

### Optometric Education Consultants

# OCT-Angiography What You Need to Know with this New Technology

Greg Caldwell, OD, FAAO November 14, 20/20



### Disclosures- Greg Caldwell, OD, FAAO

Will mention many products, instruments and companies during our discussion

 I don't have any financial interest in any of these products, instruments or companies
 Pennsylvania Optometric Association –President 2010

 POA Board of Directors 2006-2011
 American Optometric Association, Trustee 2013-2016
 I never used or will use my volunteer positions to further my lecturing career
 Lectured for: Alcon, Allergan, Aerie, BioTissue, Maculogix, Optovue
 Advisory Board: Allergan, Maculogix, Sun, Kala
 Envolve: PA Medical Director, Credential Committee
 HealthCare Registries: Consultant
 Optometric Education Consultants - Scottsdale, WDW, St. Paul, Quebec City, and Nashville,

Ger Optometric Education Consultants - Scottsdale, WDW, St. Paul, Quebec City, and Nashv Owner



# OCT CONNECT

Post your questions & cases so we can #OCTConnect!



Join this group to become part of our OCT Connect Family!

### **Book Resources**



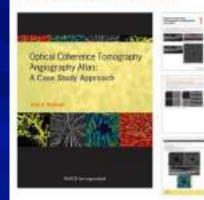
### ATLAS of RETINAL OCT

Darin R. Goldman Nadia K. Waheed Jay S. Duker

LINTER

#### Optical Coherence Tomography Angiography Atlas: A Case Study Approach

#### Julie A Rodman, OD MSc FAAO

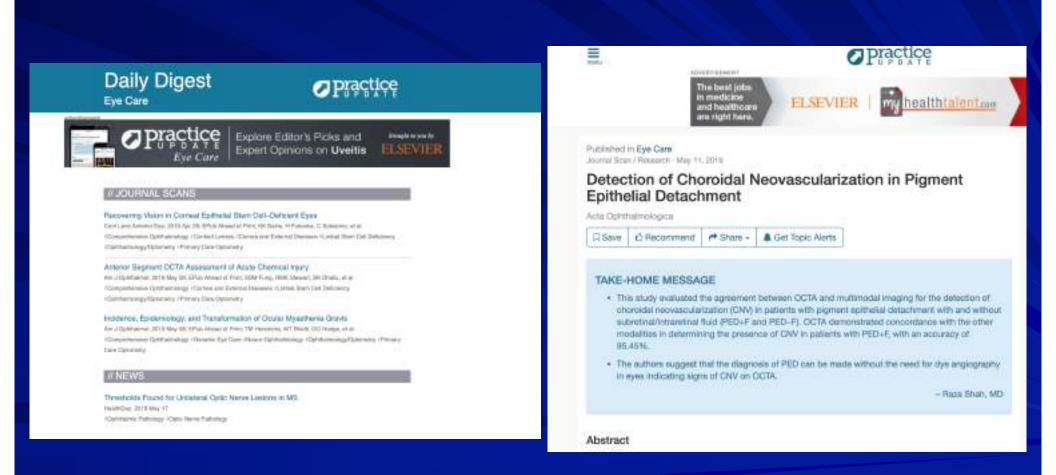


#### \$149.95 ISBN 10 1-83091-641-2 ISBN 13 978-1-63091-641-1 200 pp Hand Cover Pub. Date: 2019 Order# 66411

# How Many People Here Have an OCT?

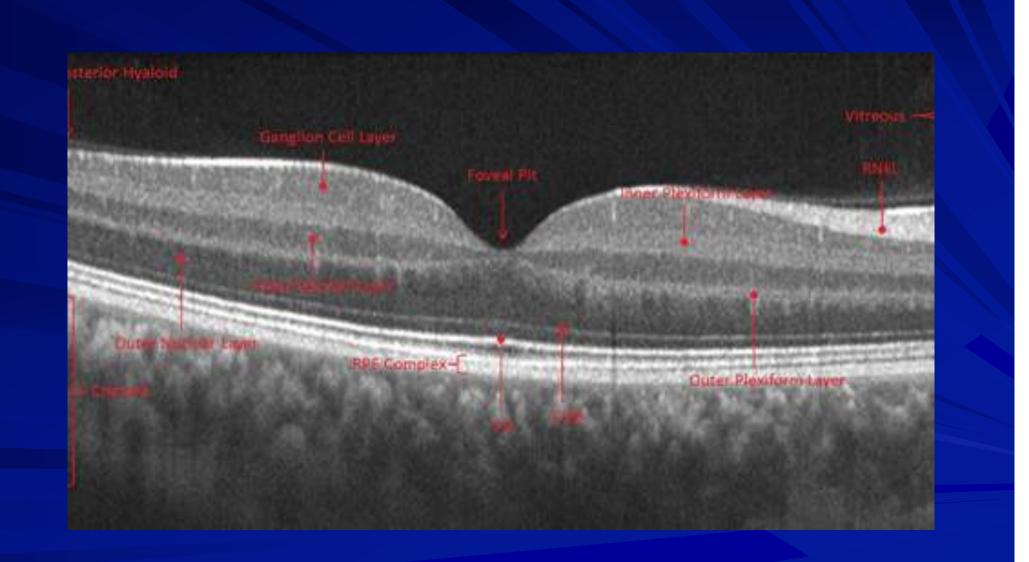
### Optical Coherence Tomography

- Gr OCT is an optical signal acquisition and processing method
- A Time domain OCT
  - \* 15-16 microns of resolution
  - \* Stratus (Zeiss)
- Ger Spectral domain (SD-OCT) or Fourier domain OCT
  - \* Spatially encoded frequency domain OCT (SEFD-OCT)
  - \* 5-6 microns of resolution
    - Able to see photoreceptor morphology (inner/outer segments)
  - \* 50 times faster than time domain
- ← Swept source OCT
  - \* Time encoded frequency domain OCT
  - \* 1 micron of resolution
- & Future of OCT- intraoperative imaging, blood flow and oxygenation measurements
- Ger May have the possibility to assess retinal pathology like a pathologist



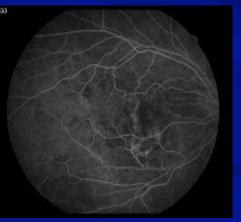
