Micropulse modulation can confine thermal stress to

**B0782**
Kenneth M. Yee, None; Lizzi Center

A 577 nm laser was used to deliver 140 µm laser spots onto the retina in Dutch-belted rabbits (n = 11) with overall pulse envelopes of 20 or 200 ms. The micropulse modulation was done with 500 Hz repetition rate and duty cycles of 3%, 6%, 10%, 25%, 50%, or 100% (continuous-wave, CW). Each laser lesion was given a binary visible-or-invisible grade for 3 different levels of tissue response: ophthalmoscopic visibility, which is indicative of photoreceptor damage (a) immediately after laser treatment; (b) delayed by 1-5 min (DV), and (c) on fluorescein angiography (FA), which indicates RPE damage. The thresholds were determined as the 50% damage points in probit model fit and were compared to an Arrhenius integral of the modeled tissue response.

**Methods:** Micropulse modulation did not affect the average power for IV and DV thresholds, except at 20 ms, 3% duty cycle. The average power for FA thresholds was slightly reduced by micropulse modulation, with increasing effect for shorter pulse envelope and shorter duty cycles. For 5% duty cycle, FA threshold was lower than with CW exposure by 35 ± 21.5% for 20 ms and by 22 ±15% for 200 ms envelopes. These results validated our computational model of tissue response, which was then used for extrapolation to the non-damaging regime. Our model predicts that micropulse modulation reduces the therapeutic window between the onset of heat shock protein expression and RPE damage at 5% duty cycle vs CW by 16% and 4% for 20 and 200 ms envelopes, respectively.

**Conclusions:** Micropulse modulation can confine thermal stress to the light-absorbing RPE and choroid when employed with sufficiently short pulse envelopes and duty cycles. However, it does not offer any advantages for non-damaging therapy and actually reduces the non-damaging therapeutic window due to higher temperatures in the pigmented layers.

**Commercial Relationships:** Jenny Wang, Yi Quan, None; Roopa Dalal, Daniel V. Palanker, Topcon Medical Laser Systems (C), Topcon Medical Laser Systems (P), Topcon Medical Laser Systems (F)

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550 Clinical retinal imaging 2 and lasers
Thursday, May 11, 2017 11:30 AM–1:15 PM
Exhibit/Poster Hall Poster Session
**Program #/Board # Range:** 5980–6009/B0780–B0809
**Organizing Section:** Retina

**Program Number:** 5980 **Poster Board Number:** B0780
**Presentation Time:** 11:30 AM–1:15 PM

**Functional and Structural Effects of Nd:YAG laser for Vitreous Floaters**
Kenneth M. Yee1, Jonathan Mamou1, Justin Nguyen1, Jeffrey Ketterling2, Ronald H. Silverman1, J Sebag1. 1VMR Institute for Vitreous Macula Retina, Huntington Beach, CA; 2Lizzi Center for Biomedical Engineering, Riverside Research, New York, NY; 3Harkness Eye Institute, Columbia University Medical Center, New York, NY.

**Purpose:** To evaluate the effects of YAG laser vitreolysis of floaters on visual function and vitreous structure.

**Methods:** Patient satisfaction was evaluated with the NEI Visual Function Questionnaire (VFQ). Visual function was assessed by measuring visual acuity (VA; Snellen decimal) and contrast sensitivity (CS; Freiburg Acuity Contrast Testing; %W) in 28 eyes of 28 patients with clinically significant floaters; 14 had prior YAG laser vitreolysis. As previously described (IOVS 56:1611–17, 2015) vitreous structure was evaluated with quantitative ultrasound (QUS; AVISO, Quantel, France) to measure 3 parameters: Energy; the sum of the square of the acoustic values within the central/posterior vitreous divided by the area of measurement; P50, the percentage of the central/posterior vitreous filled by echogenic clusters greater than 50 pixels (0.069 mm); and Mean, the mean of the acoustic values divided by the area of the central/posterior measurement area. Two scan orientations were employed: Long (longitudinal to the limbus through the plane of the macula) and LMAC (horizontal longitudinal through the plane of the macula).

**Results:** There was no difference in VFQ between YAG-treated (76 ± 6) and untreated eyes (74 ± 6; P=0.3859). There were also no differences in VA (YAG: 0.64 ± 0.2 vs. non-YAG: 0.66 ± 0.15; P=0.82), or CS (YAG: 4.80 ± 1.97 %W vs. non-YAG: 4.07 ± 1.07 %W; P=0.22). In YAG-treated eyes, QUS detected less backscatter (Energy: LMAC = 614 ± 233 in YAG-treated vs. 820 ± 279 in untreated; P<0.037; longitudinal = 513 ± 135 in YAG-treated vs. 670 ± 194 in untreated; P<0.017) and a lower mean acoustic value (Mean; LMAC = 22 ± 4 in YAG-treated vs. 25 ± 4 in untreated; P<0.045; longitudinal = 20 ± 2 in YAG-treated vs. 23 ± 3 in untreated; P=0.02). Total vitreous echodensity (P50) trended lower in YAG-treated vs. untreated eyes (LMAC = 2.48 ± 3.36 vs. 5.25 ± 4.50; P=0.067; longitudinal = 1.64 ± 1.85 vs. 3.45 ± 3.15; P=0.068).

**Conclusions:** Vitreous particle sizes and total vitreous echodensity were reduced in YAG-treated eyes compared to untreated eyes, but VA and CS were the same as untreated eyes, suggesting no improvement in patient satisfaction nor vision improvement by YAG vitreolysis. Thus, in spite of apparent structural effects, YAG laser vitreolysis does not appear to improve patient satisfaction and visual function as has been experienced with vitrectomy (Retina 34:1062-8, 2014; Surv Ophthalmol 61:211-27, 2016).

**Commercial Relationships:** Kenneth M. Yee, None; Jonathan Mamou, None; Justin Nguyen, None; Jeffrey Ketterling, None; Ronald H. Silverman, None; J Sebag, None

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5981 Program Number: 5981 **Poster Board Number:** B0781
**Presentation Time:** 11:30 AM–1:15 PM

**Optimizing Non-Damaging Retinal Laser Therapy: Tissue Response to Micropulse Modulation**
Jenny Wang, Yi Quan, Roopa Dalal, Daniel V. Palanker. Stanford University, Stanford, CA.

**Purpose:** Recent progress in retinal laser therapy has centered upon using sub-lethal thermal stress or selective lethality of the retinal pigment epithelium (RPE) layer as a stimulus for repair of retinal disorders. Temporal modulation of the laser pulse, including micropulse, is believed to increase the selectivity of laser treatment but this effect has not been carefully evaluated. In this study, we measure the tissue response to different duty cycles of micropulse laser and calculate the therapeutic window to evaluate the advantages and drawbacks of temporal modulation.

**Methods:** A 577 nm laser was used to deliver 140 µm laser spots onto the retina in Dutch-belted rabbits (n = 11) with overall pulse envelopes of 20 or 200 ms. The micropulse modulation was done with 500 Hz repetition rate and duty cycles of 3%, 6%, 10%, 25%, 50%, or 100% (continuous-wave, CW). Each laser lesion was given a binary visible-or-invisible grade for 3 different levels of tissue response: ophthalmoscopic visibility, which is indicative of photoreceptor damage (a) immediately after laser treatment; (b) delayed by 1-5 min (DV), and (c) in fluorescein angiography (FA), which indicates RPE damage. The thresholds were determined as the 50% damage points in probit model fit and were compared to an Arrhenius integral of the modeled tissue response.

**Results:** Micropulse modulation did not affect the average power for IV and DV thresholds, except at 20 ms, 3% duty cycle. The average power for FA thresholds was slightly reduced by micropulse modulation, with increasing effect for shorter pulse envelope and shorter duty cycles. For 5% duty cycle, FA threshold was lower than with CW exposure by 35 ± 21.5% for 20 ms and by 22 ±15% for 200 ms envelopes. These results validated our computational model of tissue response, which was then used for extrapolation to the non-damaging regime. Our model predicts that micropulse modulation reduces the therapeutic window between the onset of heat shock protein expression and RPE damage at 5% duty cycle vs CW by 16% and 5% for 20 and 200 ms envelopes, respectively.

