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جامعة الملك سعود
King Saud University

Utility of Optical Coherence Tomography Angiography in Diabetic retinopathy

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I have no financial interest relevant to this presentation

OCTA and DR

- OCT angiography (OCTA) has been significantly incorporated to improve the diagnosis and management of DR.

- OCTA is a relatively fast, non-invasive technique that can generate high-resolution images of the retinal microvasculature at distinct depths, allowing an improved delineation of vascular features seen in DR.

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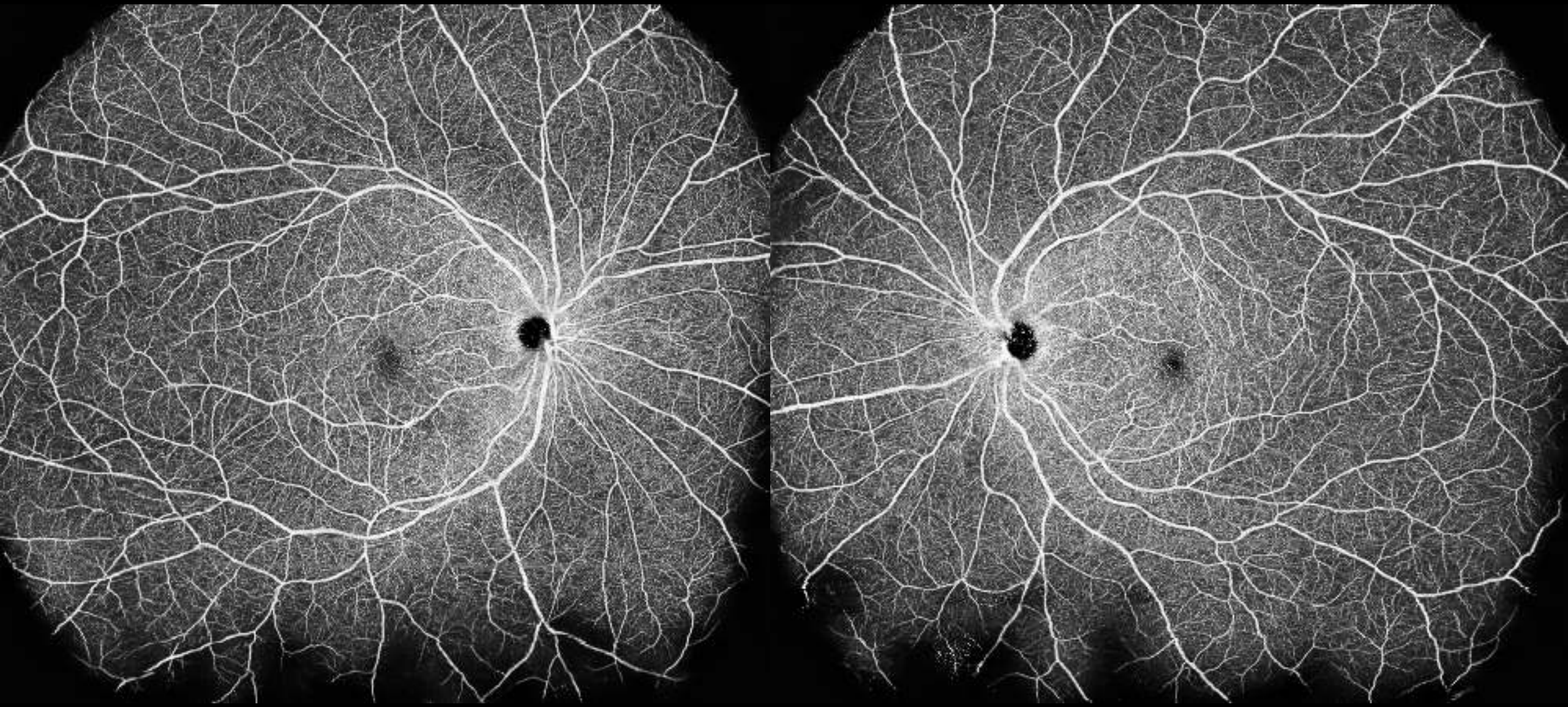

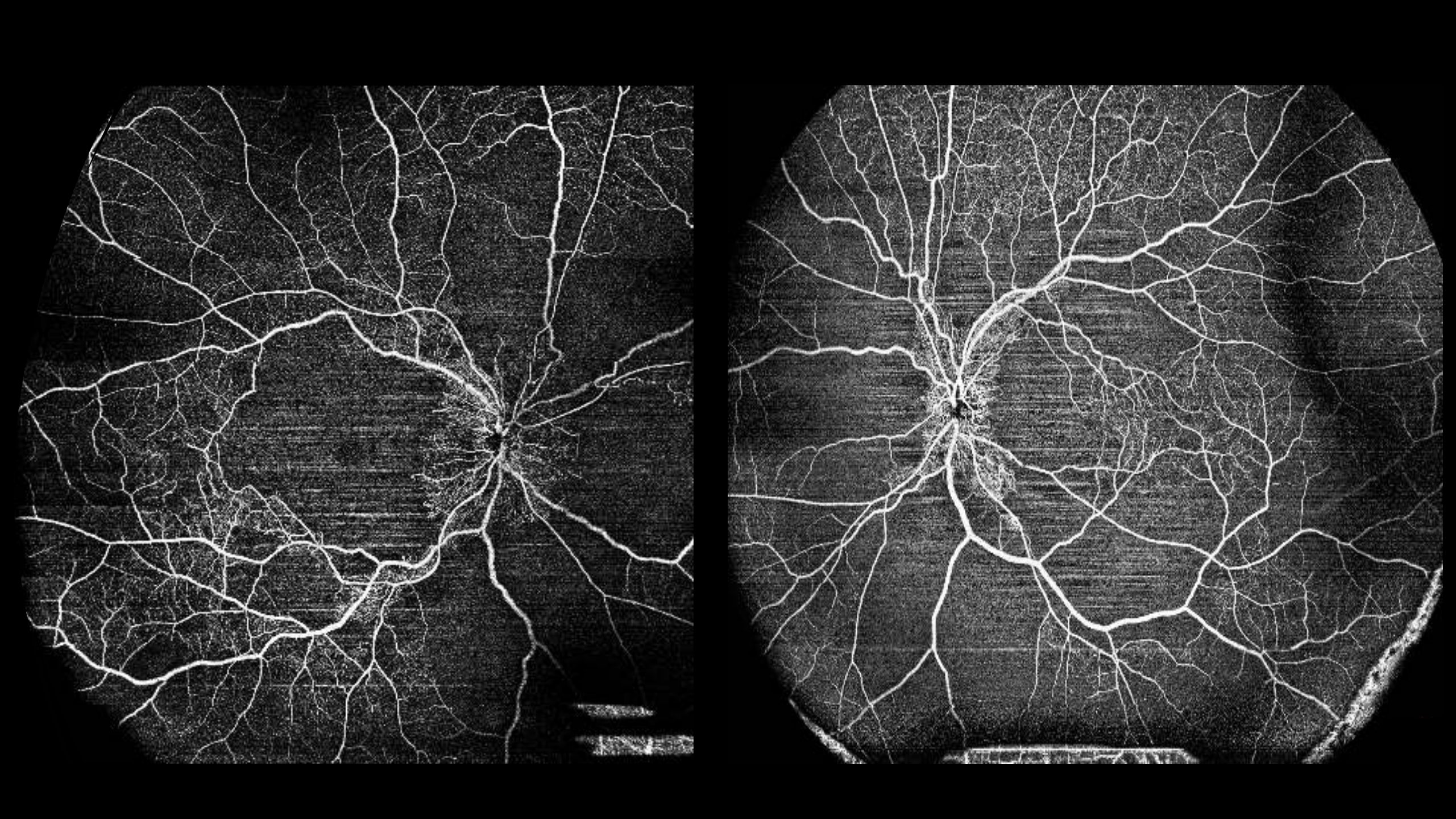

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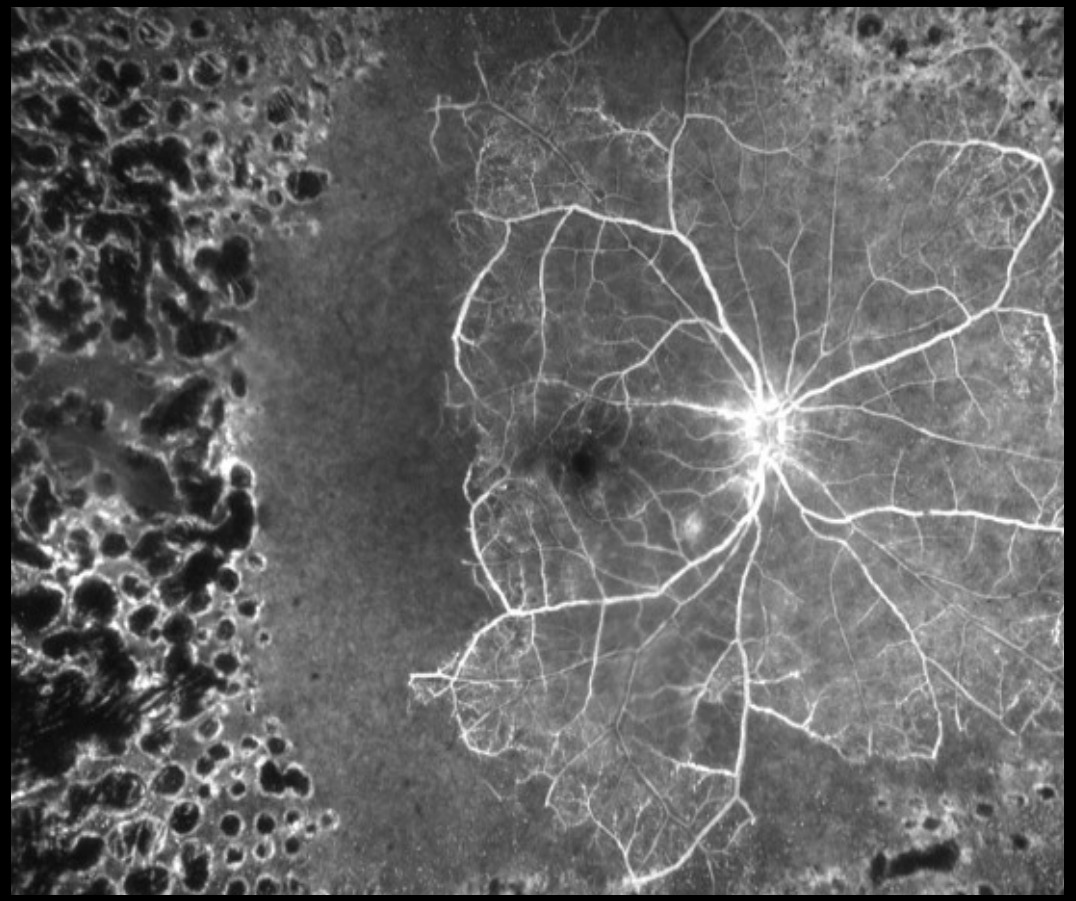

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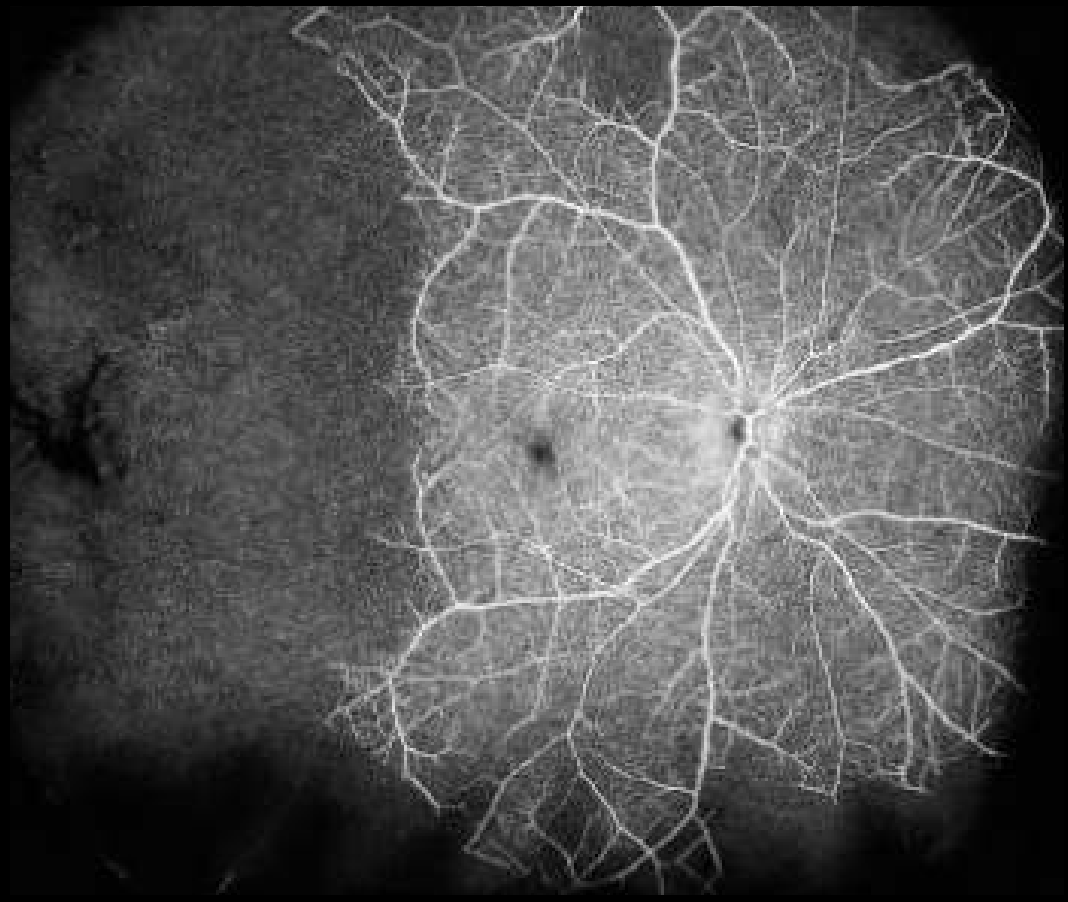
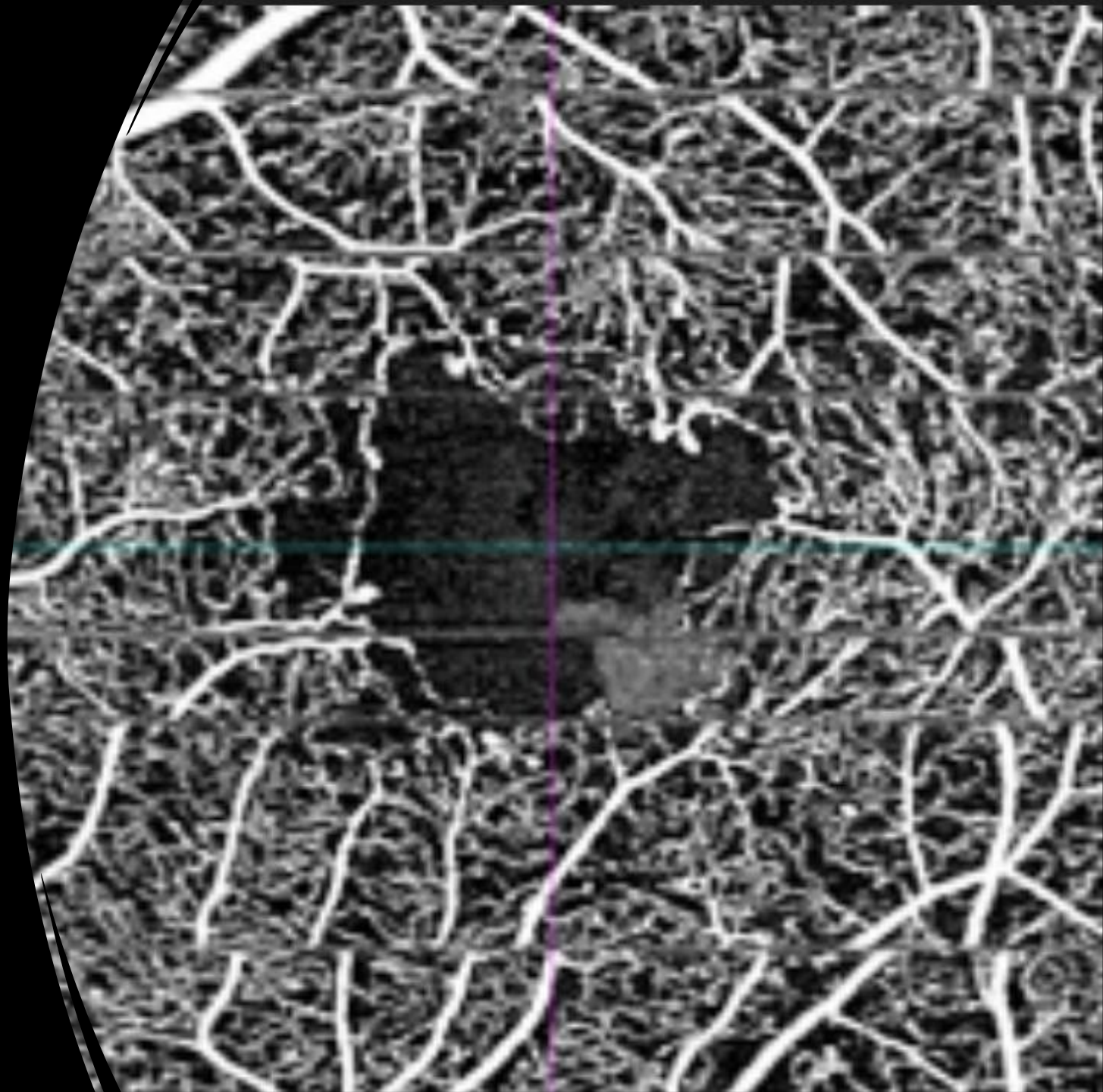
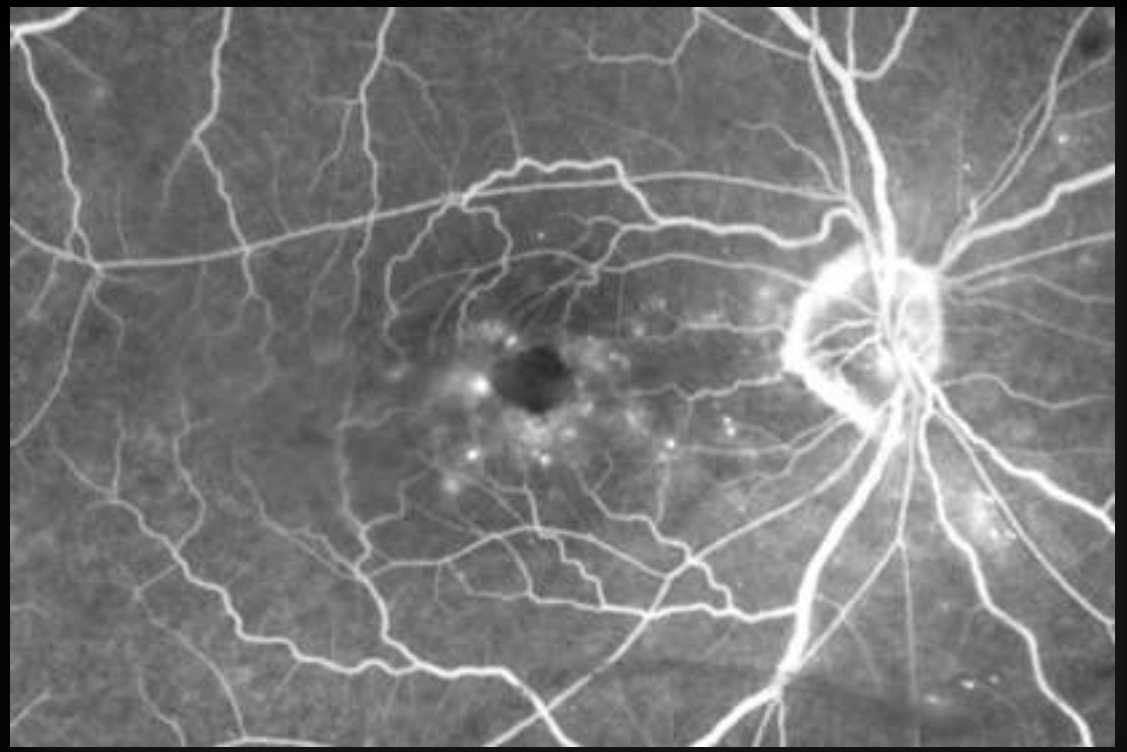
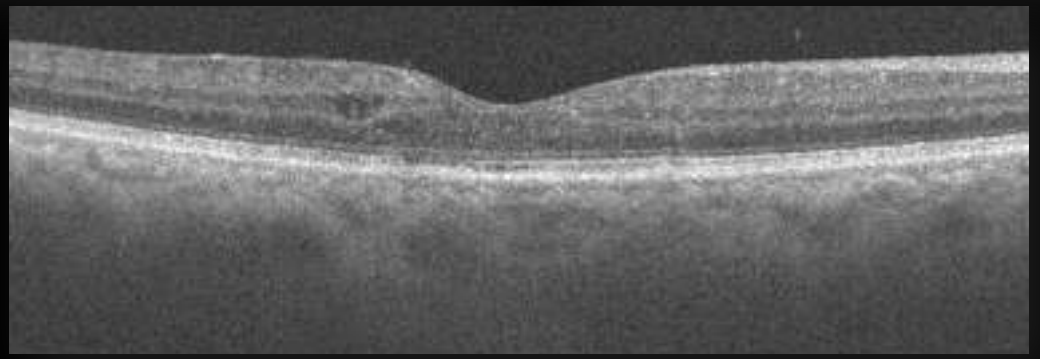


Diabetic macular ischemia (DMI)



Diabetic Macular Ischemia (DMI)





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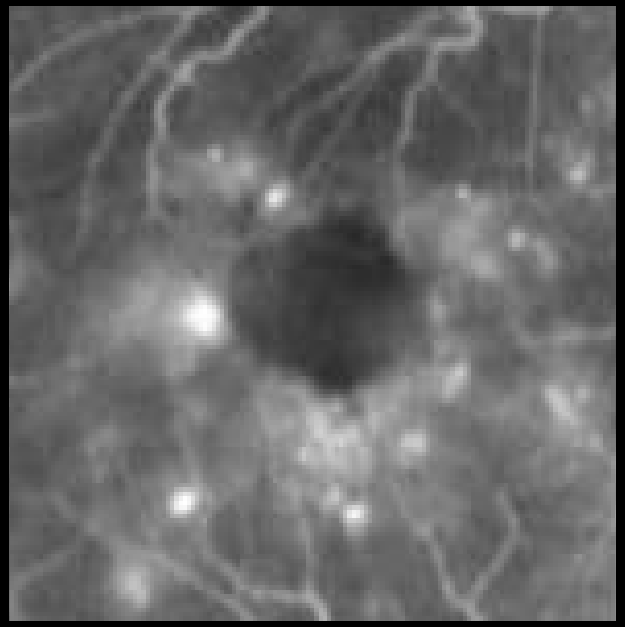
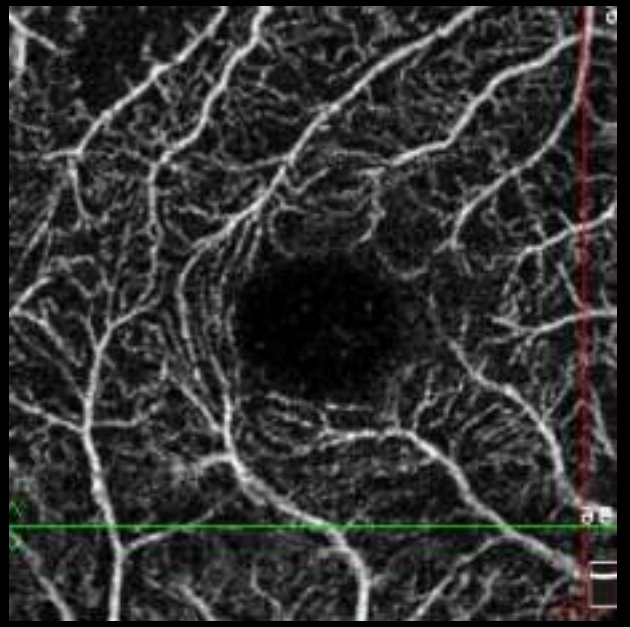
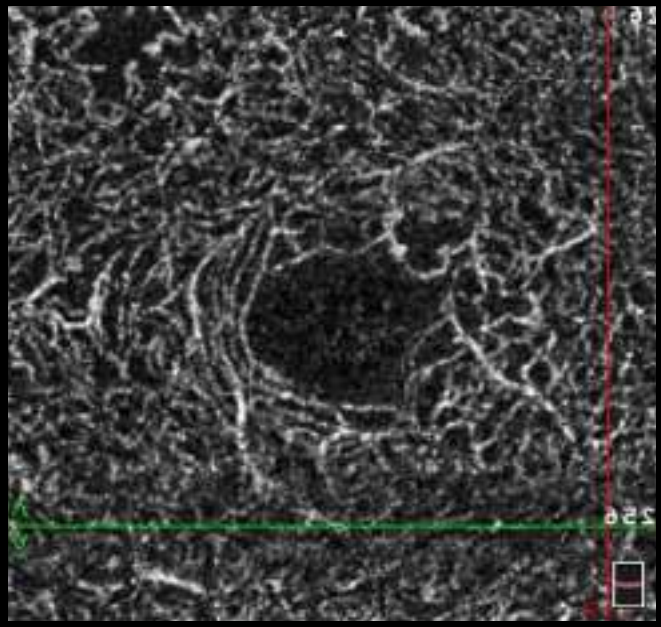




