

- Relevant Disclosures**
- Consultant / Grant Support: Allergan, Apellis, Genentech / Roche, Novartis, Regeneron, REGENXBIO, Adverum, Clearside Biomedical, Ophthea, Samsung, Santen, Bayer, Senju, Zeiss, Heidelberg, OHR, BioTime, Gemini, Chengdu Kanghong Biotechnology, Optos, Kodiak Sciences, Johnson & Johnson
 - Co-patent holder on OPTOS de-warping algorithms
 - OPTOS provided support for DAVE
DMB had full control of the presentation

Scanning Laser Ophthalmoscopy and Angiography With a Wide-Field Contact Lens System

David M. Brown, MD, PhD, and David R. Williams, MD, PhD

Abstract Scanning laser ophthalmoscopy (SLO) and scanning laser angiography (SLA) are high-resolution imaging techniques that provide detailed views of the retinal microvasculature. However, these techniques are limited by their narrow field of view. We describe a wide-field contact lens system that allows for wide-field SLO and SLA imaging. The system consists of a contact lens with a wide field of view and a scanning laser system. The contact lens system was used to image the retina of a patient with a wide-field retinal vascular disease. The results show that the wide-field contact lens system allows for wide-field SLO and SLA imaging with high resolution. This system may be useful for the diagnosis and management of retinal vascular diseases.

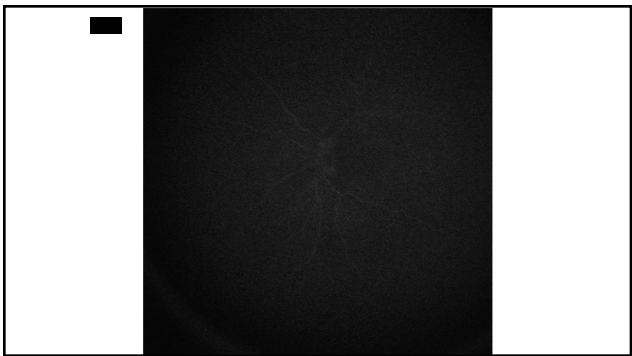
Introduction Scanning laser ophthalmoscopy (SLO) and scanning laser angiography (SLA) are high-resolution imaging techniques that provide detailed views of the retinal microvasculature. However, these techniques are limited by their narrow field of view. We describe a wide-field contact lens system that allows for wide-field SLO and SLA imaging. The system consists of a contact lens with a wide field of view and a scanning laser system. The contact lens system was used to image the retina of a patient with a wide-field retinal vascular disease. The results show that the wide-field contact lens system allows for wide-field SLO and SLA imaging with high resolution. This system may be useful for the diagnosis and management of retinal vascular diseases.

Methods A wide-field contact lens system was designed and fabricated. The system consists of a contact lens with a wide field of view and a scanning laser system. The contact lens system was used to image the retina of a patient with a wide-field retinal vascular disease. The results show that the wide-field contact lens system allows for wide-field SLO and SLA imaging with high resolution. This system may be useful for the diagnosis and management of retinal vascular diseases.

Results The wide-field contact lens system was used to image the retina of a patient with a wide-field retinal vascular disease. The results show that the wide-field contact lens system allows for wide-field SLO and SLA imaging with high resolution. This system may be useful for the diagnosis and management of retinal vascular diseases.

Conclusion The wide-field contact lens system allows for wide-field SLO and SLA imaging with high resolution. This system may be useful for the diagnosis and management of retinal vascular diseases.

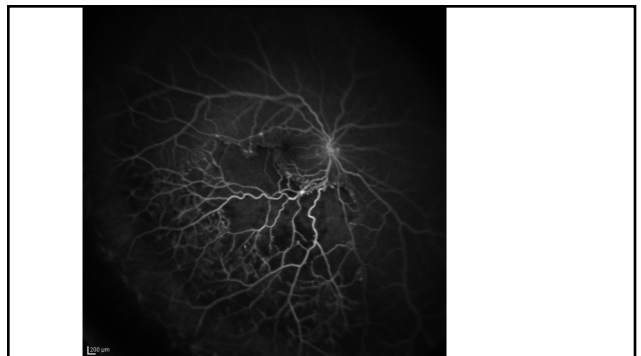
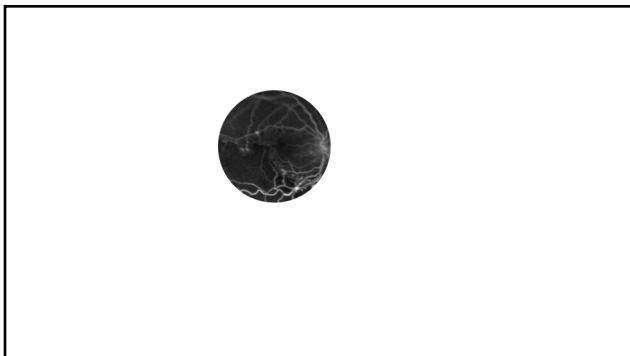
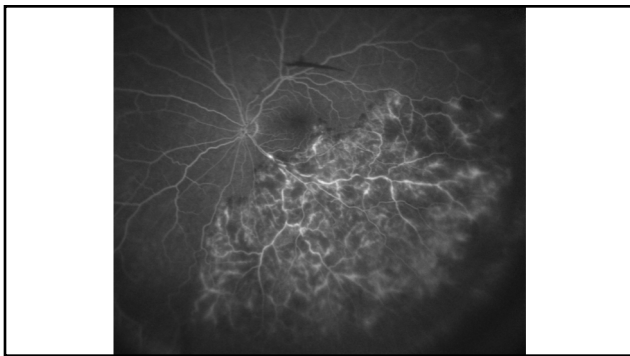
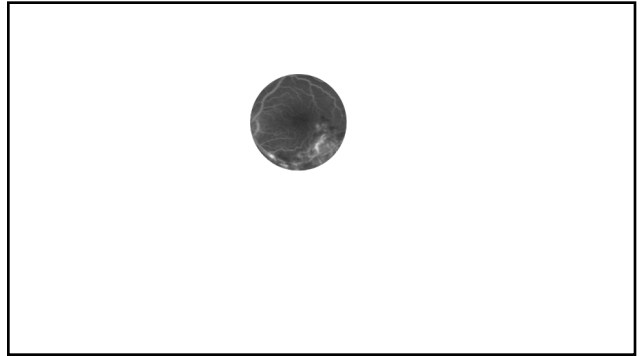
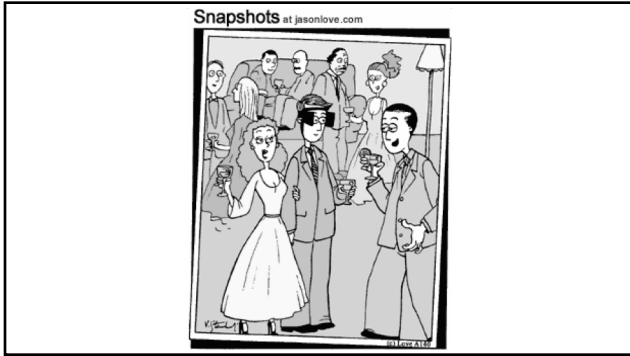
Keywords Scanning laser ophthalmoscopy, scanning laser angiography, wide-field contact lens system, retinal vascular disease.

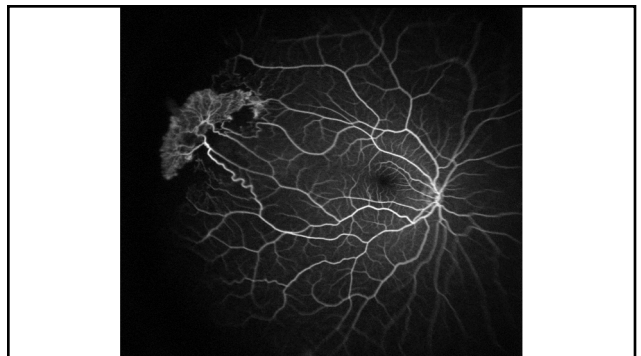
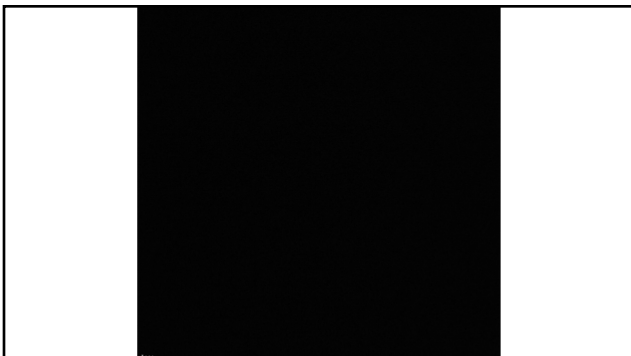
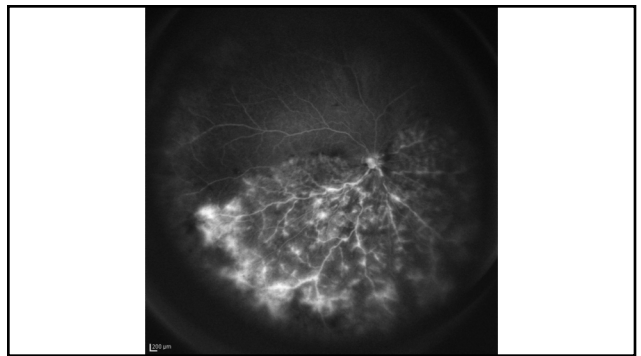
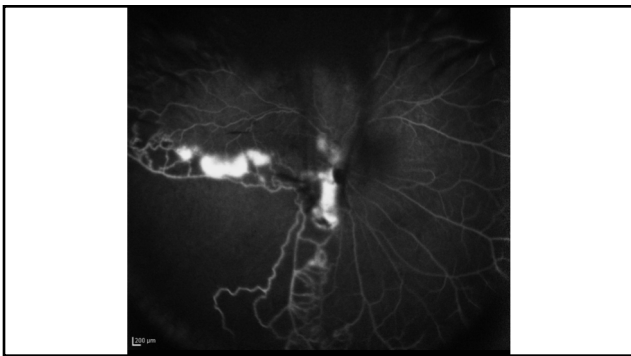
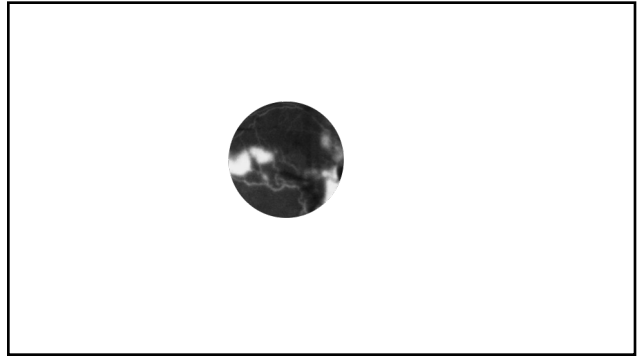


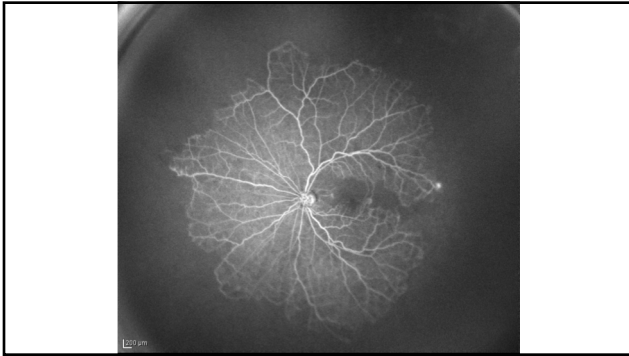
Clinical Importance of the Peripheral Retina

- Retinal Vascular Diseases
- Diabetic Retinopathy
- Surgical Diseases
- Uveitis & Tumors