**Conclusions:** Micropulse modulation can confine thermal stress to the light-absorbing RPE and choroid when employed with sufficiently short pulse envelopes and duty cycles. However, it does not offer any advantages for non-damaging therapy and actually reduces the non-damaging therapeutic window due to higher temperatures in the pigmented layers.

**Commercial Relationships:** Jenny Wang, Yi Quan, None; Roopa Dalal, Daniel V. Palanker, Topcon Medical Laser Systems (C), Topcon Medical Laser Systems (P), Topcon Medical Laser Systems (F)
at year 1 compared to ranibizumab monotherapy with a significantly reduced number of injections. The purpose of this study was to determine if the long-term stability of visual gains and lower need of injections in combination therapy patients stated at year 1 could be maintained in a 3 year-follow-up period.

**Methods:** The charts of CAVNAV patients in both arms remaining under the care of the investigators were subjected to retrospective analysis to determine BCVA at 12, 24 and 36 months and injection count from months 13-36. BCVA measurements following the original 1 year study were taken using logMAR charts. Injections had been provided with standard of care using PRN based on change in BCVA and CRT using Spectral domain OCT scans. Main outcome measures was change in BCVA and mean number of injections from baseline (12 months) to month 36.

**Results:** BCVA was stable within one line of vision in both groups between from 12 through 36 months, with both cohorts showing a change of 0.16 ± 0.1 logMAR. The lead in BCVA of the cohort with navigated laser of approximately 2 lines was also maintained through month 36. Following the initial reduction in required injections at month 12, combination therapy patients continued to require 1.4 times fewer injections over the next 24 months (2.91 ± 2.3 vs 4.27 ±3.8 injections for monotherapy).

**Conclusions:** Combination of navigated laser and ranibizumab achieved BCVA gains comparable to anti-VEGF monotherapy. These results could be maintained through month 36. Concerning the number of required ranibizumab injections we observed a reduction of 3 injections in year 1 and further 1.4 injections in year 2 and 3 compared to the monotherapy group. Thus, adding navigated laser photocoagulation to intravitreal anti-VEGF therapy may represent a superior therapeutic approach to DME patients with stable functional results and lower injection burden.

**Commercial Relationships:** Julian Langer, None; Efstathios Vountrypidis, None; Marcus Kernt, None; Siegfried Priglinger, None; Tina Herold, None

**Program Number:** 5983 **Poster Board Number:** B0783

**Presentation Time:** 11:30 AM–1:15 PM

**Photo-mediated ultrasound therapy as a novel method to selectively treat eye vasculature**

Yannis M. Paulus, Haonan Zhang, Jia Li, Zizhong Hu, Aghapi Mordovanakis, Xueding Wang, Xinnai Yang.

1Ophthalmology, University of Michigan, Kellogg Eye Center, Ann Arbor, MI; 2Institute of Acoustics, Tongji University, Shanghai, China; 3Biomedical Engineering, University of Michigan, Ann Arbor, MI; 4Mechanical Engineering, University of Kansas, Lawrence, KS.

**Purpose:** Pathologic microvasculature plays a pivotal role in the leading causes of blindness including diabetic retinopathy, retinal vein occlusions, and macular degeneration. Conventional laser treatment results in collateral thermal damage. We developed a novel treatment called photo-mediated ultrasound therapy (PUT), which uses a combination of a low intensity laser concurrently with ultrasound to selectively treats vessels without damaging surrounding tissue. We present the first evaluation of PUT on rabbit choroidal vessels.

**Methods:** An integrated therapeutic ultrasound (0.5 MHz bursts of 10% duty cycle at a rate of 10 Hz, HI107 Sonic Concepts, Bothell, WA) and laser treatment system was devised. A pulsed neodymium-doped yttrium aluminum garnet (Nd:YAG) laser (Powerlite, Continuum, Santa Clara, CA) produced 532 nm laser pulses with 3-ns pulse duration and 10-Hz repetition rate at the beginning of each ultrasound burst. Sixty New Zealand white rabbits were used. Fundus photography and indocyanine green angiography (ICGA) were acquired using the Topcon 50EX Fundus Camera and Digital Imaging System (Topcon, Tokyo, Japan). ICGA was performed before, immediately after, and weekly following PUT treatment for 1 month by injecting 0.2 mL/kg of ICG into the marginal ear vein.

**Results:** Treatment with laser or ultrasound only resulted in no appreciable vascular changes. PUT treatment with laser and ultrasound was able to selectively treat the choroidal vasculature with optimized parameters. Hemorrhage occurred with 2 MPa ultrasound + 150 mJ/cm² laser (estimated at the choroidal layer) whereas 2 MPa ultrasound + 30 mJ/cm² laser caused no effect. The optimal parameters were 2 MPa ultrasound + 75 mJ/cm² laser, which caused edema immediately after treatment. By 1 week, pallor occurred in the region of treatment with greatly diminished choroidal vessels which persisted to 4 weeks (Fig 1). Indocyanine green angiography (ICGA) demonstrated a decrease in number of choroidal vessels in the region by 1 week that persisted to 4 weeks after treatment (Fig 2).

**Conclusions:** PUT holds significant promise as a novel, non-invasive method to precisely target blood vessels in neurovascular eye diseases by more selectively treating vasculature with minimized side-effects and no systemic photosensitizing dye.
Purpose: In retinal laser treatments, poor thermal damage confinement can lead to undesirable photoreceptors damage and affect patient visual functions. Additionally, consistent dosing of energy is challenging due to tissue inhomogeneity. The objective of this work is to develop a novel phototherapeutic platform to improve control over photo-thermal and mechanical damage as well as photoacoustic feedback/dosimetry in retinal treatments. The system takes advantage of a tunable energy deposition rate which provides a better control on its impact on tissue.

Methods: The system uses a programmable fiber laser (532 nm). Different pulse shapes from 3 ns to 1.6 us in length were programmed. Effects of these shapes on cells and photoacoustic (PA) feedback were evaluated. Experiments were conducted on custom photoacoustic (PA) phantom and retinal pigment epithelium (RPE) explants. Explants were prepared from fresh adult rabbit eyes, in accordance with the ARVO Animal Statement and our institution’s guidelines.

Results: In our previous work, we found that the threshold for cavitation is 30% higher for a Q-switch-like impulse shape than it is for a ramp shape. We also compared the microbubble size at twice the cavitation threshold and found that the averaged radius of evoked cavitations was 25% larger for Q-switch-like than for ramp shape. In this preliminary study, 395 trials on 15 RPE sheet samples from 5 different subjects were performed. In average, we found a damage thresholds of 170 ± 27 and 150 ± 25 mJ/mm² for ramp and Q-switch-like shapes respectively. Additionally, we report that modulating laser pulses help optimize the signal-to-noise ratio of the PA wave generated. This demonstrate the potential for real-time treatment feedback and dosimetry.

Conclusions: To conclude, both treatment and PA monitoring can benefit from the pulse formating capabilities of programmable fiber lasers. This lead to a customizable, programmable multimodal ophthalmic laser platform.

Commercial Relationships: Suzie Dufour; Robert B. Brown, None; Sébastien J. Méthot, None; Pascal Gallant, None; Patrick J. Rochette, None; Ozzy Mermut, None

Program Number: 5986 Poster Board Number: B0786
Presentation Time: 11:30 AM–1:15 PM
Resident v. Attending Surgical Outcomes: Demarcation Laser Photocoagulation
Gopal Desai, Elliot S. Crane, Marco A. Zarbin, Neelakshi Bhagat. The Institute of Ophthalmology and Visual Science, New Jersey Medical School, Newark, NJ.

Purpose: To compare anatomic and functional outcomes of demarcation laser photocoagulation (DLP) for retinal pathology performed by fellowship-trained retina specialists (“attendings”) to those performed by residents under direct supervision of an attending (“residents”).

Methods: A retrospective review of all DLPs (CPT: 67415) performed from 2006 to 2016 at the ambulatory clinic at the Institute of Ophthalmology and Visual Science, Rutgers New Jersey Medical School (NJMS). Failure, the primary outcome measure, was defined as: development of a retinal detachment (RD) within 3 months of DLP, need for additional laser treatment to the same retinal break, or vision loss due to a complication. Secondary outcome measures included changes in best-corrected visual acuity (BCVA) calculated using modified LogMAR. Calculations were done with Microsoft Excel and Graphpad. Statistical analysis included t- and Fisher’s exact tests; \( \alpha = 0.05 \).

