY010572, and an unrestricted grant from Research to Prevent Blindness.

Program Number: 5495 **Poster Board Number:** C0099
Presentation Time: 3:45 PM–5:30 PM

Analysis with Spectral-Domain Optical Coherence Tomography Angiography after Treatment for Proliferative Diabetic Retinopathy

Michael Chen[1], Jesse J. Jung[2], Soraya Rofagha[2,3], Mary K. Durbin[1], Patty Chung[2], Scott Lee[2]. [1]Carl Zeiss Meditec Inc., Fremont, CA; [2]East Bay Retina Consultants, Inc., Oakland, CA; [3]Department of Ophthalmology, University of California, San Francisco, San Francisco, CA.

Purpose: To demonstrate the role of spectral-domain optical coherence tomography angiography(SD-OCTA) as a clinically relevant tool for objectively monitoring treatment response in proliferative diabetic retinopathy(PDR).
Methods: This retrospective cohort study reviewed 5 patients with PDR and newly developed neovascularization(NV) between 7/1/2015 and 12/1/2015. Patients were imaged with SD-OCTA AngioPlex™ (ZEISS, Dublin, CA) at baseline centered on the NV with either a 3x3-mm or 6x6-mm scan. Patients then received either intravitreal bevacizumab(IVB), panretinal photocoagulation(PRP) or a combination of both based on clinical need. Patients were re-imaged with SD-OCTA at least once between 1 week and 3 months post-treatment, using the same scan pattern and scan location as baseline. *En-face* SD-OCTA images were exported and analyzed with ImageJ, a public-domain image processing software developed by the National Institutes of Health available at http://rsb.info.nih.gov/ij to determine lesion area, size and density. NV lesions were manually traced to determine lesion area and greatest linear diameter(GLD); the smallest box that encompassed the NV was drawn around the baseline lesion and the mean gray value of the area was also calculated at baseline and subsequent follow-up. Each measurement was made 3 times to determine intra-grader repeatability standard deviation, and the mean of the 3 measurements was used for final analysis.
Results: Five patients (3 male), with a mean age of 43 (range 23-64), had a mean follow-up time of 5 weeks (range 1-12 weeks). Two patients were treated with IVB, 2 with PRP and 1 with a combination of both. At visit 2, NV area and GLD both decreased by 4-100%. Mean gray value decreased by 13-98%. Intra-grader coefficient of repeatability for area was 2.2% and for GLD was 0.7%. Standard deviation of the differences observed were greater than standard deviation of intra-grader repeatability in all circumstances, suggesting that the differences were due to treatment effect, not variability in the measurement.
Conclusions: SD-OCTA provides a reliable and objective way to monitor NV lesions, and may be useful in following patients' response to treatment. Future automated algorithms for lesion size measurement and longitudinal change analyses may further optimize SD-OCTA for applications in clinical practice.



A: NV lesion at baseline. B: 1 week after IVB
Commercial Relationships: Michael Chen, Carl Zeiss Meditec Inc. (C); **Jesse J. Jung**, Optos (C), Carl Zeiss Meditec Inc. (C); **Soraya Rofagha**, Carl Zeiss Meditec Inc. (C); **Mary K. Durbin**, Carl Zeiss Meditec Inc.; **Patty Chung**; **Scott Lee**, Carl Zeiss Meditec Inc. (C)

Program Number: 5496 **Poster Board Number:** C0100
Presentation Time: 3:45 PM–5:30 PM

Foveal avascular zone acircularity index in diabetic eyes and healthy controls measured by optical coherence tomography angiography (OCTA)

Brian Krawitz[1, 2], Shelley Mo[1, 2], Lawrence Geyman[1, 2], Toco Y. Chui[2, 1], Steven A. Agemy[2], Nicole K. Scripsema[2], Patricia Garcia[2], Richard B. Rosen[2, 1]. [1]Icahn School of Medicine at Mount Sinai, Brooklyn, NY; [2]Ophthalmology, New York Eye and Ear Infirmary of Mount Sinai, New York, NY.

Purpose: Foveal avascular zone (FAZ) acircularity index, a metric that does not require the axial length correction for retinal magnification, was used to compare differences between diabetic eyes and healthy controls.
Methods: 3x3mm OCTA images centered at the fovea were obtained in 20 control subjects (20 eyes, mean age 49, range 32-65 years) and 47 diabetic subjects (47 eyes, mean age 51, range 21-69 years) using a spectral domain OCT system (Avanti RTVue-XR, Optovue, Fremont, CA). A split-spectrum amplitude decorrelation angiography (SSADA) algorithm was used to generate en face OCT angiograms (Fig A & B). Diabetics were divided into 3 groups based on the stage of disease: no clinically observable diabetic retinopathy (NoDR), nonproliferative diabetic retinopathy (NPDR), or proliferative diabetic retinopathy (PDR). Full-thickness angiographic images (superficial + deep capillary plexuses) were analyzed by manually tracing the FAZ. FAZ acircularity index was calculated as the ratio of the perimeter of the FAZ to the perimeter of a circle with equal area. Statistical analysis was performed using unpaired t-tests.
Results: Mean FAZ acircularity index ± SD was 1.39±0.19 in the control group, 1.37±0.11 in the NoDR group, 1.66±0.40 in the NPDR group, and 1.75±0.40 in the PDR group. FAZ acircularity index was significantly higher in the NPDR and PDR groups compared to the NoDR group (p=0.0058 and p=0.0009, respectively) and control group (p=0.0088 and p=0.0013, respectively). No significant difference was detected between the NoDR and control groups.
Conclusions: Acircularity index provides a quantitative evaluation of the FAZ without the need for retinal magnification correction, which may prove clinically useful for detecting and grading diabetic retinopathy.

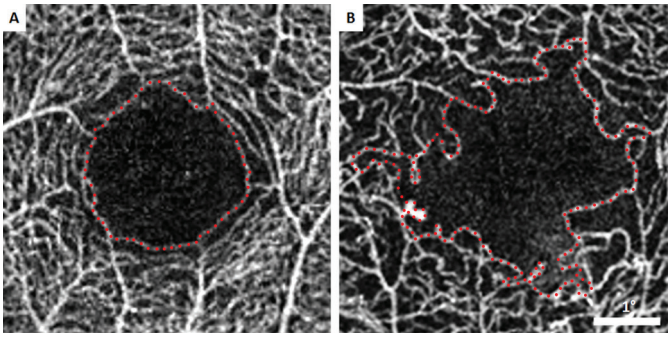
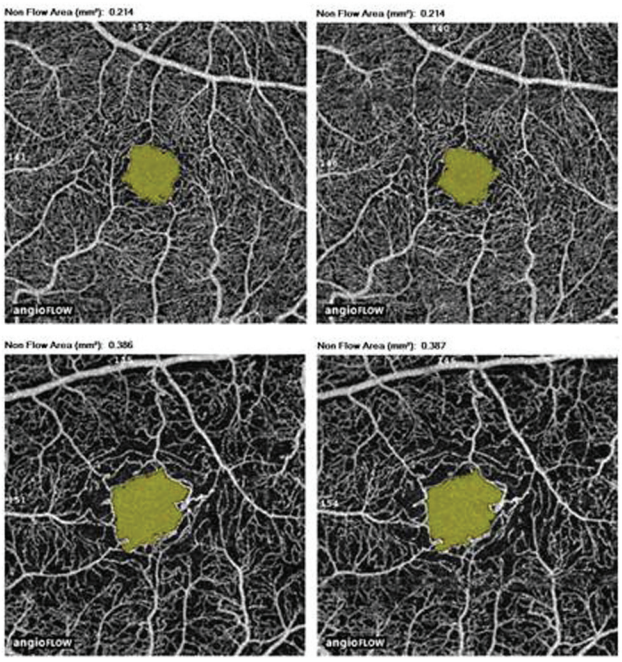