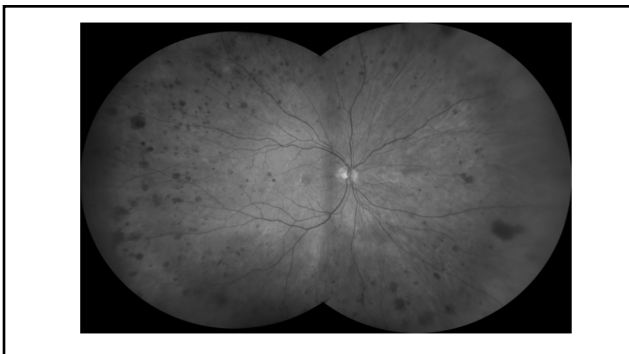
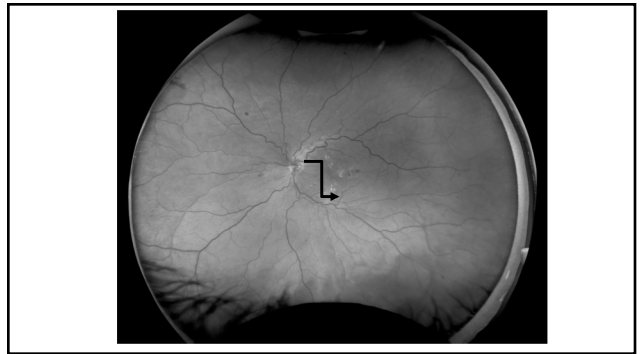
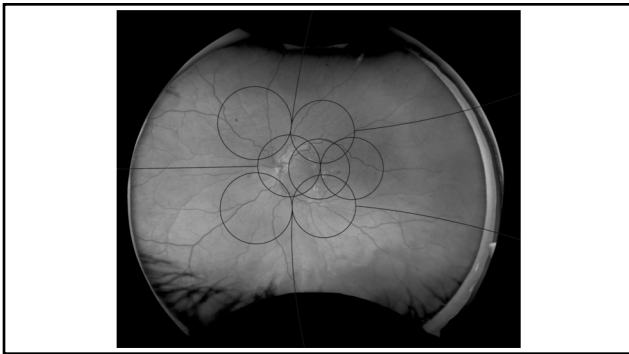




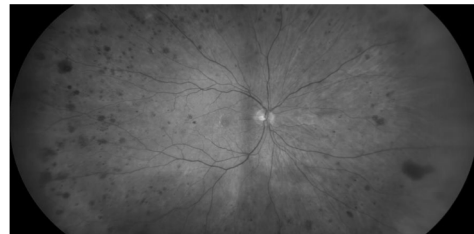


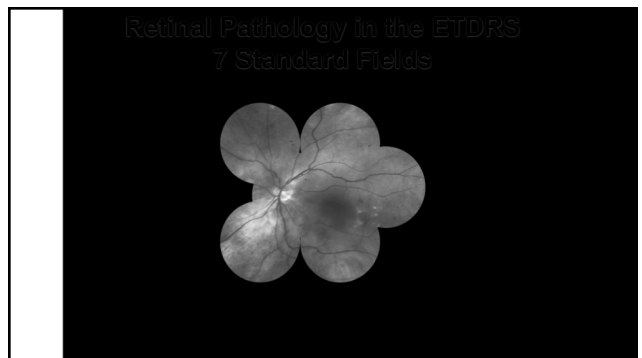
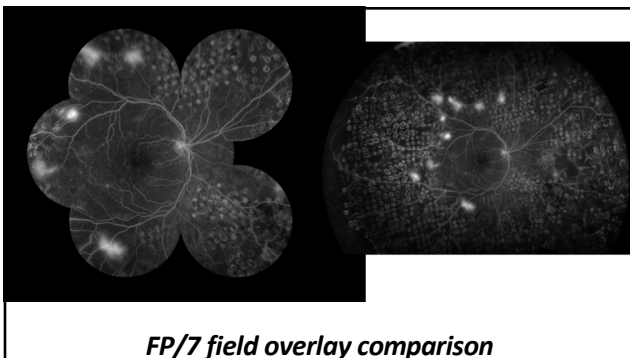
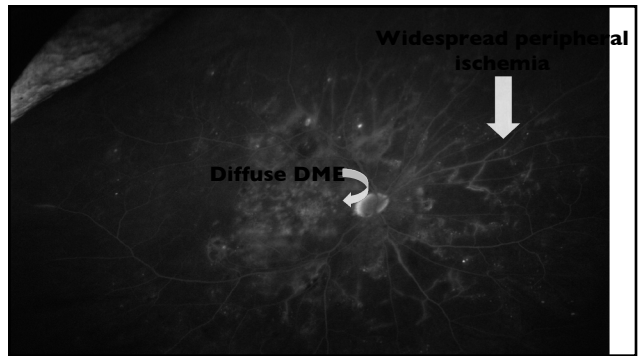
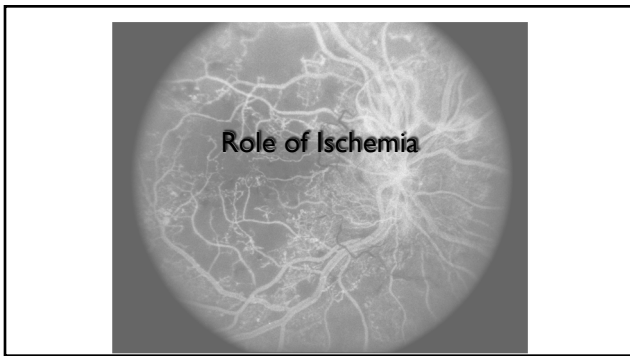
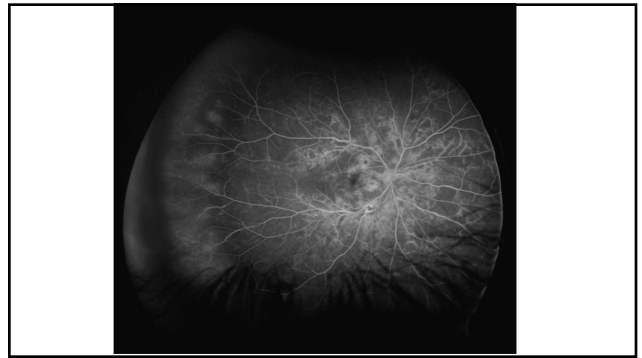
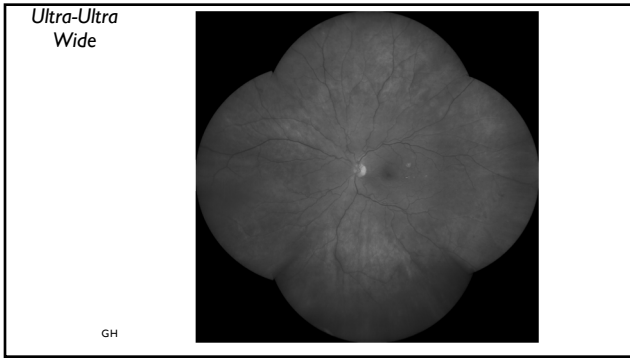
Clinical Importance of the Peripheral Retina

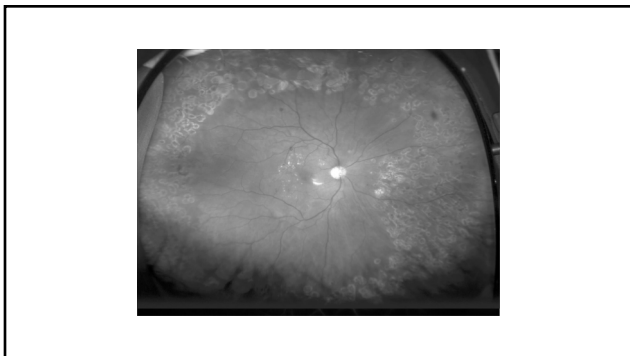
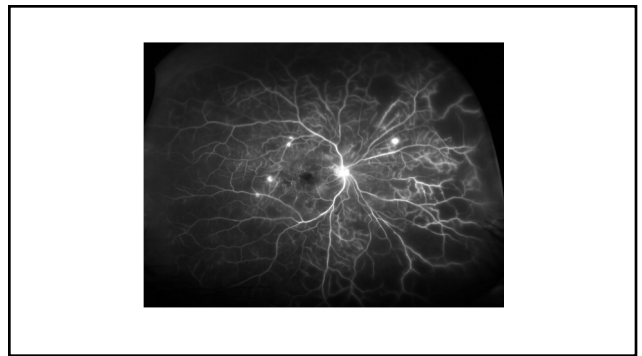
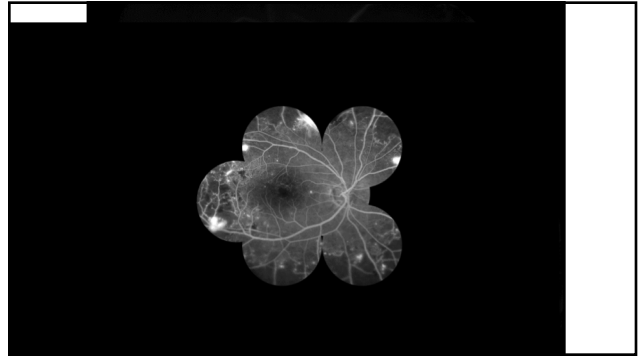
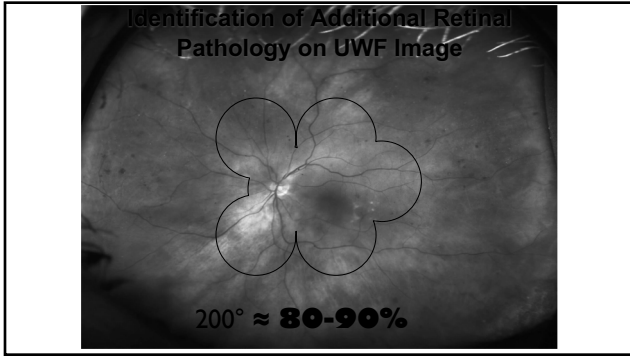
- Retinal Vascular Diseases
- Diabetic Retinopathy
- Surgical Diseases
- Uveitis & Tumors



Clarus UWF- Diabetic Retinopathy Pt. 1
(cropped top/bottom)







Ultra Widefield Imaging

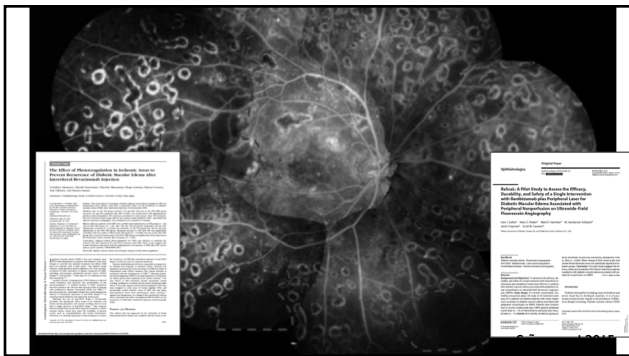
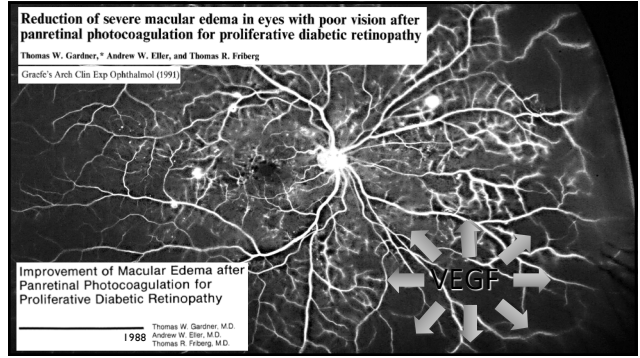
Diabetes and Diabetic Retinopathy

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This complex block contains three circular wide-field fundus images arranged in a triangle. The text 'Ultra Widefield Imaging' is at the top. Below the images is the title 'Diabetes and Diabetic Retinopathy'. At the bottom, there are logos for 'RETINA AMERICAN JOURNAL OF OPHTHALMOLOGY', 'Ophthalmology JOURNAL OF OPHTHALMOLOGY', and 'Lippincott Williams & Wilkins'. The copyright notice '© Székely Kiss, MD' is on the left, and the 'Will-Cornell Medicine' logo is on the right.



RaScAL: A Pilot Study to Assess the Efficacy, Durability, and Safety of a Single Intervention with Ranibizumab plus Peripheral Laser for Diabetic Macular Edema Associated with Peripheral Nonperfusion on Ultrawide-Field Fluorescein Angiography

Thomas W. Gardner, M.D., Andrew W. Eller, M.D., Thomas R. Friberg, M.D.