Results: One hundred sixty eyes (146 subjects) met inclusion criteria (86 male [54%], mean ± standard deviation (SD) age 52 ± 17 years at DLP, mean ± SD follow up 3.3 ± 2.5 years). Of 160 eyes,
Time-resolved LOPL change measurement revealed the quality measures become increasingly prevalent, we recorded B-scan videos using a slit-lamp adapted OCT. JSPS KAKENHI 15K13371; MEXT Program for Building Seven Tissue deformation measurement by using OCT. B0788 Reliable dosage of retinal photocoagulation depends on laser treatment. The mean ± SD change in LogMAR BCVA at 3 months were compared to laser lesion existence by using multiple logistic regression. The regression model with the maximum deformation metric and laser power and duration is good to explain the laser lesion formation (McFadden’s pseudo-R² = 0.91). Wald test indicates that the deformation metric is only one statistically significant (p < 0.01) factor to explain laser lesion formation. Conclusions: Tissue deformation measurement by using OCT will be a good investigation and monitoring method of laser lesion formation.

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68 (43%) were treated by attendings and 92 (53%) were treated by residents. Treatment indications varied: 71 (44%) tears (67% horseshoe, 33% oculolated), 56 (35%) atrophic holes, and 16 (10%) lattice degeneration. One (1%) resident-treated eye and one (2%) attending-treated eye met failure criteria due to RD (P=1.00). Nine (11%) resident-treated eyes and two (2%) attending-treated eyes met the failure criterion of repeat treatment to the same spot (P=0.11). There were no instances of vision loss due to complications of laser treatment. The mean ± SD change in LogMAR BCVA at 3 months was -0.006 ± 0.39 for resident-treated eyes and -0.019 ± 0.23 for attending-treated eyes (P=0.844). Other postoperative complications within 3 months included: new retinal hole/tear (7, 4%), vitreous hemorrhage (4, 3%), retinal hemorrhage (3, 2%), posterior vitreous detachment (8, 5%), and epiretinal membrane (2, 1%).

Conclusions: As quality measures become increasingly prevalent, the relationship between providing high-quality patient care and resident education must be investigated. This retrospective review of 160 eyes undergoing DLP at Rutgers-NJMS demonstrates that when residents are supervised by fellowship-trained attendings, there is no significant difference in anatomic outcome between attending- and resident-performed DLP.

Commercial Relationships: Gopal Desai, None; Elliot S. Crane, None; Marco A. Zarbin, Frequency Therapeutics (C), Novartis Pharma AG (C), Coherus Biosciences (C), Genentech/Roche (C), Ophthotec (C), Makindus (C); Neelakshi Bhagat, None

Program Number: 5987 Poster Board Number: B0787
Presentation Time: 11:30 AM–1:15 PM
Depth-resolved measurement of lesion formation process during retinal laser photocoagulation by using phase sensitive optical coherence tomography Shuichi Makita, Yoshiaki Yasuno. Computational Optics Group, University of Tsukuba, Tsukuba, Japan.

Purpose: Retinal laser photocoagulation requires dosage management to control the severity of laser lesion. High-sensitivity, depth-resolved tissue deformation measurement might be a promising technology for the dosage management. Retinal lesion formation due to photocoagulation was investigated by local tissue deformation measurement based on phase sensitive optical coherence tomography (OCT).

Methods: Seven ex vivo enucleated porcine eyes were involved in the experiment. The 1-μm wavelength spectral-domain OCT system combined with coagulation laser (GYC-1000, Nidek Co., Ltd., Japan) was used. Laser illumination with 20 configurations (5 powers times 4 durations) were applied to each eye. During the laser illumination, an M-mode OCT scan was acquired at the illumination point. Depth-localized optical path length (LOPL) change which derives local tissue deformation was computed by phase analysis of the M-mode OCT. A deformation metric was computed by integrating the absolute change of LOPL. After this time, the deformation metric is significantly increased. The regression model with the maximum deformation metric and laser power and duration is good to explain the laser lesion formation. (McFadden’s pseudo-R² = 0.91). Wald test indicates that the deformation metric is only one statistically significant (p < 0.01) factor to explain laser lesion formation.

Conclusions: Tissue deformation measurement by using OCT will be a good investigation and monitoring method of laser lesion formation.

A representative experimental result of one porcine eye with 400 mW power and 100 ms duration of coagulation laser. (a) Time-resolved LOPL change rate of the porcine retina. (b) The deformation metric at the corresponding time point of (a). OCT cross sections (c) before and (d) after the laser coagulation.

Commercial Relationships: Shuichi Makita, Tomey (F), Topcon (F), Nidek (F); Yoshiaki Yasuno, Tomey (F), Topcon (F), Nidek (F)
Support: JSPS KAKENHI 15K13371; MEXT Program for Building Innovation Ecosystem

Program Number: 5988 Poster Board Number: B0788
Presentation Time: 11:30 AM–1:15 PM
Quantitative assessment of laser beam displacement during photocoagulation on patient retina using high-speed optical coherence tomography (OCT)
Stefan O. Koinzer1, Moritz C. Moltmann2, Hendrik Spahr1, Claus von der Burchard1, Anna Jaich1, Konstantine Purtskhovadze3, Dirk Theissen-Kunde1, Johann Roader1, Ralf Brinkmann1, Gereon Hüttmann1, 1Ophthalmology, Kiel University, Kiel, Germany; 2Medical Laser Center Lübeck, Lübeck, Germany; 3Institute of Biomedical Optics, University of Luebeck, Lübeck, Germany.

Purpose: Reliable dosage of retinal photocoagulation depends on exact lesion application. Precision is increasingly important in non-damaging treatments where the therapeutic window shrinks. Patient and physician unsteadiness, however, blur the laser beam image on the fundus, increasing lesion diameter and decreasing irradiance in an uncontrolled manner. In this study, we quantified such movements.

Methods: We recorded B-scan videos using a slit-lamp adapted OCT at a frame rate of 3 ms. OCT videos were acquired prospectively.

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To evaluate the correlations between macular features observed by spectral-domain optical coherence tomography (SD-OCT) and best corrected visual acuity (BCVA) after vitreomacular traction (VMT) surgery.

Methods: This consecutive retrospective study included 24 patients (29 eyes) with successfully resolved VMT by pneumatic vitreolysis (PV, n=9), intravitreal ocirplasmin (IVO, n=6) or pars plana vitrectomy (PPV, n=14). SD-OCT was used to obtain the pre- and postoperative macular features including length of the cone outer segment tips (COST) line defect, the inner segment/outer segment (IS/OS) junction defect, central retinal thickness (CRT), photoreceptor outer segment (PROS) thickness and size of the vitreomacular attachment area. The Snellen BCVA was converted to logarithm of the minimal angle of resolution (LogMAR) for analysis. Correlations between macular features and BCVA were determined using simple linear regression analysis and multivariable regression analysis.

Results: Both the COST line and IS/OS line defect were restored continuously along with BCVA improvement during the postoperative 12-month follow-up period. Postoperative BCVA was significantly correlated with length of the COST line defect at 1, 3, 6, and 12 months postoperatively (p=0.05). However, forward stepwise regression analysis showed that BCVA was only significantly correlated with length of the COST line defect pre-operatively and 1, 3, 6, and 12 months postoperatively (p<0.05). Postoperative BCVA improvement at 12 months was significantly correlated with preoperative length of the COST line defect (p=0.0011). Postoperative BCVA improvement at 12 months can be calculated by the regression equation: BCVA = 0.005069*(length of preoperative COST line defect) – 0.0466316 (F=13.37, R²=0.3311, P=0.0011).

Conclusions: Recovery of the COST line and IS/OS line defect as observed by SD-OCT is positively associated with visual acuity improvement after successful VMT surgery. BCVA improvement may be predicted by length of the preoperative COST line defect.