Figure: Higher FAZ acircularity index in diabetic retinopathy. (A) FAZ acircularity index = 1.12 in healthy control. (B) FAZ acircularity index = 2.49 in patient with nonproliferative diabetic retinopathy. FAZ border is shown in red.
Commercial Relationships: Brian Krawitz, None; **Shelley Mo**, None; **Lawrence Geyman**, None; **Toco Y. Chui**, None; **Steven A. Agemy**, None; **Nicole K. Scripsema**, None; **Patricia Garcia**, None; **Richard B. Rosen**, OD-OS (C), Optovue (C), Carl Zeiss Meditech (C), Regeneron (C), Clarity (C), Advanced Cellular Technologies (C), Genentech (F), Opticology (I), Allergan (C), NanoRetina (C)

Support: Marrus Family Foundation, Bendheim-Lowenstein Family Foundation, Wise Family Foundation, New York Eye and Ear Chairman's Research Fund, Violett Fund, Milbank Foundation, Research to Prevent Blindness

Program Number: 5497 **Poster Board Number:** C0101
Presentation Time: 3:45 PM–5:30 PM
Assessment of Foveal Avascular Zone (FAZ) Area in Normal and Diabetic Retinopathy Eyes using OCT Angiography (OCTA)
Kelly A. Soules, Yulia Wolfson, Yi-Sing Hsiao, Ben K. Jang, Qienyuan Zhou. Optovue, Fremont, CA.
Purpose: OCT Angiography (OCTA) en face images generated by AngioVue software provide high-resolution fine vasculature detail of the retina. The FAZ is known to be affected by pathology such as diabetic retinopathy. The purpose of this study is to compare the performance of the non-flow area measurement tool for FAZ area measurement in Normal and Diabetic Retinopathy eyes, and to explore FAZ areas distribution in the two groups.
Methods: OCTA en face images were acquired with AngioVue software on Avanti SD-OCT systems (Optovue, Fremont, CA) from consented subjects enrolled in the IRB-approved study. 16 Normal eyes and 17 eyes clinically diagnosed with Diabetic Retinopathy were used for analysis. FAZ area measurement is generated automatically by the software, following the user-pointed click inside the FAZ. Repeatability assessment was performed on 3mm x 3mm enface images (2 same-session scans) generated from retinal superficial layer (from ILM to IPL) with maximum intensity projection (MIP) methods. Descriptive statistics of the Normal and Diabetic eyes FAZ distribution were calculated based on averaged FAZ area derived from the two scans.
Results: Mean age was 62 and 55 years; there were 8 out of 16 males and 11 out of 17 males; and 7 right eyes out of 16, and 6 out of 17 in the Normal and Diabetic groups accordingly. The intraclass correlation coefficient (ICC) for repeat scans was 0.964 for Normal eyes and 0.969 for Diabetic eyes. Normal eyes mean FAZ area was 0.28 mm^2 (range 0.08 – 0.46 mm^2, STDV 0.08 mm^2), with median of 0.28 mm^2 (Q1:Q3 of 0.23 mm^2: 0.33 mm^2). Diabetic eyes mean FAZ area was 0.35 mm^2 (range 0.07 - 0.81 mm^2, STDV 0.16 mm^2), with median of 0.33 mm^2 (Q1:Q3 of 0.28:0.39 mm^2).
Conclusions: The FAZ area can be measured from OCTA en face images generated by AngioVue with good repeatability in both Normal and Diabetic eyes. As expected, the FAZ area distribution range is wider in diabetic retinopathy eyes. Good repeatability suggests that the OCTA images and the AngioAnalytics non-flow area measurement tool can possibly be utilized for non-invasive baseline and follow-up assessments of the FAZ in diabetic patients.



Repeat scans with FAZ area measurement in Normal (top row) and Diabetic Retinopathy (bottom row) eyes.
Commercial Relationships: Kelly A. Soules, Optovue; **Yulia Wolfson**, Optovue; **Yi-Sing Hsiao**, Optovue; **Ben K. Jang**, Optovue; **Qienyuan Zhou**, Optovue

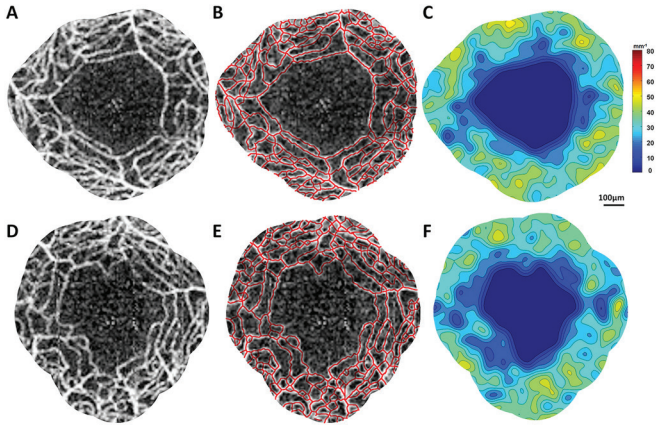
Program Number: 5498 **Poster Board Number:** C0102
Presentation Time: 3:45 PM–5:30 PM
Longitudinal analysis of the foveal avascular zone in diabetic retinopathy using optical coherence tomography angiography
YIJUN CAI[1, 2], Jibran Mohamed-Noriega[1], Pearse A. Keane[1], Catherine A. Egan[1], Adnan Tufail[1], Dawn A. Sim[1]. [1]Moorfields Eye Hospital, London, United Kingdom; [2]Barts and the London School of Medicine and Dentistry, London, United Kingdom.
Purpose: To evaluate the variance of different methods for analyzing Optical Coherence Tomography Angiography (OCTA)- derived images of the foveal avascular zone (FAZ) in diabetic retinopathy.
Methods: Patients with evidence of diabetic retinopathy and OCTA imaging on two separate visits were included. A commercial OCTA system (AngioVue, Optovue, Inc. Fremont, CA, USA) was used to acquire 3x3mm images of the superficial and deep vessel layers, centered on the fovea. FAZ area (mm^2), perimeter (mm), and circularity were analyzed using ImageJ. The F-test was used to compare the variances within each parameter in the superficial and deep vessel layers.
Results: 12 eyes of 6 patients were included. All eyes had been previously diagnosed with diabetic macular ischemia of varying severities; 4/12 (33.3%) questionable, 4/12 (33.3%) mild, 2/12 (16.7%) moderate, and 2/12 (16.7%) severe. The mean time between OCTA imaging was 104 days (range 56 to 210). In the superficial layer, the median difference (variance) in FAZ area was 0.045 (0.012), FAZ perimeter 0.243 (2.49), and FAZ circularity 0.001 (0.005). In the deep layers, median difference (variance) in FAZ area was 0.15 (0.016), FAZ perimeter 0.138 (2.55), and FAZ circularity 0.061 (0.005). There were no significant differences in the variance ratios for superficial and deep layer analysis of FAZ area 1.30 (p=0.67), perimeter 1.02 (p=0.91), or circularity 1.09 (p=0.88).