Key Words: Diabetic macular edema - Fluorescein angiography - Anti-VEGF - Ranibizumab - Laser photocoagulation - Combination therapy - Optical coherence tomography

Abstract: To determine the efficacy, durability, and safety of a single treatment with intravitreal ranibizumab plus peripheral scatter laser (RaScAL) in patients with diabetic macular edema associated with peripheral retinal nonperfusion on ultrawide-field fluorescein angiography (UWFA). **Study Design:** A 6-month, randomized, controlled, prospective phase I/II study of 30 treatment-naïve eyes of 22 patients (8 bilateral patients) with visual impairment secondary to diabetic macular edema associated with peripheral nonperfusion on UWFA. Patients were randomized to receive ranibizumab plus UWFA-guided peripheral scatter laser (n = 15) or triamcinolone acetonide plus macular laser (n = 15). **Results:** At 6 months, the RaScAL group patients had fewer recurrences warranting retreatment (33% vs. 80%, p < 0.003). Mean change in final visual acuity and central foveal thickness were not statistically significant between groups. **Conclusion:** This pilot study suggests the efficacy, safety and durability of the RaScAL treatment regimen in patients with diabetic macular edema associated with peripheral nonperfusion on UWFA.

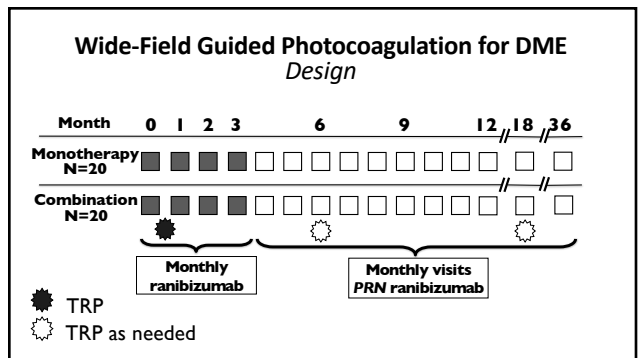
Wide-Field Guided Photocoagulation for DME

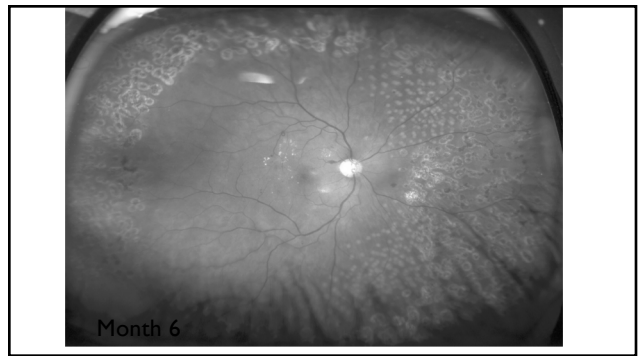
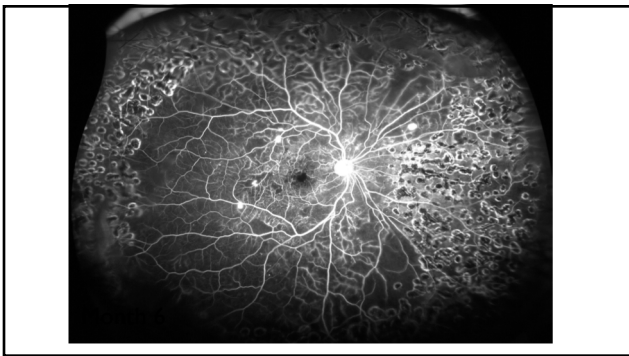
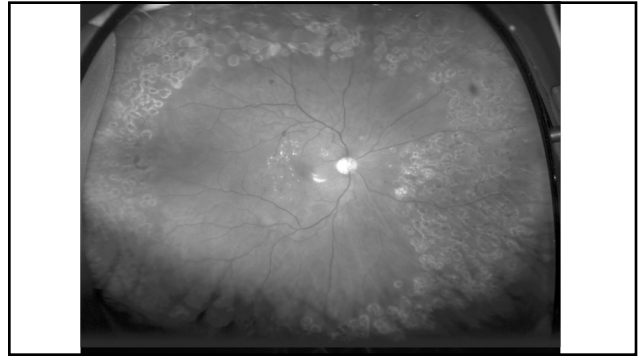
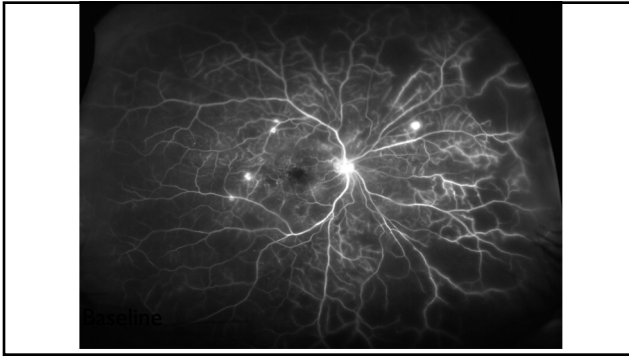
DAVE

Inclusion Criteria

- 40 patients: center-involving DME
- 20/32 - 20/400 (Snellen equivalent)
- Extensive peripheral retinal non-perfusion

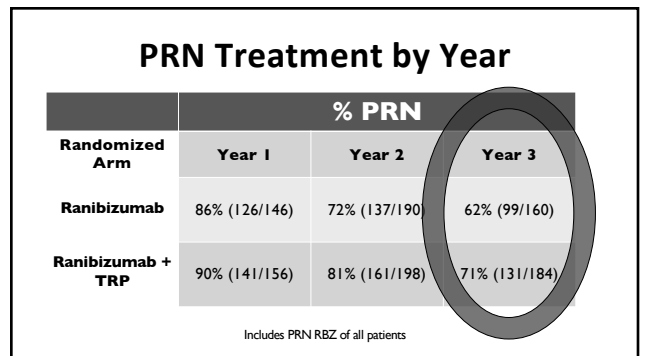
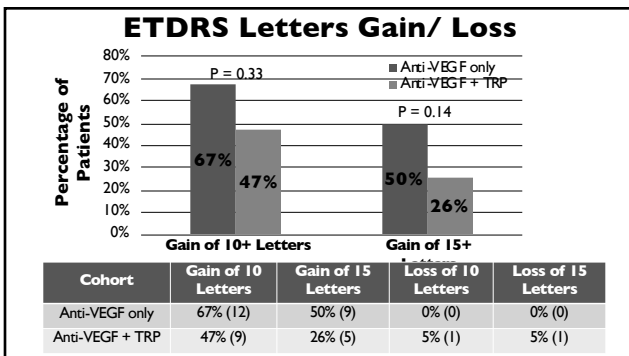
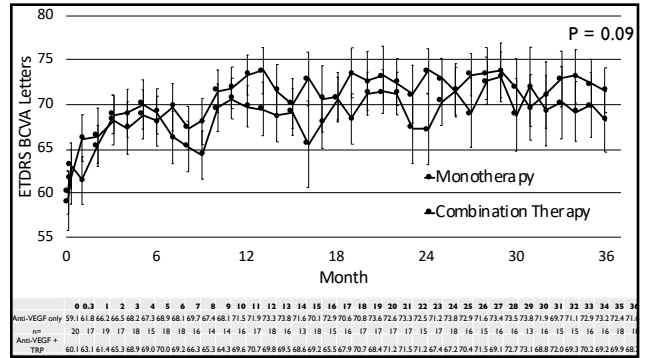
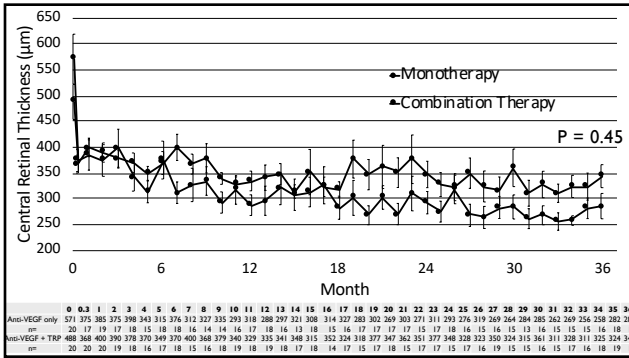
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Baseline Patient Demographics			
	Anti-VEGF only	Anti-VEGF + TRP	Total
% OD	35% (7/20)	55% (11/20)	45% (18/40)
Mean Age (range)	55 (44-73)	56 (31 - 73)	55 (31 - 73)
% Female	20% (4/20)	25% (5/20)	24% (7/29)
Mean HbA1C (range)	8.8 (5.9 - 12.9)	8 (5.9 - 12.8)	8.6 (5.9 - 12.9)
Mean DM Diagnosis Year (range)	2002 (1982 - 2012)	2001 (1980 - 2012)	2001 (1980 - 2012)
Mean DME Diagnosis Year (range)	2012 (2008 - 2014)	2012 (2010 - 2014)	2012 (2008 - 2014)
Mean ETDRS BCVA (range) Snellen equivalent	59.1 (23 - 75) 20/63 (20/400 - 20/32)	60.1 (37 - 76) 20/63 (20/200 - 20/32)	59.6 (23 - 76) 20/63 (20/400 - 20/32)
Mean CRT (range)	571 μm (262 - 1034)	488 μm (273 - 946)	530 μm (262 - 1034)

Protocol Compliance						
Cohort	# Patients Completed M36	# Patients Dropped	# Patients Analyzed (LOCF)	# Possible Visits	# Missed Visits	% Visits Missed
Anti-VEGF only	16	4	18	694	71	10%
Anti-VEGF + TRP	18	2	19	743	70	9%

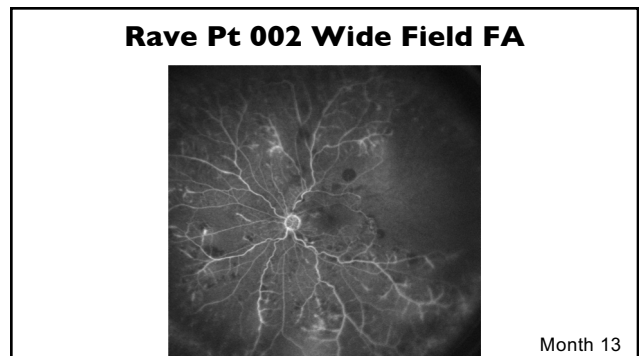
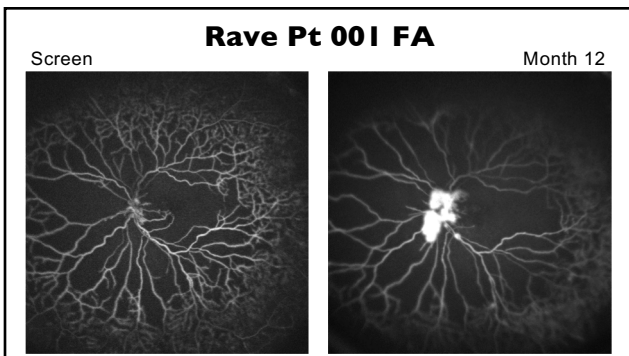
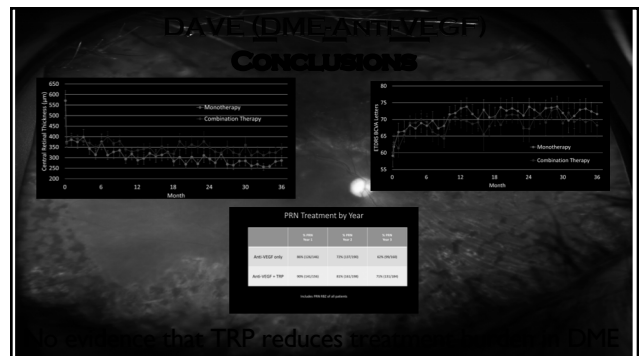
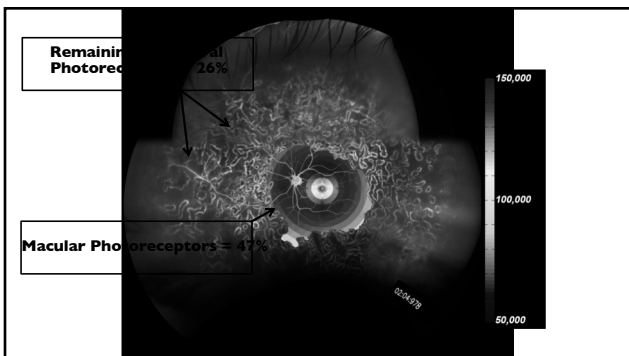
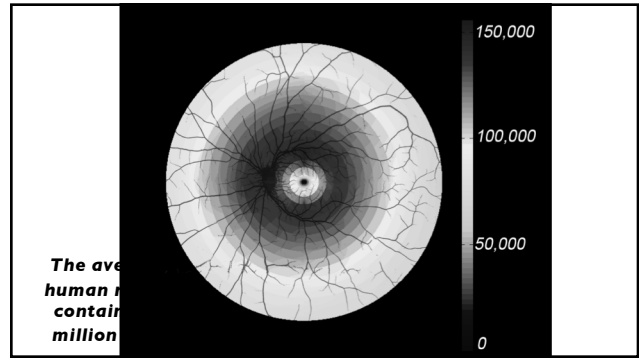
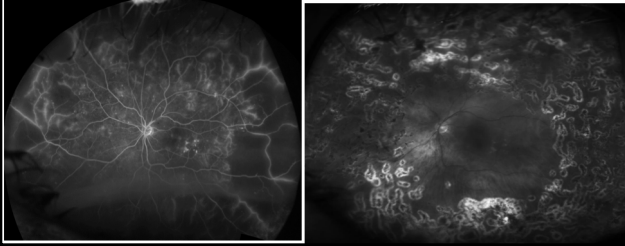