Commercial Relationships: PENG SUN, None; Rachel M. Tandias, None; Gina Yu, None; Jorge G. Arroyo, None

Program Number: 5992 Poster Board Number: B0792
Presentation Time: 11:30 AM–1:15 PM
Association Between Glaucoma and Microcystic Macular Edema in Patients with Epiretinal Membranes
Daniel Su, Andrea Govetto, Matthew Farajzadeh, Alin Megedichian, Eva Platner, Jean-Pierre Hubschman. Stein Eye Institute, UCLA, Los Angeles, CA.

Purpose: To determine the frequency of microcystic macular edema (MME) in patients with epiretinal membranes (ERM) and to explore its association with glaucoma.

Methods: We retrospectively included eyes with ERMs and reviewed their baseline clinical characteristics including the presence of glaucoma. Optical coherence tomography (OCT) images were reviewed for the presence of MME as evidenced by hyporeflective cystic spaces within the inner nuclear layer (INL). Quantitative analysis of MME was performed by manually counting the number of INL cysts within a volume (20° x 15°) OCT scan. Mean number of INL cysts were compared between eyes with glaucoma and those without. In addition, eyes that underwent vitrectomy for ERM removal were divided based on the presence of glaucoma. The number of INL cysts between the two groups at baseline and 6 months after surgery were analyzed and compared. Mean visual acuities between the two groups were compared at baseline and 6 months after surgery.

Results: Two hundred and sixty-eight eyes with ERMs were included (53 with glaucoma and 215 without). MME was present in 27 eyes with glaucoma (50.9%) and 19 eyes without glaucoma (8.8%, p<0.0001). Thirty-eight eyes (19 with glaucoma and 19 without glaucoma) underwent vitrectomy for ERM removal. At baseline, the mean number of INL cysts between the glaucoma and non-glaucoma groups were not significantly different (49.9 ± 65 and 83 ± 99, respectively; p = 0.33). Mean visual acuity of the glaucoma and non-glaucoma groups were similar at baseline (logMar 0.39 ± 0.15 and 0.40 ± 0.16, respectively; p = 0.9). Six months after ERM removal, the number of INL cysts decreased in 10/19 eyes (52.6%) with glaucoma and in 17/19 eyes (89.4%) without glaucoma. The number of INL cysts increased in 9/19 eyes (47.3%) with glaucoma (Fig. A) and in only 2/19 eyes (10.5%) without glaucoma (p=0.02; Fig. B). Mean visual acuity was significantly improved at 6 months post-operatively in the non-glaucoma group (logMar 0.30 ± 0.20; p=0.003) but not in the glaucoma group (0.32 ± 0.25; p=0.2).

Conclusions: MME was more likely to be present in eyes with ERMs and glaucoma than those with ERMs but without glaucoma. Furthermore, MME was more likely to persist or worsen after vitrectomy for ERM removal in eyes with glaucoma.

Commercial Relationships: Daniel Su, None; Andrea Govetto, None; Matthew Farajzadeh, None; Alin Megedichian, None; Eva Platner, None; Jean-Pierre Hubschman, None

Program Number: 5993 Poster Board Number: B0793
Presentation Time: 11:30 AM–1:15 PM
ACUTE SYMPTOMATIC FLOATER
Moon Jung Choi, Su Jin You. Retina, Kim’s Eye Hospital, Seoul, Korea (the Republic of).

Purpose: To evaluate and establish the rate of pathologic findings for patients with acute, symptomatic floater.

Methods: Retrospectively records of 3377 eyes (2649 patients) with acute, symptomatic floater who visited Kim’s Eye Hospital from January 1, 2015 to December 31, 2015 were evaluated. Patients with previous retinal detachments resulting from other ocular pathologic features, direct ocular trauma, or previous vitrectomy and cataract surgery were excluded. Their standard examination included visual acuity, intraocular pressure measurement, anterior segment examination, and dilated fundus examination using a slit-lamp biomicroscope and indirect ophthalmoscope.

Results: The incidence of floater symptom was common in female than male respectively (p<0.05). And the most common cause of floater was posterior vitreous detachment (10.4%). The incidence of retinal tear was 0.8% (28 eyes) and 27 eyes of them were undergone
In this study, OCT-A identified a reduction of 2 ± 0.165 mm² and 39.96 ± 13.99 in healthy eyes and unaffected fellow eyes. The area and density of deep retinal capillary exhibited a same trend that both eyes of MH patients were lower than healthy eyes. The parafoveal blood perfusion were not changed after vitrectomy. The FAZ area in male and female healthy control was 0.41 ± 0.103 mm² and 0.54 ± 0.165 mm² in female, respectively, and in female IMH patients, the FAZ area of unaffected fellow eyes was 0.61 ± 0.203 mm². The FAZ area was in healthy larger in females than in males (p < 0.001, Mann Whitney test). No significant difference was found between female healthy eyes and female unaffected fellow eyes.

Conclusions: In this study, OCT-A identified a reduction of parafoveal perfusion at superficial and deep retinal capillary network in both eyes of IMH patients. The alteration of retinal microcirculation in macular hole might be related with the pathogenesis of idiopathic macular hole.

Commercial Relationships: Yufei Teng, None; Marco Yu, None; Wu Liu, None

Program Number: 5995 Poster Board Number: B0795
Presentation Time: 11:30 AM–1:15 PM

New staging of Acute Posterior Multifocal Placoid Pigment Epiteliopathy by using multimodal imaging

Ester Carreno1, Tomas Burke1, Colin Chu2, Serena Salvatore1, Richard W. Lee1, Clare Bailey1, Andrew D. Dick1, 2, Adam H. Ross1.
1Bristol Eye Hospital, Bristol, United Kingdom; 2School of Clinical Sciences, Faculty of Medicine and Dentistry, University of Bristol, Bristol, United Kingdom.

Purpose: Acute posterior multifocal placoid pigment epitheliopathy (APMPPE) is a rare disease involving the choriocapillaris, retinal pigment epithelium and retina. Although the pathoetiology remains unknown, inflammation of the choriocapillaris is the likely primary insult. The aim of this study by using multimodal imaging was to determine a sequence of structural changes during evolution and course of APMPPE.

Methods: All patients with a new diagnosis and acute presentation of APMPPE seen at our regional care centre from October 2015 to October 2016 were included. Multimodal imaging employed on all patients from diagnosis included: fundus fluorescein angiography (FFA), indocyanine green angiography (ICGA), fundus autofluorescence (FAF), spectral domain-optical coherence tomography (SD-OCT) and OCT-Angiography (OCT-A). Non-invasive imaging was repeated during follow-up.

Results: Five patients were included in the study, 3 males and 2 females, with a mean age of 26.2 (range: 21-32) years and a mean follow-up of 4.69 (range: 2.3-10.3) months. All patients presented with bilateral disease and macular involving lesions, accompanied by significant headache and a viral-prodrome prior to presentation. Multimodal imaging has consistently highlighted 4 sequential stages during APMPPE (see legend).

Conclusions: The use of multimodal imaging for the follow-up of patients with APMPPE supports the increasing evidence of a choriocapillaritis. The evolution shows resolution of ischaemia but a defined sequence that results in permanent changes at the level of the retinal pigment epithelium (RPE).
Multimodal imaging in APMPPE was able to define 4 stages. Stage 1: Choriocapillaris hypoperfusion disclosed through OCT-A and confirmed with ICGA and early FFA phenotype. Stage 2: Evidence of classic active lesion on the FFA with early hypofluorescence and late hyperfluorescence, persistent hypopigmentation lesion through ICGA frames, hypoperfusion on the OCT-A and disorganisation and hyporeflectivity of the outer retinal layers on the SD-OCT. Stage 3: Thinning and disruption of outer retinal layers on the SD-OCT, but persistent ischemia of the choriocapillaris on the OCT-A. Stage 4: Remaining retinal thinning in the SD-OCT at the level of outer retina with hyporeflectivity at the RPE and hypoauflorescent lesions, but normalised choriocapillaris on the OCT-A.