Conclusions: OCTA is non-invasive method for the rapid acquisition of images of the retinal vasculature. This promising new technology lends itself to longitudinal imaging in diabetic retinopathy for the purpose of monitoring of diabetic macular ischemia. We demonstrate the feasibility of using OCTA for this purpose and show that parameters such as area, perimeter and circularity can be used for quantification of the FAZ in both superficial and deep vessel layers.
Commercial Relationships: YIJUN CAI, None; **Jibran Mohamed-Noriega**, None; **Pearse A. Keane**; **Catherine A. Egan**, None; **Adnan Tufail**, None; **Dawn A. Sim**, None

Program Number: 5499 **Poster Board Number:** C0103
Presentation Time: 3:45 PM–5:30 PM
Foveal avascular zone measurements by high resolution femtosecond mode-locked laser optical coherence tomogramphy in healthy eyes
Itaru Kimura[1], Hiroto Kuroda[1], Masayuki Suzuki[1], Hisashi Ibuki[1], Takuhei Shoji[1], Makoto Araie[2, 1], Shin Yoneya[1]. [1]Dept of Ophthalmology, Saitama Medical University Faculty of Medicine, Iruma, Saitama, Japan; [2]Kanto Central Hospital, Tokyo, Japan.
Purpose: Foveal avascular zone (FAZ) area has been measured by means of femtosecond mode-locked laser optical coherence tomography (OCT) that we developed. We measured FAZ area using en-face images obtained by this OCT in healthy eyes.
Methods: In right eyes of 10 healthy subjects (8 males and 2 females with an average age of 35.6±7.8 y/o), a total of 300 macular single B-scans (3 mm x 3 mm) centered on the foveola were obtained in 10-μm steps using high resolution mode-locked laser OCT installing an ultra-broadband Kerr lens mode-locked Ti:Sapphire laser and a wideband spectrometer. The spectral bandwidth of the light source was 200 nm full-width at half maximum at a central wavelength of 840 nm. A high-speed CCD camera with 2048×300 pixels (Basler, Ahrensburg, Germany) was used as the detection system. The measurement speed was 50,000 depth-scans/s, and depth resolution was measured to be less than 2.0 μm into the tissue (Kuroda H, et al, Applied Physics Letters 2013). Three-dimensional images were rendered from these image sequences to obtain 2-μm thin slice en-face images of macular area. The nasal and temporal distances from foveola to the nearest vessels in the superficial ganglion cell layers were measured.
Results: The FAZ areas in the superficial ganglion cell layer could be apparently observed in the en-face images thus obtained. The averaged distances from the foveola to the nearest nasal and temporal vessels were 242.0±48.9μm and 262.0±86.3μm (N=10), with no significant difference, respectively, and the mean horizontal FAZ diameter was 504.0±127.2μm. The current result was compatible with those reported using OCT angiographic technique, for example, 573±177μm in healthy eyes (Freiberg FJ, et al, Graefes Arch Clin Exp Ophthalmol 2015).
Conclusions: En-face images need short aquisition time and exact 3-D images can be structured in the femtosecond mode-locked laser OCT that we developed. FAZ area can be measured by means of this OCT.
Commercial Relationships: Itaru Kimura; **Hiroto Kuroda**, None; **Masayuki Suzuki**, None; **Hisashi Ibuki**, None; **Takuhei Shoji**, None; **Makoto Araie**, None; **Shin Yoneya**, None
Support: (JSPS) KAKENHI Grant Number 24592663, 15K15639

Program Number: 5500 **Poster Board Number:** C0104
Presentation Time: 3:45 PM–5:30 PM
Superficial and deep foveal avascular zone size and characteristics evaluated using optical coherence tomography angiography
Isaac W. Chay[1, 2], Louis W. Lim[2, 3], Vernon Chow[1, 2], Shoun Tan[1, 2], Kai Xiong Cheong[2], Gabriel Tan[1, 2], Srinivas R. Sadda[4], Colin S. Tan[2, 3]. [1]Yong Loo Lin School of Medicine, Singapore, Singapore; [2]Ophthalmology, National Healthcare Group Eye Institute, Singapore, Singapore; [3]Fundus Image Reading Center, National Healthcare Group Eye Institute, Singapore, Singapore; [4]Doheny Eye Institute, University of California, Los Angeles, CA.
Purpose: To evaluate the size and characteristics of the foveal avascular zone (FAZ) in the superficial and deep capillary plexus in normal, healthy adults using optical coherence tomography angiography (OCTA).
Methods: In a prospective cohort study of 85 healthy volunteers, 3mm x 3mm OCTA scans were performed on both eyes using the AngioVue OCTA system. The superficial and deep FAZ boundaries were manually traced by trained graders and the FAZ area and characteristics were calculated. Circularity represents the degree of resemblance of the area to a perfect circle (a value of 1.0 denotes a perfect circle).
Results: The mean age of the 85 participants (44 males and 41 females) was 22.7 years, with mean axial length and spherical equivalent of 25.4 mm and, -4.3 D, respectively. The mean areas of the superficial and deep FAZ were 0.25 mm^2 (range, 0.04 to 0.48 mm^2) and 0.38 mm^2 (range, 0.12 to 0.66 mm^2) respectively. The 25^{th}, 50^{th} and 75^{th} percentiles for the superficial FAZ were 0.20, 0.25 and 0.31 mm^2, respectively. Comparing the 2 vascular layers, the deep FAZ size correlated significantly with the superficial FAZ (correlation coefficient 0.707, $p<0.001$) and was significantly larger compared to the superficial FAZ (mean difference 0.13 mm^2, $p<0.001$). No retinal vessels were visualized within the outer retinal layer. Comparing the right and left eyes, the superficial and deep FAZ sizes correlated strongly (correlation coefficients of 0.94 and 0.89, respectively), with mean differences between contralateral eyes of 0.001 mm^2 ($p=0.720$) and 0.005 mm^2 ($p=0.408$), respectively. The mean circularity index was 0.81 (range 0.54 to 0.95) for the superficial FAZ, and 0.89 (range 0.76 to 0.97) for the deep FAZ. The mean maximum diameter was 0.65 mm for the superficial FAZ and 0.78 mm for the deep FAZ ($p<0.001$), with Feret's angle of 92.3^o for the superficial FAZ and 78.4^o for the deep FAZ. The mean central choroidal thickness was 315.3 μm (range, 119 to 537 μm). Neither superficial nor deep FAZ correlated with central choroidal thickness.
Conclusions: The FAZ area of the superficial and deep capillary plexus varies significantly among healthy adults. There is strong correlation between the areas of the superficial and deep FAZ, and between the contralateral eyes. Deep FAZ area and Feret's diameter are significantly larger than the superficial FAZ.
Commercial Relationships: Isaac W. Chay; **Louis W. Lim**, None; **Vernon Chow**, None; **Shoun Tan**, None; **Kai Xiong Cheong**, None; **Gabriel Tan**, None; **Srinivas R. Sadda**, None; **Colin S. Tan**, None