	Baseline GVF	M36 GVF	% Change
Anti-VEGF only (n=9)	10291 degrees ²	10076 degrees ²	-2%
Anti-VEGF + TRP (n=8)	9826 degrees ²	8102 degrees ²	-18%

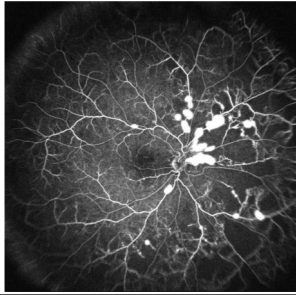
Adverse Events	Adverse Events	
	Monotherapy Cohort	Combination Therapy Cohort
Ocular Adverse Events		
Vitreous Hemorrhage	2 (10%)	2 (10%)
Neovascularization elsewhere	4 (20%)	0 (0%)
Neovascularization of the disc	2 (10%)	0 (0%)
Neovascularization of the iris	2 (10%)	0 (0%)
Worsening glaucoma	3 (15%)	0 (0%)
Worsening cataract	3 (15%)	6 (30%)
Posterior vitreous detachment	4 (20%)	5 (25%)
Epiretinal membrane	1 (5%)	3 (15%)
Hyphema	2 (10%)	0 (0%)
Dilated pupil	0 (0%)	1 (5%)
Notable Serious Adverse Events		
Neovascular glaucoma	2 (10%)	0 (0%)
Vitreous hemorrhage with acute vision loss	0 (0%)	1 (5%)
Sepsis	1* (5%)	1* (5%)
Systolic heart failure	1* (5%)	1* (5%)
Atrial flutter	1* (5%)	1* (5%)
Coronary artery disease	0 (0%)	1 (5%)
Pneumonia	2* (10%)	1* (5%)
Osteomyelitis	3* (15%)	1* (5%)
Cellulitis	2 (10%)	1 (5%)
Worsening renal failure	3 (15%)	4 (20%)

* Systemic events experienced by patients with both eyes enrolled are reported in both columns. Events reported on a per patient basis.

Why Didn't TRP Reduce Tx Burden?



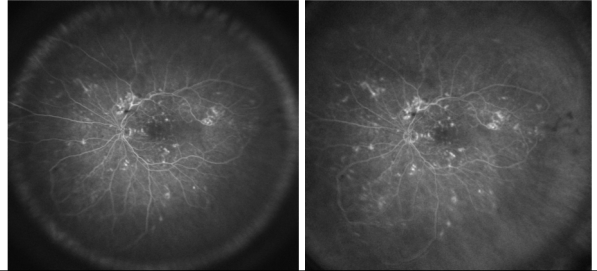
Rave Pt 004 Wide Field FA



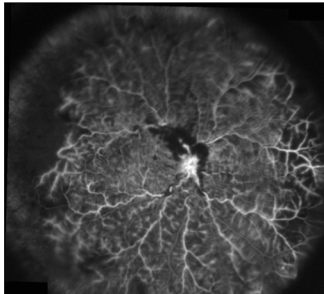
Month 12

Rave Pt 005 Wide Field FA

Month 8



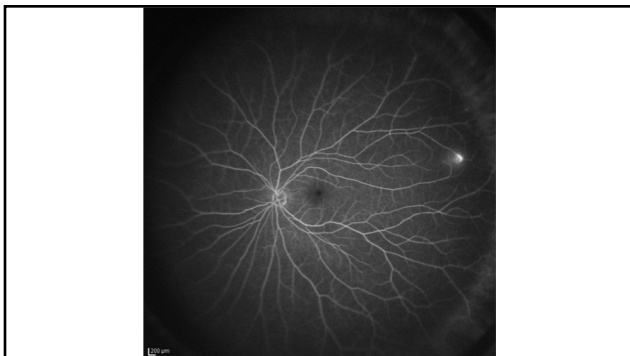
Rave Pt 008 Wide Field FA



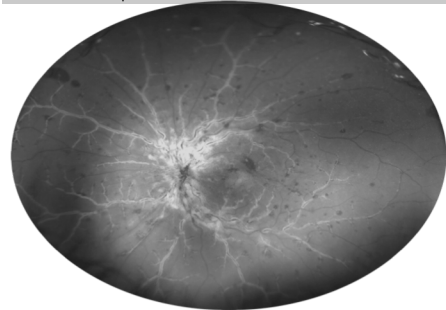
Month 8

Clinical Importance of the Peripheral Retina

- Retinal Vascular Diseases
- Diabetic Retinopathy
- Surgical Diseases
- Uveitis & Tumors

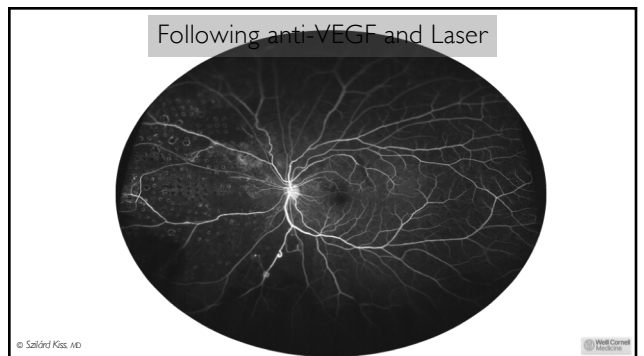
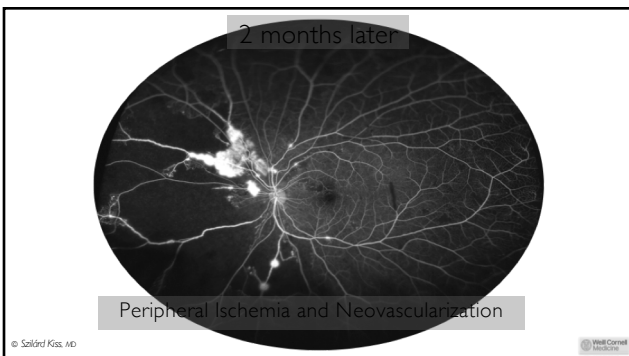
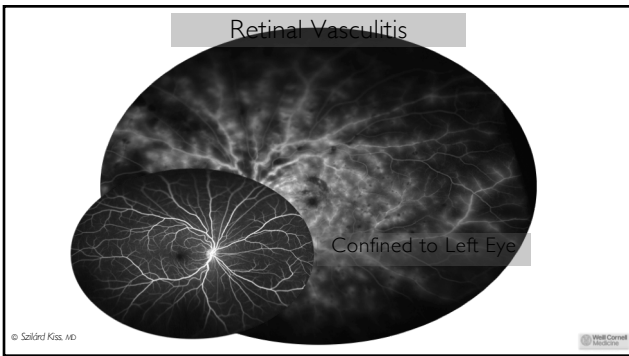
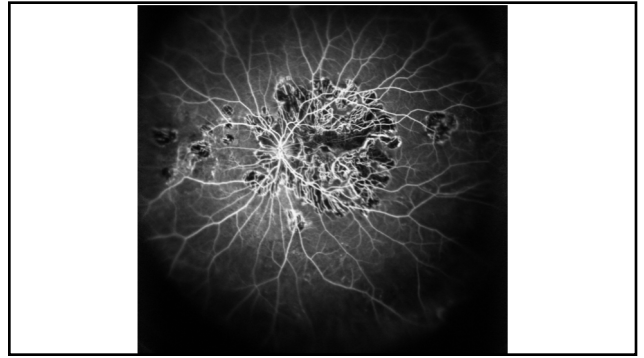
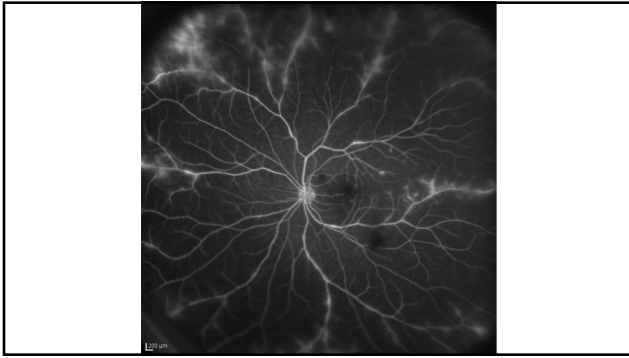


Idiopathic Retinal Vasculitis



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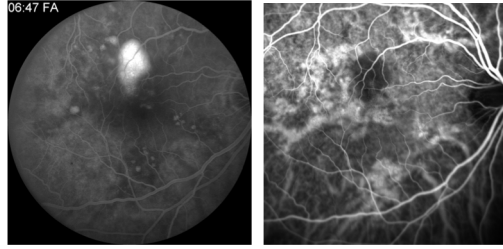


Indocyanine Green Angiography



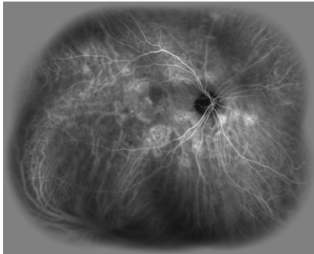
Central Serous Retinopathy (CSR)

Indocyanine Green Angiography



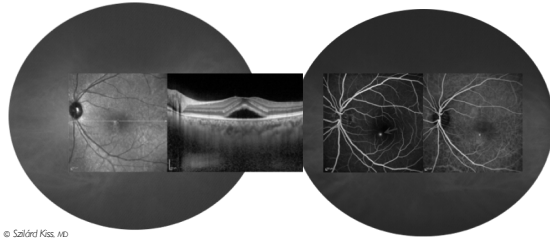
Central Serous Retinopathy (CSR)

Indocyanine Green Angiography



Central Serous Retinopathy (CSR)

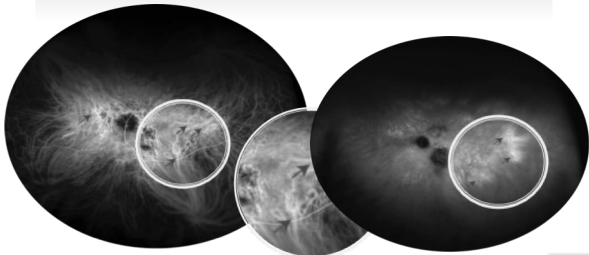
Central Serous Choroidopathy Late Staining Throughout the Fundus Even in Asymptomatic Eye



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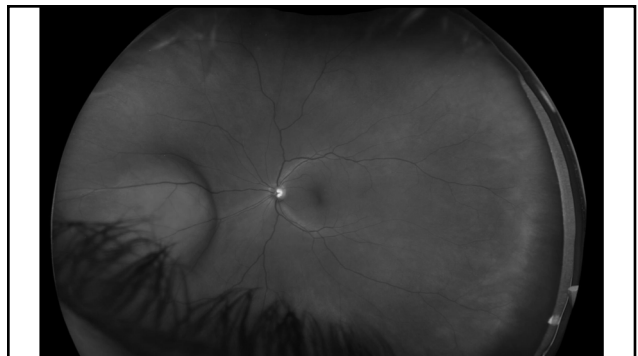
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Chronic Central Serous Choroidopathy Late Hyperfluorescence Corresponding to the Areas of Dilated Vessels