Commercial Relationships: Ester Carreno, None; Tomas Burke, None; Colin Chu, None; Serena Salvatore, None; Richard W. Lee, None; Clare Bailey, None; Andrew D. Dick, None; Adam H. Ross, None

Program Number: 5996 Poster Board Number: B0796
Presentation Time: 11:30 AM–1:15 PM
Assessing the Henle Fiber Layer in Albinism Using Directional OCT
Daniel J. Lee1, Melissa A. Wilk2,3, Brandon J. Lujan4, Bhavna J. Antony5, Joseph Carroll6,7. Ophthalmology & Vision Sciences, Medical College of Wisconsin, Milwaukee, WI; 2Cell Biology, Neurobiology and Anatomy, Medical College of Wisconsin, Milwaukee, WI; 3Hudson Alpha Institute For Biotechnology, Huntsville, AL; 4Casey Eye Institute, Oregon Health & Science University, Portland, OR; 5Electrical and Computer Engineering, John Hopkins University, Baltimore, MD.

Purpose: The Henle fiber layer (HFL) is comprised of extended photoreceptor axons resulting from the process of foveal cone packing and concomitant displacement of the inner retina during foveal pit formation. Directional optical coherence tomography (D-OCT) allows visualization of the HFL in vivo. Here we use D-OCT to measure HFL thickness in subjects with albinism and normal controls to assess relationships between the HFL and peak cone density.

Methods: Horizontal D-OCT B-scans were acquired, registered and averaged as previously described (Lujan et al, 2015) for 9 subjects with albinism, 2 carriers of ocular albinism and 39 controls. Averaged images were manually segmented to extract HFL thickness and true outer nuclear layer (ONL) thickness. An adaptive optics scanning light ophthalmoscope (AOSLO) was used to acquire images of the foveal cone mosaic, from which peak cone density was assessed.

Results: HFL was observable in all subjects, and the topography of the HFL layer was dramatically different in albinism compared to normal controls (see Figure). Mean HFL thickness at the incipient fovea in subjects with albinism ranged from 7.59 to 66.86μm (avg ± stdev 51.20±18.00μm) while HFL thickness at the foveal center in controls ranged from 0.45 to 31.56μm (avg ± stdev 10.61±7.87μm). Peak cone density was negatively correlated with central HFL thickness (Spearman r = -0.54, p < 0.01) but positively correlated with the eccentricity of peak HFL thickness (Spearman r = 0.62, p < 0.001).

Conclusions: Higher foveal cone densities are associated with thinner foveal HFL and increased displacement of peak HFL thickness, consistent with foveal cone density playing an important role in establishing HFL topography. The presence of HFL in subjects with albinism is consistent with there being extensive foveal cone packing even in the absence of a normal foveal pit contour. This data may be useful in understanding the anatomical basis for visual acuity deficits in albinism.

D-OCT images revealing the true ONL (shaded blue) and HFL (immediately above the ONL) in a normal control (top) and a subject with albinism (bottom).

Commercial Relationships: Daniel J. Lee; Melissa A. Wilk. None; Brandon J. Lujan, Genentech (C), US Patent 9,427,147 (P); Bhavna J. Antony, None; Joseph Carroll, Optovue (F), US Patent 9,427,147 (P)

Support: P30EY001931, R01EY024969, Vision for Tomorrow

Program Number: 5997 Poster Board Number: B0797
Presentation Time: 11:30 AM–1:15 PM
OCT Angiography Perifoveal Retinal Capillary Perfusion Density Analysis in Proliferative Diabetic Retinopathy Pre-and Post- Panretinal Photocoagulation

Purpose: To evaluate the usefulness of optical coherence tomography angiography (OCTA) for assessing differences in perfused perifoveal...
Methods: This prospective study included patients with PDR. Patients with other systemic ocular conditions, except mild cataract and controlled hypertension, were excluded. All patients were imaged at baseline, 2 weeks, and 1, 2 and 3 months after PRP. A 70-kHz, 840nm wavelength spectral OCT system (Optovue, Fremont, CA) was used to obtain 3x3mm and 6x6mm perifoveal scans. A split-spectrum amplitude-decorrelation angiography (SSADA) algorithm generated en face OCT angiograms identifying perfused perifoveal capillaries. Capillary perfusion density (CPD) value was calculated and color-coded CPD maps were generated for each scan. Changes in OCTA color maps and CPD values were compared pre- and post-PRP using paired t-tests.

Results: Preliminary results of 17 patients who completed 2 and 4 week post-PRP visits were included. Mean CPD values in 3x3mm superficial retinal capillary scans showed a small decrease after PRP. Mean CPD values were 40.46 ± 3.94% pre-PRP, 39.26 ± 3.86% 2 weeks post-PRP, and 38.08 ± 4.15% 4 weeks post-PRP (p= 0.173 and 0.45, respectively). Similar trends were seen in superficial and deep retinal capillary layers in both 3mm and 6mm scans. OCTA color-coded CPD maps also showed decreased CPD after PRP (Figure 1).

Conclusions: OCTA is uniquely capable of imaging the perifoveal retinal capillaries allowing in a rapid, non-invasive qualitative mapping and quantitative analysis of CPD. This novel technique can identify subtle changes in response to interventions such as PRP, and may prove beneficial in monitoring response to treatment in patients with PDR. Further data is necessary to understand the relationship between perifoveal CPD and PRP treatment.


Program Number: 5998 Poster Board Number: B0798
Presentation Time: 11:30 AM–1:15 PM

Improved Visualization and Quantification of OCT Angiography Data using a Novel 3D Projection Artifacts Removal Algorithm

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Purpose: To evaluate the performance of applying a novel 3D projection artifacts removal (PAR) algorithm to OCT Angiography (OCTA) volume data acquired with AngioVue® (Optovue, Inc., Fremont, CA).

Methods: AngioVue Retina 3x3 mm fovea-centered scans from 10 normal, 10 diabetic retinopathy (DR), and 10 age-related macular degeneration (AMD) subjects with choroidal neovascularization (CNV) were included. Analyses were performed on 1) OCTA B-scans; and 2) OCTA en face images generated from superficial plexus (ILM–IPL), deep plexus (IPL–OPL), outer retina (OPL–BM) and choriocapillaris (30 micron slab under BM) layers. 2D correlation coefficient was used to measure the similarity between superficial and deep plexus in all subjects. Area vessel density analysis was applied to deep plexus for normal and DR subjects. To evaluate CNV, grading of outer retinal slab images generated with and without PAR was performed by two independent human graders to evaluate identification of CNV (yes/no) and to estimate level of difficulty to identify CNV extent/boundary (easy/difficult).

Results: Following PAR, B-scans display less tailing, and projection artifacts are largely reduced in the outer retinal layer (Fig. 1). 2D correlation coefficient between superficial and deep plexus without PAR is 0.67 ± 0.05 (N = 30) and it lowers to 0.20 ± 0.12 with PAR, indicating that the two layers have more distinct capillary networks. With PAR, deep plexus area vessel density in the entire 3x3 mm image is 45.27 ± 2.92 % in normal and 41.60 ± 9.18 % in DR subjects. Following PAR application, CNV vessels remain connected and intact, and the CNV extent becomes easier to identify on the outer retinal slab (Fig. 2).

Conclusions: The novel 3D PAR algorithm applied to AngioVue® data has the potential to improve visualization for identification of pathologies, and may facilitate quantification of separate retinal vascular networks.
Fig 1. Comparison of (A) OCTA en face images and (B) B-scans from original OCTA and post-3D PAR volume of a normal eye. B-scan location is indicated by the dashed line in the upper left image in (A).

Fig 2. (A) Comparison of the outer retina in CNV cases, without (original) and with 3D PAR. Bar plots of (B) number of “Yes” cases when grader 1 and 2 (G1, G2) attempt to identify CNV from en face images without and with PAR, and (C) number of “Easy” cases when identifying the CNV extent.

Commercial Relationships: Yi-Sing Hsiao, Optovue, Inc. (E); Yulia Wolfson, Optovue, Inc. (E); Jing Tian, Optovue, Inc. (E); Xingwei Wang, Optovue, Inc. (E); Susan Luh, Optovue, Inc. (E); Ben K. Jang, Optovue, Inc. (E); Qienyuan Zhou, Optovue, Inc. (E)

Program Number: 5999 Poster Board Number: B0799
Presentation Time: 11:30 AM–1:15 PM
Use of smartphone fundus camera photographs for screening of retinal pathologies in premature and newborn patients

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Purpose: To evaluate the use and feasibility of smartphones fundus photographs in preterms and newborns screening for ROP and/or retinal disorders.