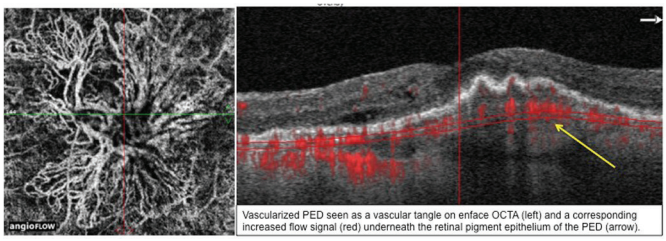
Program Number: 5501 **Poster Board Number:** C0105
Presentation Time: 3:45 PM–5:30 PM
Age-Related Variations in Foveal Avascular Zone Geometry and Vessel Density - an Optical Coherence Tomography Angiography (OCTA) study x
Richard B. Rosen[1, 2], Brian Krawitz[1, 2], Shelley Mo[1, 2], Lawrence Geyman[1, 2], Erika Phillips[3], Joseph Carroll[3], Rishard Weitz[1], Toco Y. Chui[1, 2]. [1]Ophthalmology, New York Eye & Ear Infirmary, New York, NY; [2]Ophthalmology, Icahn School of Medicine at Mount Sinai, New York, NY; [3]Ophthalmology, Medical College of Wisconsin, Milwaukee, WI.
Purpose: : To study the influence of age on foveal avascular zone (FAZ) geometry and vessel density in a healthy population using OCTA.
Methods: OCTA perfusion maps 3x3 mm were obtained in 50 subjects (50 eyes) aged between 5 and 74 (mean±SD: 38±19 years) using a commercial system (AngioVue, Avanti RTVue-XR, Optovue). For each eye, a region of interest (ROI) defined as the area within 200µm of the FAZ margin was generated using distance transformation (Fig. A). Foveal vascular network was skeletonized in a semiautomatic fashion using custom MATLAB programs (Fig. B). Quantitative measurements of the FAZ including area, effective diameter, and acircularity index were obtained. Foveal vessel density was computed within the 200µm ROI (Fig. C), as well as quadrant-specific regions (superior, inferior, nasal, and temporal). Individual retinal magnification factor was corrected using axial length. Pearson's correlation was used to analyze age vs OCTA parameters.
Results: Variability of FAZ among healthy subjects was considerable. Mean±SD values for FAZ area, effective FAZ diameter, and FAZ acircularity index were 0.20±0.07mm^2, 498±99µm, and 1.39±0.14, respectively. Age did not significantly correlate with variation in any of the FAZ parameters. Mean±SD of foveal vessel density measured within 200µm ROI was 35.27±2.32mm^{-1}. Vessel density was the highest inferiorly (36.16±3.04mm^{-1}), followed by superior (35.55±3.00mm^{-1}), temporal (34.74±2.64mm^{-1}), and nasal (33.85±3.13mm^{-1}) quadrants. No significant correlation was found between vessel densities and age.
Conclusions: FAZ geometry and vessel density as measured using OCTA, appear to be unaffected by age. These findings further substantiate prior studies performed with less advanced technologies.



Top row: a 25-year-old male. Bottom row: of a 56-year-old male. A&D) OCTA foveal perfusion map, B&E) superimposed OCTA perfusion map and skeletonized vasculature, C&F) colorized vessel density contour map.
Commercial Relationships: Richard B. Rosen, Clarity (C), OD-OS (C), Optovue (C), Carl Zeiss Meditech (C), Regeneron (C), Allergan (C), NanoRetina (C), Ocata Therapeutics (ACT) (C), Opticology (I); **Brian Krawitz**, None; **Shelley Mo**, None; **Lawrence Geyman**, None; **Erika Phillips**, None; **Joseph Carroll**, ImagineEyes (C), Optovue (C); **Rishard Weitz**, None; **Toco Y. Chui**
Support: Marrus Family Foundation, Bendheim-Lowenstein Family Foundation, Wise Family Foundation, New York Eye and Ear Chairman's Research Fund, NEI U01 EY025477-01, Violett Fund, Milbank Foundation, Research to Prevent Blindness.

Program Number: 5502 **Poster Board Number:** C0106
Presentation Time: 3:45 PM–5:30 PM
OCT Angiography (OCTA) of Neovascularization in Macular Telangiectasia Type 2
Gillian Robbins[1], Luiz Roisman[1], Qinqin Zhang[2], Ruikang K. Wang[2], Giovanni Gregori[1], Chieh-Li Chen[2], Mary K. Durbin[3], Paul F. Stetson[3], Andrew D. Legarreta[1], Andrew R. Miller[1], Philip J. Rosenfeld[1]. [1]Bascom Palmer Eye Institute, Miami, FL; [2]Bioengineering, University of Washington, Seattle, WA; [3]Advanced Development, Carl Zeiss Meditec, Inc, Dublin, CA.
Purpose: To evaluate neovascularization in proliferative macular telangiectasia Type 2 (MacTel2) using swept-source (SS) and spectral-domain (SD) optical coherence tomography (OCT) angiography.
Methods: Patients with MacTel2 were enrolled in a prospective, observational study and evaluated using a prototype 1050 nm SS-OCT system at a 100 kHz A-scan rate and an 840nm SD-OCT system at a 68 kHz A-scan rate. On both systems, angiographic images were obtained by using a complex algorithm that incorporates changes in both intensity and phase information from repeated B-scans. 3X3 mm raster scans were obtained from both systems, with 4 repeated B-scans at each location. In the SS-OCT system, 300 A-scans were contained in each B-scan and a total of 300 B-scans positions were generated over a 3mm distance. The SD-OCT used for this study was the Zeiss AngioPlex OCT angiography instrument in which 245 A-scans were contained in each B-scan and 245 B-scan positions were generated over the 3 mm distance. The algorithms for both SS-OCT and SD-OCT segmented the retina into five layers including the inner retinal layer, middle retinal layer, outer retinal layer, choriocapillaris, and choroid. Custom segmentations were also performed to optimize visualization of the neovascularization. Fluorescein angiography (FA) was performed on all patients and two of the patients underwent indocyanine green angiography (ICGA).
Results: OCT angiography imaging was performed on 42 patients (84 eyes) with MacTel2 and of those, 6 patients (10 eyes) were affected with neovascularization. SS-OCT and SD-OCT imaging identified neovascularization better than FA and were comparable to images obtained using ICGA. In all 6 cases, custom segmentation of the neovascularization identified the presence of choroidal vessels anastomosing with the retinal vasculature in the subretinal compartment.
Conclusions: Both SS-OCT and SD-OCT angiography provided rapid and detailed depth-resolved information about neovascularization in MacTel2 patients. These results suggest that OCT angiography is superior to FA in documenting the microvascular changes, extent of neovascularization, and its communication with the choroidal circulation.
Commercial Relationships: Gillian Robbins, None; **Luiz Roisman**, None; **Qinqin Zhang**, None; **Ruikang K. Wang**, None; **Giovanni Gregori**, Bascom Palmer (F), Bascom Palmer (P); **Chieh-Li Chen**, None; **Mary K. Durbin**, None; **Paul F. Stetson**, None; **Andrew D. Legarreta**, None; **Andrew R. Miller**, None; **Philip J. Rosenfeld**, Bascom Palmer (R), Bascom Palmer (F)