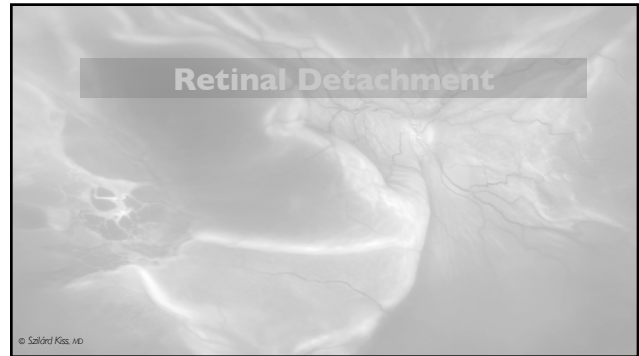
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Clinical Importance of the Peripheral Retina

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Case 1

Sudden Onset Homonymous Visual Field Cut in a Phakic 38 year old man

Two days following cryotherapy and a pneumatic retinopathy

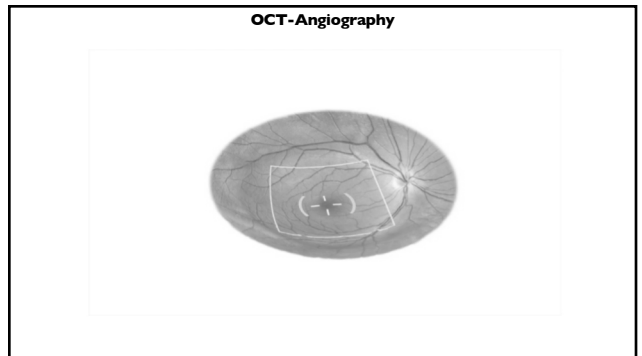
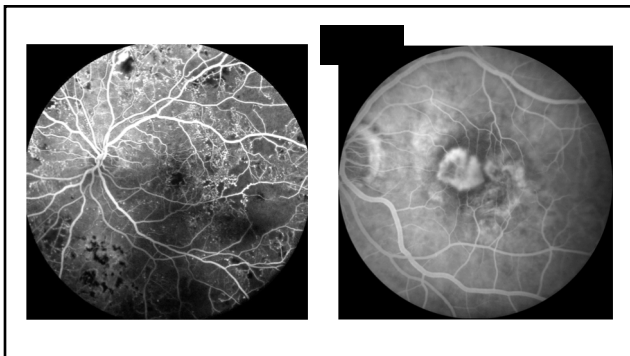
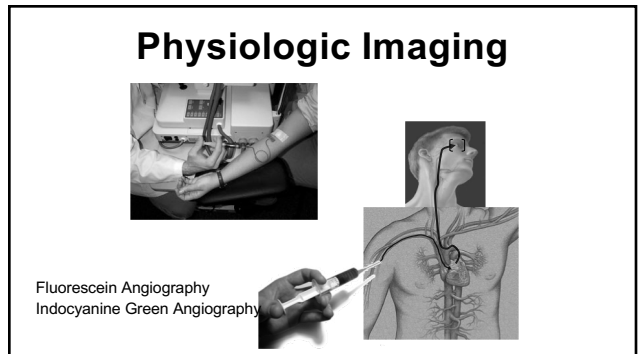
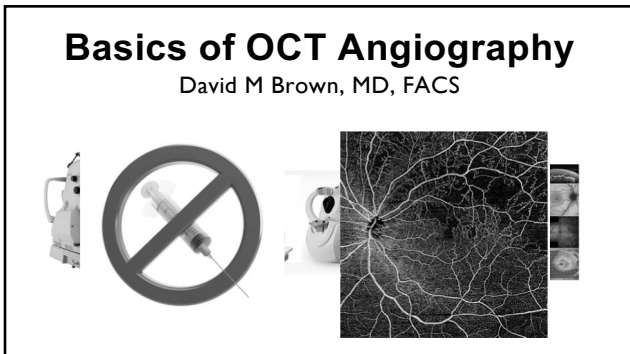
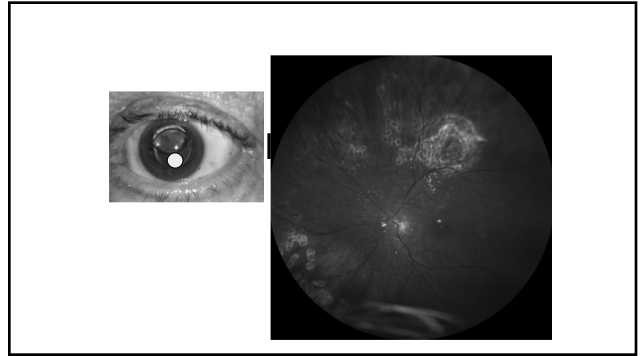
Case 2

Six weeks following small gauge trans-conjunctival 25-gauge vitrectomy, endolaser and SF6

Case 3

Two months following small gauge trans-conjunctival 25-gauge vitrectomy, cryotherapy and C3F8

Case 4 – Prognosis



Principles of OCT Angiography

Motion Contrast Detection of Flow

Structure : OCT Flow : OCT Angiography

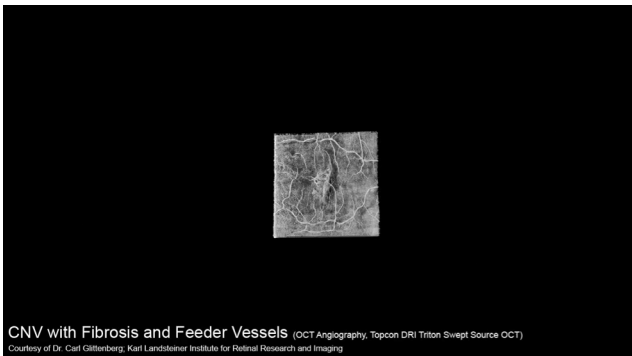
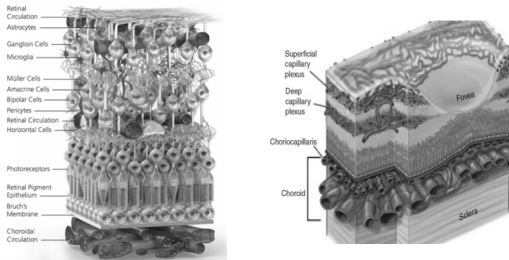


Example of using motion contrast to highlight the flowing water in this water faucet video

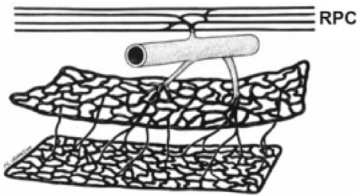
- Detects blood cell motion contrast
- Cross-sectional images acquired rapidly and repeatedly from the same location on the retina
- The flow is seen as the **difference** between two subsequent image frames:
Flow = Frame #1 – Frame #2

- Non-invasive way of imaging blood vessels
- Allows visualization of the deep choroidal plexus
- Allows information in 3 seconds
- Used for:
CNV, RVO, Diabetes, Arterial occlusion, Uveitis, AMPPE, Polypoidal disease,

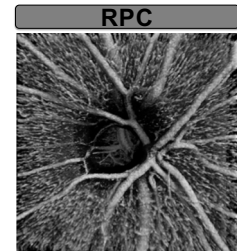
Superficial Vascular Plexus, Deep Vascular Plexus and Choriocapillaris at Normal macula

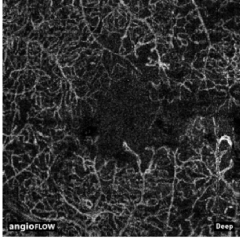


Inner Retina Capillary Network Has 3 Individual Layers



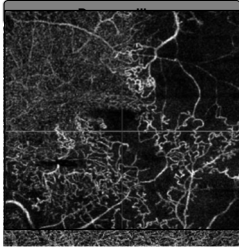
Radial peripapillary capillaries are clearly visible





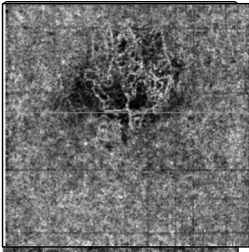
Superficial vascular plexus is clearly visible

- Valuable for vascular diseases involving the macula



Deep capillary plexus is clearly visible

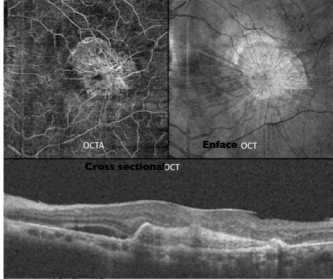
- Important for outer retinal vascular diseases
- Helps to analyze deep capillary ischemia



Choriocapillaris is visible

- Helpful to highlight the tightly packed network under the macula
- May help to show impact of treatments to RPE

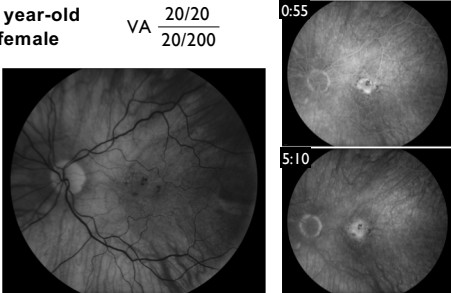
OCT-A : Structure & Function



Images courtesy of C.J. Chen, MD

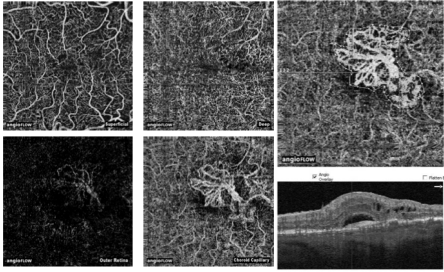
Neovascular AMD

81 year-old female VA $\frac{20/20}{20/200}$



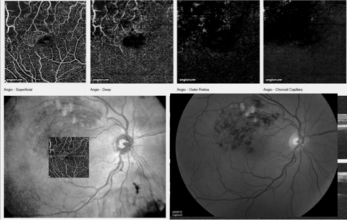
0:55
5:10

Select area: 1.455 mm²
Vessel area: 0.872 mm²



52-year-old male
Hx of systemic HTN


VA $\frac{20/100}{20/20}$



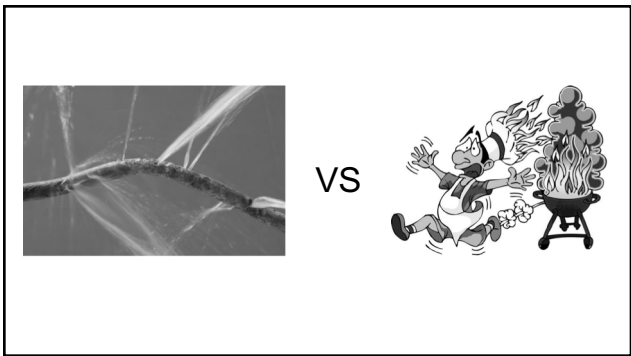
Branch Retinal Vein Occlusion
(3*3 mm Scan Area)

A TALE OF TWO RETINAS...