SCP



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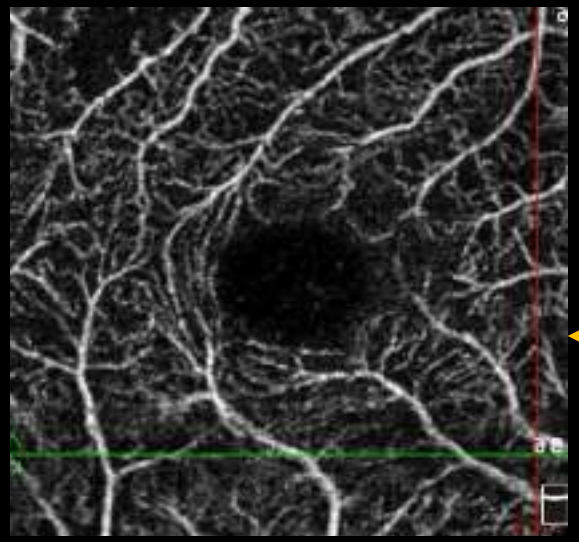
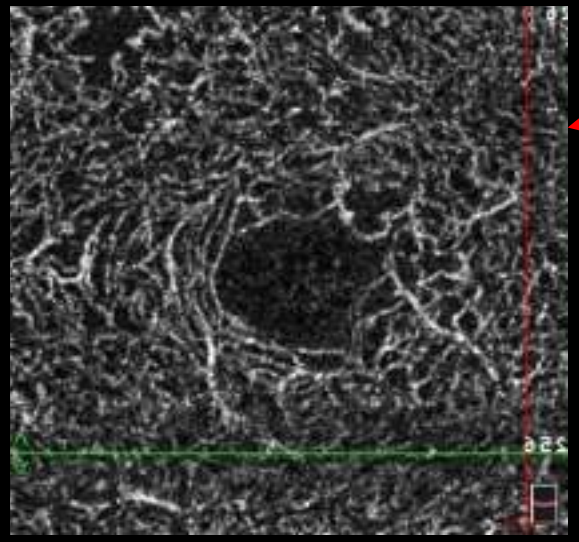
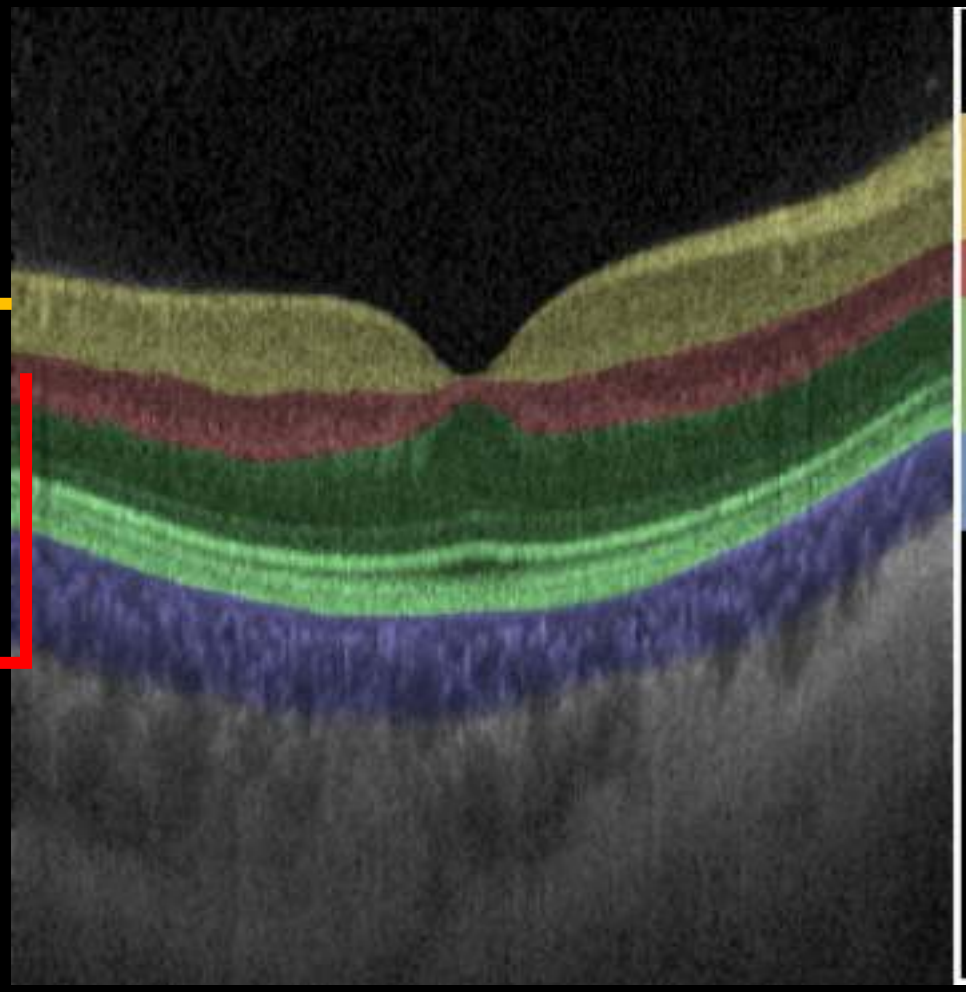
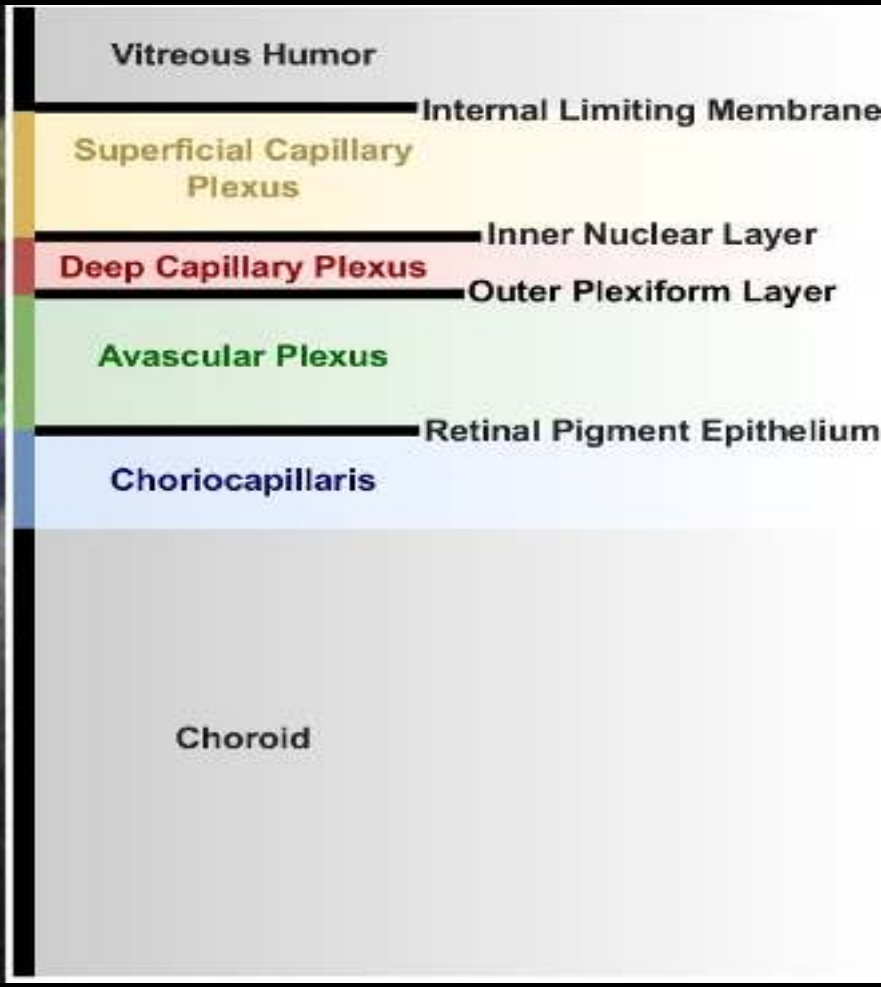
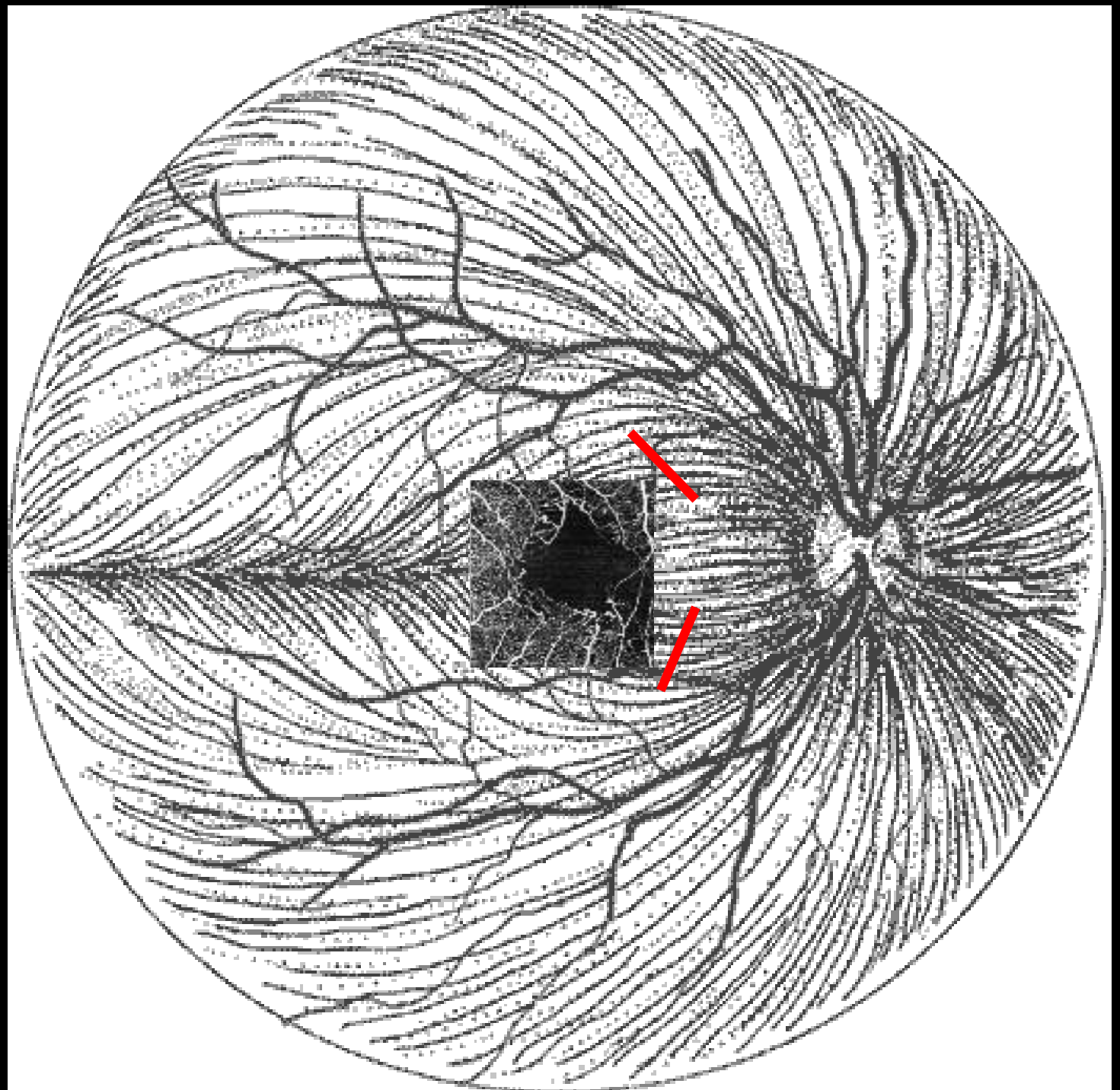
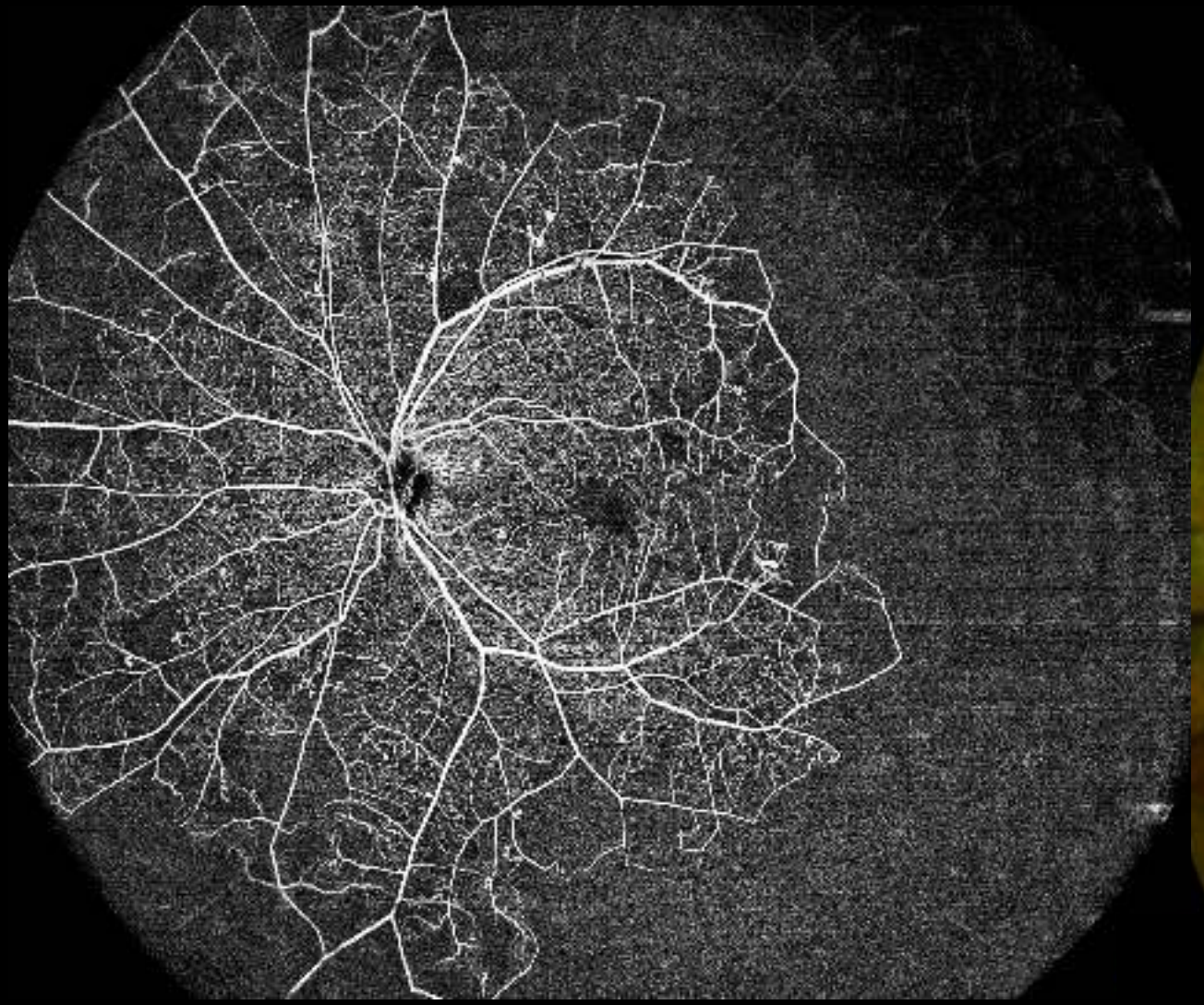


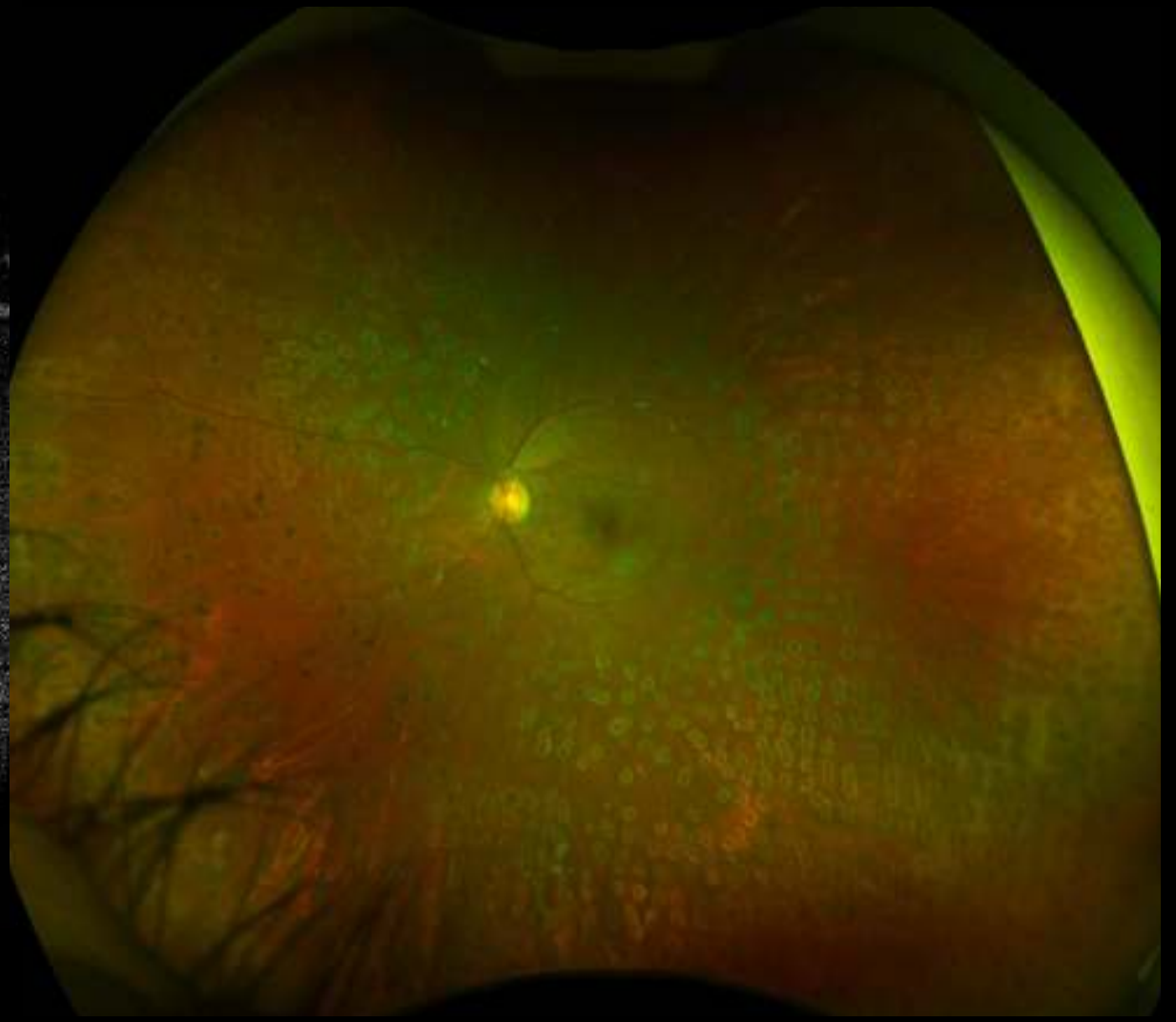


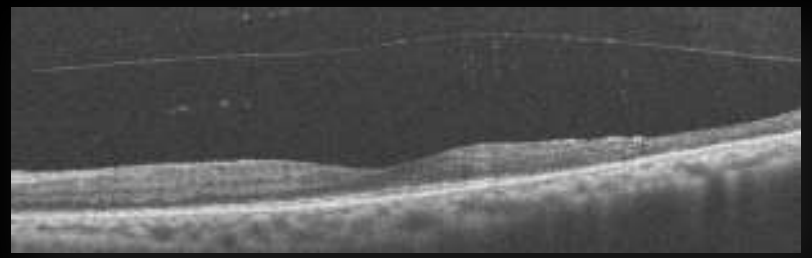


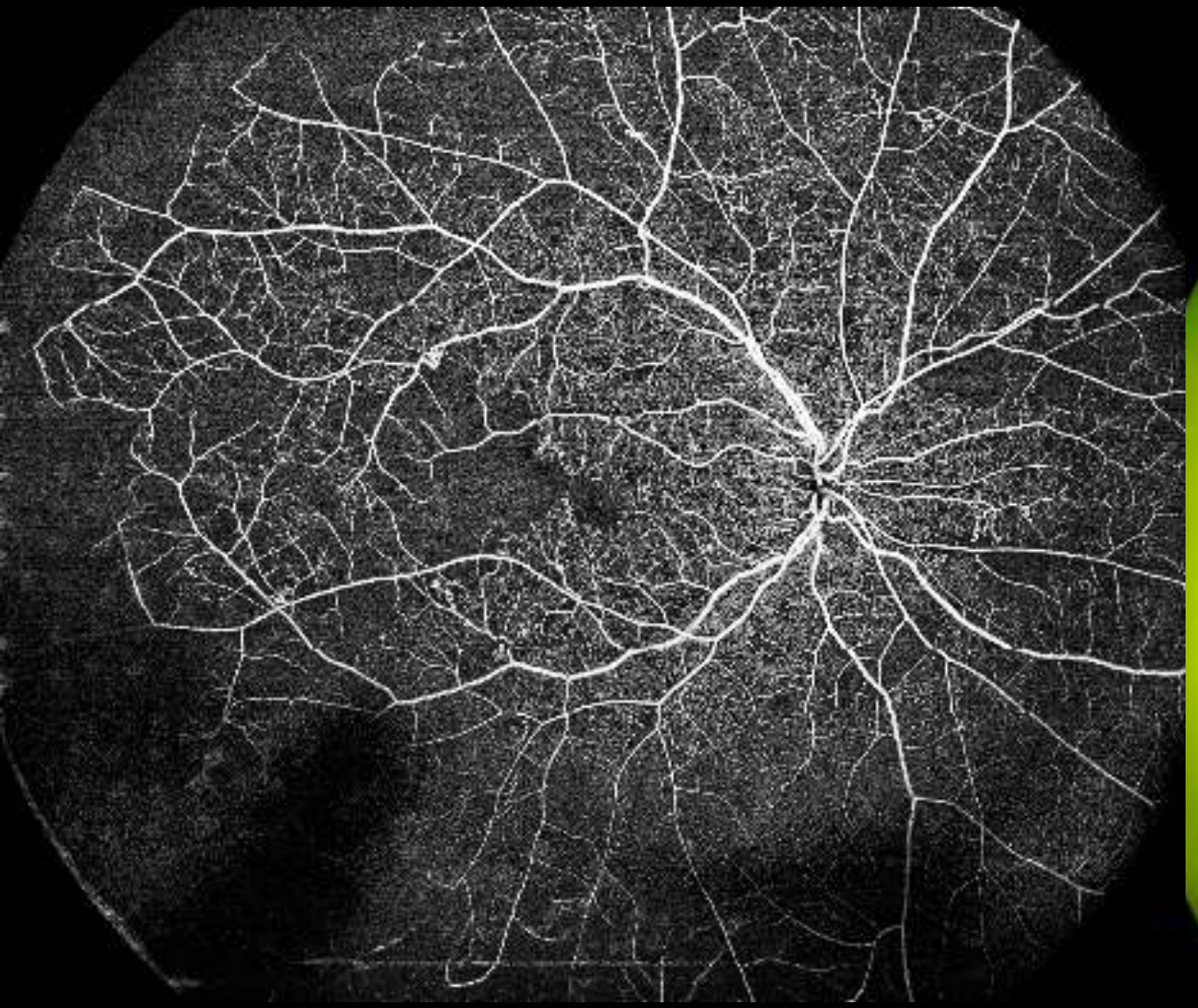

Vitreous Humor
Internal Limiting Membrane
Superficial Capillary Plexus
Inner Nuclear Layer
Deep Capillary Plexus
Outer Plexiform Layer
Avascular Plexus
Retinal Pigment Epithelium
Choriocapillaris
Choroid

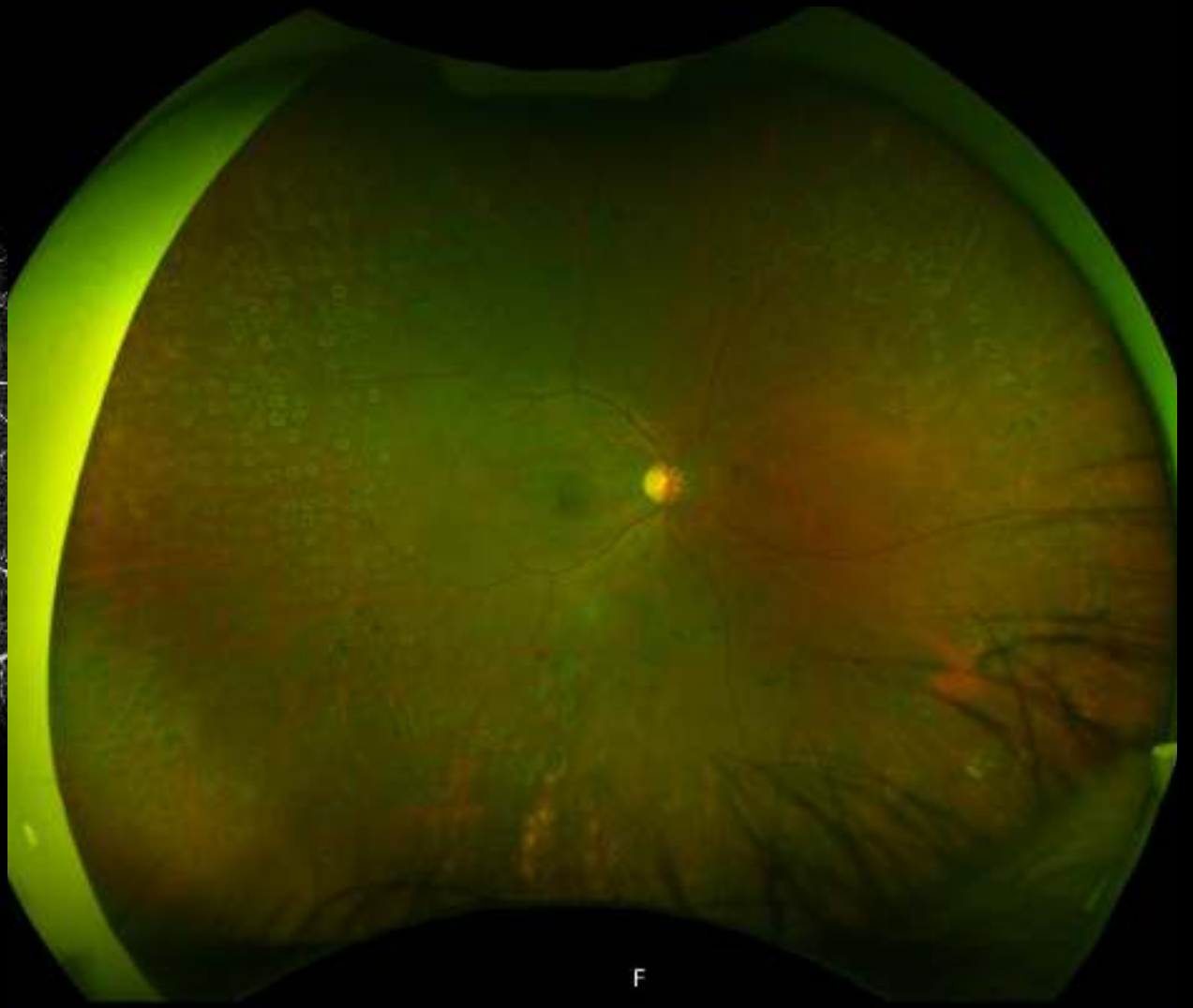








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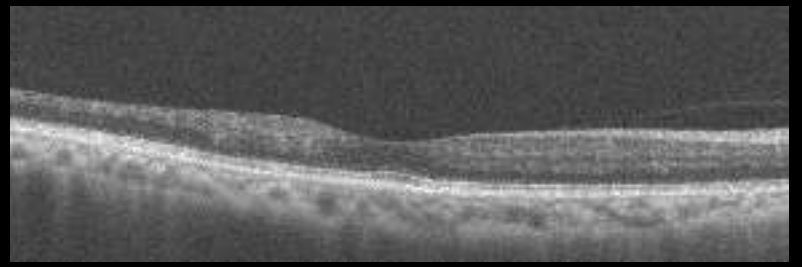
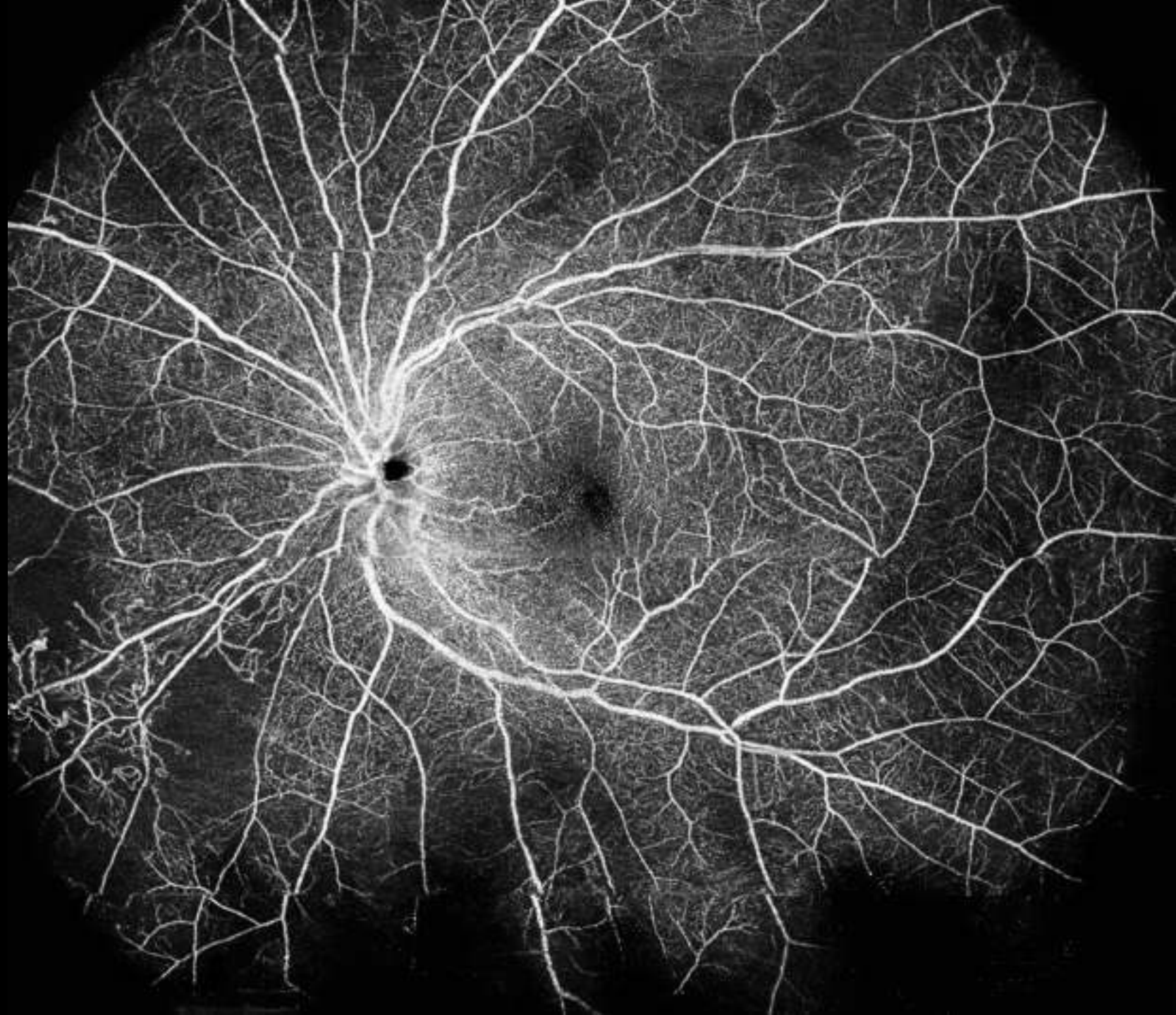
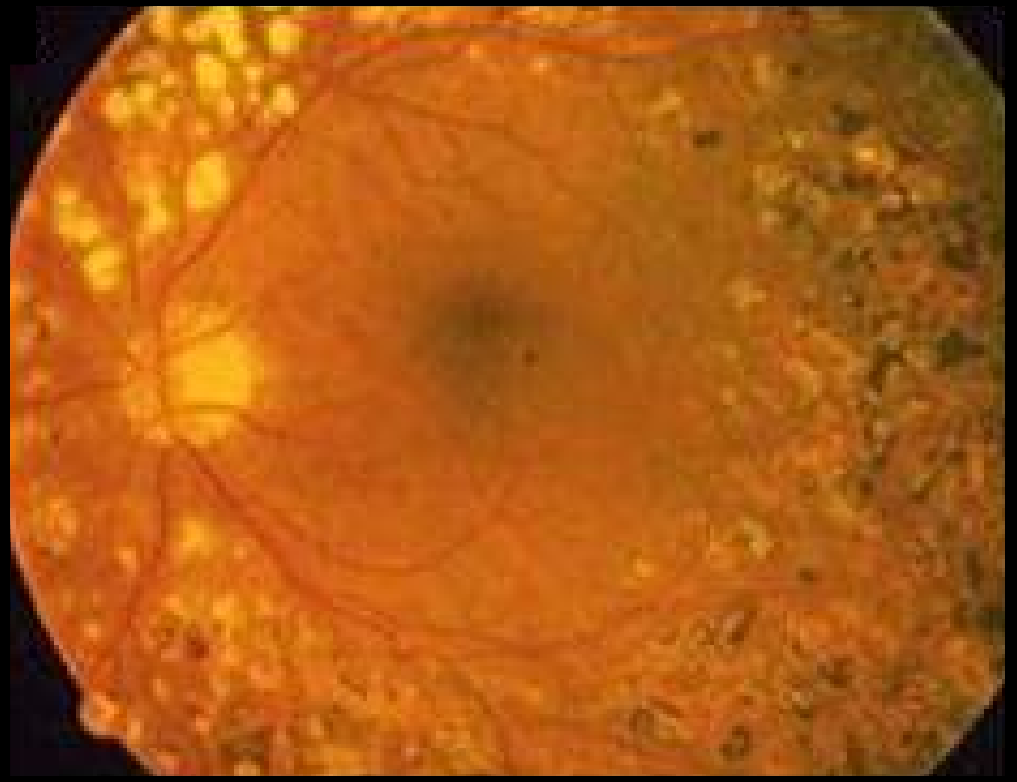