Program Number: 5503 **Poster Board Number:** C0107
Presentation Time: 3:45 PM–5:30 PM
The Phenotypic Characterization of Pigment Epithelial Detachments (PEDs) with Optical Coherence Tomography Angiography (OCTA)
Daniel Simhaee[1, 3], Anna C. Tan[2, 3], Kunal K. Dansingani[2, 3], Lawrence A. Yannuzzi[2, 3]. [1]Ophthalmology, New York University, New York, NY; [2]Vitreous, Retina Macula, Consultants of New York, New York, NY; [3]LuEsther T Mertz Retinal Research Center, Manhattan, Eye, Ear and Throat Hospital, New York, NY.
Purpose: There are many different types of PED and some are vascularized and others are not. This distinction is often significant in the management of the patient and has historically been assessed by clinical exam and multi-modal imaging, including fluorescein and indocyanine green angiography. OCTA is an emerging technology that may be able to evaluate the vascularity of PEDs. The purpose of this study was to evaluate characteristics of vascularized and non-vascularized PEDs with OCTA.
Methods: This was a retrospective study of patients with PED that had OCTA imaging in addition to other multi-modal imaging. The PEDs were imaged by both cross-sectional and en face OCTA imaging for the presence of flow underneath the PED and the presence of a tangle of vessels, respectively. Vascularized PEDs were defined as those that had both features. Active disease from a vascularized PED was defined as the presence of subretinal or intra-retinal fluid on structural OCT.
Results: Seventy-nine eyes of 46 consecutive patients were included. Mean age of our study cohort was 77 years old (range of 40-92) and there was an equal number of males and females. Sixty-one eyes (77%) were noted to have flow under the PED and of these eyes, 36 (59%) had an associated vascular tangle and 36 (59%) had associated active disease. In PEDs with a larger height, attenuated signal was observed underneath the PED in 44 eyes (56%), but a vascular tangle could still be imaged in 32 (73%) of these eyes by adjustment of different segmentation presets.
Conclusions: With the use of anti-angiogenic injections to treat neovascular age-related macular degeneration, the importance of differentiating between vascularized and non-vascularized PEDs has become even more crucial. OCTA may play an important role but projection of overlying retinal vessels onto the RPE and window defects due to RPE atrophy may give false positive signs of vascularization underneath a PED. Correlation to other forms of multi-modal imaging is therefore important.



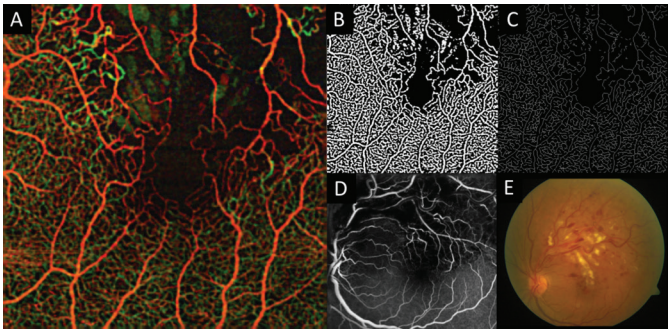
Vascularized PED seen as a vascular tangle on enface OCTA (left) and a corresponding increased flow signal (red) underneath the retinal pigment epithelium of the PED (arrow).

Commercial Relationships: Daniel Simhaee, None; **Anna C. Tan**, None; **Kunal K. Dansingani**, None; **Lawrence A. Yannuzzi**

Program Number: 5504 **Poster Board Number:** C0108
Presentation Time: 3:45 PM–5:30 PM
Qualitative and Quantitative Analysis of Optical Coherence Tomography Angiography in Patients with Retinal Vasculitis
Angela P. Bessette[2], Ashleigh L. Levison[1], Kimberly Baynes[2], Careen Y. Lowder[2], Sunil K. Srivastava[2]. [1]Retinal Consultants of Arizona, Phoenix, AZ; [2]Cleveland Clinic, Cole Eye Institute, Cleveland, OH.
Purpose: To evaluate the retinal microvasculature in a cohort of patients with retinal vasculitis using optical coherence tomography angiography (OCTA)
Methods: This is a retrospective cohort study of patients with retinal vascular inflammation imaged with OCTA (Optovue Avanti RTVue-XR). OCTA images were evaluated for qualitative changes and compared to fluorescein angiography images where available. Quantitative analysis of the superficial and deep retinal capillaries was performed using flow density software on the Optovue Avanti RTVue-XR.
Results: 20 patients with retinal vasculitis were identified. Mean age was 43 years and included 10 women and 10 men. The diagnostic spectrum included 8 patients with Susac syndrome, 6 patients with idiopathic retinal vasculitis, 4 patients with Behcet's disease, one patient with anti-synthetase syndrome, and one patient with intermediate uveitis. OCTA imaging on 11 patients revealed findings not visible on fluorescein angiography. These included loss of retinal blood flow in the superficial and deep vascular layers, capillary remodeling, and normal capillary flow in eyes with exudates. Quantitative analysis showed decreased flow density in both the superficial and deep retinal capillaries in eyes with vascular inflammation involving the macula compared to eyes without macular involvement. In eyes with asymmetric involvement of the macula, decreased flow density values were identified in areas of retinal vascular loss.
Conclusions: OCT angiography provides information on capillary blood flow in patients with retinal vasculitis. In some patients, OCTA revealed capillary abnormalities that were not visible on fluorescein angiography. Quantitative analysis demonstrated decreased flow density in areas of retinal vascular loss.
Commercial Relationships: Angela P. Bessette, None; **Ashleigh L. Levison**, None; **Kimberly Baynes**; **Careen Y. Lowder**, Xoma (S); **Sunil K. Srivastava**, Allergan (F), Clearside (C), Clearside (F), Regeneron (C), Bioptigen (P), Santen (C), Synergetics (P), Allergan (C), Optos (C), Bausch and Lomb (C), Carl Zeiss Meditec (C), Novartis (F), Sanofi (C)

Program Number: 5505 **Poster Board Number:** C0109
Presentation Time: 3:45 PM–5:30 PM
Quantitative Microvascular Analysis of Retinal Venous Occlusion by Optical Coherence Tomography Angiography
Nicole Koulisis[1, 2], Alice Y. Kim[1], Zhongdi Chu[3], Anoush Shahidzadeh[1], Ruikang K. Wang[3], Carmen A. Puliafito[1], Amir H. Kashani[1]. [1]USC Eye Institute, Los Angeles, CA; [2]University of Massachusetts Medical School, Worcester, CA; [3]University of Washington, Seattle, WA.
Purpose: To quantitatively and noninvasively evaluate the retinal microvasculature in human subjects with retinal venous occlusions (RVO) using optical coherence tomography angiography (OCTA).
Methods: This was a retrospective study of adult human subjects with RVO. OCTA was performed on a prototype, SD-OCTA system (Carl Zeiss Meditec, Dublin, CA, USA) in a 3 mm x 3 mm region centered on the fovea. Retinal vasculature was quantified within a single horizontal slab extending from the internal limiting membrane to the retinal pigment epithelium. Quantitative analysis with custom