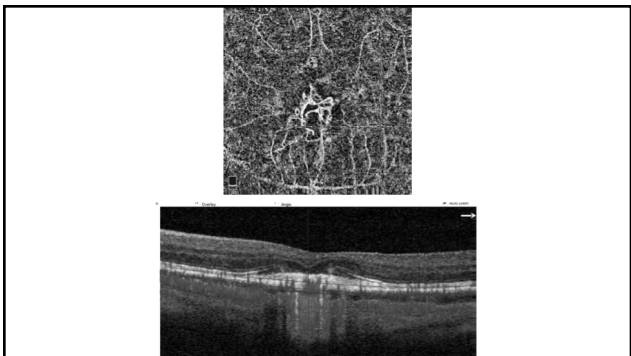
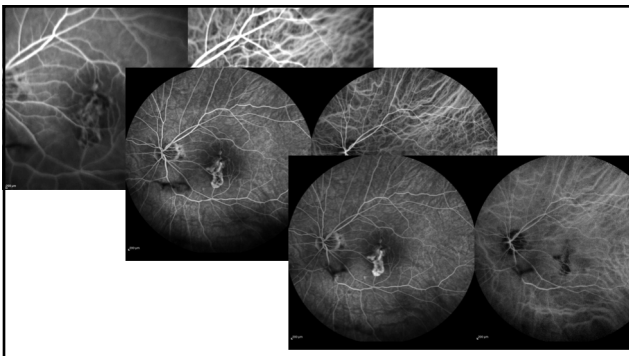
David M Brown MD
Retina Consultants of Houston, Houston Methodist Hospital, TX

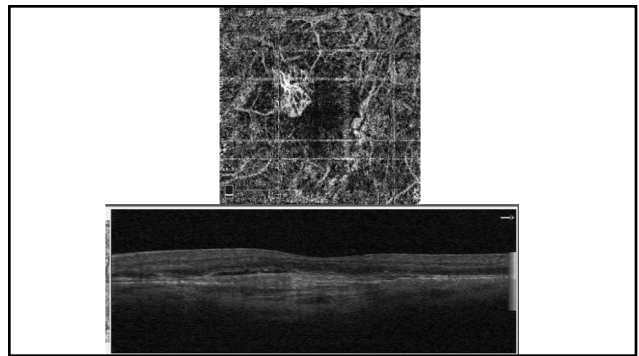
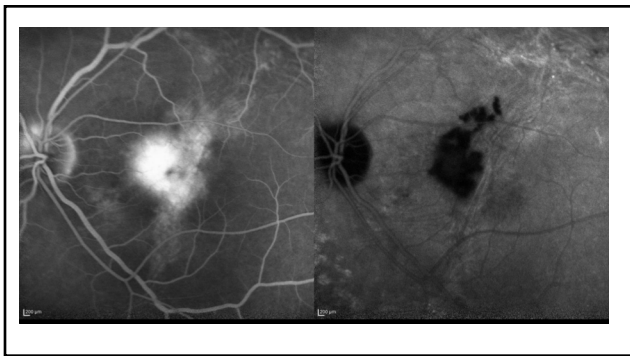
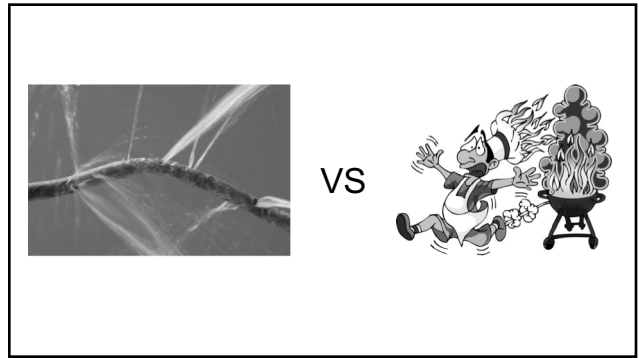
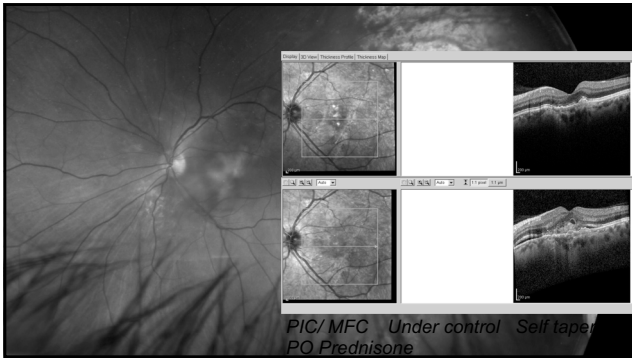


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ered off, 88 days s/p Ozurdex



VS



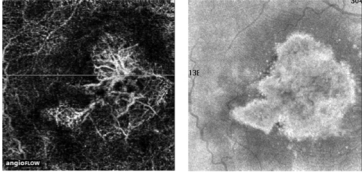


CNV in Central Serous

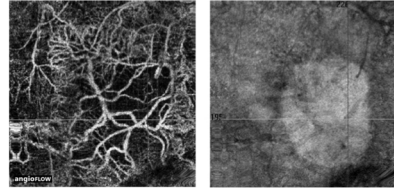
- A.=IVFA
- B.=OCT-A
- Using automated depth imaging
- C.=ICG
- D.=OCT-A

Type 1 NV Tangled Network

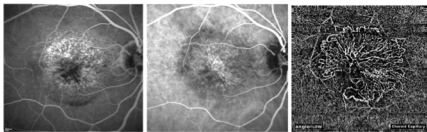
Type 1 NV Sea fan-like blood vessels with large feeder vessels and large caliper vessels



Type 1 NV Cartwheel network



Type 2 NV FA vs. ICGA vs. OCT Angiography



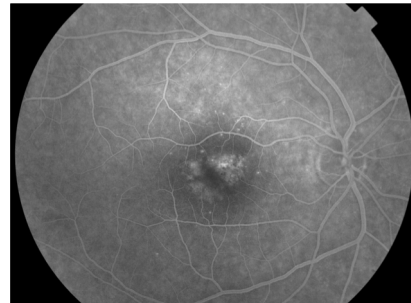
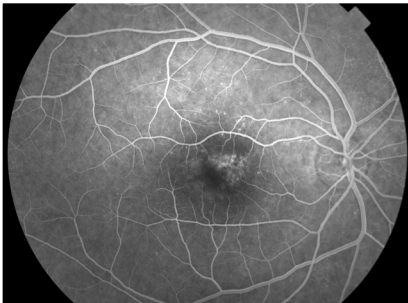
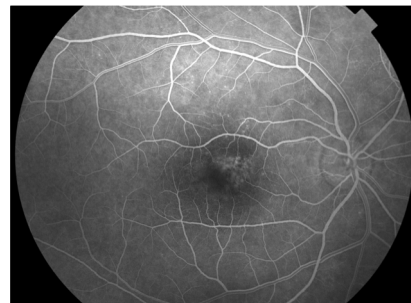
FA

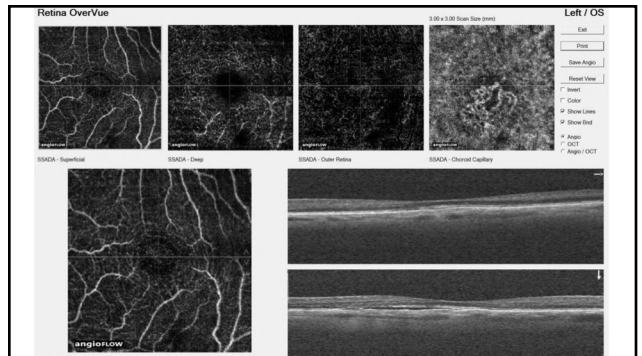
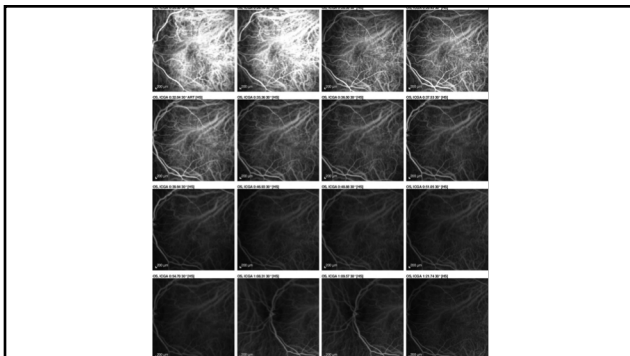
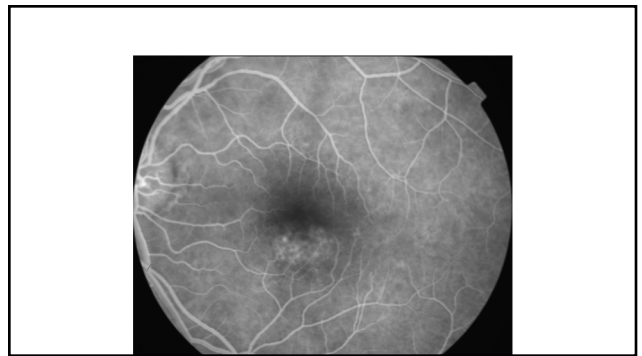
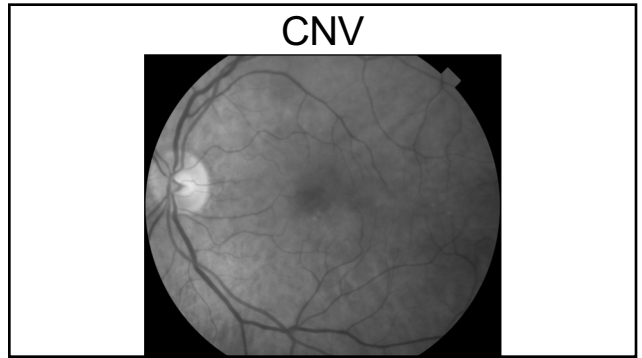
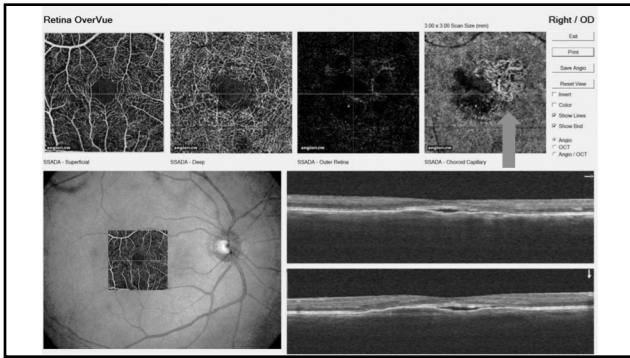
ICGA

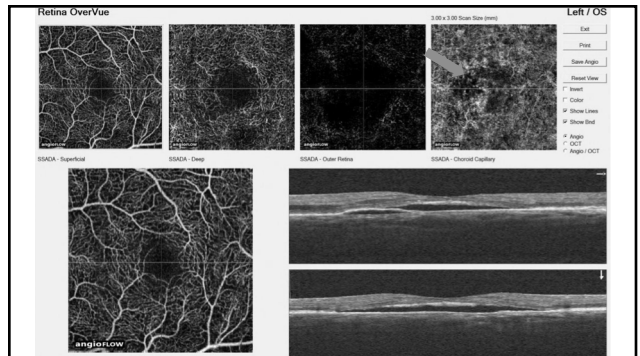
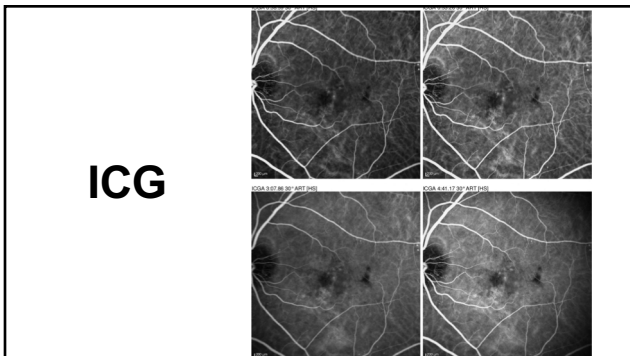
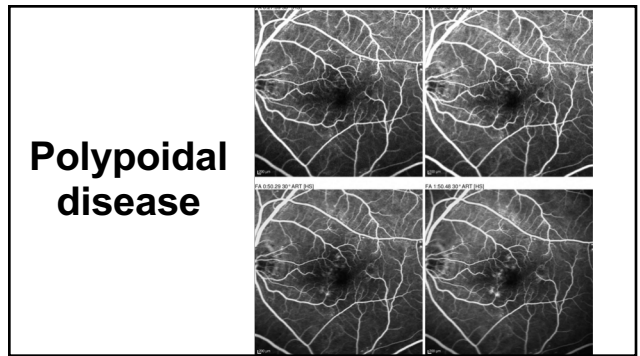
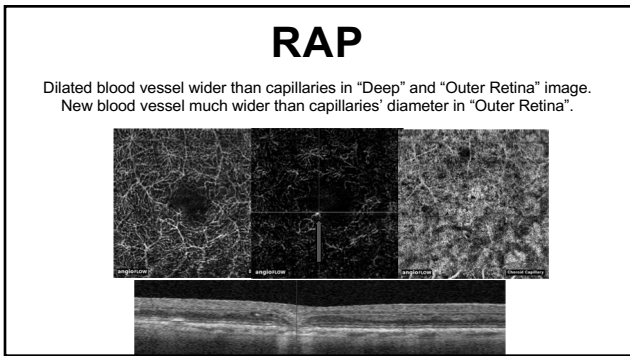
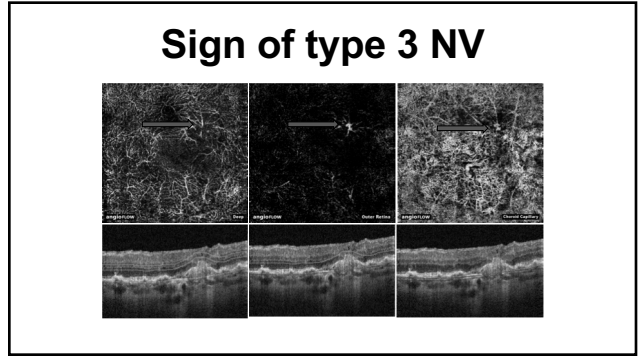
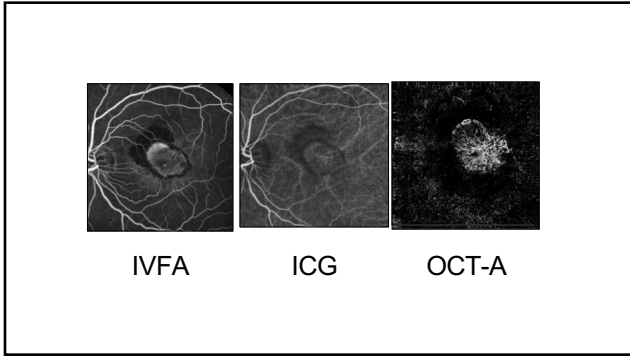
AngioVue