Grading of DR



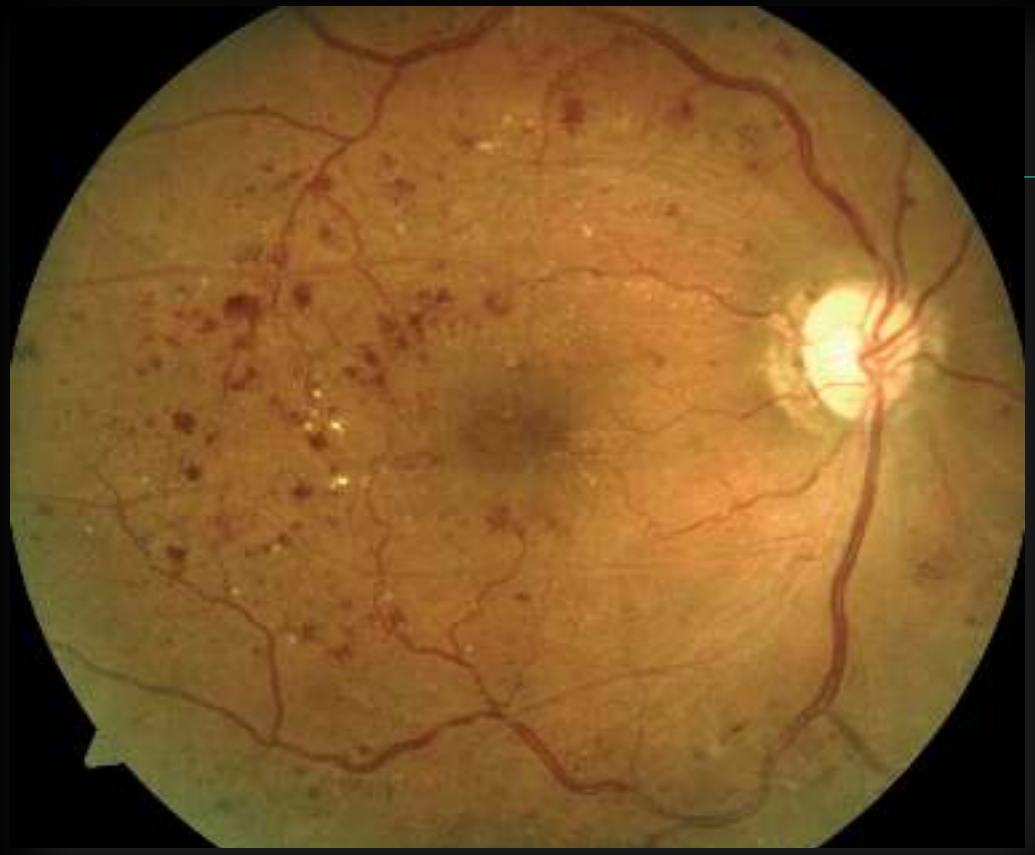
- The Diabetic Retinopathy Study (DRS) demonstrated that panretinal photocoagulation (PRP) could significantly reduce proliferative diabetic retinopathy (PDR) progression and severe visual acuity loss due to complications of PDR.
- The Early Treatment Diabetic Retinopathy Study (ETDRS) subsequently confirmed that PRP was recommended in all eyes with severe non-PDR (NPDR) and non-high-risk PDR
- In recent years, the treatment paradigm for PDR has seen the beginning of a shift from PRP to intravitreal anti-VEGF therapy, based on the results of the DRCR.net Protocol S and Clinical Efficacy and Mechanistic Evaluation of Aflibercept for Proliferative Diabetic Retinopathy (CLARITY) studies.



- Patients with PDR may sometimes present diagnostic and management challenges:

- *The sensitivity of fundus biomicroscopy for distinguishing NV from intraretinal microvascular abnormalities (IRMAs) is not high.*
- *Smaller lesions may be missed by the examiner, especially when not accompanied by more pronounced signs of severe retinopathy.*
- *Screening with narrow angle color fundus photograph or pseudocolor images can miss some of the lesions*
- *Inability to have standard FA testing*

IRMA VS NVE (Severe NPDR vs PDR)



Digital photographs

AI Algorithm

Fundus biomicrospcopy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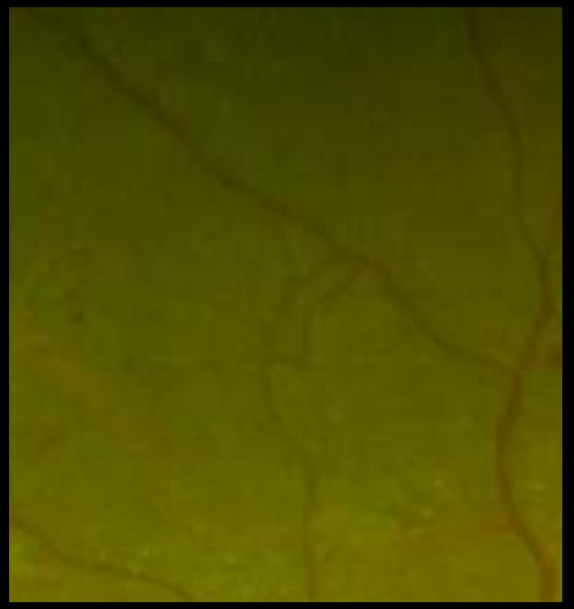
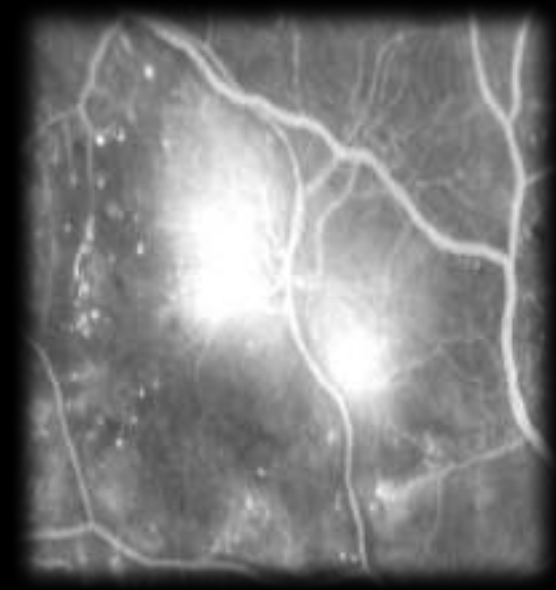
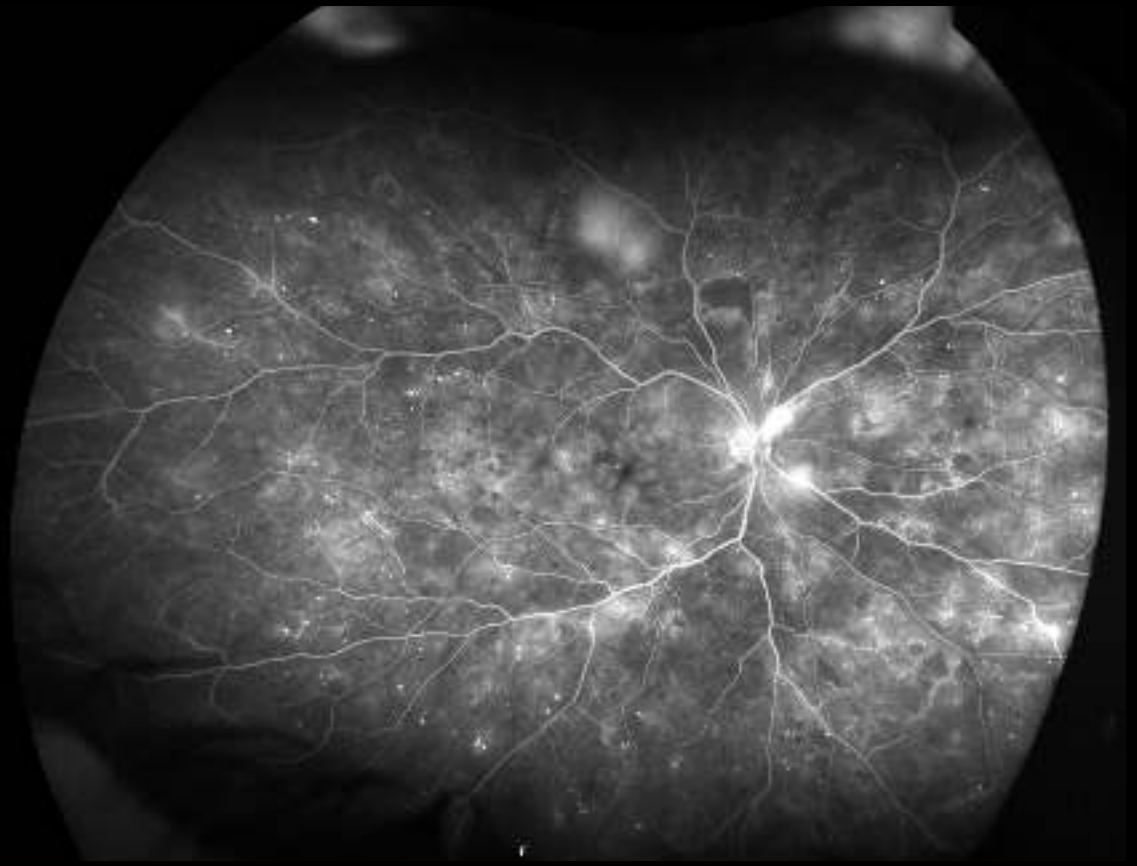
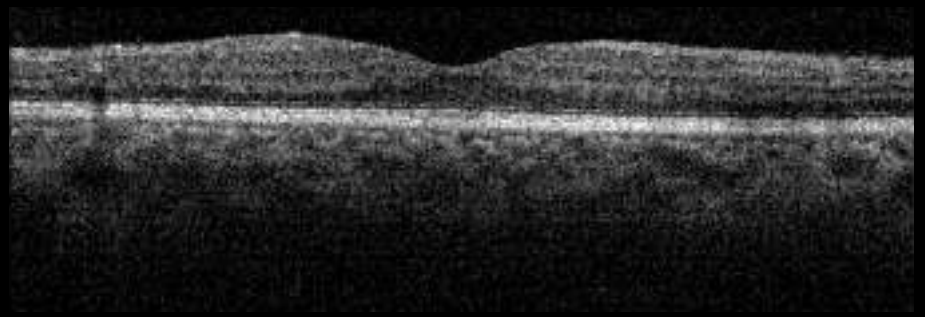
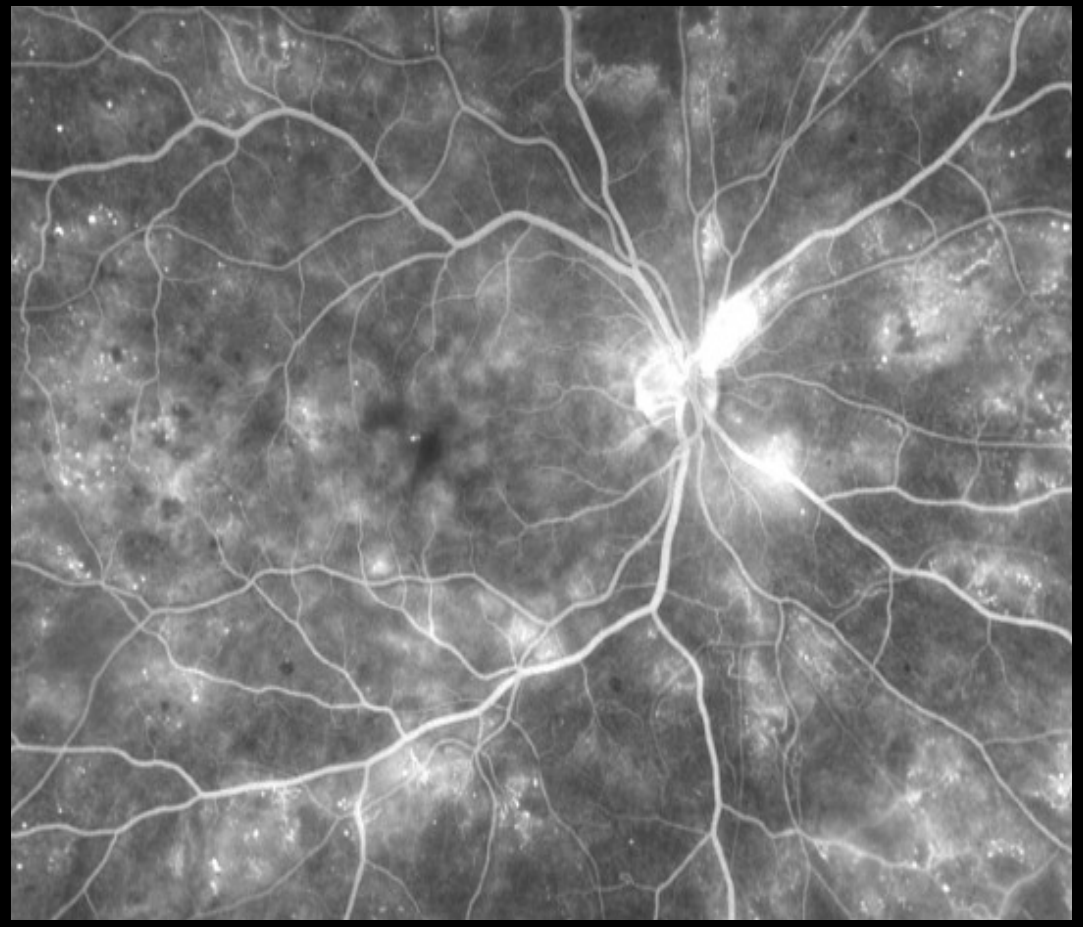