MATLAB software was used to transform the OCTA retinal segment into binarized and skeletonized images, from which fractal dimension (FD), vessel density (VD), skeletal density (SD), and vessel diameter index (VDI) were calculated using previously described protocols (Reif et al., Int J Biomed Imag). These parameters were compared to those from a cohort of healthy eyes, as well as the contralateral eyes of patients with RVO.
Results: Thirty-nine eyes from 22 patients with retinal venous occlusions (12 branch, 10 central; 14 females, 8 males) were analyzed. Mean age was 65.5 years (range 36-80). Twelve of 22 subjects had RVO greater than one year duration. Three of 22 had RVO less than two months old. Collectively, RVO eyes demonstrated decreased FD (1.66 vs 1.72; $p<0.0001$), decreased VD (0.33 vs 0.41; $p<0.0001$), decreased SD (0.08 vs 0.1; $p<0.0001$) and increased VDI (4.3 vs 4.1; $p<0.0001$) when compared to normal eyes. These trends held when compared to the other eye ($p<0.0001$ for FD, VD and SD; $p<0.05$ for VDI). Figure 1 illustrates representative images from one subject with RVO.
Conclusions: RVO causes quantifiable changes in the retinal vascular parameters as measured by OCTA. These findings support previously described qualitative findings of decreased capillary perfusion, vessel dropout, and dilated vessels noted qualitatively on OCTA and fluorescein angiography (Kashani et al., Retina). This algorithm provides a quantitative and reproducible tool for monitoring microvascular disease.



Depth-encoded OCTA image of a subject with RVO involving the supra-temporal quadrant, left eye (A). Binarized image, skeletal image, mid-laminar phase fluorescein angiogram, and fundus image of the corresponding occlusion (B-E).
Commercial Relationships: Nicole Koulisis, Research to Prevent Blindness (F), Carl Zeiss Meditec (F); **Alice Y. Kim**; **Zhongdi Chu**, Carl Zeiss Meditec (F); **Anoush Shahidzadeh**, Carl Zeiss Meditec (F), Research to Prevent Blindness (F); **Ruikang K. Wang**, Carl Zeiss Meditec (R), Carl Zeiss Meditec (P), Carl Zeiss Meditec (C), Carl Zeiss Meditec (F); **Carmen A. Puliafito**, Research to Prevent Blindness (F), Carl Zeiss Meditec (F); **Amir H. Kashani**, Research to Prevent Blindness (F), Carl Zeiss Meditec (F), Carl Zeiss Meditec (C), Carl Zeiss Meditec (R)
Support: The authors would like to thank Research to Prevent Blindness for an unrestricted departmental grant and Carl Zeiss Meditec for providing the prototype OCT angiography device used in this study.

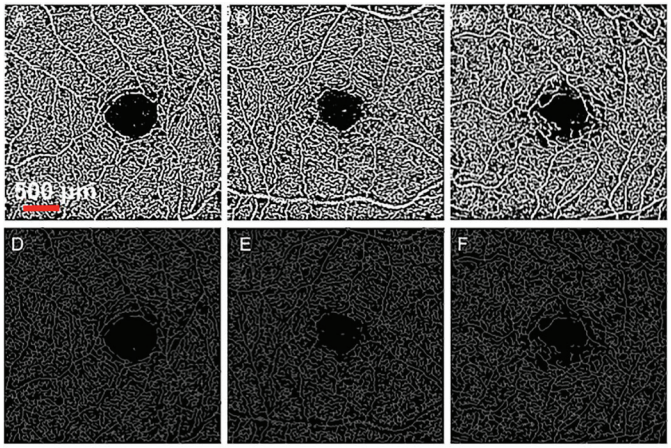
Program Number: 5506 **Poster Board Number:** C0110
Presentation Time: 3:45 PM–5:30 PM
Optical Coherence Tomography based Microangiography Findings in Patient's with Retinitis Pigmentosa
Kasra Attaran-Rezaei, Qinqin Zhang, Erica Brewer, Jennifer R. Chao, Chieh-Li Chen, Ruikang K. Wang. University of Washington, Seattle, WA.

Purpose: Retinitis pigmentosa is a common hereditary retinal dystrophy that results in progressive loss of photoreceptors and retinal pigment epithelium. The ocular blood circulation has shown to be altered in RP. Optical coherence tomography based microangiography (OMAG) is a non-invasive imaging modality, capable of acquiring 3 dimensional retinal and choroidal microvascular maps without the use of exogenous dye. In this study we evaluated the retinal and choroidal microvascular architecture and circulation in different stages of RP using OMAG.
Methods: Thirteen patients (twenty six eyes) with different stages of Retinitis Pigmentosa underwent complete eye examination including slit lamp examination, fundus examination, Goldmann visual fields and imaging tests as part of the evaluation. Imaging testing options include color fundus imaging, FA imaging and Heidelberg Spectralis OCT and OMAG. In assessing visual fields, they were scored according to their results of Goldmann perimetry. OMAG was performed by Zeiss spectral domain OCT-angiography prototype using a 6 mm X 6 mm field of view around macular region. The resulting retinal image was segmented into two layers: the inner retinal layer from the ganglion cell layer to the inner plexiform layer, the deeper retinal layer from the inner nuclear layer to the external limiting membrane. The choroidal image was segmented into choriocapillaris and choroidal layers. The vascular distribution in each layer was depicted as an enface image.
Results: In all RP patients imaged by OMAG, abnormal microvasculature was detected in both the deeper retinal vasculature layer (from the inner nuclear layer to the external limiting membrane) and the choroidal vasculature. The OMAG results correlated very well with goldman visual field finding and with reduced choroidal-retina thickness measured by Zeiss SD-OCT angiography prototype in RP patients.
Conclusions: OMAG is a new, non-invasive imaging modality that can evaluate the architecture and circulation of the retina and choroid. It provided detailed, depth-resolved information of the microvasculature changes in Retinitis Pigmentosa. OMAG showed progressive loss of microvascular architecture and decrease blood flow in the choriocapillaris, and deeper retinal vascular layer with progression of RP. This imaging modality may be useful as a novel screening method to evaluate the progression of the RP.
Commercial Relationships: Kasra Attaran-Rezaei, None; **Qinqin Zhang**; **Erica Brewer**, None; **Jennifer R. Chao**, None; **Chieh-Li Chen**, None; **Ruikang K. Wang**, Zeiss (P), Zeiss (F)
Support: NEI R01EY024158, Carl Zeiss Meditec Inc, and Research to Prevent Blindness.