#### Macular and Peripapillary Angiographic Changes With in the second Intravitreal Injections NOVERTHEINENT The best jobs in medicine and healthcare are right here. Petina (Philadelphia, Pa.) ELSEVIER healthtalent.com Save C Pacommend P\* Share -A Get Topic Alerts TAKE-HOME MESSAGE Published in Eve Care Journal Scan / Research - March 30, 2019 This retrospective observational study of 38 patients with various retinopathies assessed retrial perfusion density changes on OCT. Results showed that an acute change in intraocular pressure **Detection of Clinically Unsuspected Retinal** due to intravitreal injections was associated with a decrease in macular and peripapillary perfusion Neovascularization With Wide-Field OCTA density. These findings suggest that intravitrial injections may lead to the development of glaucoma. Retina (Philadelphia, Pa.) causing damage to the macula and optic nerve. A Share -A Get Topic Alerts Save C Recommend - Raza M. Shah, MD TAKE-HOME MESSAGE Abstract This study evaluated the accuracy of wide-field optical coherence tomography angiography (OCTA) for detection of clinically unsuspected neovascularization (NV) in patients with diabetic retinopathy. This abstract is available on the publisher's site. There were 27 participants, who underwent a clinical examination, standard 7-field polor Access this abstract new C photography, and OCTA with commercial and prototype swept-source devices. Nonproliferative diabetic retinopathy was found to be mild in 13 patients, moderate in 7, and severe in 7 based on photographic gracing. The conventional 6- = 6-mm OCTA detected NV in 2 eyes (7%) and the 3- = PURPOSE 3-mm scan detected none. Both prototype and commercial wide-field OCTA detected NV in 2 intravitreal injections acutely and temporarily increase intraocular pressure (IOP), and this may have additional eyes. All eyes with OCTA-detected NV were photographically graded as severe nonproliferative DR. cumulative long-term effects including an increased risk for glaucoma surgery. This study was designed to measure ratinal perfusion density changes on optical coherence tomography (OCT) angiography and OCT Wide-field OCTA can aid in the detection of retinal changes that would seemingly escape detection thickness alterations associated with acutely increased IOP after intravitreal injections. otherwise. However, the study population in this study was small, and the positive findings were METHODS particularly few, which makes it difficult to draw any significant conclusions.