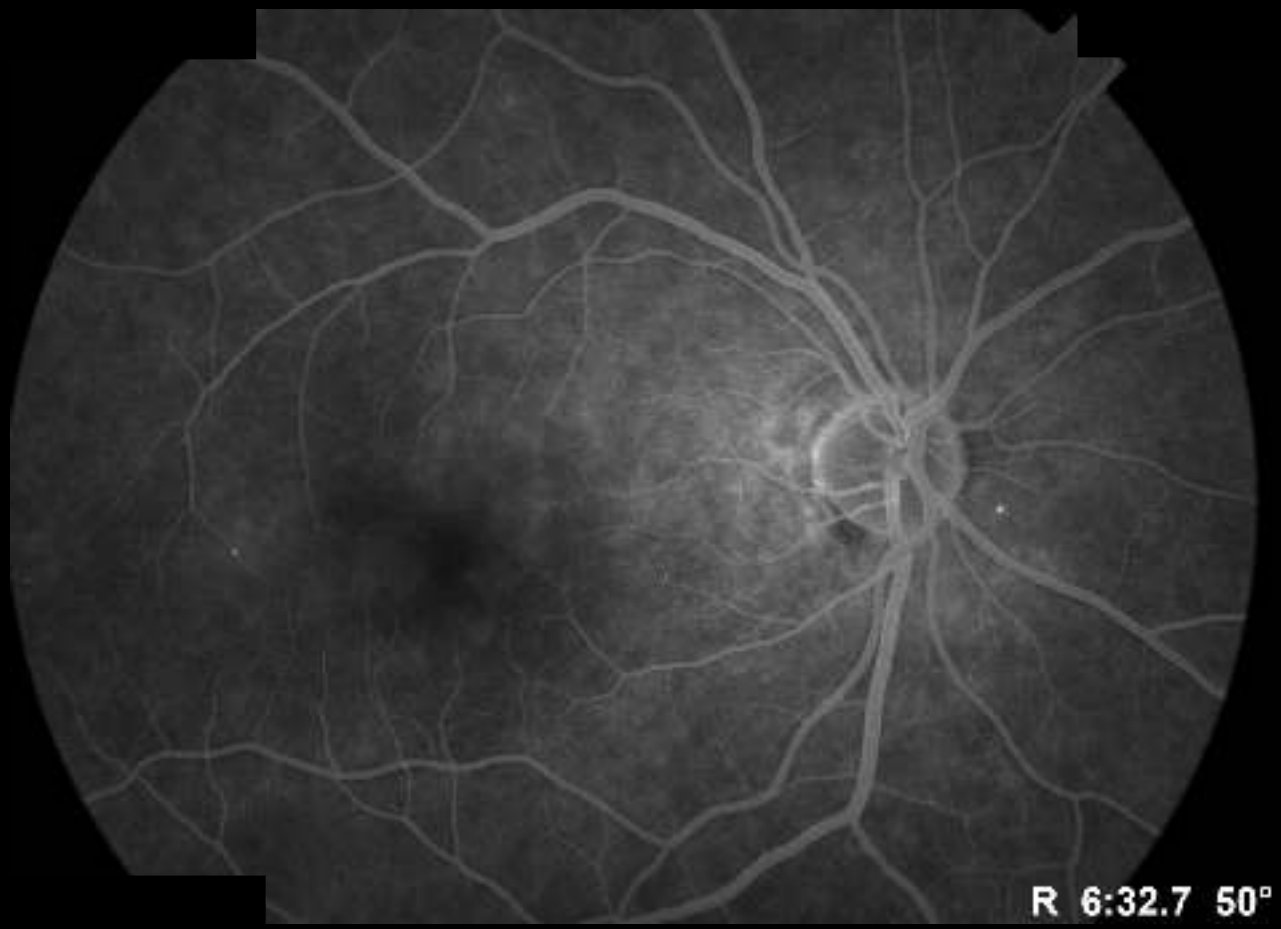






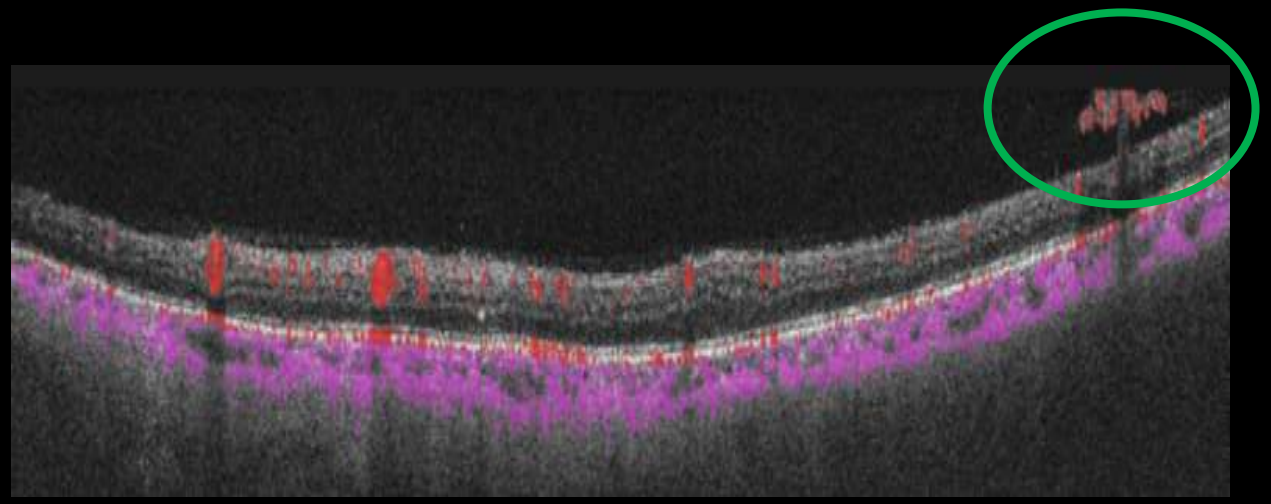


At presentation

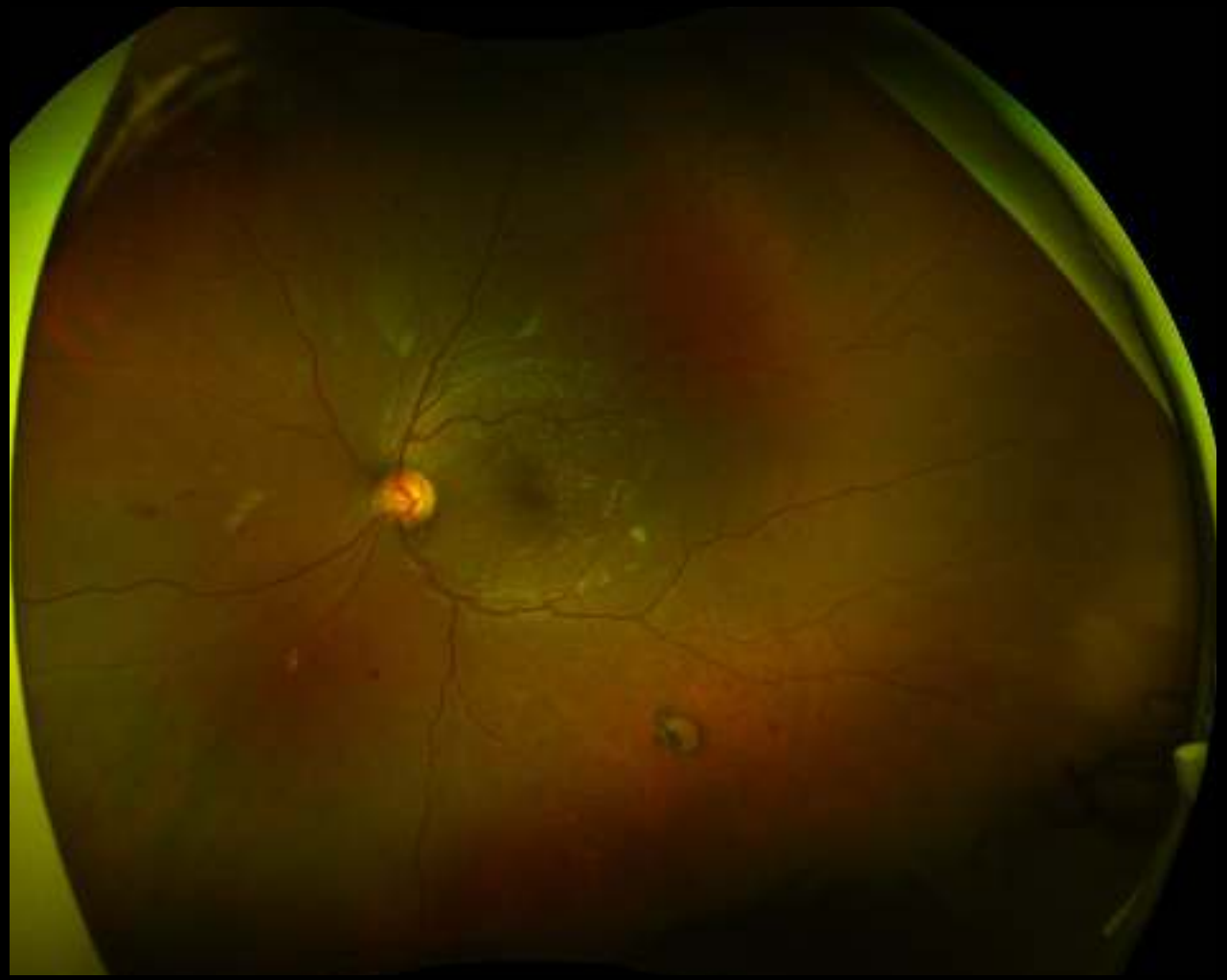


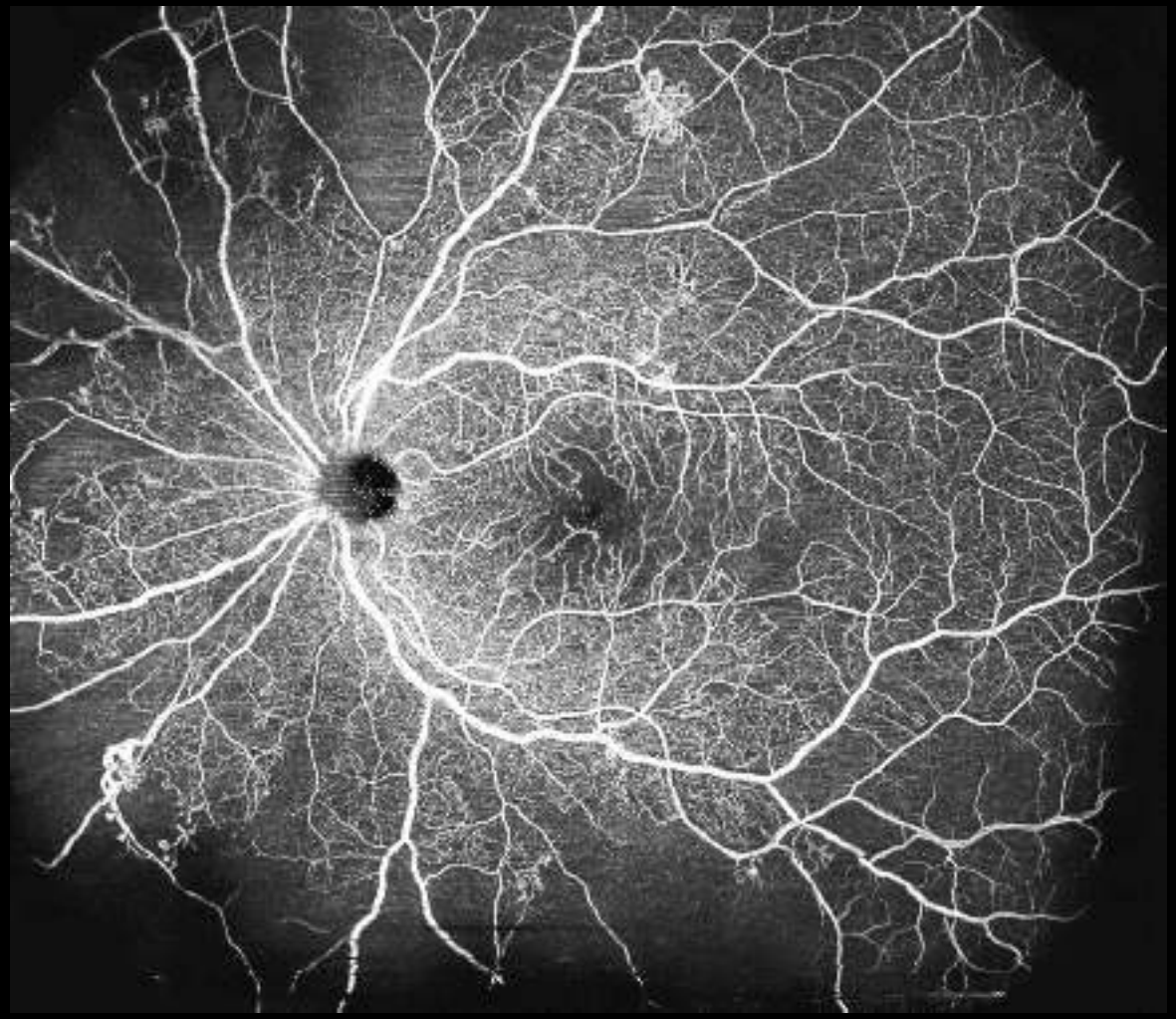
12 weeks post 3 aflibercept

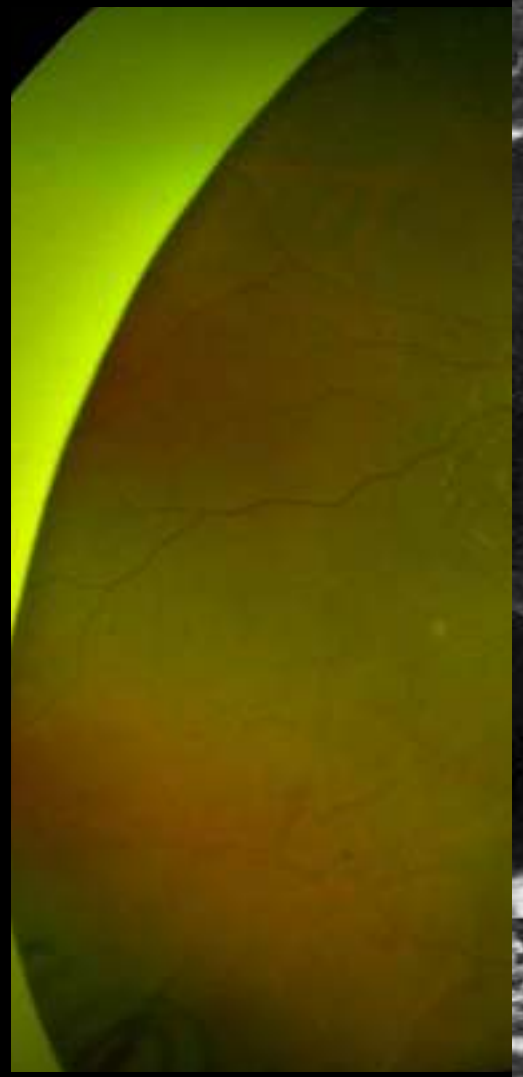
Severe NPDR vs PDR

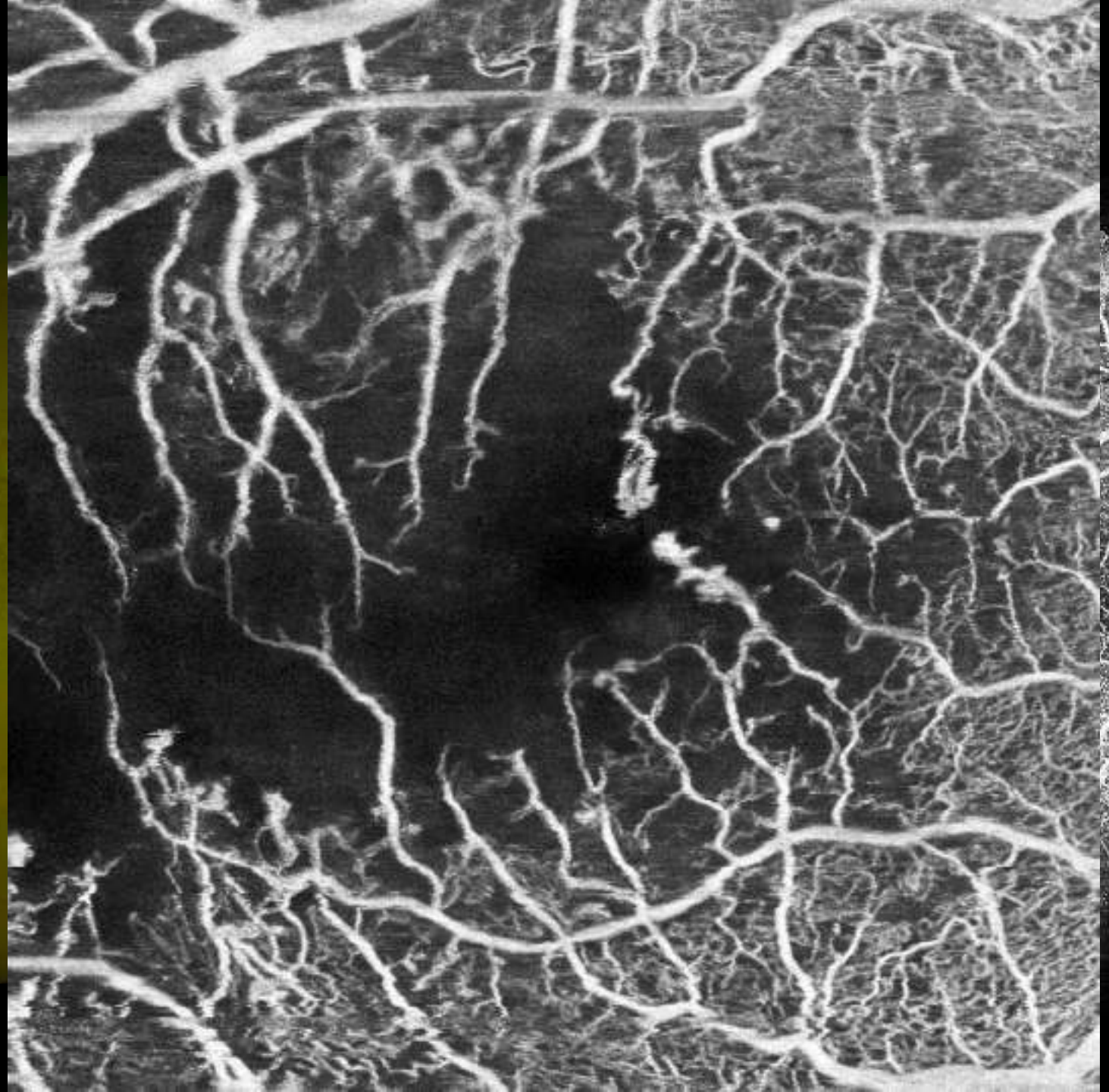


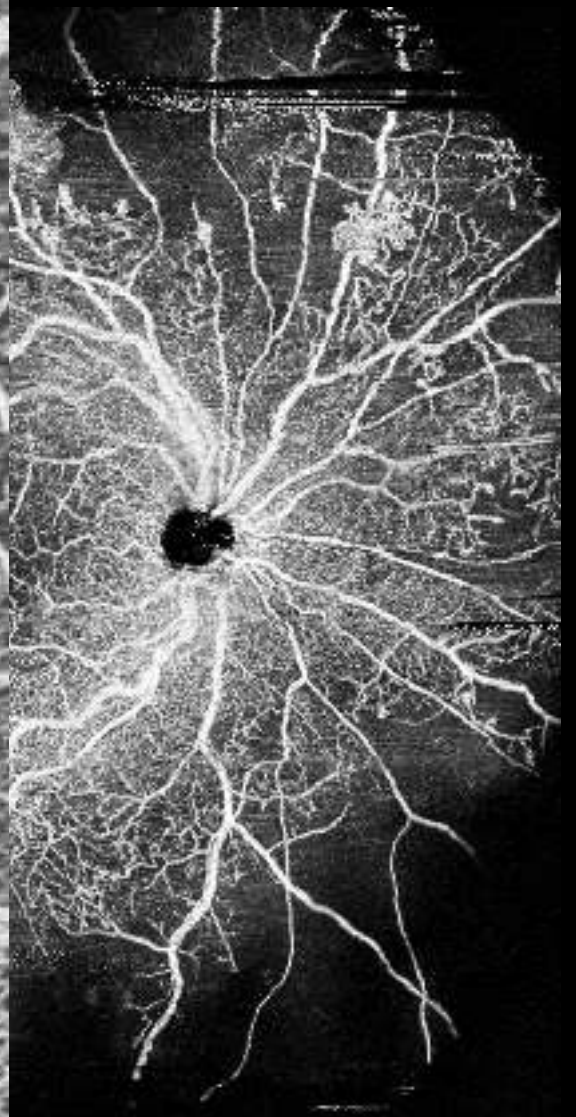
Ultrawide field
OCTA

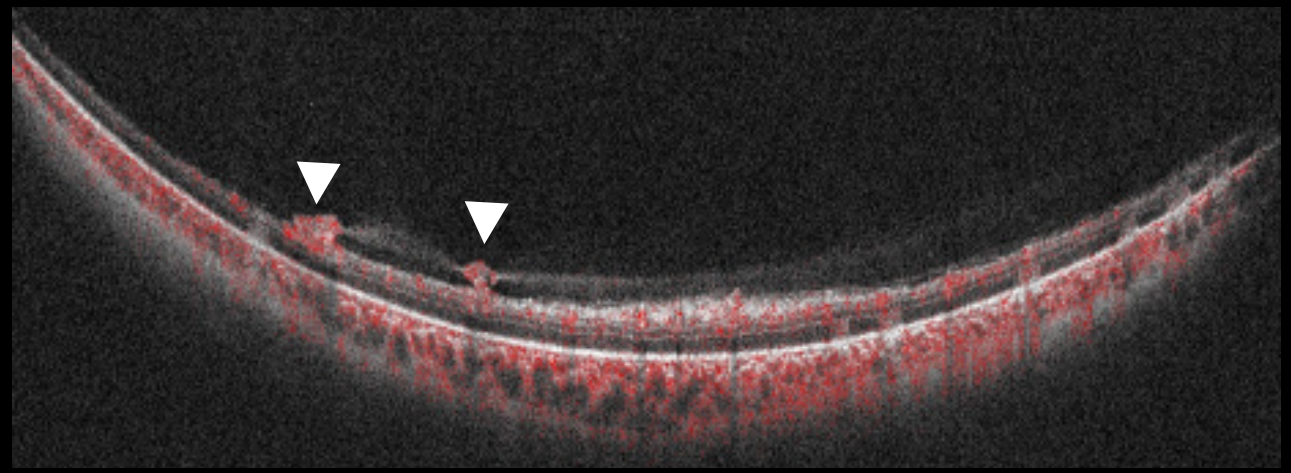


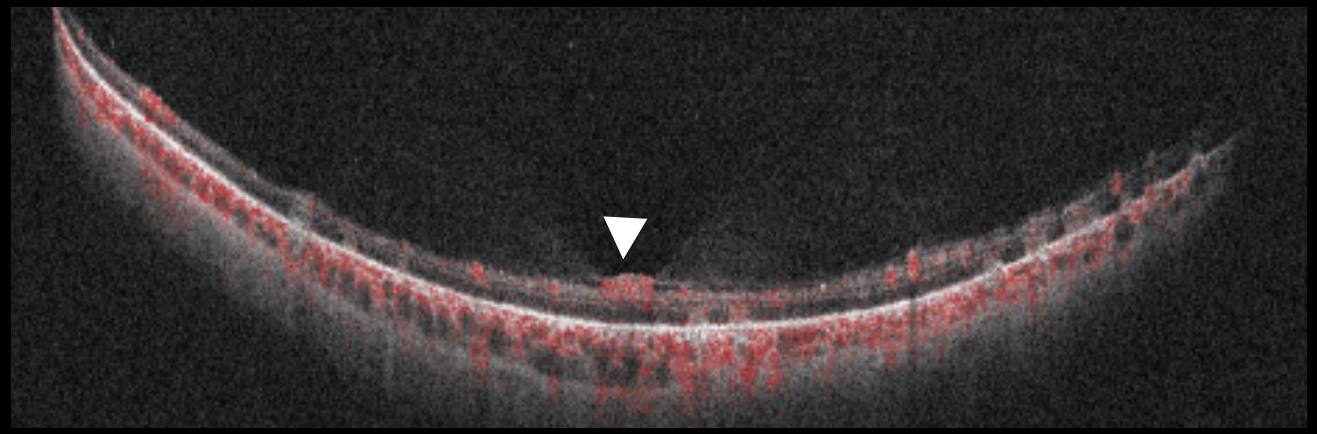


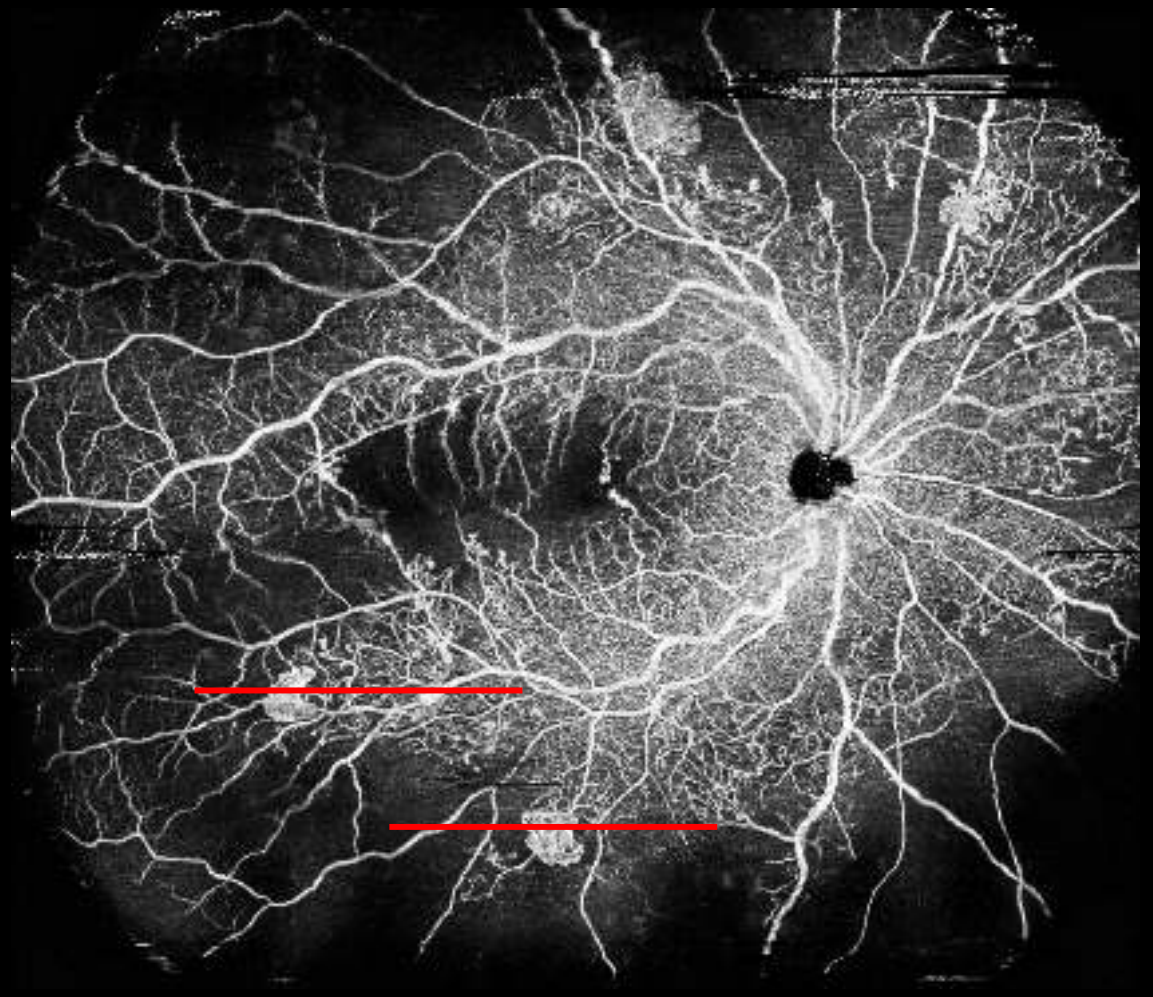




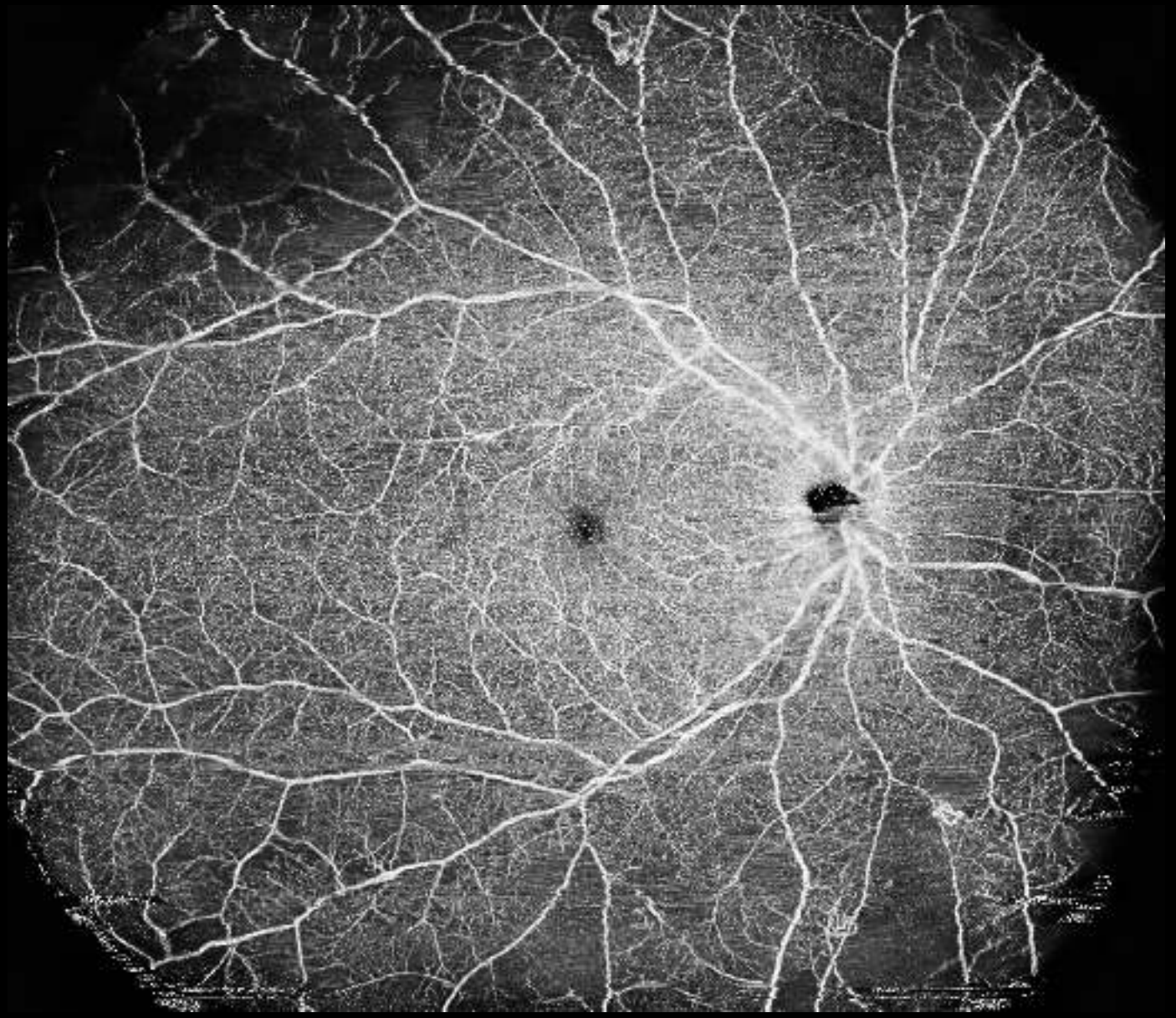








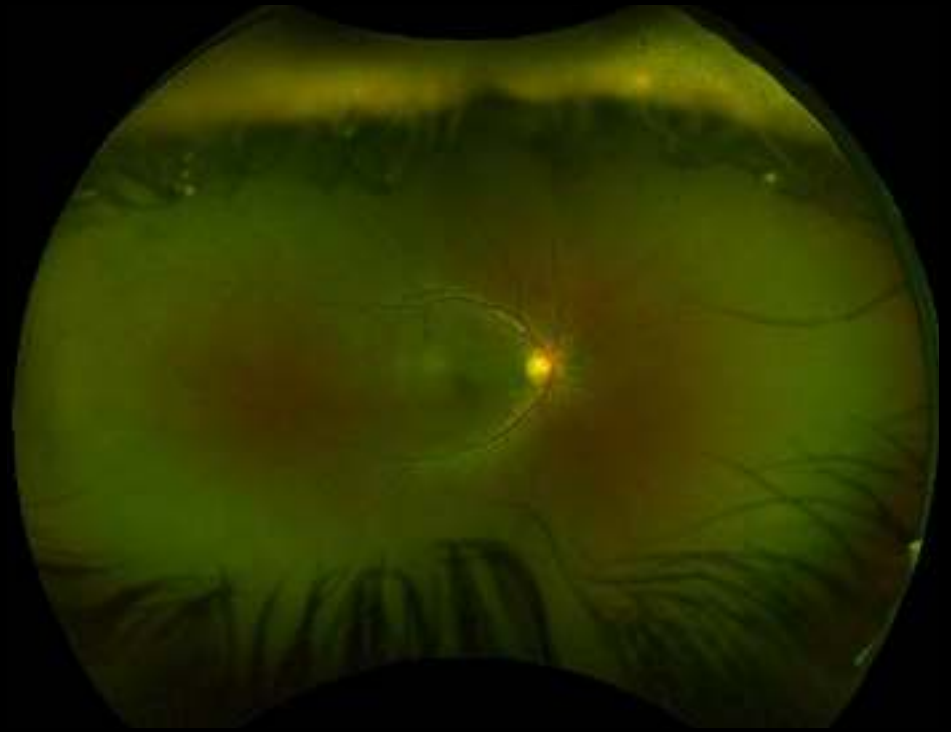
DR in Pregnancy

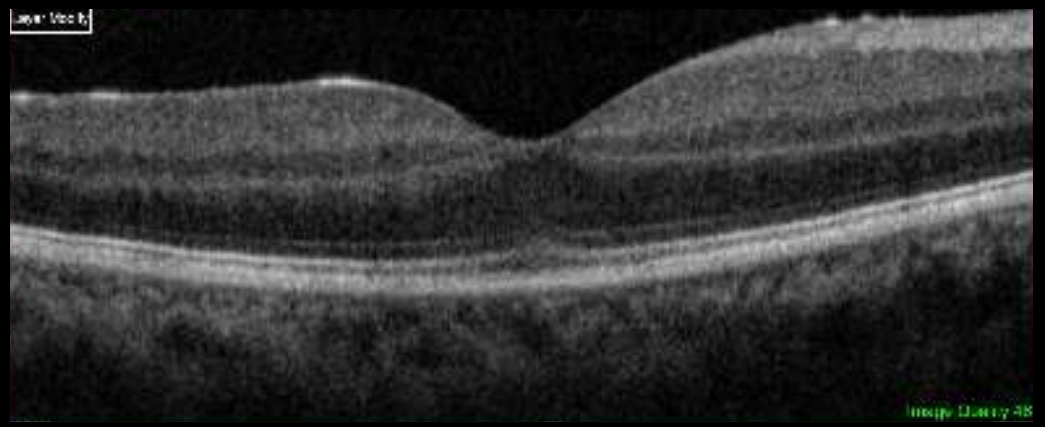


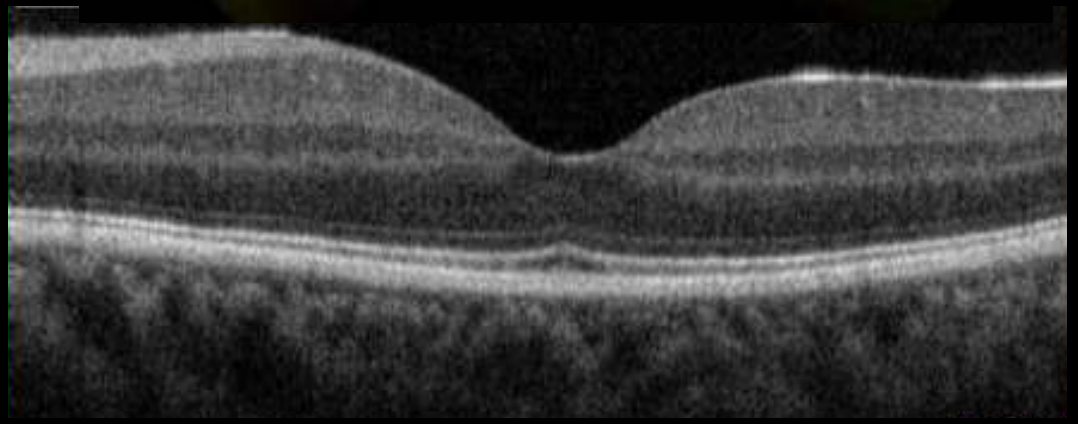
Case

- A 28-year-old female
- Known case of type 1 DM
- Pregnant with 8-weeks GA
- Bilateral anterior uveitis and right inferior snowballs.
- On topical steroids.