Program Number: 5507 **Poster Board Number:** C0111
Presentation Time: 3:45 PM–5:30 PM
Macular microangiopathy in sickle cell disease using optical coherence tomography angiography
Minvielle Wilfried, Violaine Caillaux, Salomon Y. Cohen, Olivia Zambrowski, Alexandra Miere, Eric H. Souied. centre hospitalier intercommunal de créteil, Paris, France.
Purpose: To characterize the optical coherence tomography angiography (OCTA) appearance of the perifoveal macular microvasculature in visually asymptomatic patients with sickle cell disease, and to compare these findings with those of fluorescein angiography (FA).
Methods: Retrospective observational case series.
Eighteen eyes of 9 consecutive patients with a median age of 41 years (range: 19-54) with electrophoretic confirmation of sickle cell disease were included and analyzed. A complete ophthalmologic examination was performed, including fundus examination, FA (Spectralis HRA+OCT, Heidelberg Engineering, Heidelberg, Germany), and

OCTA (RTVue XR Avanti, Optovue Inc, Fremont, California, USA). Nine eyes of five healthy subjects were also analyzed with OCTA to serve as a control group.
Results: OCTA demonstrated microvascular abnormalities in the perifoveal region of the macula in all eyes, whereas FA appeared normal in 9/18 eyes (50%). Most capillary abnormalities were located in the temporal juxtafoveal region and involved both the superficial and the deep capillary plexuses. The non-flow area (foveal avascular zone) was significantly larger in sickle cell disease patients than in the control group, both in the superficial and the deep capillary plexuses ($P < 0.0001$). The perifoveal vessel density was significantly lower in the sickle cell disease patients than in the control group in both the superficial ($P = 0.0011$) and the deep capillary plexuses ($P = 0.0018$).
Conclusions: OCTA provided detailed imaging of the perifoveal microvasculature in sickle cell disease. It appeared more sensitive than FA in detecting macular microangiopathy in asymptomatic patients. Microvascular abnormalities in sickle cell disease involved both the superficial and the deep capillary plexuses.
Commercial Relationships: Minvielle wilfried, None; **Violaine Caillaux**, None; **Salomon Y. Cohen**, None; **Olivia Zambrowski**, None; **Alexandra Miere**, None; **Eric H. Souied**, None

Program Number: 5508 **Poster Board Number:** C0112
Presentation Time: 3:45 PM–5:30 PM
Quantitative analysis of changes in the retinal microvasculature in uveitis using spectral domain optical coherence tomography angiography (SD-OCTA)
Damien C. Rodger[1], Alice Y. Kim[1], Anoush Shahidzadeh[1], Zhongdi Chu[2], Ruikang K. Wang[2], Carmen A. Puliafito[1], Narsing A. Rao[1], Amir H. Kashani[1]. [1]USC Eye Institute, University of Southern California, Keck School of Medicine, Los Angeles, CA; [2]Bioengineering and Ophthalmology, University of Washington, Seattle, WA.
Purpose: To investigate quantitative indices of retinal perfusion density and morphology in uveitis using SD-OCTA.
Methods: Cross-sectional, observational study of healthy subjects and otherwise healthy adult subjects with anterior, posterior, or pan-uveitis from the USC Eye Institute and affiliated clinics. A prototype SD-OCTA device (Cirrus, Carl Zeiss Meditec, Dublin, CA) with intensity-based optical microangiography (OMAG) algorithm was used to generate at least one 3x3 mm OCTA image centered on the fovea for each eye of interest. Non-segmented and segmented OCTA images were analyzed using a semi-automated program that converted the 2D grayscale en face OCTA images into binarized (Fig. 1A-C) and skeletonized (Fig. 1D-F) images. The density and morphology of the retinal microvasculature was then quantified using these images as the skeleton density (SD), vessel density (VD), fractal dimension (FD), and vessel diameter index (VDI). The Student's *t*-test or analysis of variance (ANOVA) with post hoc Tukey Honest Significant Difference (HSD) tests were used for all statistical analyses.
Results: Twenty-three eyes with uveitis and 14 eyes of healthy subjects were studied. In the non-segmented analysis, uveitic eyes had significantly lower SD (0.087±0.014 vs 0.102±0.005; P<0.001), VD (0.365±0.057 vs 0.423±0.020; P=0.001), and FD (1.691±0.038 vs 1.722±0.008; P<0.01), compared to healthy eyes. In the superficial retinal layer, uveitis eyes still had significantly lower SD (0.083±0.010 vs 0.098±0.003; P<0.001), VD (0.362±0.044 vs 0.426±0.019; P<0.001), and FD (1.687±0.025 vs 1.717±0.006; P<0.001), compared to healthy eyes. The same finding was true for the deep retinal layer analysis (P<0.05). VDI was greater in uveitic eyes compared to healthy eyes (e.g. 4.198±0.085 vs 4.160±0.054 for the non-segmented layer; P=0.13), but did not approach significance in any retinal segment.
Conclusions: Quantitative changes in the retinal microvasculature of uveitic eyes can be detected using measurements of SD, VD, FD, and VDI. Lower SD, VD, and FD, as well as larger VDI on OCTA analysis may indicate retinal microvascular compromise in uveitis.



Commercial Relationships: Damien C. Rodger, Carl Zeiss Meditec, Inc. (F); **Alice Y. Kim**, Carl Zeiss Meditec, Inc. (F); **Anoush Shahidzadeh**, Carl Zeiss Meditec, Inc. (F); **Zhongdi Chu**; **Ruikang K. Wang**, Carl Zeiss Meditec, Inc. (R), Carl Zeiss Meditec, Inc. (C), Carl Zeiss Meditec, Inc. (F), Carl Zeiss Meditec, Inc. (P); **Carmen A. Puliafito**, Carl Zeiss Meditec, Inc. (F); **Narsing A. Rao**, Carl Zeiss Meditec, Inc. (F); **Amir H. Kashani**, Carl Zeiss Meditec, Inc. (C), Carl Zeiss Meditec, Inc. (R), Carl Zeiss Meditec, Inc. (F)
Support: Research To Prevent Blindness, National Eye Institute (R01EY024158)

Program Number: 5509 **Poster Board Number:** C0113
Presentation Time: 3:45 PM–5:30 PM
Comparing Optical Coherence Tomography Angiography (OCTA) Radial Peripapillary Capillary Perfusion Density Maps in Glaucoma Patients and Normal Patients
Nicole K. Scripsema, Patricia Garcia, Luna Xu, Yijie Lin, Joseph Panarelli, Paul A. Sidoti, Richard B. Rosen. Ophthalmology, New York Eye and Ear Infirmary, New York, NY.
Purpose: To evaluate the usefulness of OCTA capillary perfusion density (CPD) maps for detecting differences in the perfusion of radial peripapillary capillaries (RPCs) in patients with glaucoma compared to normal patients.
Methods: A retrospective review of both normal patients and patients with open-angle glaucoma imaged with OCTA was performed. Each patient was imaged using SD-OCT (Avanti RTVue-XR, Optovue, Fremont, CA), obtaining both 3.5mm and 4.5mm peripapillary scans. A single eye of each patient was used for analysis. A split-spectrum amplitude decorrelation angiography (SSADA) algorithm generated *en face* OCT angiograms that identified RPCs. A customized algorithm generated color-coded CPD maps for qualitative analysis. We compared CPD maps in normal patients and patients with glaucoma. For each patient, CPD maps were compared to OCT Retinal Nerve Fiber Layer Analysis (RNFL, Cirrus HDT-OCT 500, Carl Zeiss Meditech Inc, Dublin, CA).
Results: A total of 66 glaucoma patients and 21 normal patients were included. Mean age was 65.63 ± 9.42 years. Age, gender, and ethnicity were similar across groups. Color-coded CPD maps identified regions of RPC perfusion loss in glaucoma patients when

compared to normal patients (Figure 1). Regions of RPC perfusion loss were most commonly seen in the superior and inferior rim. Patients with early glaucoma and normal OCT RNFL analysis demonstrated early RPC perfusion changes. In glaucoma patients with thinning on OCT RNFL analysis, the area of thinning often corresponded with regions of RPC perfusion loss. Patients with advanced glaucoma and greater RNFL thinning demonstrated larger regions perfusion loss compared to patients with early glaucomatous changes.
Conclusions: OCTA is a rapid, non-invasive technique capable of identifying changes in RPC perfusion in glaucoma patients. OCTA may offer benefits of early diagnosis and more precise monitoring of glaucoma patients. Additional investigations are necessary to establish the clinical applications of OCTA in glaucoma management.