Methods: We performed a pilot study to evaluate the fundus in premature patients suspected of ROP and newborns with photographs of the fundus using the iPhone 6 camera coupled to a Volk inView device by neonatal intensive care staff and send to Retina specialists for their evaluation and detection of probable cases which were examined more deeply through indirect ophthalmoscopy.

Results: Using photos of the fundus to assess such patients was impossible to detect cases of ROP in premature and Parschters’s like retinopathy in newborns, also was possible to compare images over time to assess the development and / or progression of these diseases effectively and safely.

Conclusions: The use of the iPhone camera coupled to the Volk inView system is an easy, accessible, safe and effective way that can be used by technicians to screen for retinal diseases in premature and newborn patients.
In fluorescein angiography (FA), decreased retinal perfusion, presumably caused by obstructed capillaries, has been shown to correlate to visual acuity (VA). The purpose of the study is to characterize the OCT-A signatures of these obstructed capillaries.

Methods: Fifty eyes of 36 subjects were examined with OCT-A, optical coherence tomography (OCT), and fluorescein angiography (FA) at the time of presentation. The cohort was composed of patients with neovascular age-related macular degeneration (n=36) and branch retinal artery occlusion (BRAO) (n=56). BRAO cases were confirmed by clinical examination and FA. OCT-A of neovascular age-related macular degeneration cases were obtained at presentation (n=1), at 3 (n=2) months, and 6 (n=1) months after diagnosis. Repeat FA showed reperfusion in 3 eyes.

Results: The algorithm was compared to qualitative examination of flow void by 3 independent readers. The location of RVD loss did not correlate to VA (p = 0.44, p = 0.38 in all affected quadrants (p = 0.005)). The amount of RVD in superficial vessels did not correlate with VA (p = 0.001). Additional, increased clock hours of flow void correlated to decreased VA. The current method might be expanded to other retinal vascular diseases.

Conclusions: Quantitative OCT-A can provide valuable information about the status of the retinal capillary bed, which may help to predict visual outcome in neovascular age-related macular degeneration and in branch retinal artery occlusion.

Support: NIH EY06109; EyeSight Foundation of Alabama; Research to Prevent Blindness; Macula Foundation

Program Number: 6001 Poster Board Number: B0801
Presentation Time: 11:30 AM–1:15 PM
Optical Coherence Tomography Angiography Quantitative Analysis and Correlation with Visual Acuity in Branch Retinal Artery Occlusion

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Purpose: In fluorescein angiography (FA), decreased retinal perfusion in branch retinal artery occlusion (BRAO) cannot be quantified. FA shows non-perfusion acutely, but reperfused BRAOs fail to show the affected area. Optical coherence tomography angiography (OCTA) allows the calculation of vessel density and examination of the flow void. We established and analyzed an algorithm for quantifying non-perfusion and correlated the extent of non-perfusion to VA in BRAO.

Methods: Eight eyes from 4 patients with BRAO were imaged by FA, spectral domain OCT, and OCTA (AngioPlex, CIRRUS HD-OCT; Carl Zeiss Meditec, Inc, Dublin, CA). OCTA 3x3 mm images of superficial and deep capillary plexus centered on the fovea were obtained. To quantify the decreased perfusion, Image J (National Institutes of Health, Bethesda, Maryland, USA) was used to calculate absolute vascular density for each macular quadrant. The quadrant with the highest vessel density in each macula was set to 1, and relative vascular density was calculated for remaining quadrants. The algorithm was compared to qualitative examination of flow void by 3 independent readers. Clock hours of flow void were noted in each affected eye. VA was converted to logMAR. Correlations were calculated using paired t-tests.

Results: Four eyes from 4 patients (3 females and 1 male; mean age 56 [33-73]) had BRAO confirmed by clinical exam and FA. OCTA was obtained at presentation (n=1), at 3 (n=2) months, and 6 (n=1) months after diagnosis. Repeat FA showed reperfusion in 3 eyes. Macular quadrants with decreased RVD correlated to areas read as qualitatively abnormal by readers (sensitivity 94%, specificity 94%) (Fig 1). RVD loss was greater in deep versus superficial vasculature in all affected quadrants (p = 0.005). The amount of RVD in superficial or deep vasculature did not correlate with VA (p = 0.44, p = 0.38 respectively). The location of RVD loss did not correlate to VA. VA correlated to the number of affected clock hours (p = 0.001).

Conclusions: A quantitative method using OCTA relative vascular density (RVD) identified areas of flow void and decreased perfusion in BRAO. RVD loss was seen in cases of re-perfused normal-appearing FAs indicating a particularly useful clinical application. Additionally, increased clock hours of flow void correlated to decreased VA. The current method might be expanded to other retinal vascular diseases.
Insights into epiretinal membranes evolution: presence of continuous ectopic inner foveal layers and a new optical coherence tomography staging scheme

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Purpose: To describe the presence of continuous ectopic inner foveal layers associated with epiretinal membranes (ERMs). This novel observation is applied in the development of an updated spectral domain optical coherence tomography (SD-OCT) staging scheme for ERM evaluation.

Methods: Clinical charts and SD-OCT images of 194 eyes of 172 consecutive patients diagnosed with idiopathic ERMs were carefully analyzed. OCT Agiography (OCT-A) was utilized to evaluate qualitatively the foveal avascular zone (FAZ) in eyes with ERMs, and to compare it with the fellow eye in patient with unilateral ERM.

Results: The presence of continuous ectopic inner foveal layers was identified in 63 out of 194 eyes (32.5%) and their presence was significantly associated with lower visual acuity (p=0.001). ERMs were divided in four stages (Figure 1). Stage 1 (43/194 eyes, 22.1%) ERMs were mild, thin and with a foveal depression. Stage 2 (88/194 eyes, 45.4%) ERMs were associated with widening of the outer nuclear layer and loss of the foveal depression. Stage 3 (51/194 eyes, 26.3%) ERMs were associated with continuous ectopic inner foveal layers crossing the entire foveal area. In stages 1, 2 and 3 all retinal layers were clearly defined on OCT. Stage 4 ERMs (12/194 eyes, 6.2%) were thick and associated with continuous ectopic inner foveal layers and significant disruption of all retinal layers. Visual acuity progressively declined from stage 1 through stage 4 (p<0.001). The OCT-A was used to image the FAZ of 43 eyes, and showed marked alterations of the FAZ, ranging from a slight reduction in the area of the capillary-free zone to the near-complete disappearance in eyes with stage 3 and 4 ERMs and ectopic inner foveal layers (Figure 2).

Conclusions: SD-OCT inner foveal layers are a frequent finding in ERM, are an independent risk factor for worse visual acuity and were the keystone of the proposed OCT staging scheme. Our results may be clinically significant and may influence visual prognosis. Further the findings of this study raise important questions regarding reactive cellular mechanisms in the middle retina.
Swept-source optical coherence tomography identifies choroidal vascular and pigmentary changes resembling pachychoroid spectrum disorders around choroidal nevi

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Purpose: The pachychoroid spectrum includes central serous chorioretinopathy, pachychoroid pigment epitheliopathy, pachychoroid neovasculopathy, and polypoidal choroidal vasculopathy which are characterized by retinal pigment epithelial (RPE) alterations overlying pachyvessels. The mechanisms giving rise to a pachychoroid phenotype remain under investigation. Choroidal nevi are benign space-occupying tumors which compress adjacent tissues as they grow and induce reactive changes. The purpose of this study was to examine choroidal vasculature surrounding choroidal nevi for features which may inform disease mechanisms in the pachychoroid spectrum.

Methods: Patients with choroidal nevi were identified through retrospective review. All patients underwent spectral-domain and swept-source optical coherence tomography (SD-OCT and SS-OCT). The main outcome measures included visualization of distended Haller layer vessels, choriocapillaris attenuation, RPE abnormalities and other nevus characteristics observed with SS-OCT.