Prof. Federico Ricci, Tor Vergata University, Rome, Italy

Occult CNV





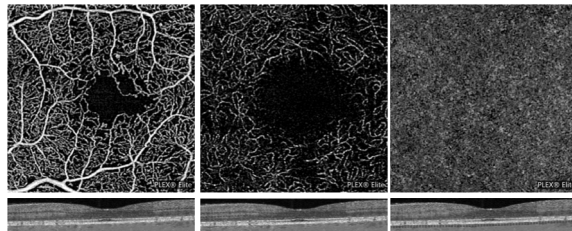


Diabetic Retinopathy

- OCT angiography can clearly visualize microaneurysms and retinal non-perfused areas and enables closer observation of each layer of the retinal capillaries

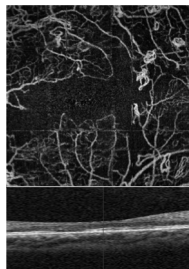
*Optical Coherence Tomography Angiography in Diabetic Retinopathy: A Prospective Pilot Study
Dr. Akhiro Ishibazawa and Dr. Akitoshi Yoshida
American Journal of Ophthalmology in April, 2015

OCT-A in Diabetic Retinopathy

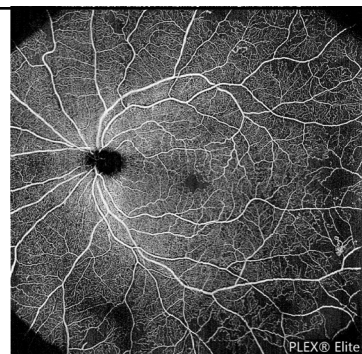


Superficial Deep Choriocapillaris

OCT-A in Diabetic Retinopathy

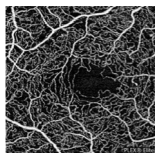


OCT-A in Diabetic Retinopathy



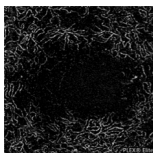
PLEX® Elite

Diabetes

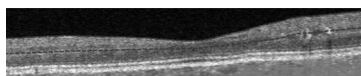


Superficial

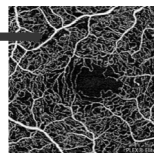
- Capillary non-perfusion
- Microaneurysms
- Microaneurysms' lumen obliteration
- Diabetes: Neovascularization (proliferative diabetic retinopathy)



Deep

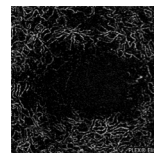


Diabetes

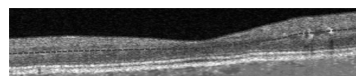


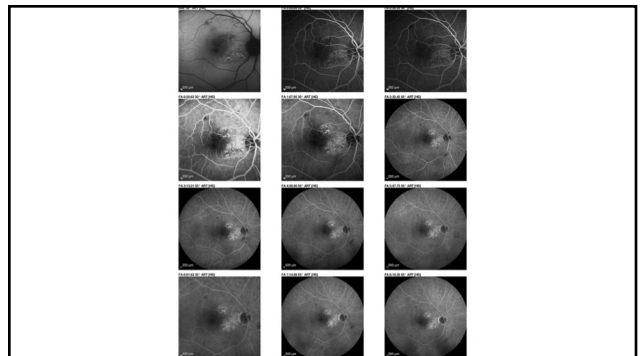
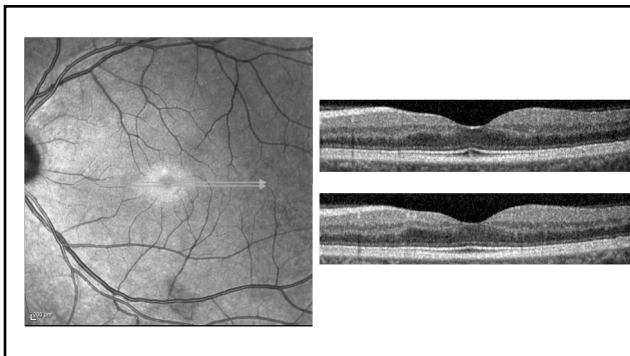
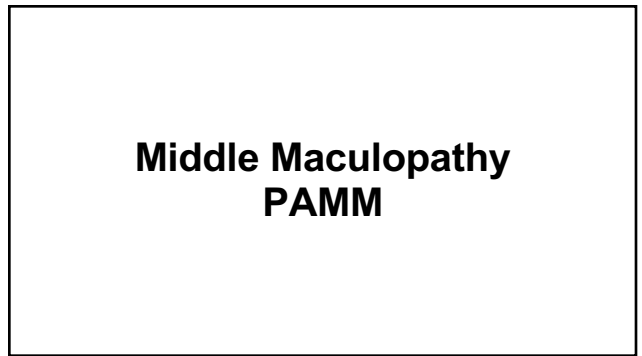
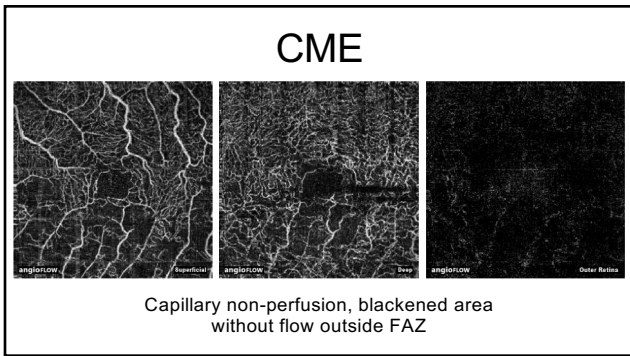
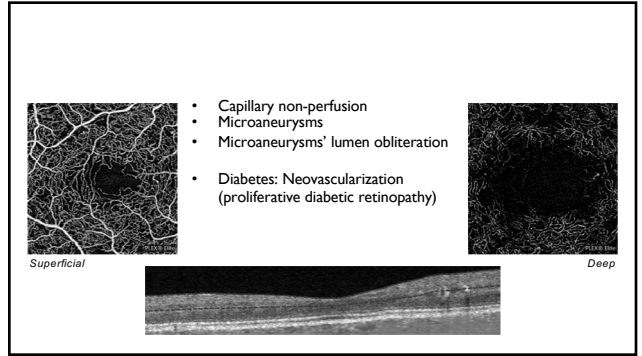
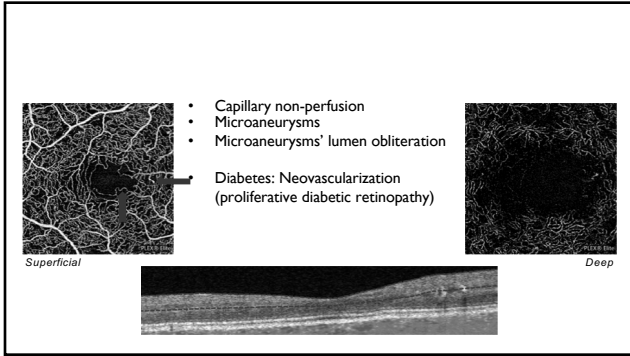
Superficial

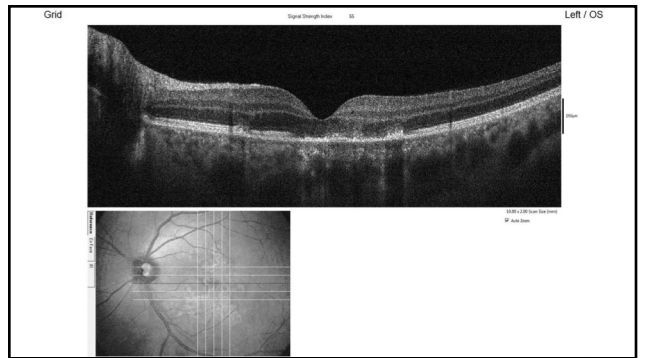
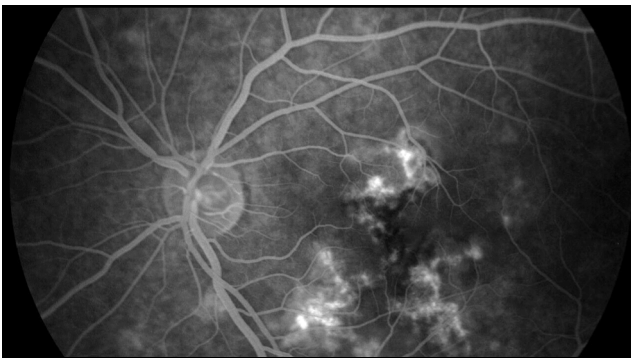
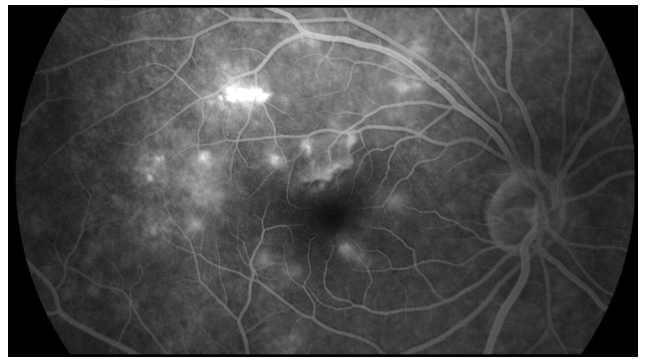
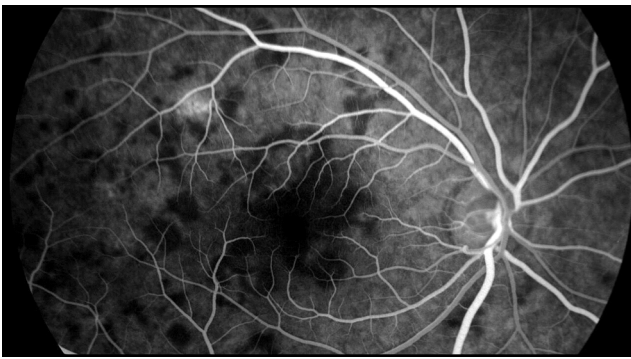
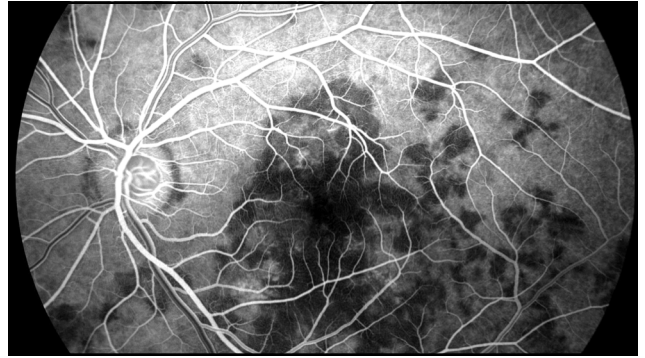
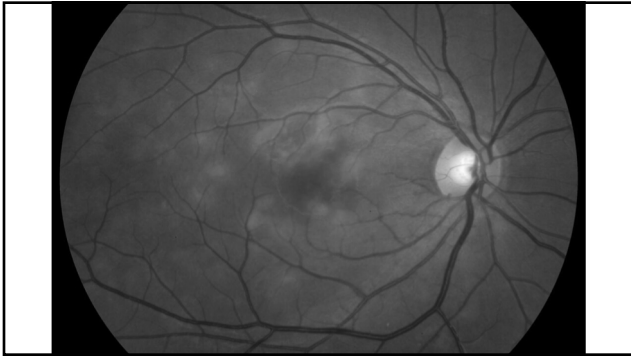
- Capillary non-perfusion
- Microaneurysms
- Microaneurysms' lumen obliteration
- Diabetes: Neovascularization (proliferative diabetic retinopathy)