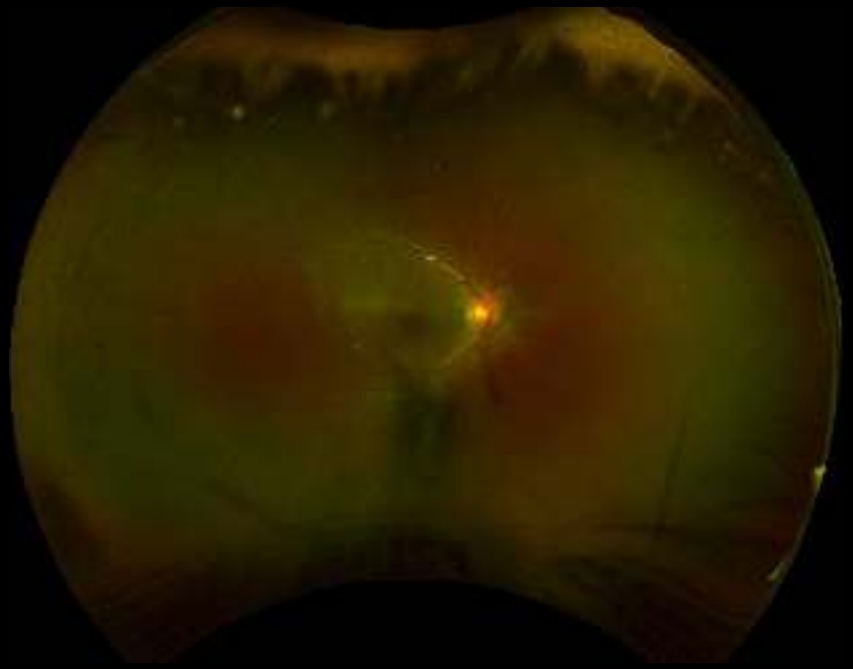
At initial presentation to Uveitis clinic

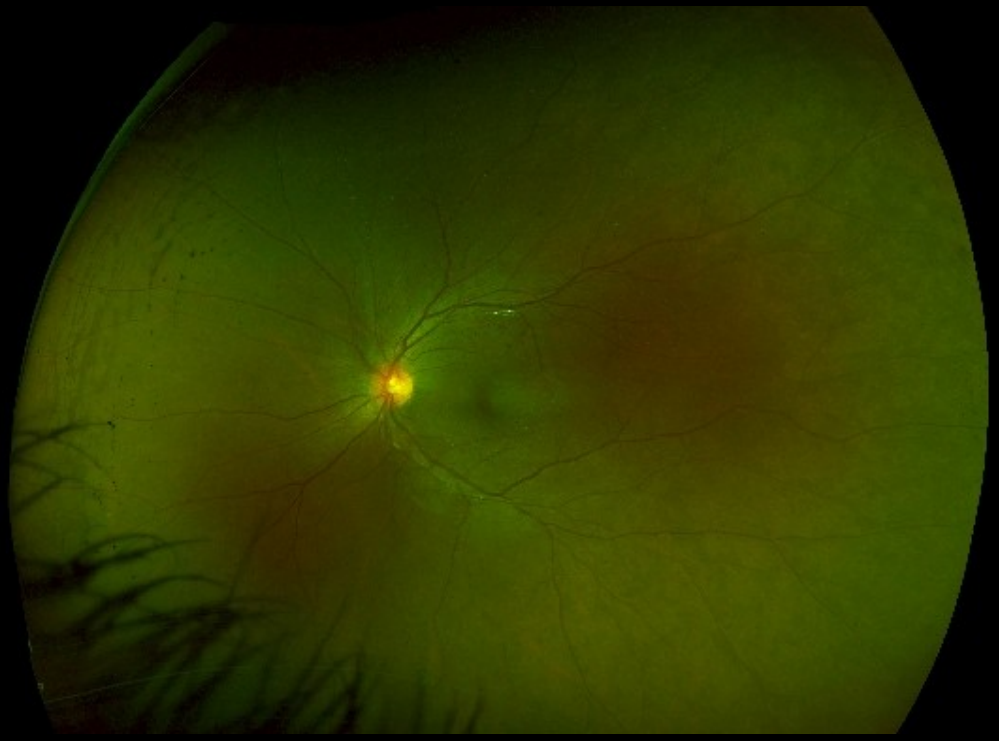


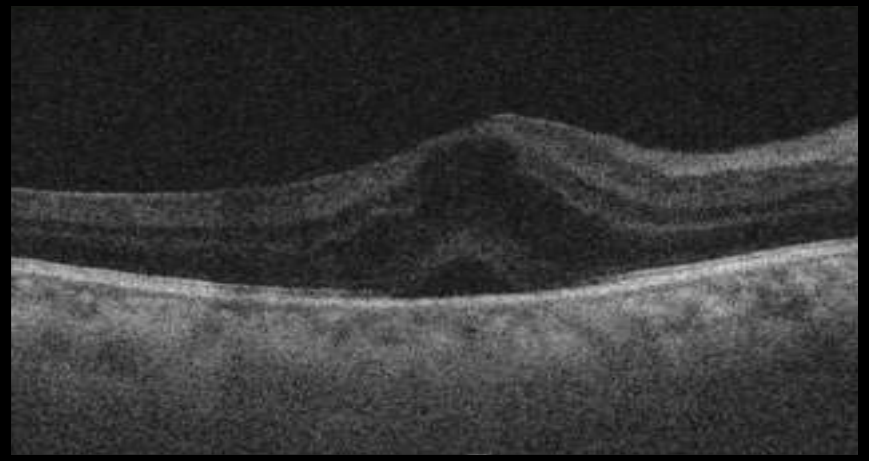


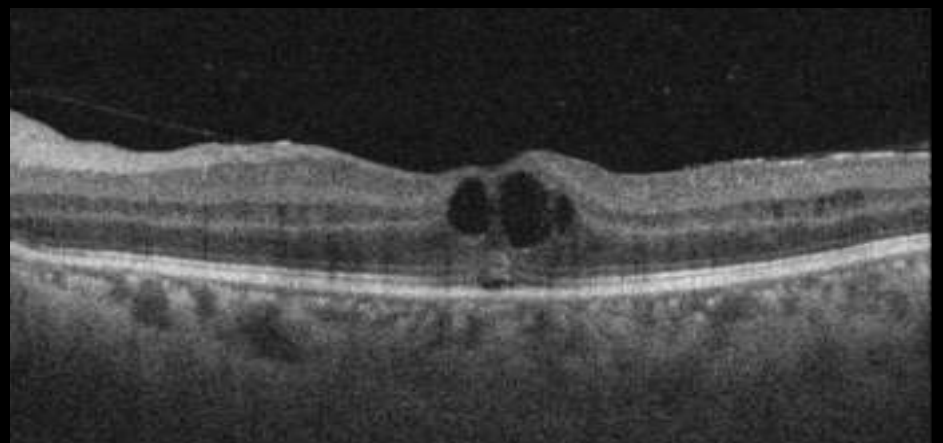


3-months later

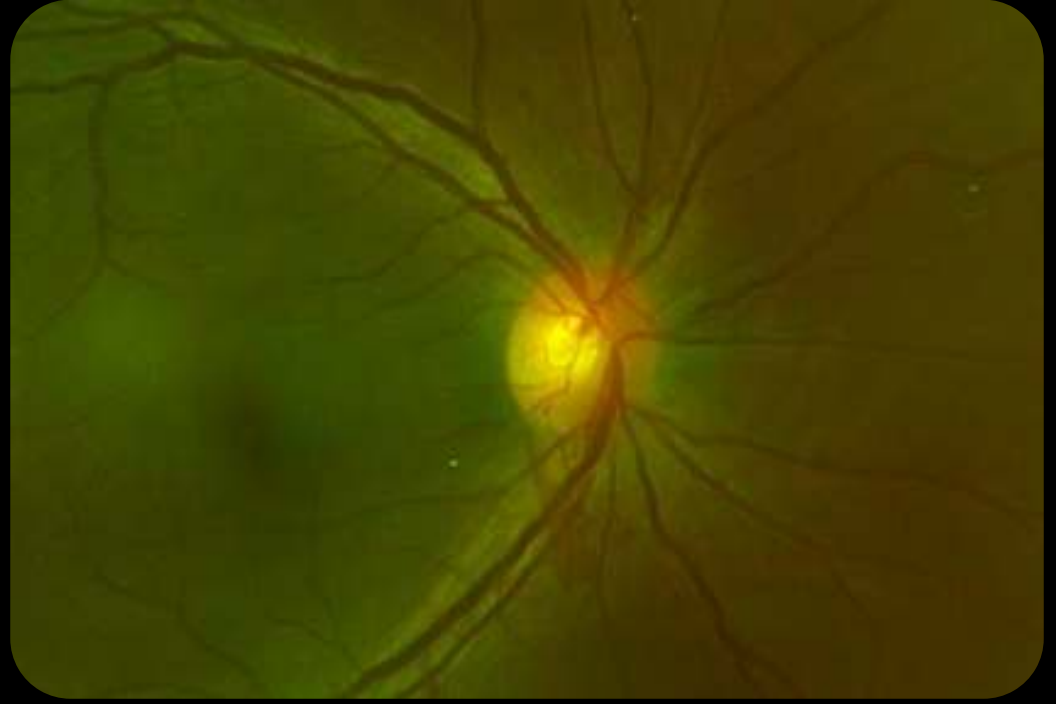


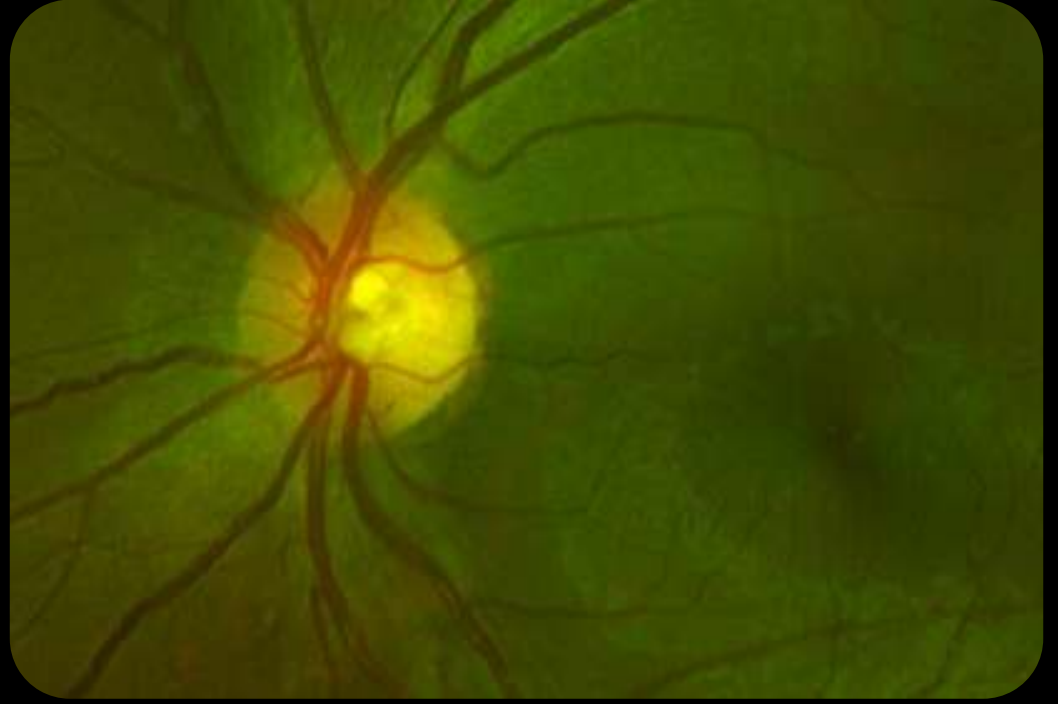




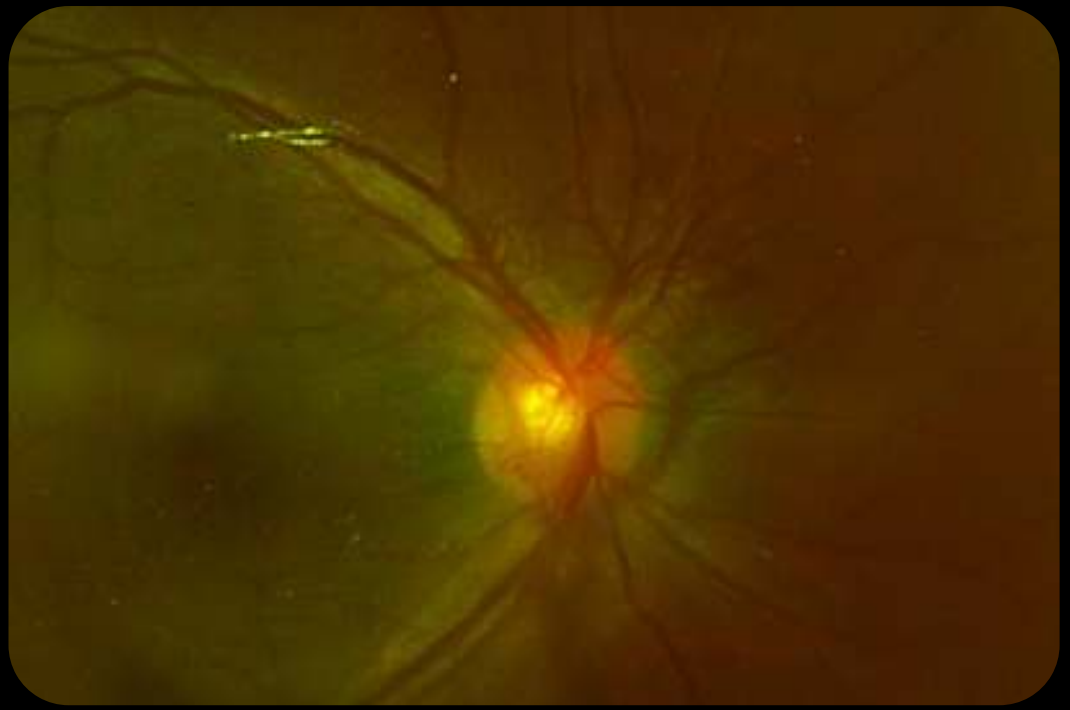


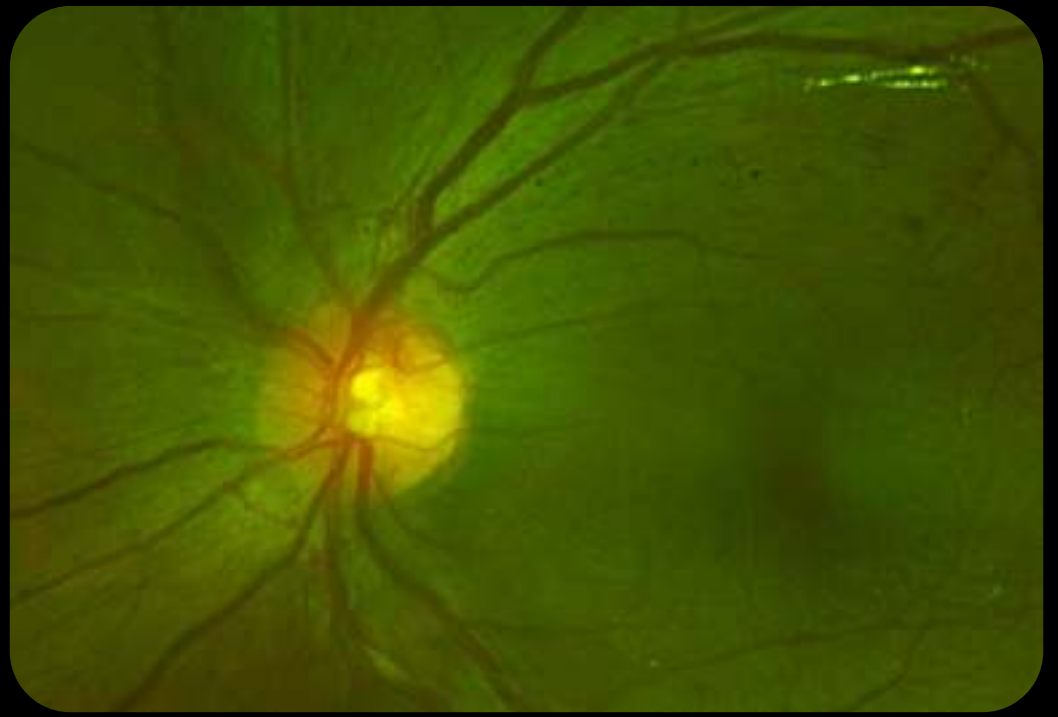
At presentation





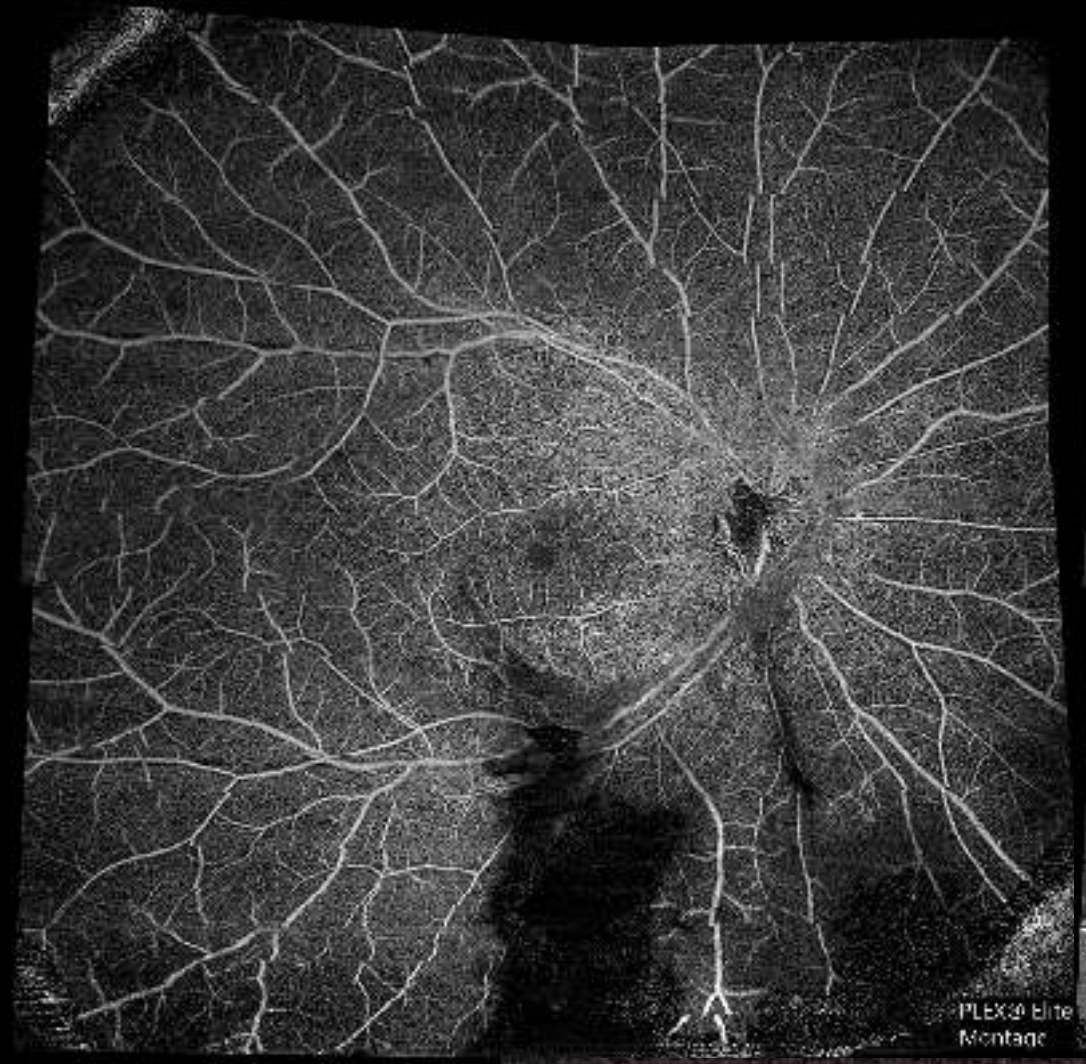
3-months later



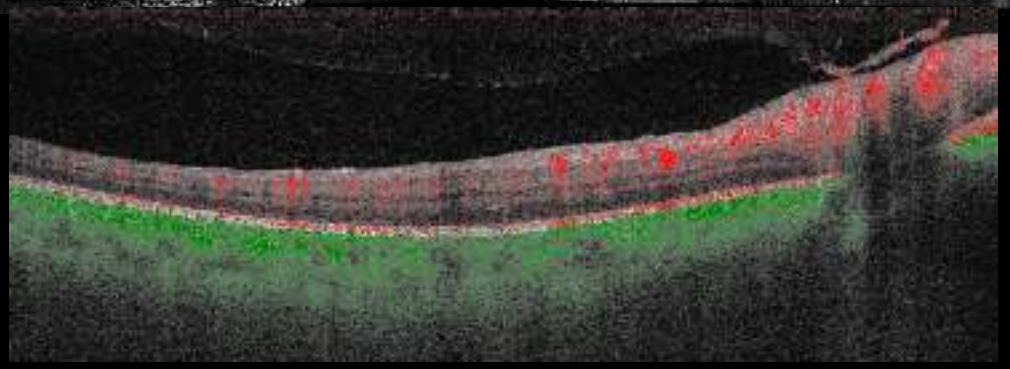


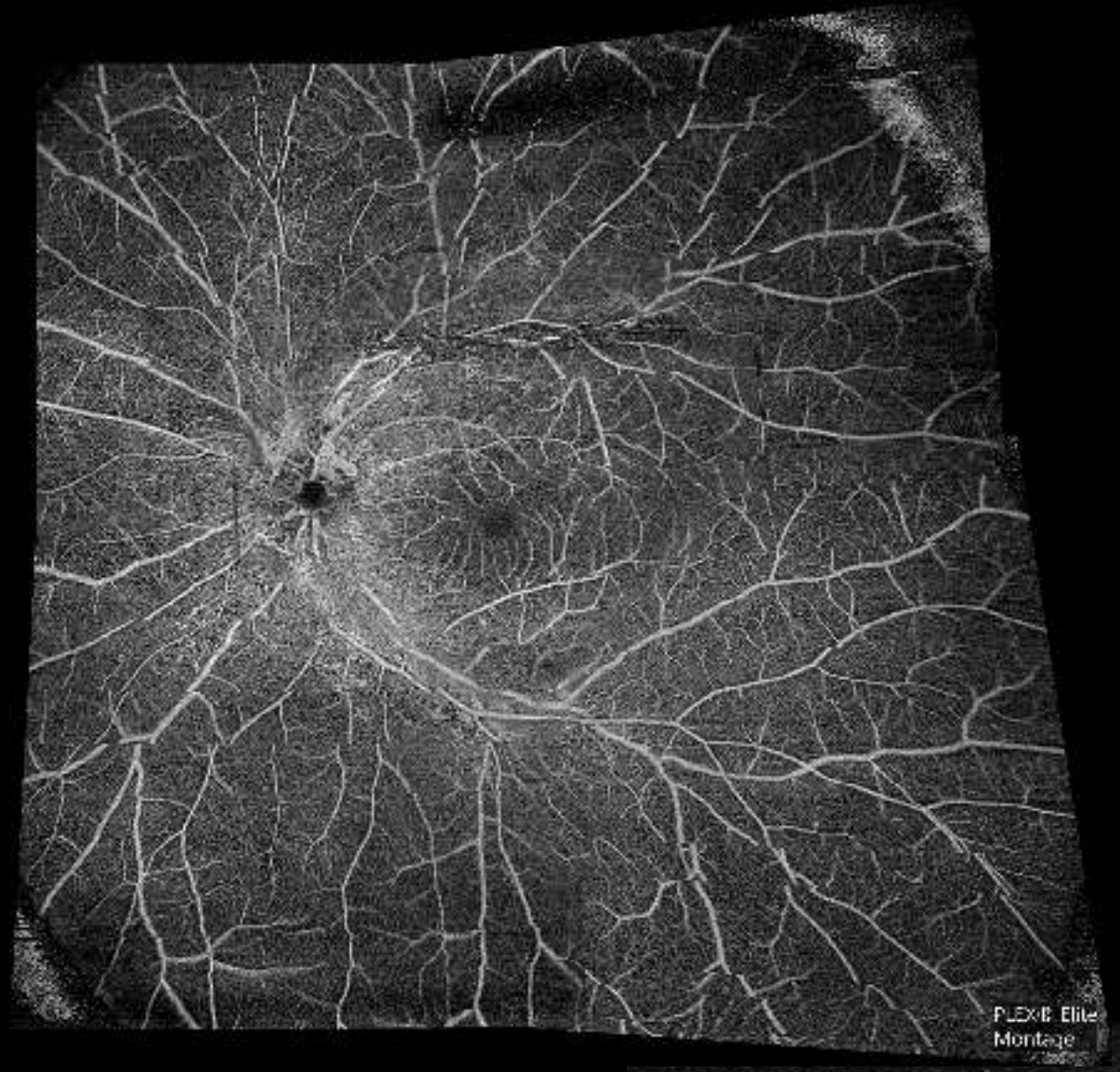
Options

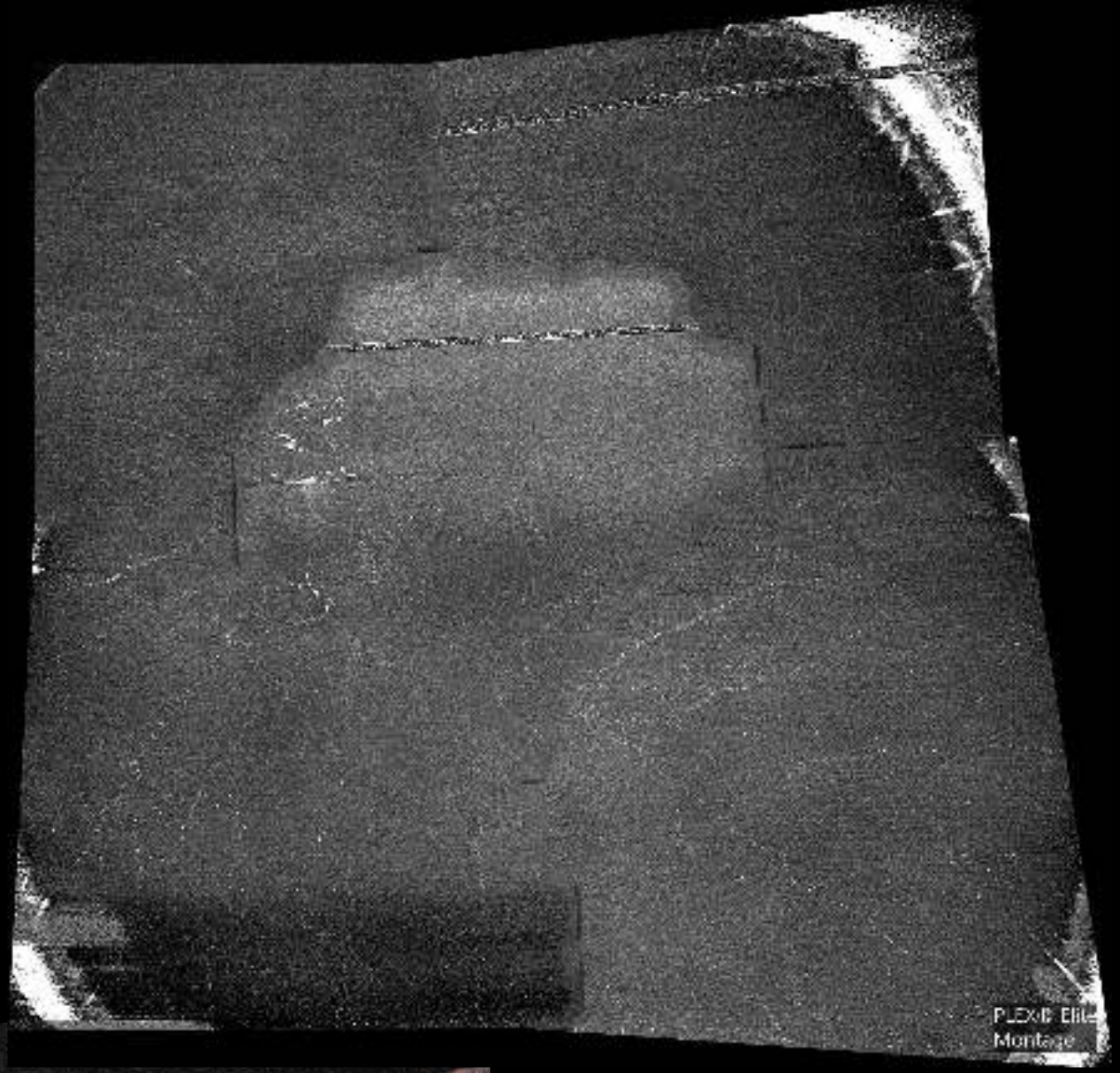
- PRP
- Anti-VEGF
- Intravitreal steroids
- Observation