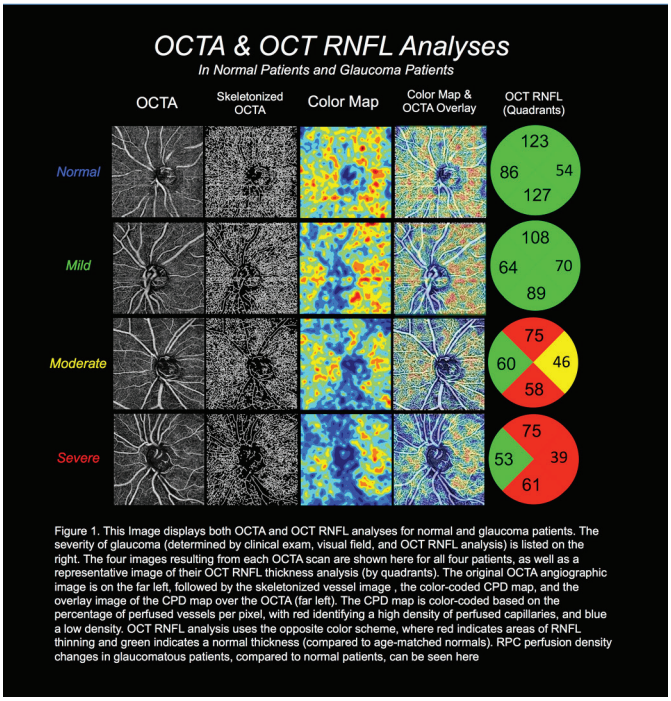


Figure 1. This Image displays both OCTA and OCT RNFL analyses for normal and glaucoma patients. The severity of glaucoma (determined by clinical exam, visual field, and OCT RNFL analysis) is listed on the right. The four images resulting from each OCTA scan are shown here for all four patients, as well as a representative image of their OCT RNFL thickness analysis (by quadrants). The original OCTA angiographic image is on the far left, followed by the skeletonized vessel image , the color-coded CPD map, and the overlay image of the CPD map over the OCTA (far left). The CPD map is color-coded based on the percentage of perfused vessels per pixel, with red identifying a high density of perfused capillaries, and blue a low density. OCT RNFL analysis uses the opposite color scheme, where red indicates areas of RNFL thinning and green indicates a normal thickness (compared to age-matched normals). RPC perfusion density changes in glaucomatous patients, compared to normal patients, can be seen here

Commercial Relationships: Nicole K. Scripsema, None; **Patricia Garcia**, None; **Luna Xu**, None; **Yijie Lin**, None; **Joseph Panarelli**, None; **Paul A. Sidoti**, None; **Richard B. Rosen**, Allergan (C), Optovue (C), Opticology (I), Regeneron (C), Ocata Medical (C), Nano Retina (C)

Program Number: 5510 **Poster Board Number:** C0114
Presentation Time: 3:45 PM–5:30 PM
OPTICAL COHERENCE TOMOGRAPHY ANGIOGRAPHY: A NEW IMAGING APPROACH FOR THE ASSESSMENT OF MACULAR CHANGES IN X-LINKED JUVENILE RETINOSCHISIS
Francesco Stringa[1], ALESSANDRO PAPAYANNIS[1], EMMANOUIL TSAMIS[1, 2], Katarzyna M. Chwiejczak[1], Susmito Biswas[1, 2], Assad Jalil[1], Paulo E. Stanga[1, 2]. [1]Manchester Vision Regeneration (MVR) Lab at Manchester Royal Eye Hospital & NIHR/Wellcome Trust Manchester CRF and Manchester Royal Eye Hospital, Central Manchester University Hospitals NHS Foundation Trust, Manchester, United Kingdom; [2]Institute of Human Development, Faculty of Medical and Human Sciences, University of Manchester, Manchester, United Kingdom.
Purpose: X-linked juvenile retinoschisis (XLRS) is a retinal degenerative disease characterized by splitting of the retinal layers. Swept Source Optical Coherence Tomography Angiography (SS OCT-A) is a new non-invasive imaging technique to evaluate retinal and choroidal vasculature. We describe macular SS OCT-A features in paediatric patients affected by XLRS.
Methods: Serial case report. Nine eyes of five males (mean age 11.5 years) were imaged on Topcon DRI OCT-1 Atlantis® SS OCT-A. Retinal segmentation provided analysis of: superficial neurovascular layer, from inner limiting membrane (ILM) to boundary between inner plexiform layer and inner nuclear layer (IPL/INL); deep neurovascular layer, from IPL/INL to the junction of inner and outer photoreceptor's segment (IS/OS); and choroidal layer, from retinal pigmented epithelium (RPE) to choroidal-scleral interface (CSI). All images were analysed by two independent ophthalmologists.
Results: All eyes showed macular petaloid-shaped hypo-reflective areas within the deep neuroretinal plexus. All eyes showed perifoveal microvascular telangectatic-like changes and capillary dropout in both superficial and deep plexuses (Figure 1). All eyes showed areas of hypo- and hyper-reflectivity on choroidal layer analysis that where not associated with any evident vascular alteration. However, these could be attributed to alterations of the SS OCT-A signal due to optical shadowing (i.e. hypo-reflectivity) or to RPE irregularities (i.e. hyper-reflectivity). There was 100% agreement between the reviewers.
Conclusions: To the best of our knowledge, this is the first description of SS OCT-A findings in XLRS. The microvascular changes described could only be picked up on SS OCT-A. These changes could potentially serve as biomarkers of prognosis. We conclude that SS OCT-A can be a useful method for the study of both the structural and vascular macular changes in XLRS disease.

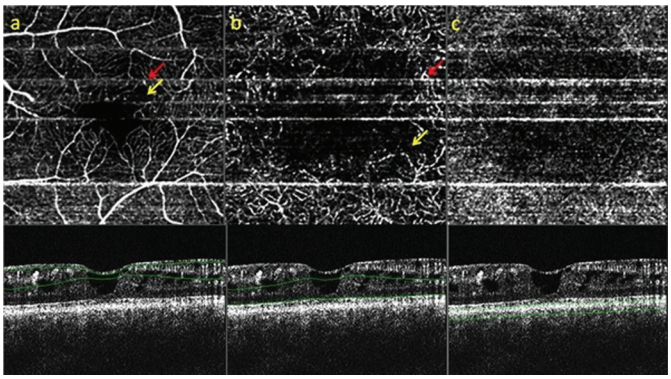


Figure 1. a) Superficial neurovascular layer. b) Deep neurovascular layer. c) Choroidal layer. Red arrows: Telangiectatic changes. Yellow arrows: capillary dropout areas.
Commercial Relationships: Francesco Stringa, None; **ALESSANDRO PAPAYANNIS**, None; **EMMANOUIL TSAMIS**, None; **Katarzyna M. Chwiejczak**, None; **Susmito Biswas**, None; **Assad Jalil**, None; **Paulo E. Stanga**