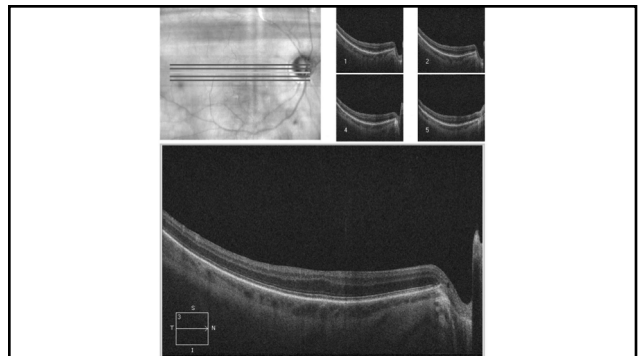
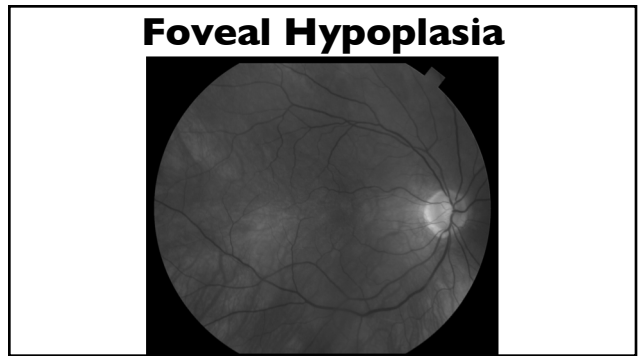
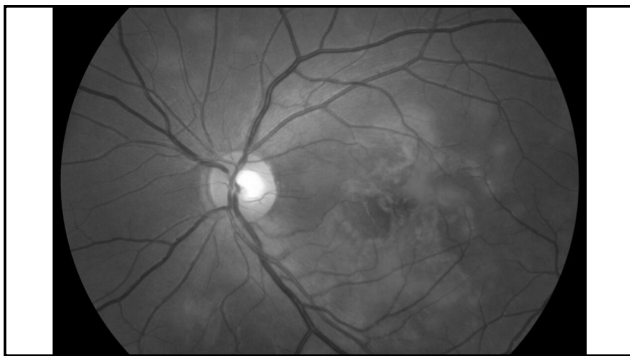
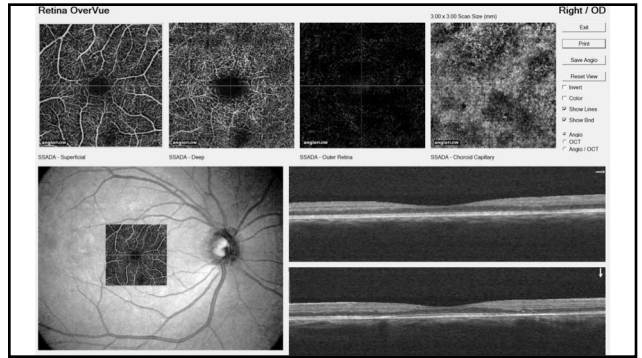
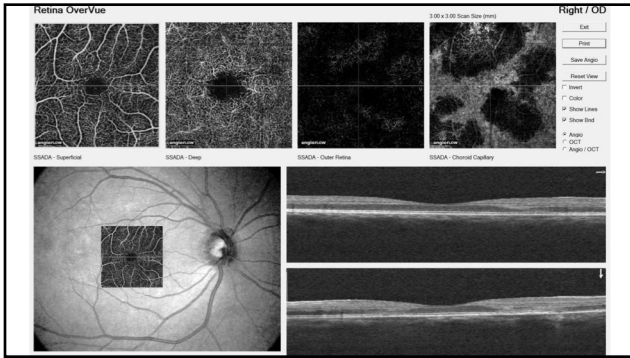


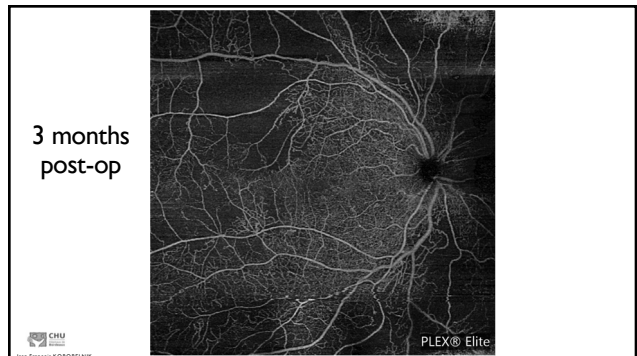
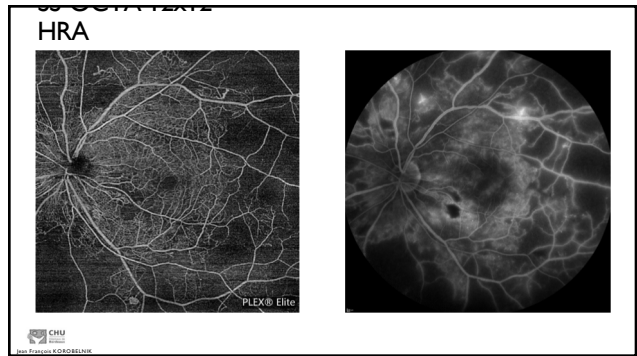
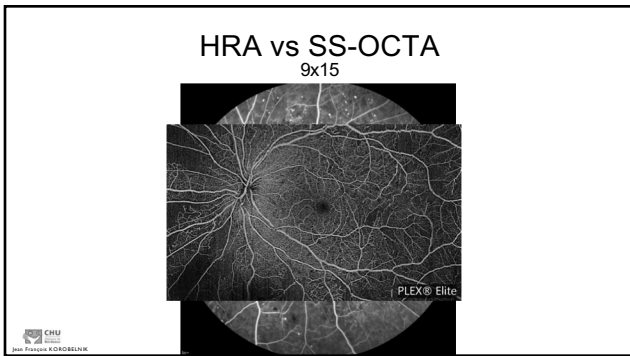
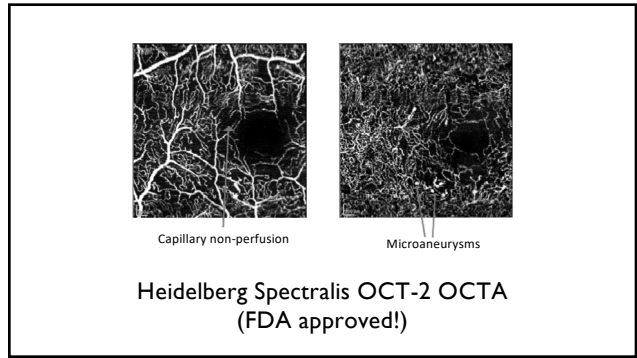
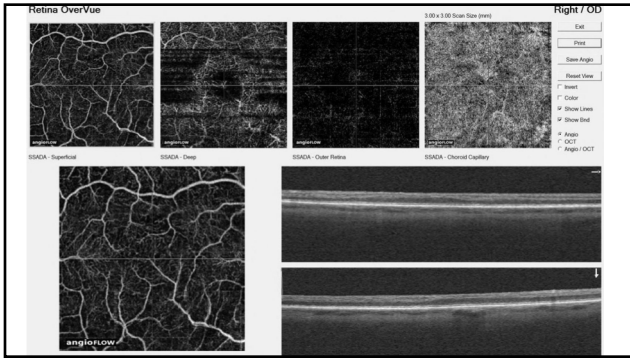
Deep

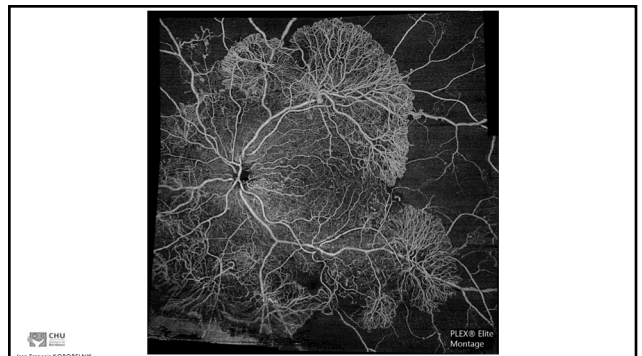
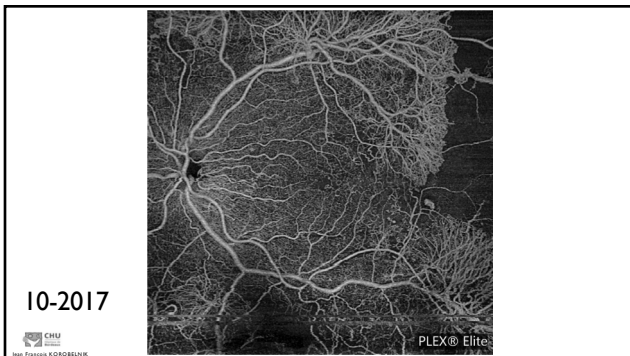
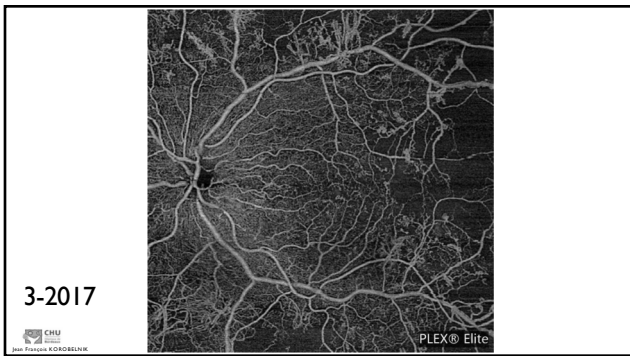
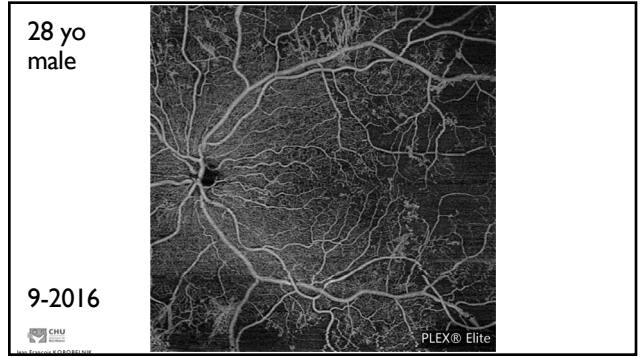
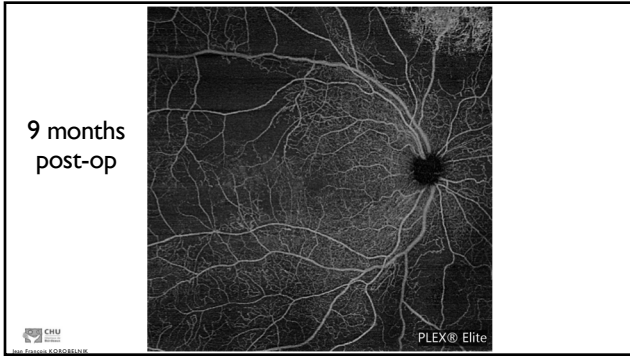












- In the future the OCT-A may help us follow, aid in diagnosis, and change our treatment paradigms for patients with CNV
- The OCT-A aids in determining where the pathology is occurring non invasively
- The OCT-A may help guide drug development