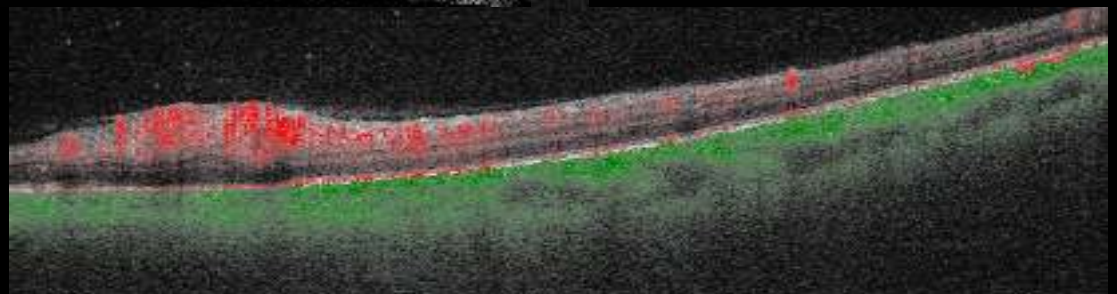

PLEX® Elite
Montage


PLEX® Elite
Montage

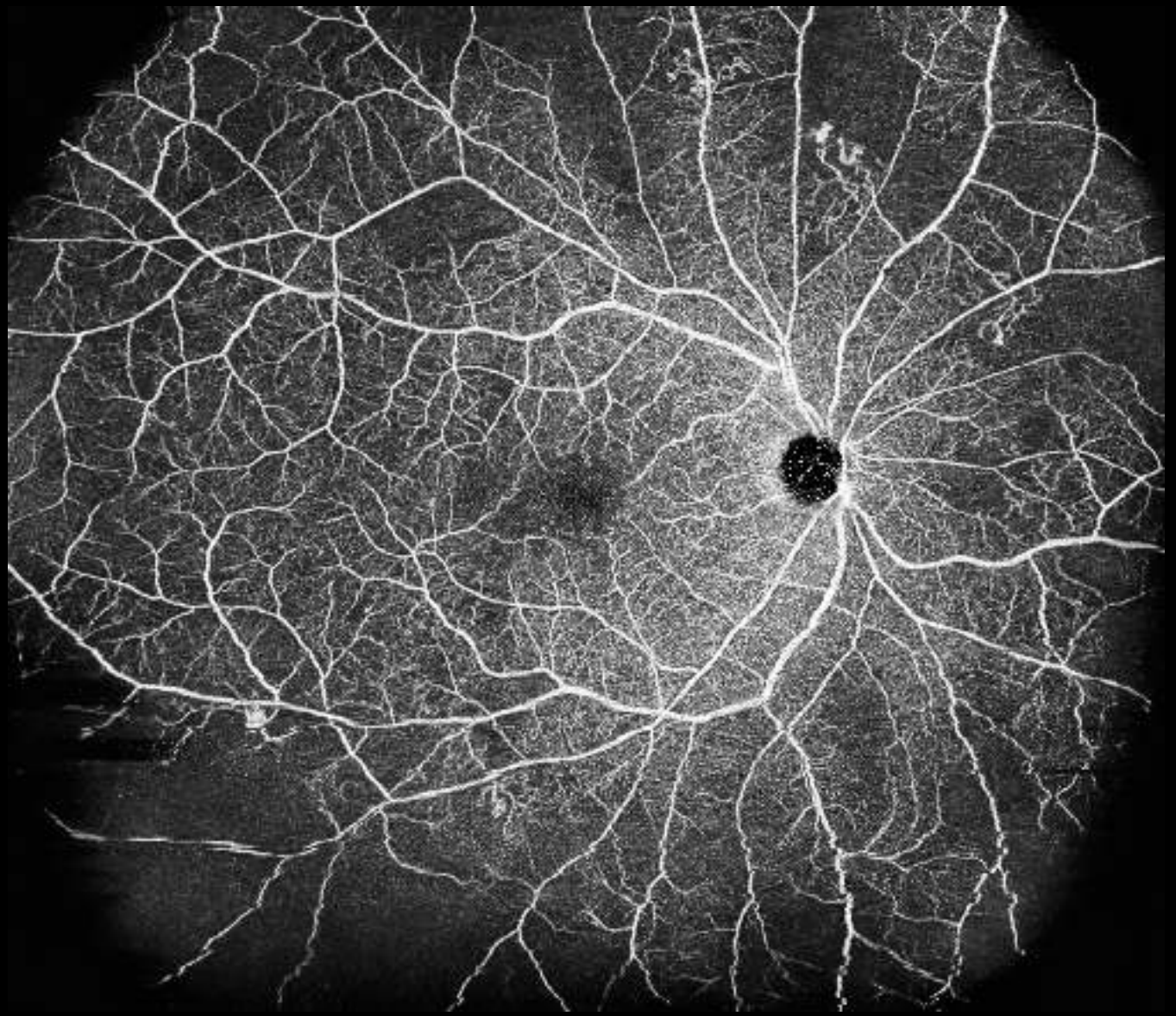



PLEX® Elite
Montage

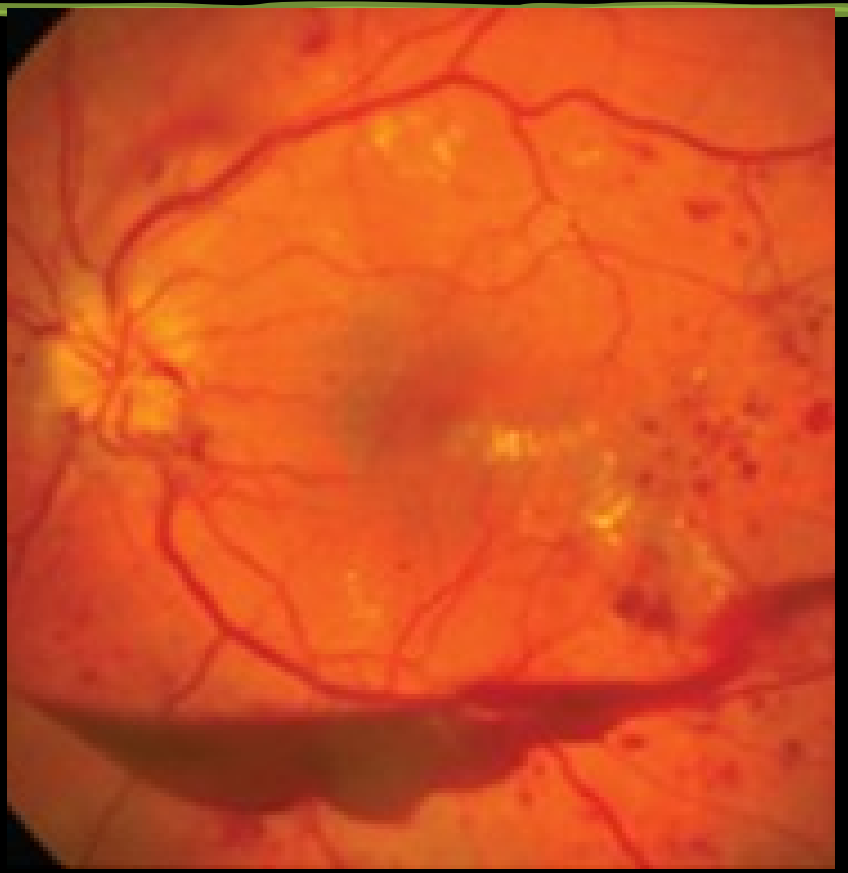

PLEX® Elite
Montage

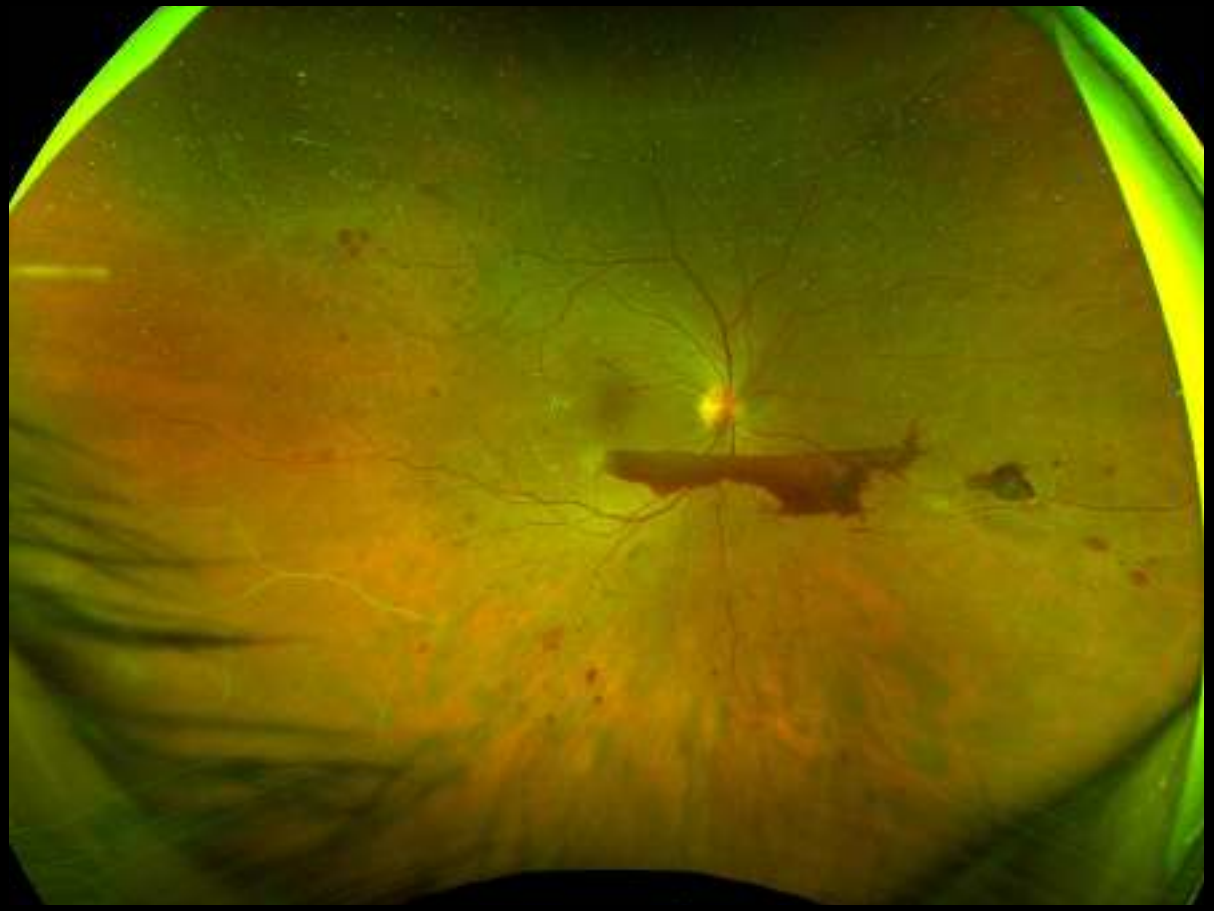


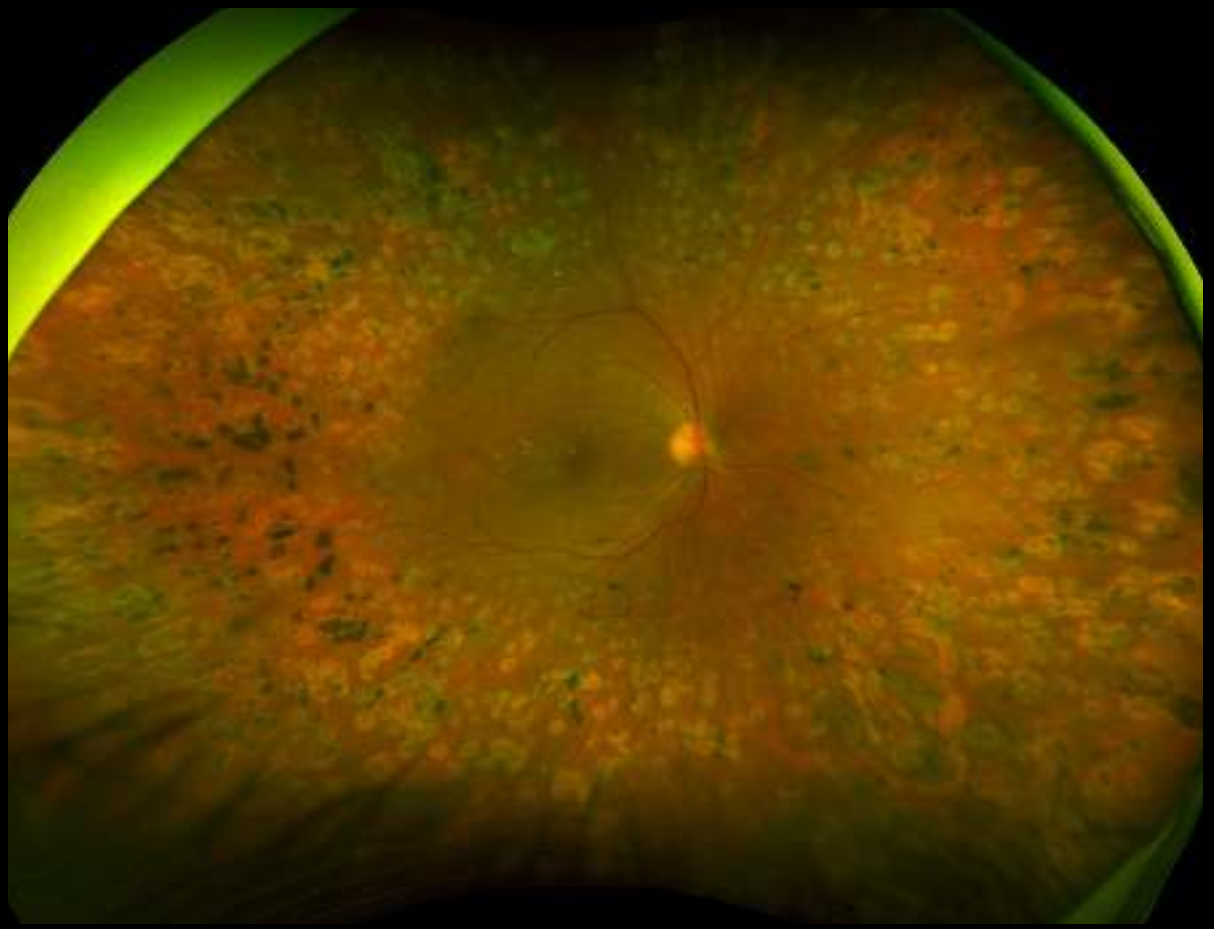
Treated PDR



- Proliferative diabetic retinopathy (PDR) is characterized by neovascularization that occurs at the vitreoretinal interface that may cause vitreous hemorrhage (VH), tractional retinal detachment (TRD), and neovascular glaucoma, thereby significantly increasing the risk of vision loss





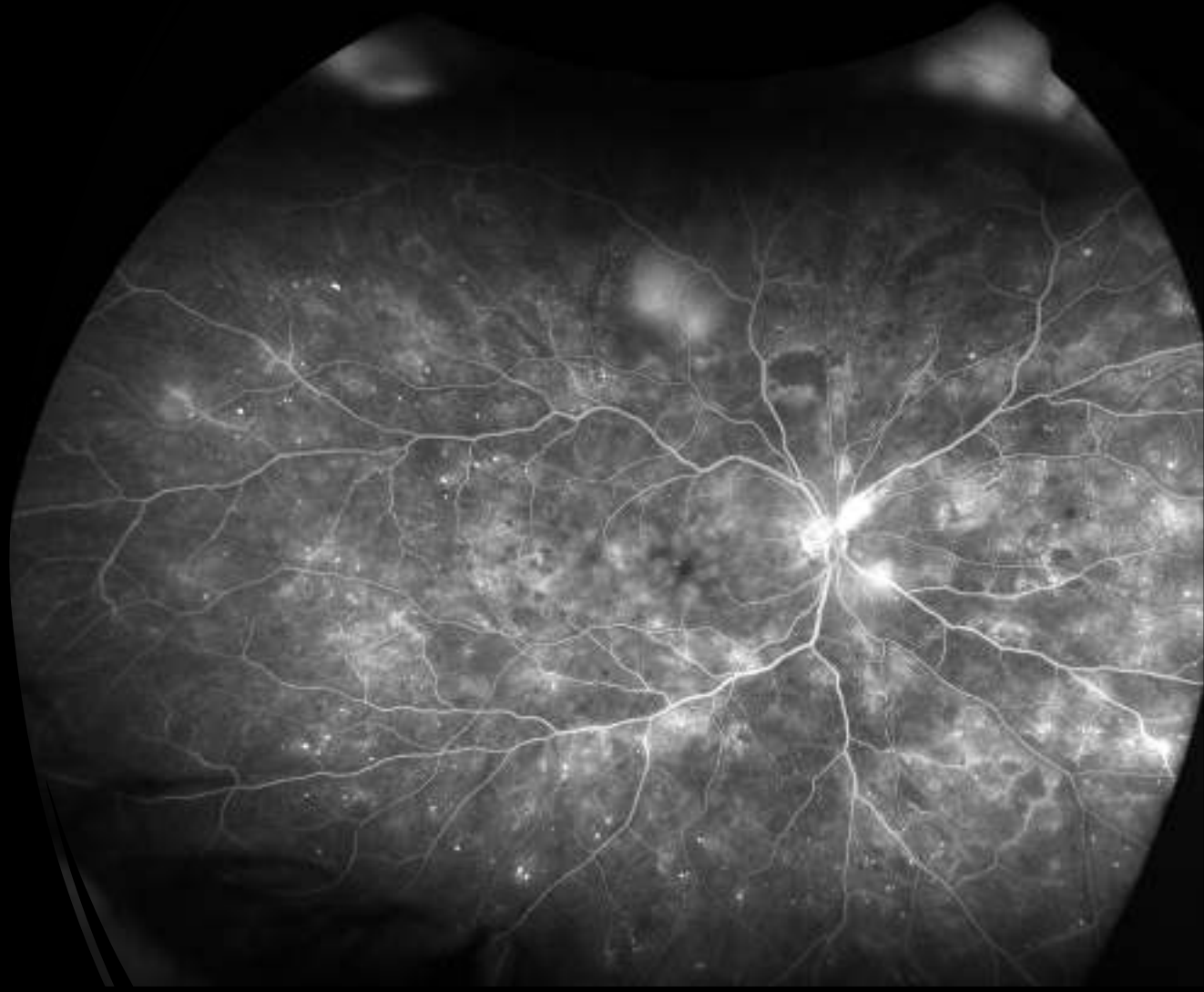


Post-treatment monitoring of PDR

- Clinical examination may show signs of a residual neovascular complex after panretinal photocoagulation (PRP) or intravitreal injection treatment.
- It may sometimes be difficult to tell whether this NV is still “active.”
- Patients with PDR treated with PRP or anti-VEGF may present with recurrent vitreous hemorrhage (VH) that can be due to NV activity or traction on the fibrovascular complex
- Some treated PDR patients may even present with VH with no clinically apparent NV or fibrovascular complex

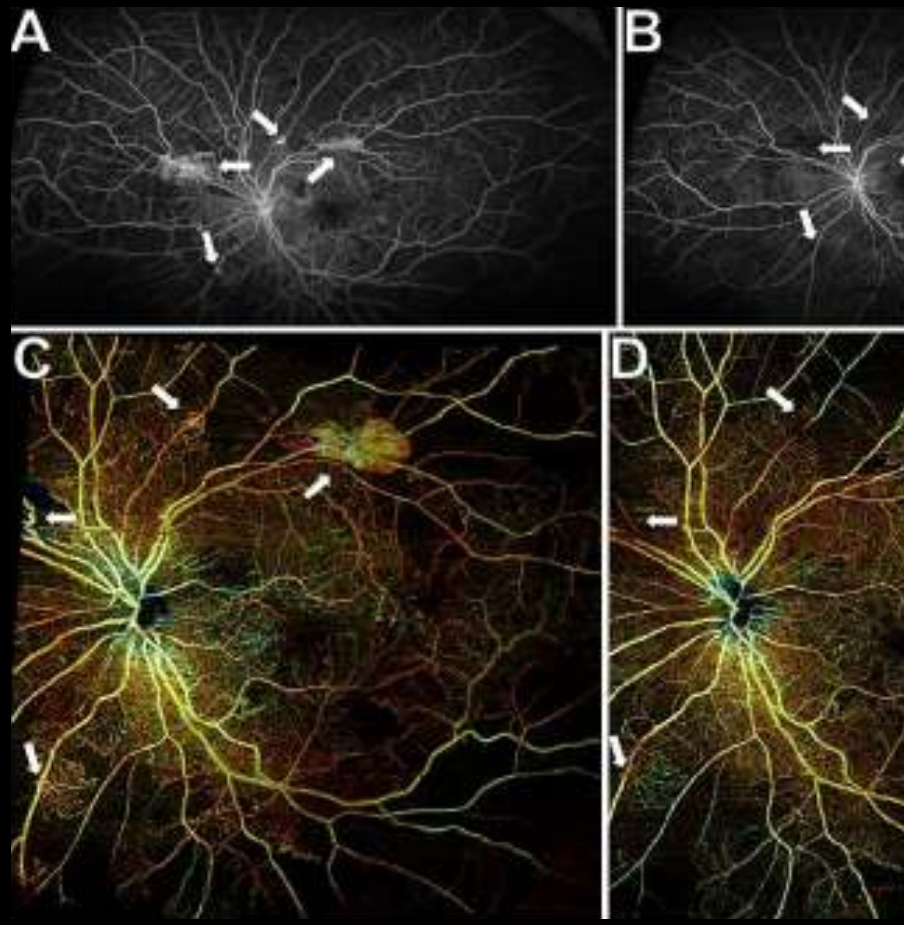
Detection of subclinical NV

- Clinical examination and color photographs proved unreliable in detecting regression
- Fluorescein angiography (FA) may still show signs of leakage despite resolution or stability of NV and may also show leakage with other vascular lesions, including IRMAs, dilated capillaries, and microaneurysms
- OCTA is a novel and noninvasive technique for demonstrating the microvascular blood flow. It produces a depth-resolved evaluation of the reflectance data from retinal tissue, providing a 3-dimensional volume of information.



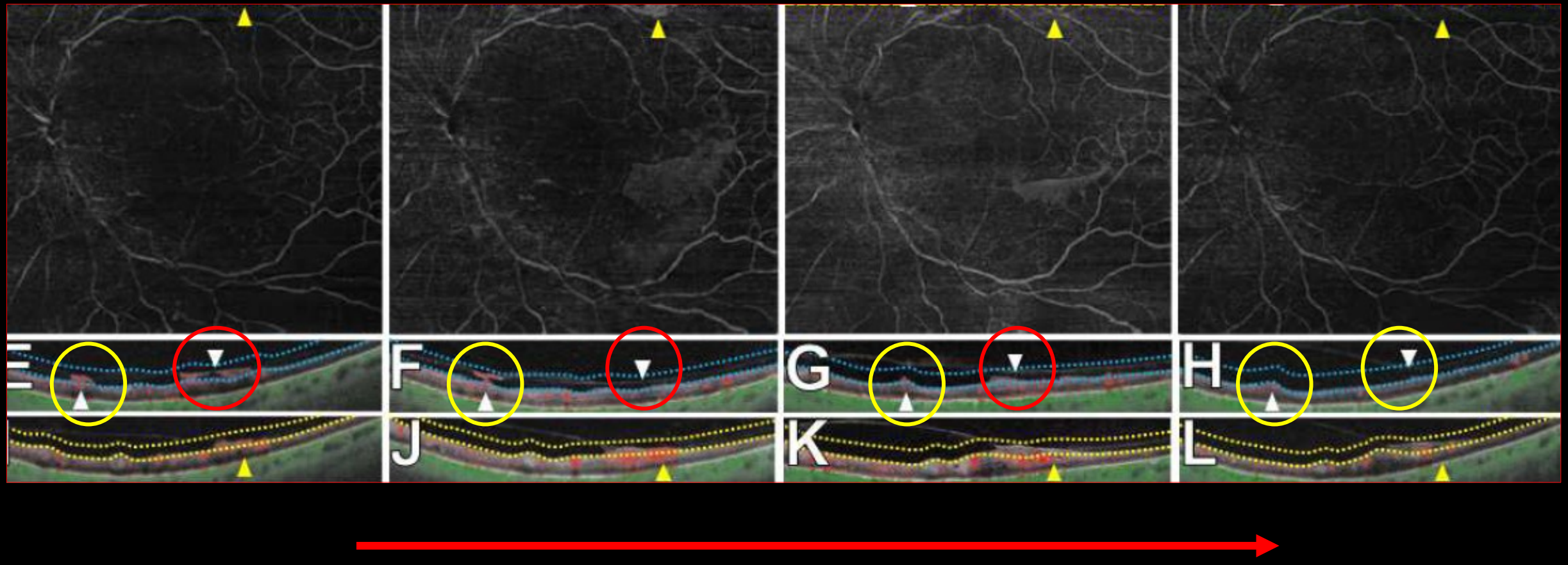
Schwartz R, Khalid H, Sivaprasad S, et al. Objective Evaluation of Proliferative Diabetic Retinopathy Using OCT. *Ophthalmol Retina*. 2020;4(2):164-174. doi:10.1016/j.oret.2019.09.004

Effect of PRP



Russell JF, Shi Y, Hinkle JW, Scott NL, Fan KC, Lyu C, Gregori G, Rosenfeld PJ. Longitudinal Wide-Field Swept-Source OCT Angiography of Neovascularization in Proliferative Diabetic Retinopathy after Panretinal Photocoagulation. Ophthalmol Retina. 2019 Apr;3(4):350-361. doi: 10.1016/j.oret.2018.11.008. Epub 2018 Nov 24. PMID: 31014688; PMCID: PMC6482856.

Effect of PRP



Russell JF, Shi Y, Hinkle JW, Scott NL, Fan KC, Lyu C, Gregori G, Rosenfeld PJ. Longitudinal Wide-Field Swept-Source OCT Angiography of Neovascularization in Proliferative Diabetic Retinopathy after Panretinal Photocoagulation. Ophthalmol Retina. 2019 Apr;3(4):350-361. doi: 10.1016/j.oret.2018.11.008. Epub 2018 Nov 24. PMID: 31014688; PMCID: PMC6482856.

Detection of subclinical NV in treated PDR

- Patients who had complete PRP for PDR and marked clinically as treated PDR for at least a year prior to the beginning of the study.
- This is usually judged clinically based on the presence of complete PRP, regression of neovessels and retinal venous dilatation, disc pallor, and disappearance of retinal hemorrhages.

- Eyes with incomplete PRP, eyes with active PDR that is evident clinically, eyes with glaucoma, eyes with high refractive errors, eyes with any retinal vascular disorder apart from DR, eyes receiving regular anti-VEGF for diabetic macular edema, eyes with history of vitrectomy and eyes with recent cataract surgery (<1year).

Methods

- **Laser Protocol:**

Patients in the current study are expected to have been treated with PRP using pattern lasers using PAtterned SCAnner Laser (PASCAL) system (Optimedica Corp., Santa Clara, CA, USA). Eyes would be labeled to have complete PRP if the laser scars spread 360 degrees covering the four retinal quadrants extended one disc diameter beyond retinal arcade and nasal to the optic disc and temporal 2-3 disc diameter from the center of the fovea. The laser wavelength is 532 nm with burn size 200–400 mm, and pulse duration ranges from 20-100 ms with half to one burn-width apart.

- **OCT and OCTA image acquisition:**

All patients included in this study had two types of images: First, colored fundus photograph using Topcon system (TRC-NW8, Topcon Corporation, Tokyo, Japan) that captures 50 degrees of the posterior pole. The second imaging modality is the OCTA using SS-OCT instrument (DRI OCT-1 Triton, Topcon, Tokyo, Japan). For each patient, the information from a high-definition 12-mm line scan, a 12x12-mm volume (the maximum) scan centered on the macula.

Results

- Twenty-three patients with treated PDR (41 eyes) were included

	(%) n
Age in years, mean ±SD [Range]	±11.4 53.1 [25.68]
Gender	
Male	(52.2) 12
Female	(47.8) 11
Type of DM	
1	(21.7) 5
2	(78.3) 18
Duration of DM in years, mean ±SD [Range]	1-] ±7.4 19.1 [35
Medications	
Insulin	(95.7) 22
Oral	(4.3) 1
HbA1C, mean ±SD [Range]	6-] ±2.2 8.7 [16

	mean ±SD [Range]
Timing of 1st PRP(years)	[1-8] ±2.2 3.5
Timing of last PRP(years)	[1-6] ±1.9 2.7
Timing of involution*(years)	[1-6] ±2.0 2.7
No. of PRP sessions	[1-4] ±1.0 2.4

Results

	Presence of Vitreous hemorrhage after involution	
	Yes (n=9) (%) n	No (n=32) (%) n
Presence of NVEs on OCTA		
Yes (n=22)	(31.8) 7	(68.2) 15
No (n=19)	(10.5) 2	(89.5) 17
Presence of NVDs on OCTA		
Yes (n=17)	(35.3) 6	(64.7) 11
No (n=24)	(12.5) 3	(87.5) 21

•In eyes labeled as treated PDR ,B-scan on OCTA (12mmx12mm) detected:

•NVEs in 22 (53.6%) eyes

•NVDs in 17 (41%) eyes

- **Development of vitreous hemorrhage (VH) during follow up:**

•9 eyes developed VH

•Of the 22 (53.6%) eyes with detected NVEs:

•7 eyes (31.8%) developed vitreous hemorrhage during follow up

•Of the 17 eyes with detected NVDs, 6 eyes (35.3%) developed vitreous hemorrhage during follow up

Results

- The number of episodes differed among these eyes.