Results: Fifteen eyes of 15 patients were included (mean age: 68 years; range 40-95). BCVA ranged from 20/20—20/60. Secondary complications included overlying subretinal fluid, shallow RPE detachments, type 1 neovascularization, and drusen. Inner choroidal attenuation was observed in all eyes and dilated Haller vessels surrounding the nevi were seen in 60% of eyes. En Face SS-OCT showed alterations in the morphology of the vasculature surrounding the nevi correlating with size, revealing dilated pachyvessels flanking the larger lesions and minor alterations in choroidal architecture surrounding smaller nevi.

Conclusions: Distended Haller vessels resembling those of the pachychoroid spectrum occur around choroidal nevi which are associated with RPE changes resembling those of the pachychoroid spectrum. These vascular changes may result from a mass effect compressing the inner choroid with resultant venous engorgement. Longitudinal study is needed to test this mechanistic hypothesis.
To determine the retinal microvascular network alterations in mild cognitive impairment (MCI) and Alzheimer’s disease (AD).

**Methods:** Optical coherence tomography angiography (OCTA) with Cirrus Angioplex™ (Carl Zeiss Meditec, Dublin, CA) was used to image the retinal microvascular network at the macular region. Fractal analysis (box counting, Df) representing vessel density in superficial and deep plexuses and retinal microvascular network was performed in different annular and quadrantal zones. In addition, macular ganglion cell-inner plexiform layer (GCIPL) thickness was measured. Microvascular dysfunction was compared between 3 groups of participants, twelve AD patients, 20 MCI patients and 21 normal subjects with a similar age range.

**Results:** AD patients had lower vascular densities in the temporal quadrant of the retinal vascular network and an annulus from 0.92 to 1.08 mm in the deep vascular plexus (P < 0.05) compared to controls. MCI patients in comparison to controls had lower vascular densities of the superficial and deeper vascular plexuses in the annulus (0.6 to 2.5 mm) (P < 0.05). In AD patients, the vascular density in the deep vascular plexus was related to GCIPL thickness (r = 0.82, P < 0.05). Both retinal and superficial vascular network densities were negatively correlated to disease duration (r = -0.58 for the retinal vascular network and r = -0.65 for the superficial vascular plexus, both P < 0.05). However, none of vascular densities in AD was significantly related to Mini-Mental State Examination (MMSE). In MCI patients, the density in the superficial vascular plexus was related to GCIPL thickness (r = 0.45, P < 0.05) but not to MMSE or disease duration.

**Conclusions:** To our knowledge, this is the first study showing impaired retinal microvascular network in MCI and AD patients, which was related to GCIPL thickness, prior to GCIPL thinning. The alteration of vascular density in AD patients is related to disease duration and may indicate progressive loss of retinal microvascular network during disease progression.

**Commercial Relationships:** Hong Jiang, None; Yantao Wei, None; Yingying Shi, None; Xiaoyan Sun, None; Giovanni Gregori, Zeiss (F), Zeiss (P); Fang Zheng, None; Byron L. Lam, None; Tatjana Rundek, None; Jianhua Wang, None

**Support:** North American Neuro-ophthalmology Society, McKnight Brain Institute, NIH Center Grant P30 EY014801, a grant from Research to Prevent Blindness (RPB).

**Program Number:** 6004 Poster Board Number: B0804

**Presentation Time:** 11:30 AM–1:15 PM

**Retinal microvascular impairment prior to ganglion cell loss in mild cognitive impairment and Alzheimer’s disease**

Hong Jiang1, 2; Yantao Wei3; Yingying Shi4; Xiaoyan Sun4; Giovanni Gregori2; Fang Zheng; Byron L. Lam; Tatjana Rundek2; Jianhua Wang1. 1Bascom Palmer Eye Institute, University of Miami, Miami, FL; 2Neurology, University of Miami, Miami, FL; 4Zhongshan Ophthalmic Center, Sun Yat-sen University, Guangzhou, China.

**Purpose:** To determine the retinal microvascular network alterations in mild cognitive impairment (MCI) and Alzheimer’s disease (AD).

**Methods:** Optical coherence tomography angiography (OCTA) with Cirrus Angioplex™ (Carl Zeiss Meditec, Dublin, CA) was used to image the retinal microvascular network at the macular region. Fractal analysis (box counting, Df) representing vessel density in superficial and deep plexuses and retinal microvascular network was performed in different annular and quadrantal zones. In addition, macular ganglion cell-inner plexiform layer (GCIPL) thickness was measured. Microvascular dysfunction was compared between 3 groups of participants, twelve AD patients, 20 MCI patients and 21 normal subjects with a similar age range.

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**Commercial Relationships:** Hong Jiang, None; Yantao Wei, None; Yingying Shi, None; Xiaoyan Sun, None; Giovanni Gregori, Zeiss (F), Zeiss (P); Fang Zheng, None; Byron L. Lam, None; Tatjana Rundek, None; Jianhua Wang, None

**Support:** North American Neuro-ophthalmology Society, McKnight Brain Institute, NIH Center Grant P30 EY014801, a grant from Research to Prevent Blindness (RPB).

**Program Number:** 6005 Poster Board Number: B0805

**Presentation Time:** 11:30 AM–1:15 PM

**Interocular symmetry and repeatability of foveal outer nuclear layer thickness in congenital achromatopsia**

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**Purpose:** To assess the interocular symmetry and repeatability of foveal outer nuclear layer (ONL) thickness measurements in patients with congenital achromatopsia (ACHM).

**Methods:** Sixty-two subjects with ACHM (34 M, 28 F) and 14 subjects with normal vision (4 M, 10 F) were recruited. Horizontal line scans (1,000 A-scans, 80-100 repeated B-scans) were acquired using Biopixteam optical coherence tomography (OCT). For each eye, B-scans were registered and averaged to create a single image. A longitudinal reflectivity profile (LRP) was obtained at the fovea for each image using custom software. 1ONL thickness was measured between the inner limiting membrane and the external limiting membrane (ELM) in cases of complete foveal excavation, or between the posterior boundary of the outer plexiform layer and the ELM in cases of foveal hypoplasia. 2Three LRP estimates of ONL thickness were obtained for each subject to assess repeatability.

**Results:** ONL thickness did not differ between eyes in ACHM (p=0.19) or control subjects (p=0.09), consistent with high interocular symmetry. The mean ± SD ONL thickness was 75.0 ± 17.2 μm for ACHM subjects and 109.4 ± 16.5 μm for normal subjects. Despite this significant difference (p<0.0001) there was substantial overlap between the two groups (Figure). Excellent intra-grader repeatability was observed with an ICC of 0.922 for ACHM subjects and 0.988 for controls. The measurement error (defined as 1.96*within-subject SD) was 10.1 μm for ACHM and 3.7 μm for controls.

**Conclusions:** Foveal ONL thickness is reduced in ACHM, consistent with previous reports1 and indicative of disrupted cone structure. Importantly, our measurements show excellent repeatability. Our observation of ONL symmetry in ACHM supports the use of the contralateral eye as a control for trials in which only one eye is treated. Perifoveal measures of ONL thickness will need to account for the presence of the Henle fiber layer, which is difficult due to the severe nystagmus in some subjects with ACHM.

1Wilk PMID:27887888
2Sundaram PMID:24148654
Commercial Relationships: Rebecca Mastey, None; Katie M. Litts, None; Margaret R. Strampe, None; Christopher S. Langlo, None; Emily J. Patterson, None; Melissa A. Wilk, None; Joseph Carroll, AGTC (F), OptoVue (F), MeiraGTx (C)

Support: NIH Grants: R01EY017607, P30EY001931, T32EY014537, T32GM080202, R24EY022023; AchromaCorp.

Clinical Trial: NCT02599922

Program Number: 6006 Poster Board Number: B0806
Presentation Time: 11:30 AM–1:15 PM

OPTIC COHERENCE TOMOGRAPHY FEATURES OF SUBRETINAL VITREOUS SUBSTITUTES

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Purpose: Vitreous substitutes (VS) such as perfluoro-n-octane (PFO), silicone oil (SO) or octafluoropropane (C3F8) may uneventfully be retained in the subretinal (SR) space after vitreoretinal surgery. Each VS requires different maneuvers to be removed from the SR space, so it would be interesting to differentiate each VS based on optic coherence tomography (OCT) findings. We compare OCT images of cases of retained SR PFO with cases of retained SR SO or C3F8.