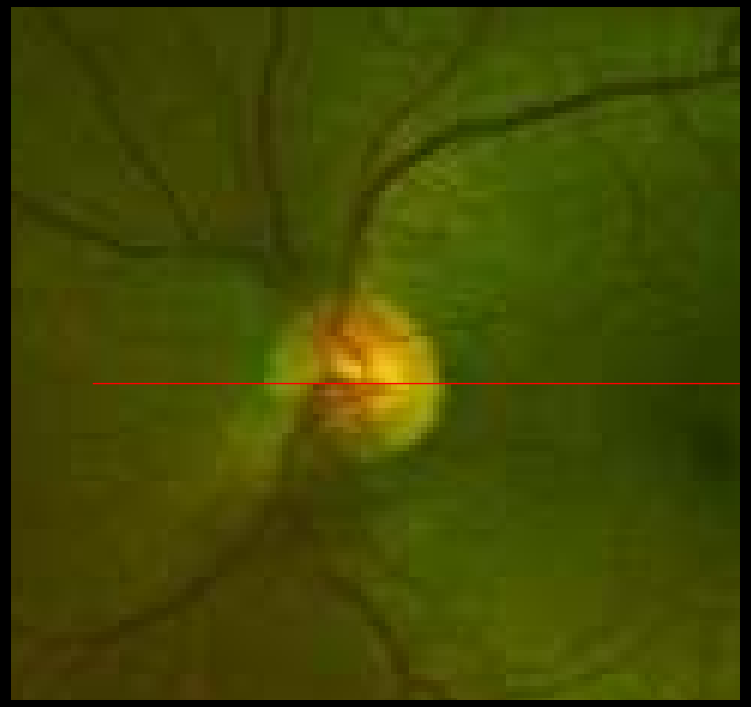
6 eyes had only 1 episode

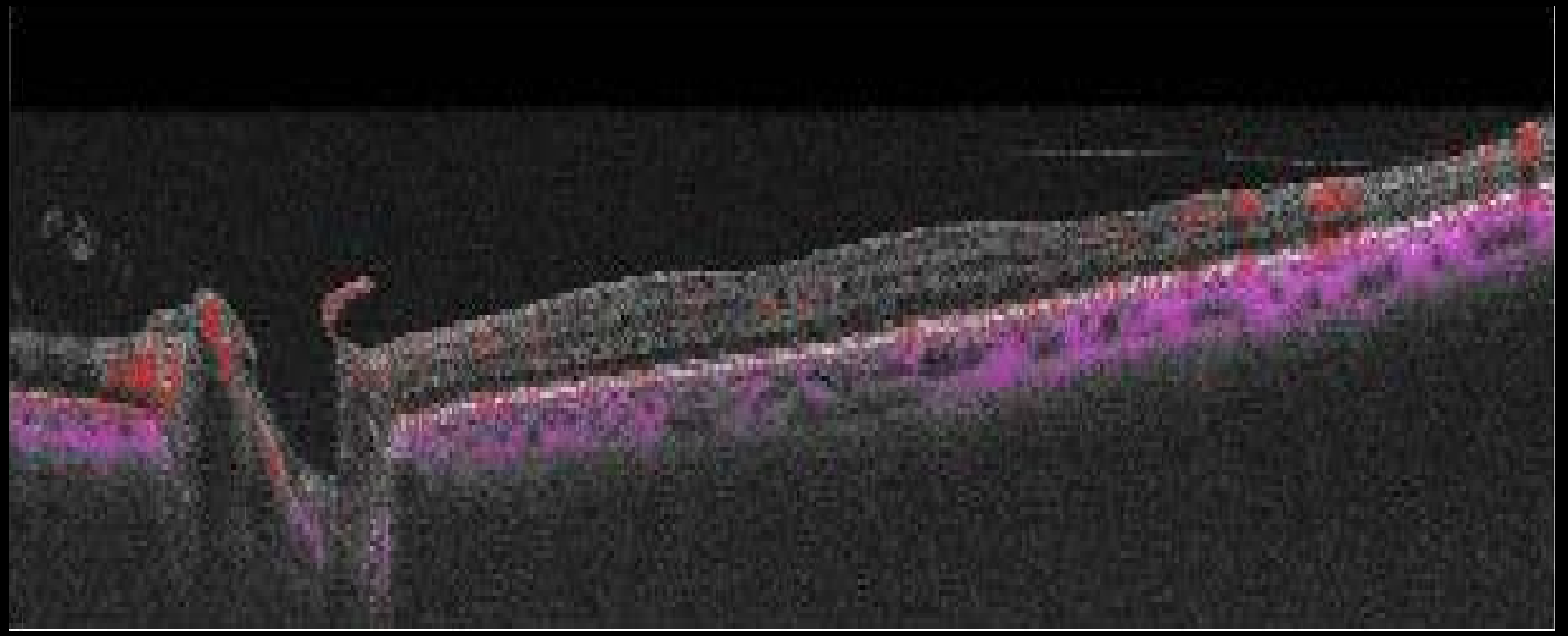
2 eyes had 2 episodes

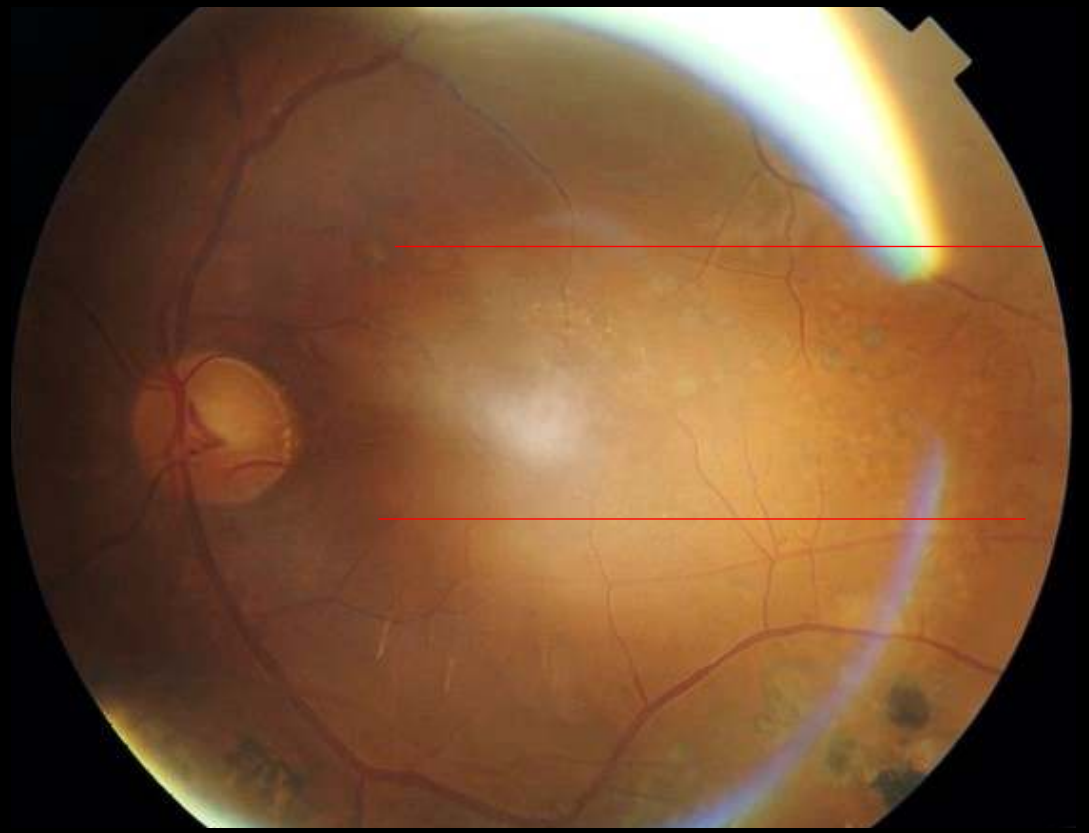
1 eye had 4 episodes.

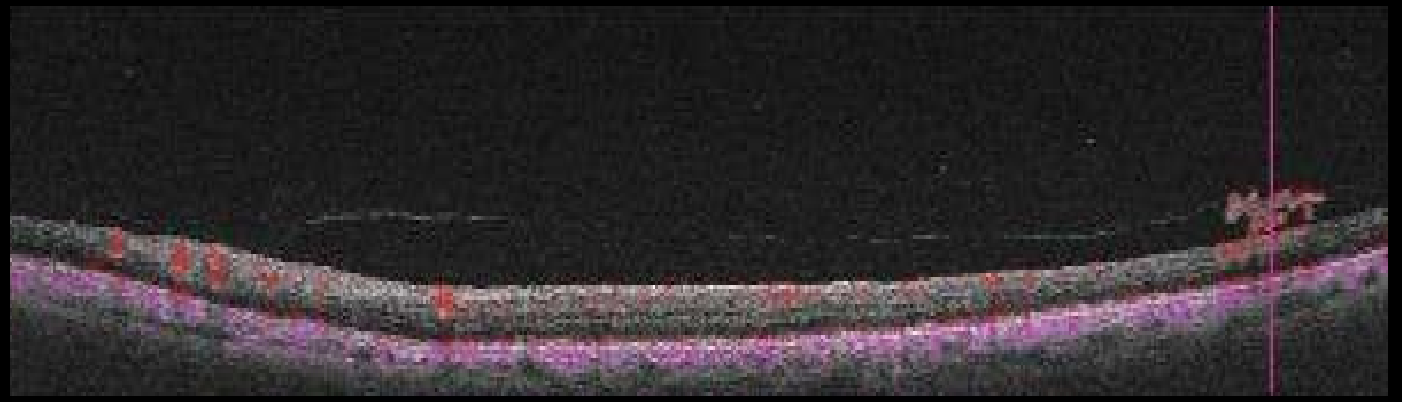
- Treatment was based on severity. 3 eyes were observed, 4 eyes received anti-VEGF and 2 eyes received augmentation of PRP (fill-in). None had PPV.