Methods: Retrospective analysis of patients with retained VS operated between 2006 and 2016. All patients were submitted to OCT examination (Heidelberg Tracking Laser System). Demographic data were collected. The following features were analyzed: hyperreflective elevated band at the VS/RPE interface, hyperreflectivity under the bubble; shadow in the choroid at the borders of the bubble; hyperreflective halo around the bubble; bubble shape (totally round vs flat base); hyperreflective apical dot. In cases of multiple bubbles, the presence of septa dividing the bubbles was analyzed.

Results: Data were collected from 9 male and 5 female patients. Median age was 48.7 years old (range 13-76). All patients were submitted to 23-gauge vitrectomy for rhegmatogenous retinal detachment (RD). One patient with SR C3F8 had optic disk coloboma. One patient with retained SR SO had recurrent RD. Elevation of the VS/RPE interface and flat shape of the bubble was noted in all cases; in the 12 cases with SR PFO: hyperreflectivity under the bubble noted in 58.3%; shadow 33.3%; Hyperreflective halo 41.6%; hyperreflective apical dot 58.3%. All two cases with multiple bubbles had septa dividing the bubbles. The case with SR SO had no hyperreflectivity under the bubble; no choroidal shadow at the edge of the bubble; + hyperreflective halo; + apical dot; no septum dividing the bubbles. The case with SR C3F8 had hyperreflectivity under the bubble; choroidal shadow at the edge of the bubble; + hyperreflective halo; + apical dot; no septum dividing the bubbles.

Conclusions: Our observations provide hints on the nature of SR VS. Gas may lead to totally round bubbles on OCT; no septa dividing bubbles may rise suspicious on the nature of the SR VS, as both cases that were not PFO presented this sign. Due to its OCT shape, we propose the term “caterpillar” for this sign. Not all SR PFO cases presented with apical dots, as previously suggested in literature.
(EZ) reflectivity on spectral domain optical coherence tomography (SDOCT). As split-detection adaptive optics scanning light ophthalmoscopy (AOSLO) enables visualization of cone photoreceptor inner segments, we investigated cone structure in EZ lesions on SDOCT by confocal and split-detection AOSLO.

**Methods:** Nine eyes of 6 subjects (53.5 ± 4.0 years, 2 women, 4 men) with MacTel type 2 underwent SDOCT (Heidelberg Spectralis) and AOSLO imaging. AOSLO images were montaged and aligned with infrared reflectance and en face SDOCT images using retinal vasculature. En face images were generated in Heidelberg Eye Explorer (version 1.9.10.0) by maximum intensity projection of segmented EZ (Fig B). En face images were used to guide AOSLO imaging and not for direct comparison of cone location due to large distances between B-scans. Images were compared to determine presence of cones within a lesion. Parafoveal cone density was measured using split-detection AOSLO images.

**Results:** Lesions (mean area ± SD, 0.39 ± 0.69 mm²) were identified as areas of absent EZ by SDOCT (Fig A). All 9 eyes contained remnant cone structures within or on borders of lesions visible by split-detection AOSLO (Fig C) but not visible by confocal AOSLO (Fig D). Cone density in foveal lesions was 32,298 cones/mm². The cone mosaic surrounding discrete lesions was relatively intact (44,799, 38,277, and 25,912 cones/mm² at 1, 2, and 3° eccentricity, respectively).

**Conclusions:** In MacTel, clusters of remnant cones may be present within outer retinal lesions, consistent with previous histological data. Future work will use split-detection AOSLO to longitudinally monitor cones within and surrounding lesions and to aid in assessing the potential to restore cone function in MacTel.

**Commercial Relationships:** Katie M. Litts, None; Mali Okada, None; Angelos Kalitzeos, None; Melissa Kasilian, None; Rebecca Mastey, None; Michel Michaelides, None; Joseph Carroll, AGTC (F), MeiraGTx (C), Optovue (F), MeiraGTx (F); Catherine A. Egan, Novartis Pharmaceuticals (F), Haag-Steit UK (R), Heidelberg Engineering (R)

**Support:** Lowy Medical Research Institute, P30EY001931, R01EY017607

**Program Number:** 6008 **Poster Board Number:** B0808

**Presentation Time:** 11:30 AM–1:15 PM

**Directional variability of photoreceptor reflectance: evidence that photoreceptor disarray is a common feature in retinal diseases**

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**Purpose:** To report clinical examples of directional variability of the reflectance of photoreceptors in macular diseases.

**Methods:** We reviewed the imaging data of 12 patients with either acute macular neuroretinopathy (AMNR) (n=3), macular...
When comparing coaxial and off-axis imaging, foci of NCT01546181, Zeiss (F), Zeiss (P); Michel Paques. This is the first study to analyze changes of retinal microcirculation, microvascular network and microstructure in healthy subjects.

**Purpose:** To characterize age-related alterations of retinal microcirculation, microvascular network and microstructure in healthy subjects.

**Methods:** Seventy-four healthy subjects with age from 18 to 82 years were recruited and divided into 4 groups with an interval of 15 years. There were 25 subjects with age < 35 years (G1), 25 subjects aged from 35 to 49 years (G2), 18 subjects aged from 50 to 64 years (G3) and 18 subjects with age ≥ 65 years (G4). Custom ultra-high resolution OCT (UHR-OCT) was used to acquire three dimensional volumes of the macula and six intraretinal layers in a diameter of 6 mm centered on the fovea area segmented. OCT angiography (OCTA) with a Cirrus Angioplex™ (Carl Zeiss Meditec, Dublin, CA) was used to image retinal microvasculature in the macula. The vessel density was quantitatively analyzed using fractal analysis with box counting method (Dbox). In addition, retinal blood flow velocities of both arterioles and venules in a field of 7.3 x 7.3 mm² centered on the fovea were measured using Retinal Function Imager (RFI).

**Results:** Compared to G1, G2 showed significant decreases of retinal vessel density in total retina and deep vascular plexus measured in an annulus (from 0.6 to 2.5 mm, P < 0.05) and thinning of RNFL (P < 0.05). G3 showed significant decreases of retinal vessel density in retinal vascular network in the annulus (0.6 – 2.5 mm, P < 0.05) and thinning of RNFL and GCIPL (P < 0.05), in addition to thickening of OPL and PR (P < 0.05). Interestingly, G3 showed an increase of arteriolar blood flow velocity (P < 0.05), compared to G1. G4 showed significant decreases of retinal vessel density in retina, superficial and deep vascular plexuses in both fields of 3 mm and 6 mm and thinning of RNFL, GCIPL and INL, in addition to thickening of OPL and PR (P < 0.05). Furthermore, G4 showed a significant decrease of venular blood flow velocity (P < 0.05). Age was negatively related to retinal vessel densities of retinal microvascular network, superficial and deep vascular plexuses, inner retinal layers including RNFL, GCIPL and INL and retinal blood flow velocity in venules.

**Conclusions:** This is the first study to analyze changes of retinal microvasculature, microcirculation and microstructure in healthy subjects over a wide age distribution. Significant decreases with age in retinal vessel density, inner retinal layer thickness and venular blood flow velocity were found.

**Commercial Relationships:** Jianhua Wang, Optical Imaging Ltd (C); Yantao Wei, None; Hong Jiang, None; Yingying Shi, None; Dongyi Qu, None; Giovanni Gregori, Zeiss (F), Zeiss (P); Fang Zheng, None

**Support:** Grant/financial support: Supported by North American Neuro-ophthalmology Society, McKnight Brain Institute, NIH Center Grant P30 EY014801, a grant from Research to Prevent Blindness (RPB).

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**Program Number:** 6009 **Poster Board Number:** B0809 **Presentation Time:** 11:30 AM – 1:15 PM **Age-related alterations of retinal microcirculation, microvasculature and microstructure**

Jianhua Wang, Yantao Wei, Hong Jiang, Yingying Shi, Dongyi Qu, Giovanni Gregori, Fang Zheng. Ophthalmology, Bascom Palmer Eye Inst Lib, Miami, FL; Zhongshan Ophthalmic Center, Sun Yat-sen University, Guangzhou, China; Department of Neurology, University of Miami, Miami, FL.

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