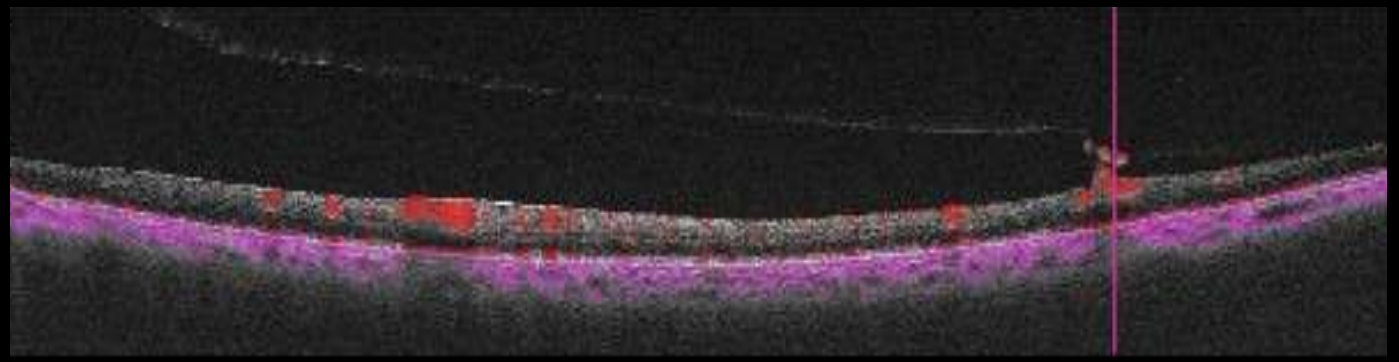
Results

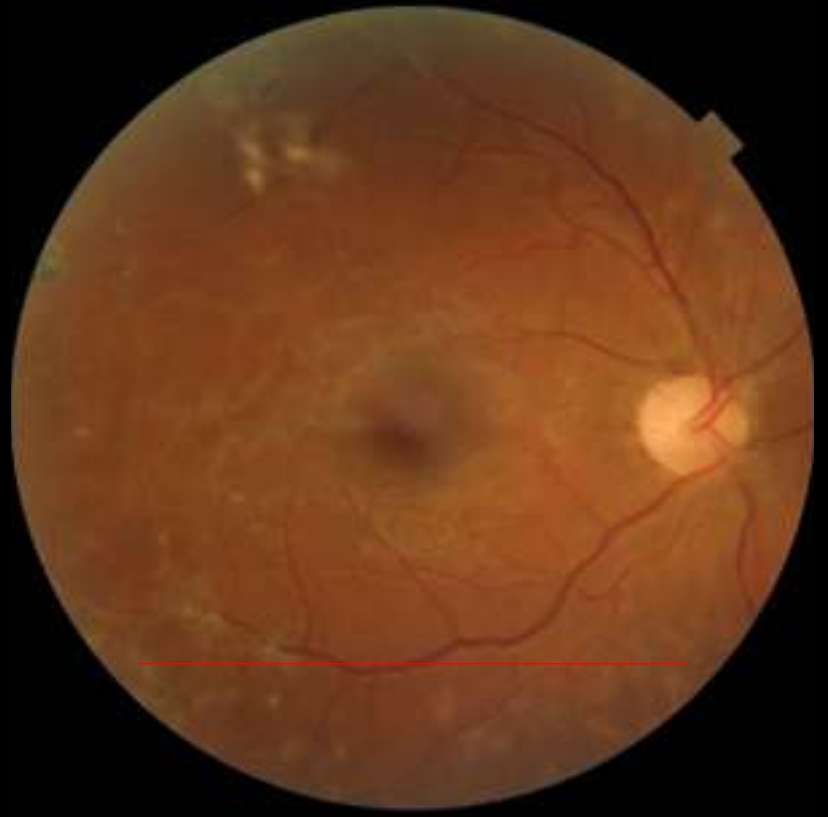


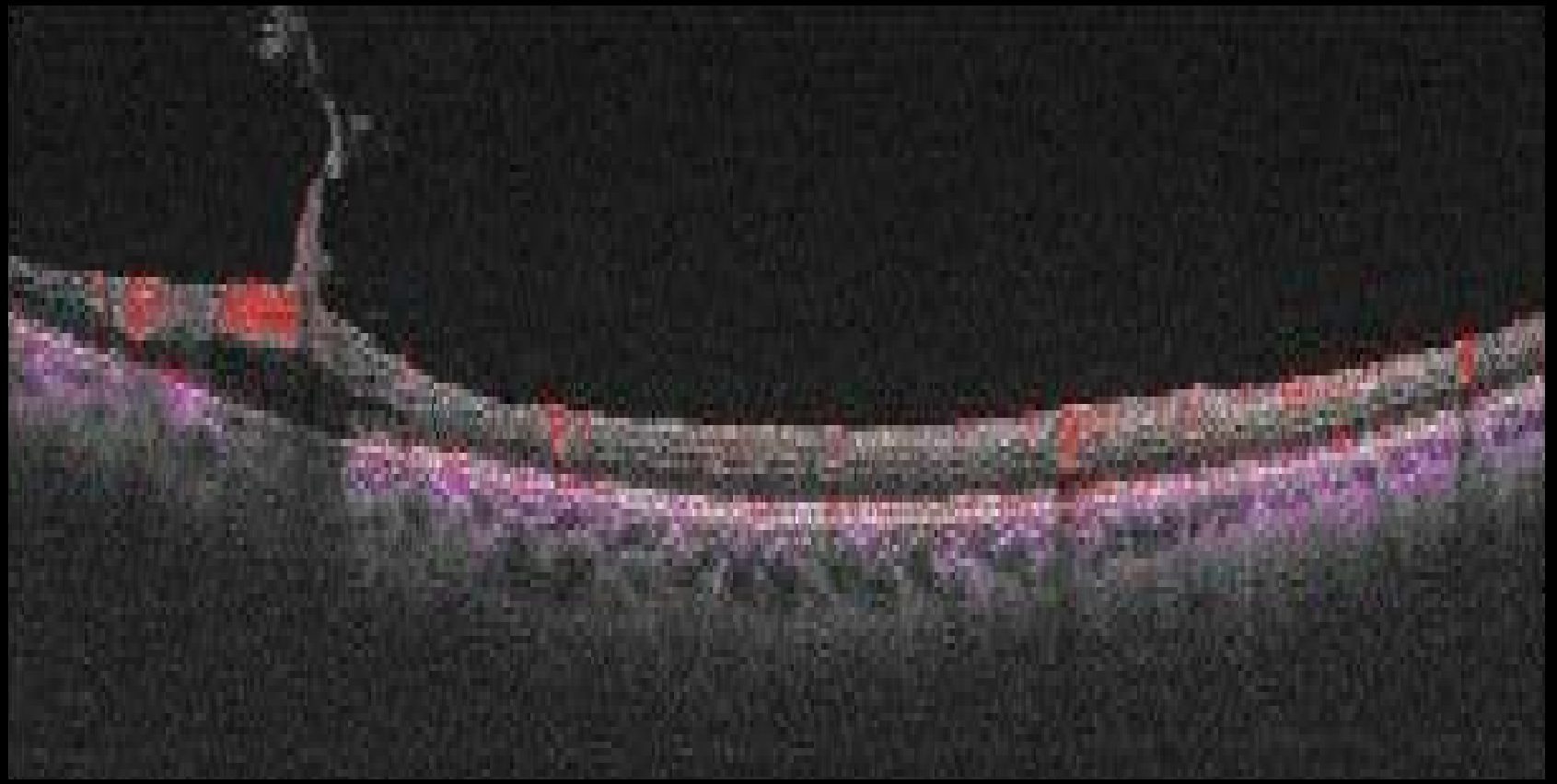




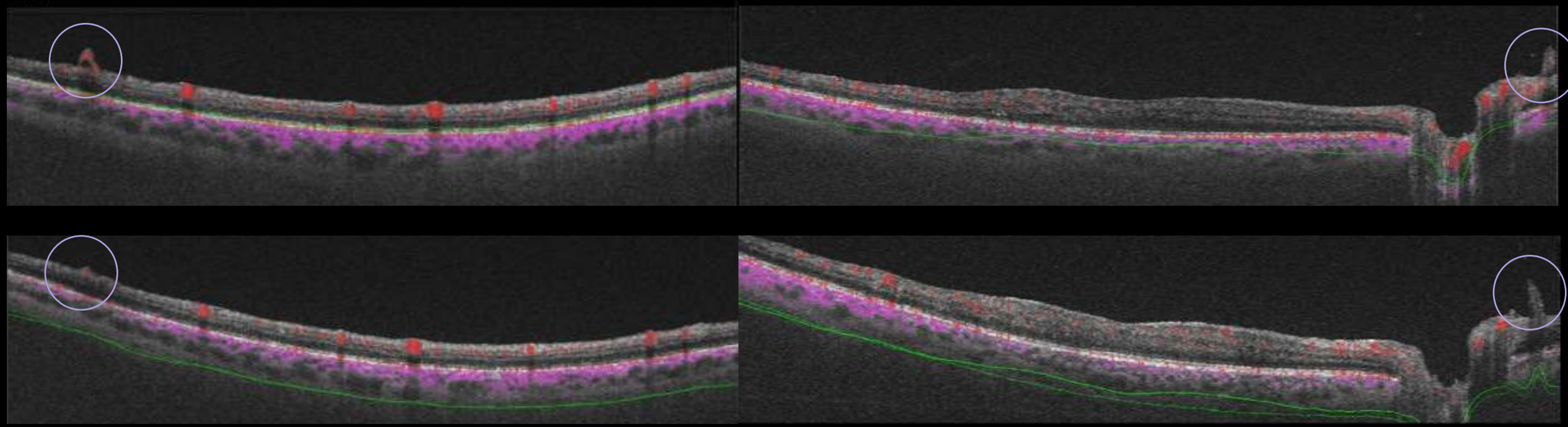


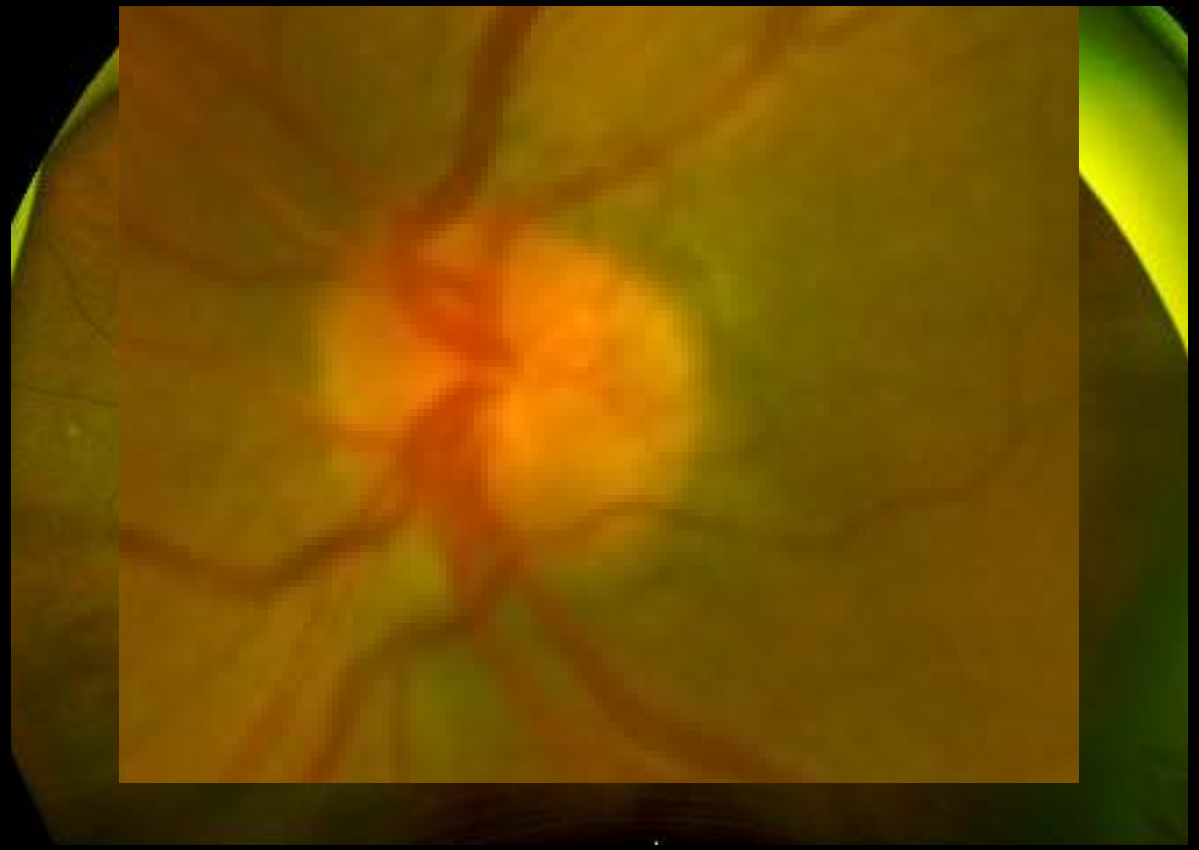


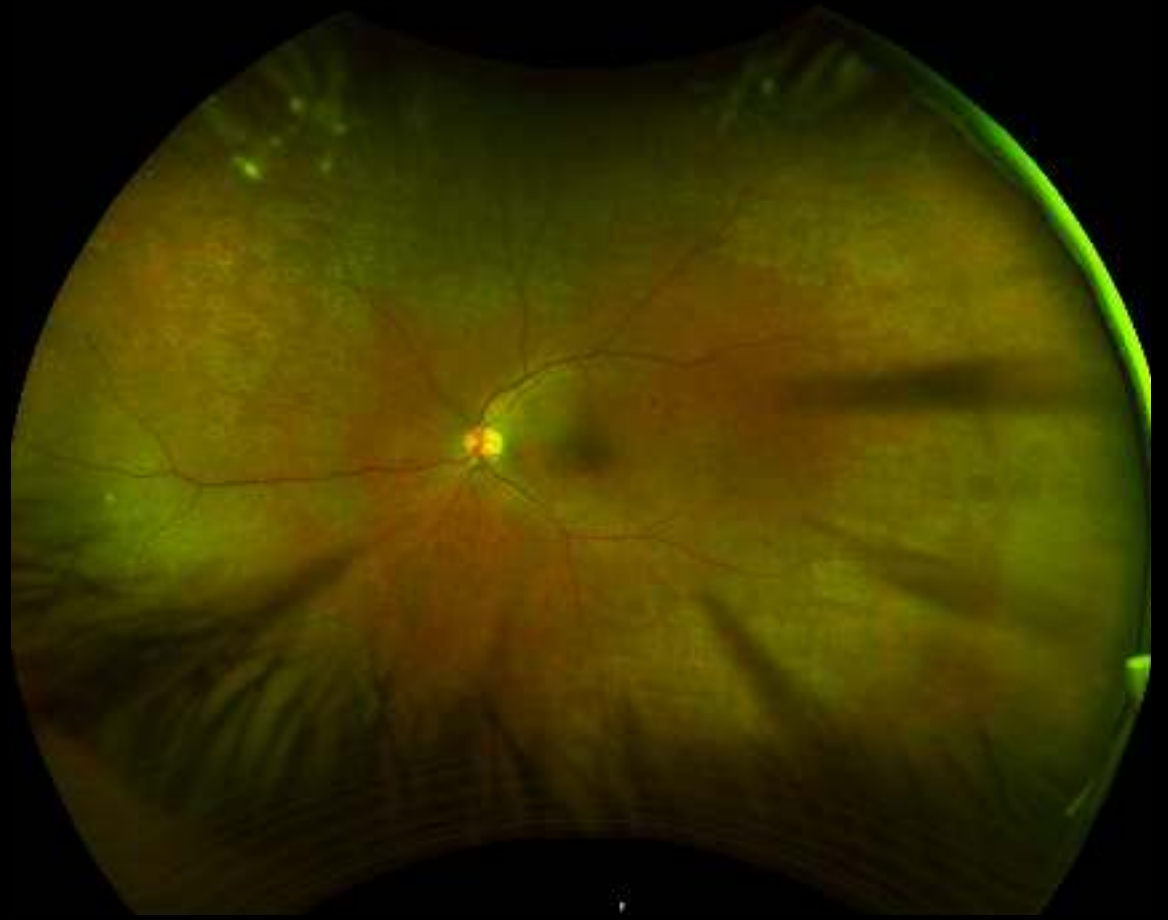


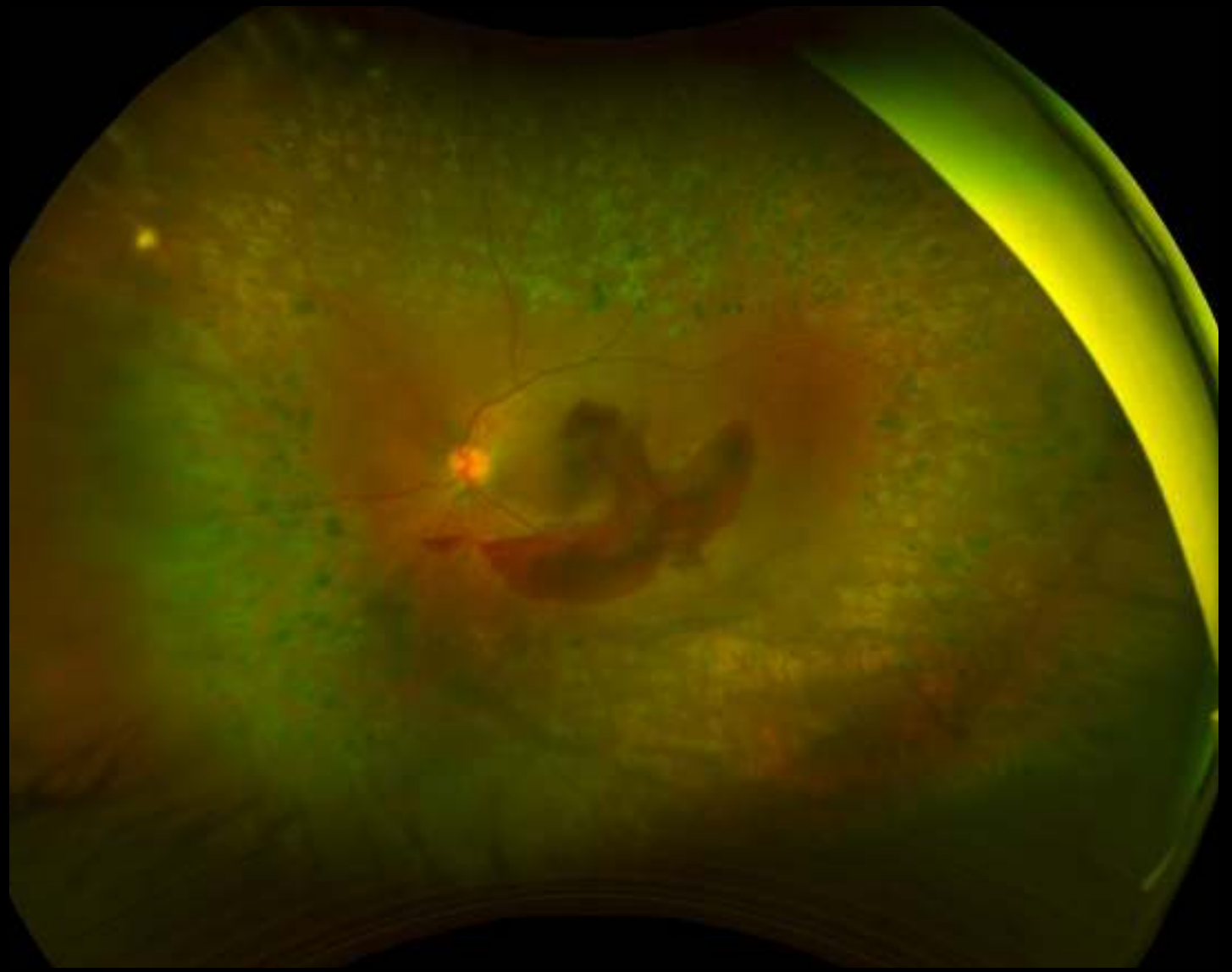


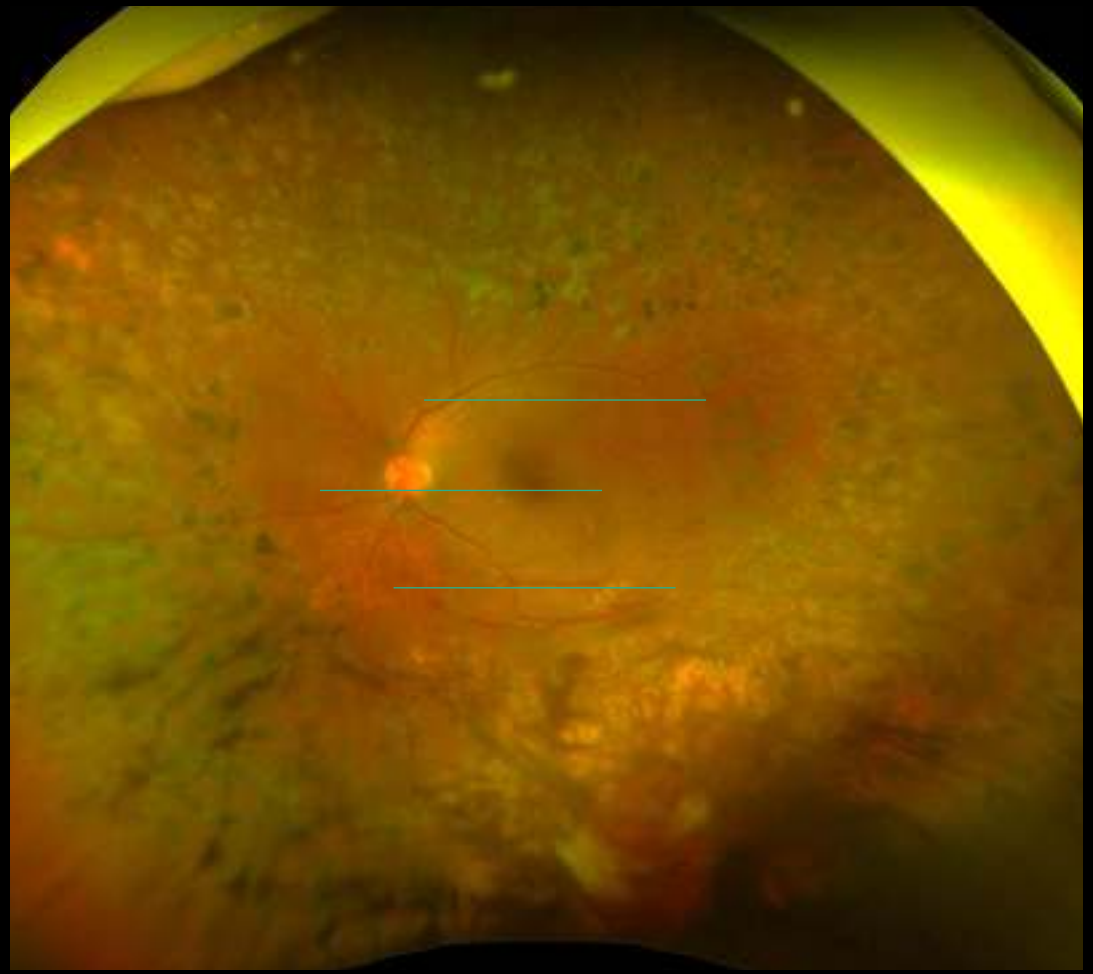
Recurrent Vitreous hemorrhage

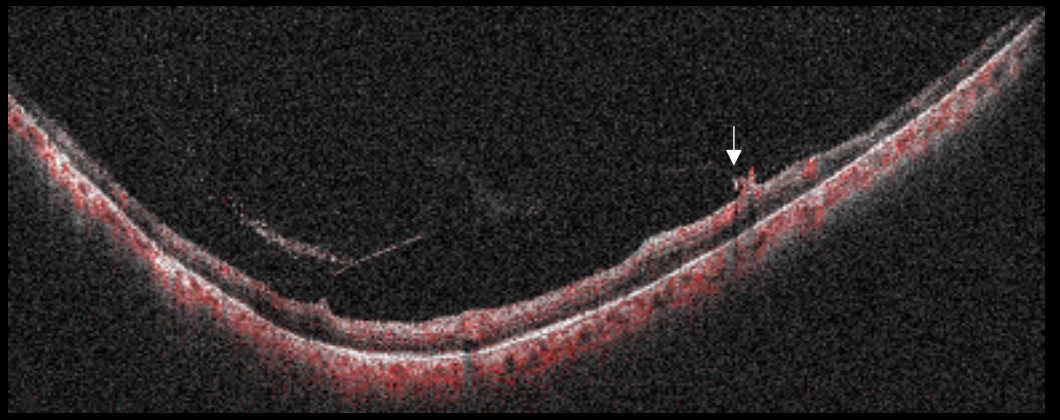


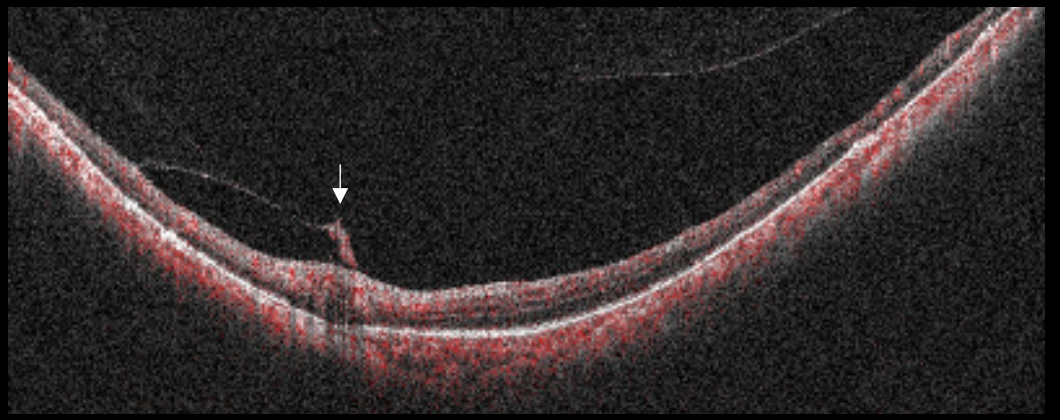


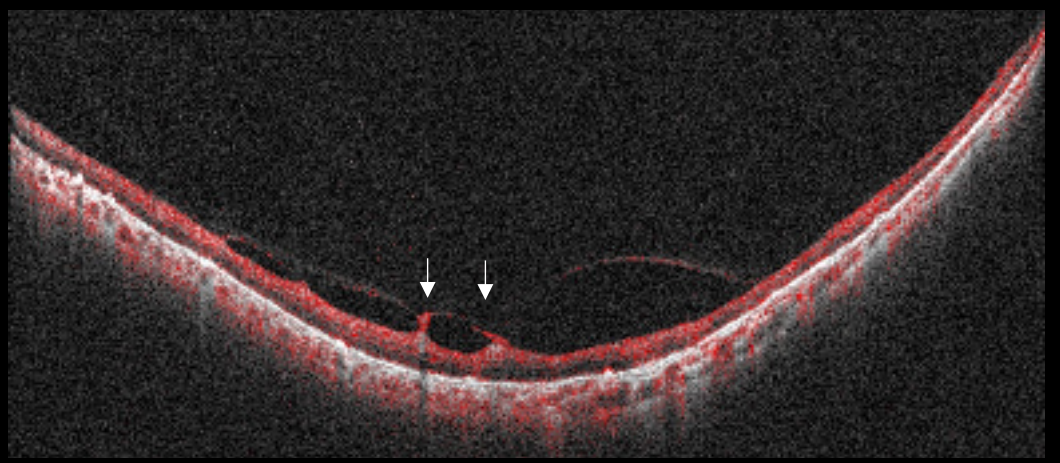


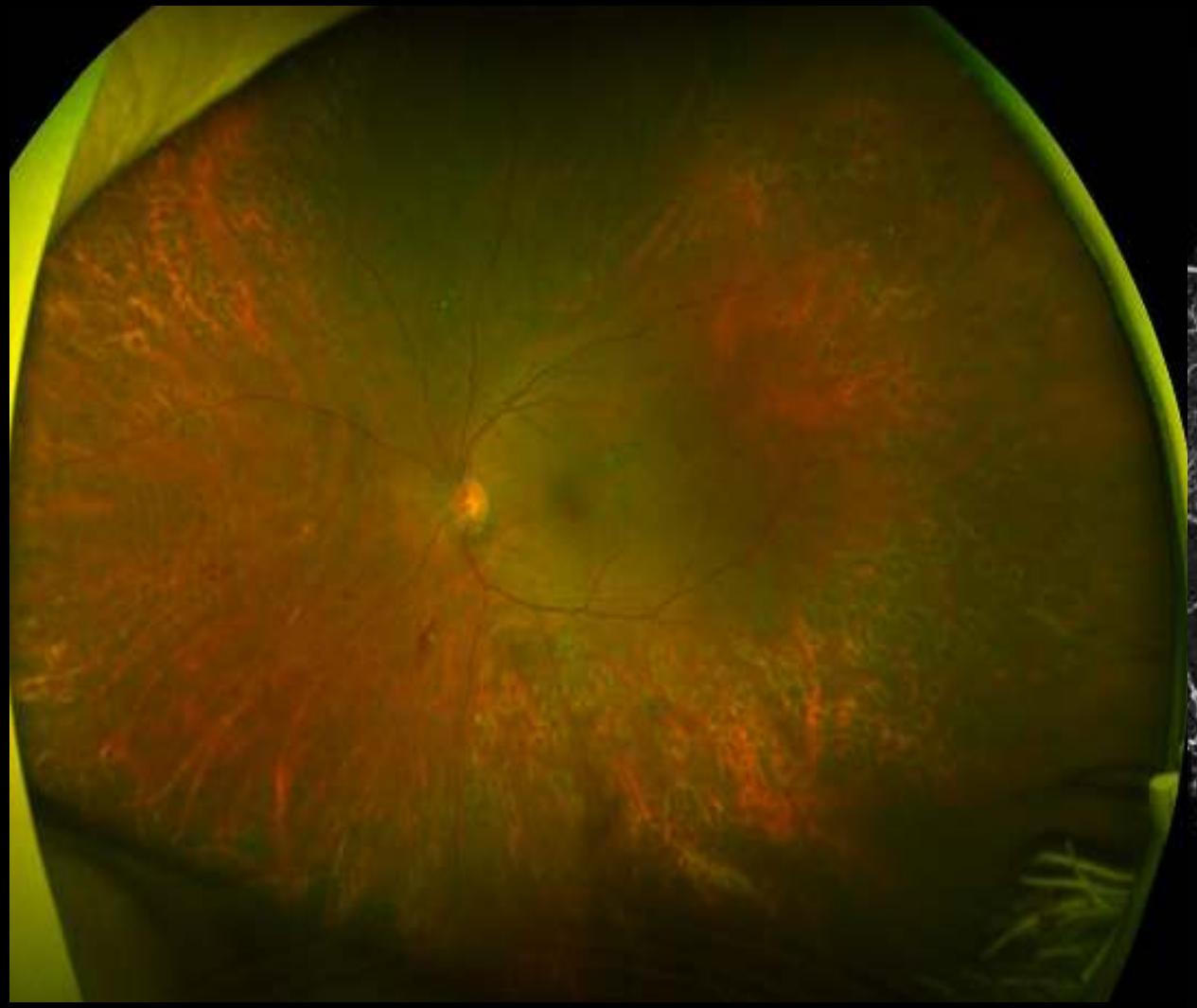


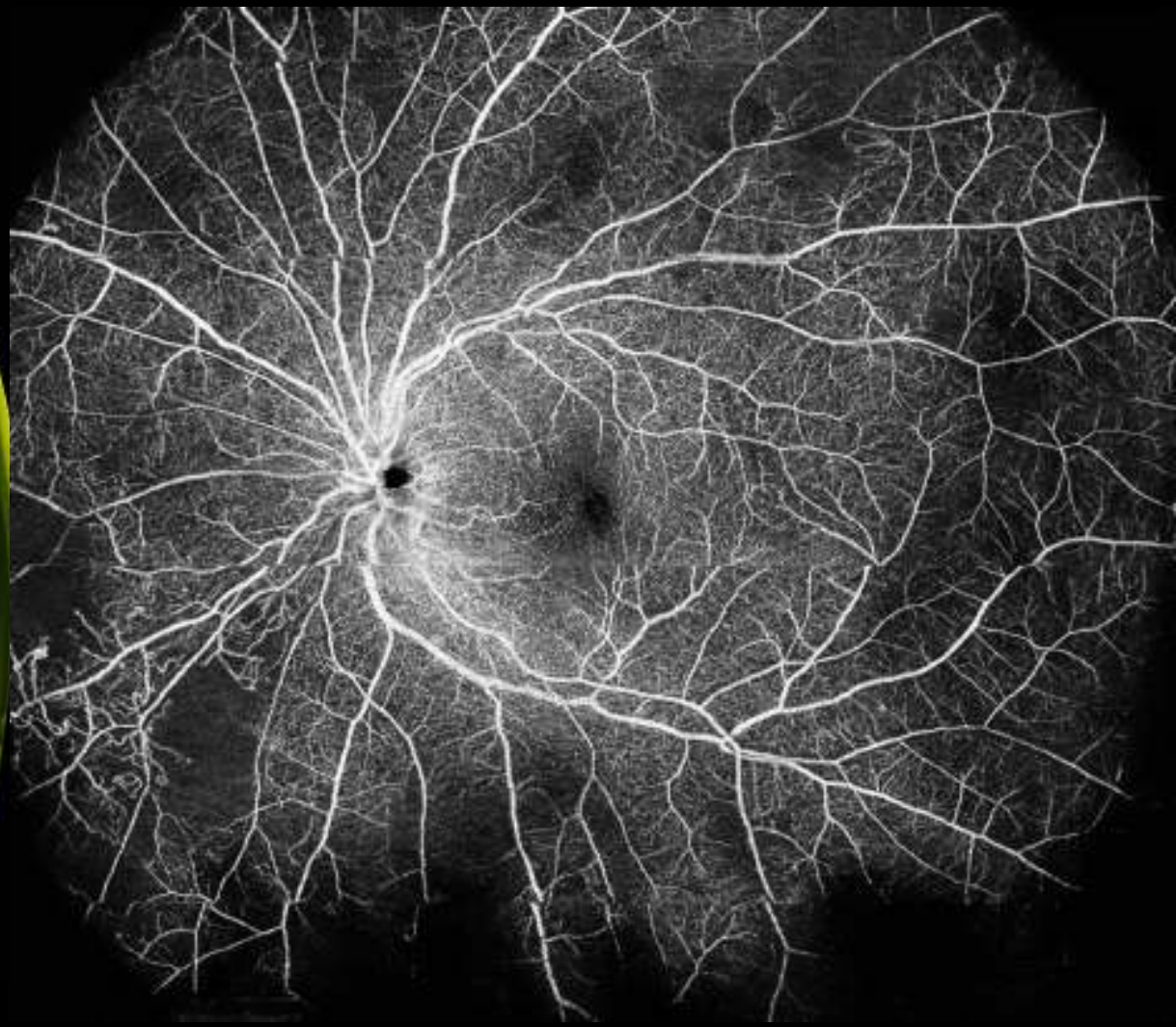


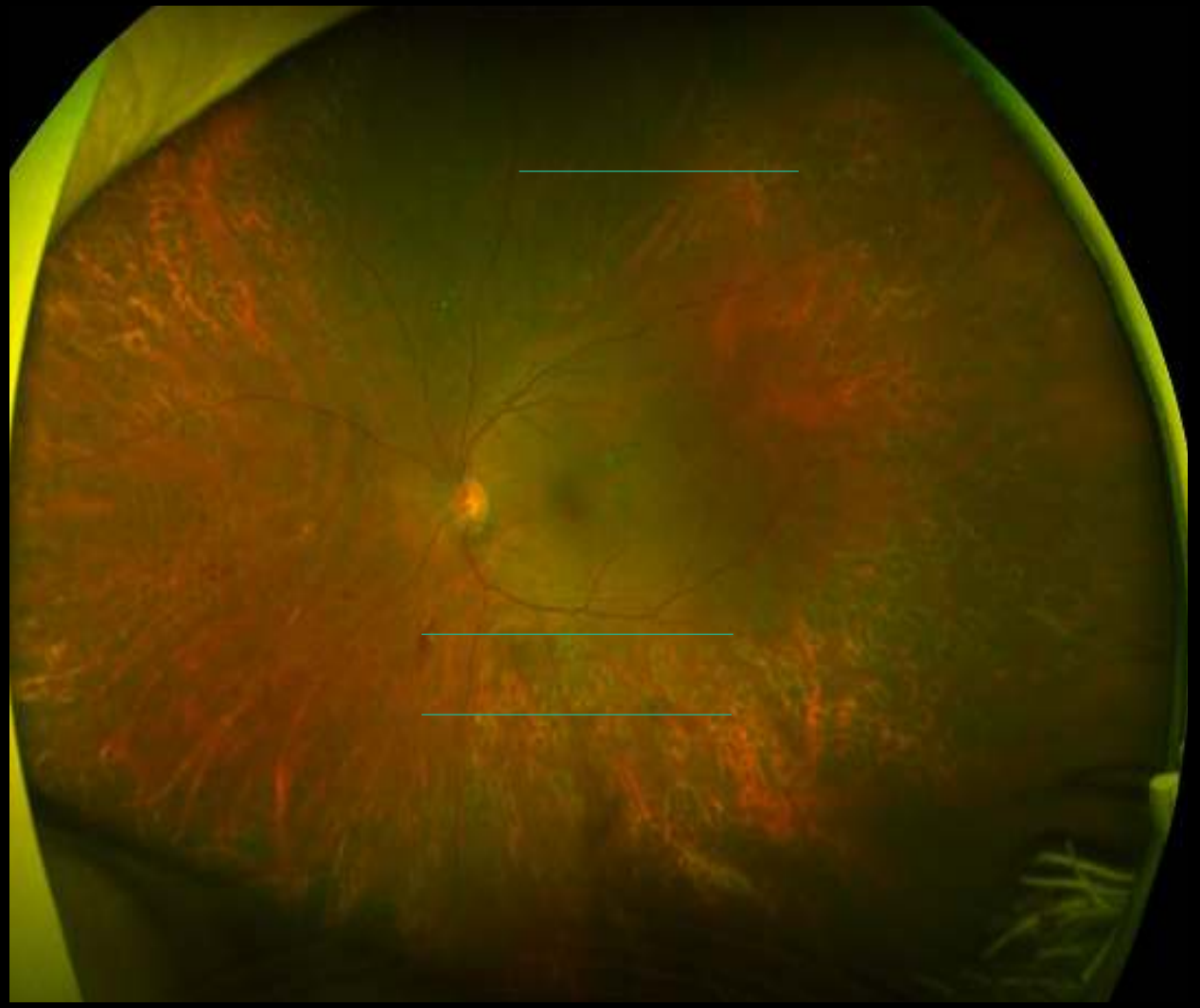


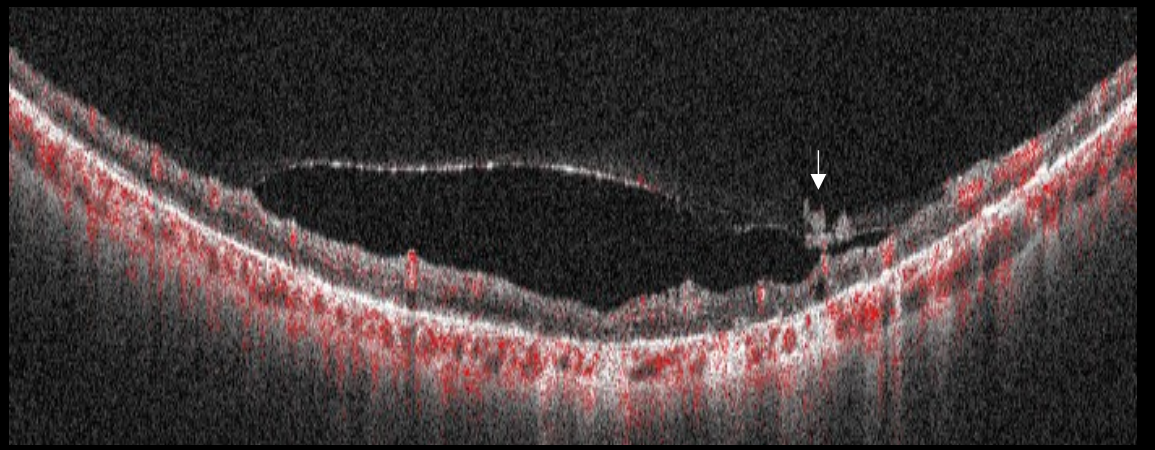


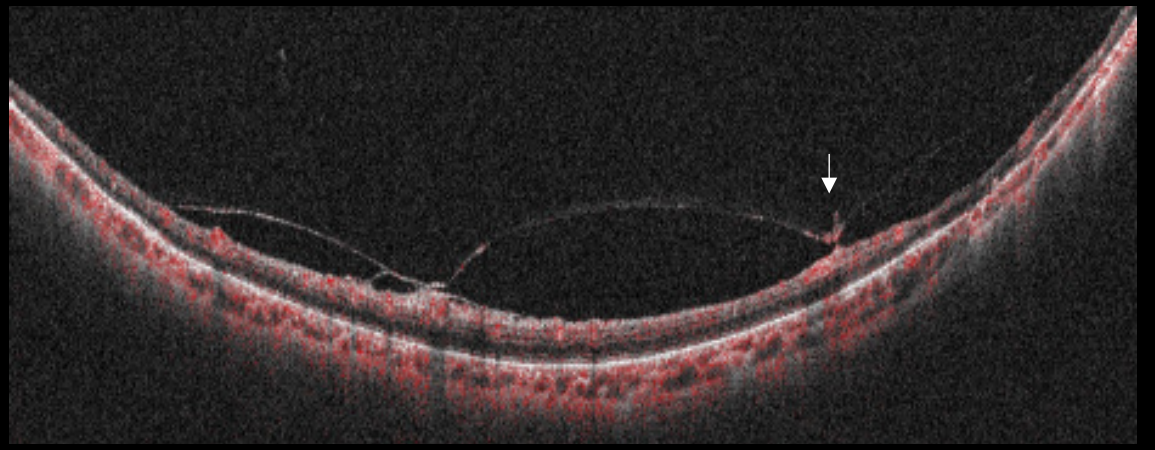


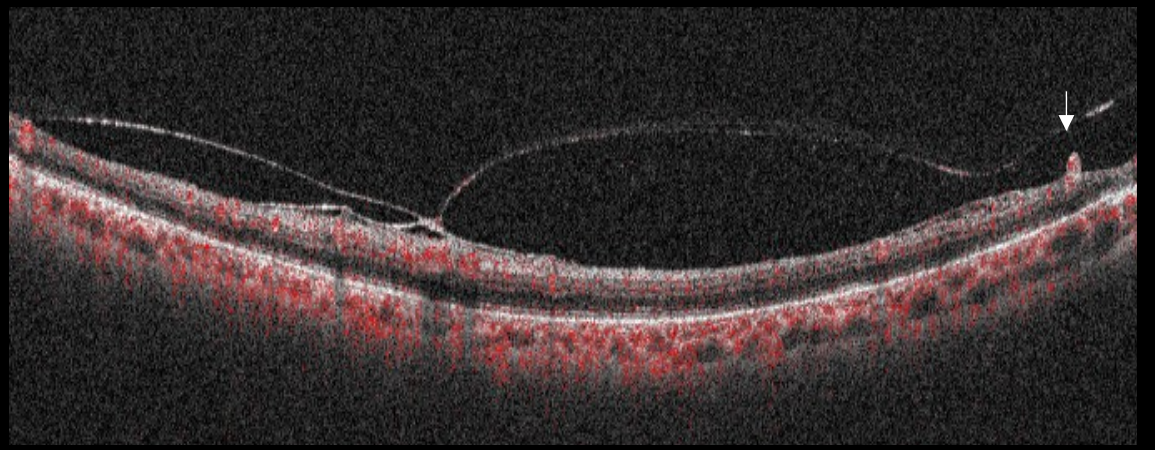


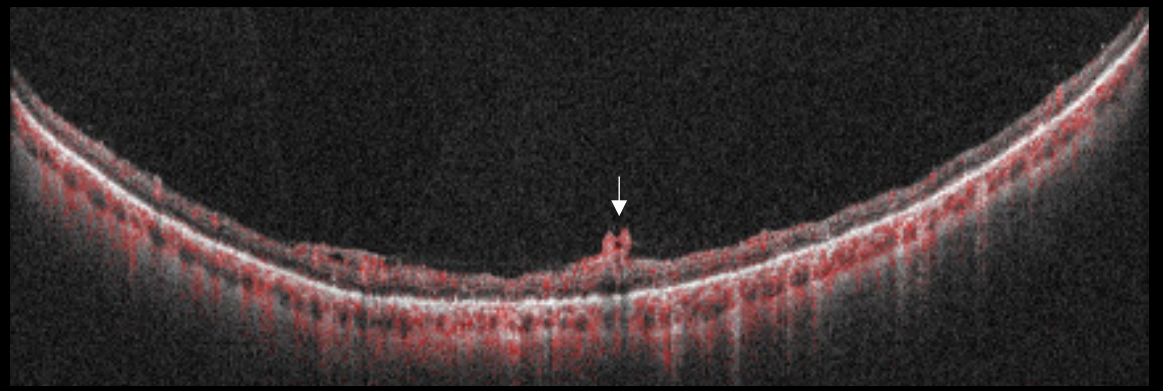


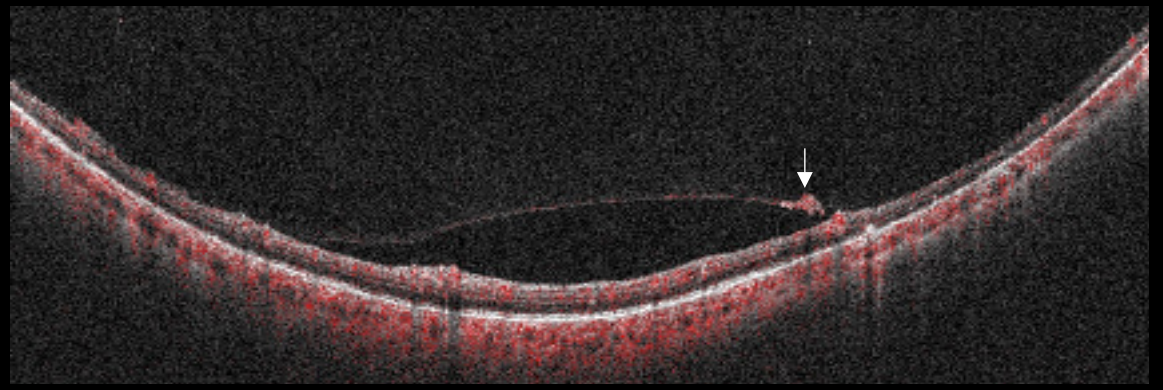












In summary

- Previous studies have shown that posterior pole structural OCT had the best detection rate of new-onset NVE and NVD but in regression or reactivation of RNV its detection rate decreased considerably. On the other hand, B-scan OCTA showed the most potential for objective monitoring of disease after treatment.
- A prior study demonstrated that the detection rate of RNV regression and reactivation using 6mmx6mm OCTA reached 100%.
- The current series shows that around 50% of treated PDR cases with no clinical evidence of NVs had active NVs that were detected only on B-scan OCTA.
- The presence of small caliper NVs on B-scan OCTA that not are not clinically apparent might contribute to recurrent VH; however, a larger studies are needed to establish this correlation.

Khadamy J, Abri Aghdam K, Falavarjani KG. An Update on Optical Coherence Tomography Angiography in Diabetic Retinopathy. *J Ophthalmic Vis Res.* 2018;13(4):487-497. doi:10.4103/jovr.jovr_57_18
Schwartz R, Khalid H, Sivaprasad S, et al. Objective Evaluation of Proliferative Diabetic Retinopathy Using OCT. *Ophthalmol Retina*. 2020;4(2):164-174. doi:10.1016/j.oret.2019.09.004

OCT-A drawbacks

- OCTA is still an evolving technology, and the challenges of interpreting the various parameters and addressing artifacts may be improved, as new hardware and software development continues.

- Future studies are needed to confirm the reliability of the current and between different OCT-A machines.

Thanks!