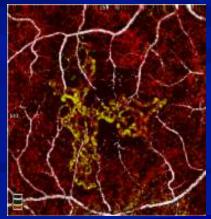
Retrospective observational clinical study of 40 eyes (39 patients) with various retinopathies from October



#### OCT Angiography A New Approach to Protecting Vision

- Non-invasive visualization of individual layers of retinal vasculature
- Pathology not obscured by fluorescein staining or pooling
- Image acquisition requires less time than a dye-based procedure
- Reduced patient burden allows more frequent imaging to better follow disease progression and treatment response

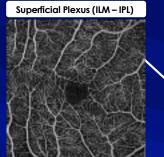


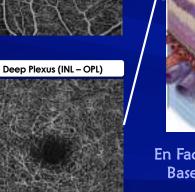


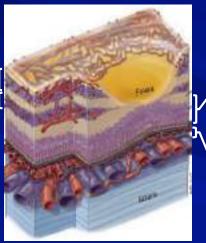
FA of CNV

OCTA of CNV

### Enface OCT-A Slabs Based on Retinal Anatomy







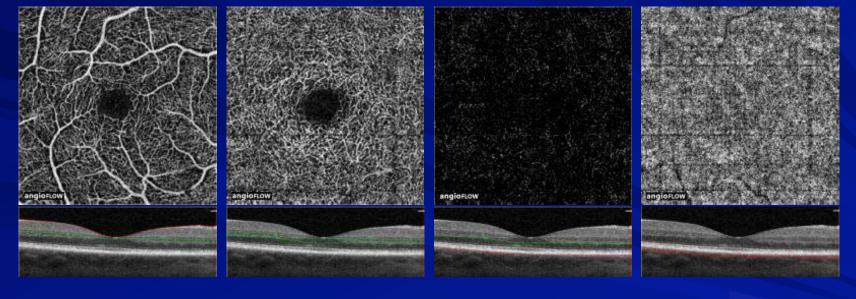
En Face Visualization of Layers Based on Retinal Anatomy



Outer Retinal Zone (ONL – BM)



### Normal Retinal Vasculature



Superficial Capillary Plexus

 $\begin{array}{rr} \mbox{3}\mu\mbox{m Below ILM} \rightarrow \mbox{15}\mbox{ }\mu\mbox{m Below IPL} \\ \mbox{Below IPL} \end{array}$ 

Deep Capillary Plexus

15µm Below ILM  $\rightarrow$  70 µm Below IPL

Outer Retina

70µm Below IPL  $\rightarrow$  30 µm Below RPE Reference

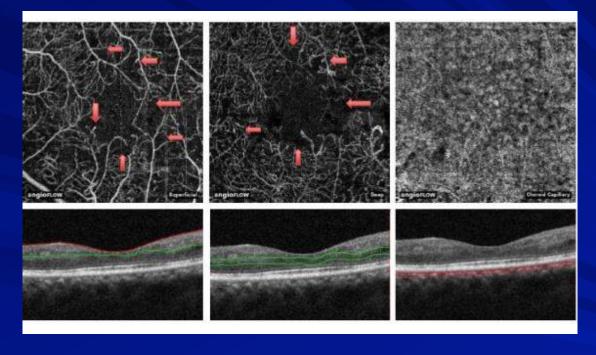
Choriocapillaris

30  $\mu$ m Below RPE Reference  $\rightarrow$  60  $\mu$ m Below RPE Reference

# **Metrics and Analytics**

Make a Difference Important

### **Diabetic Retinopathy**



Superficial Capillary Plexus

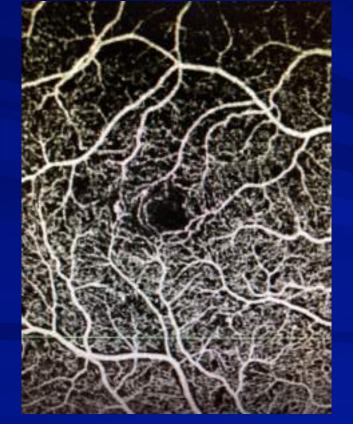
Deep Capillary Plexus

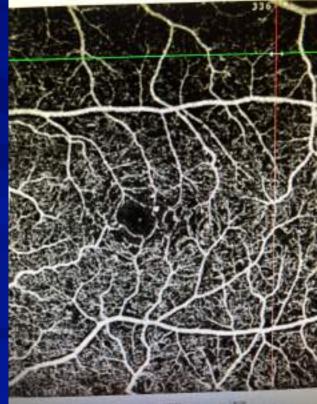
Choriocapillaris

▶ Retinal capillary non-perfusion – seen as blackened area without blood flow outside FAZ

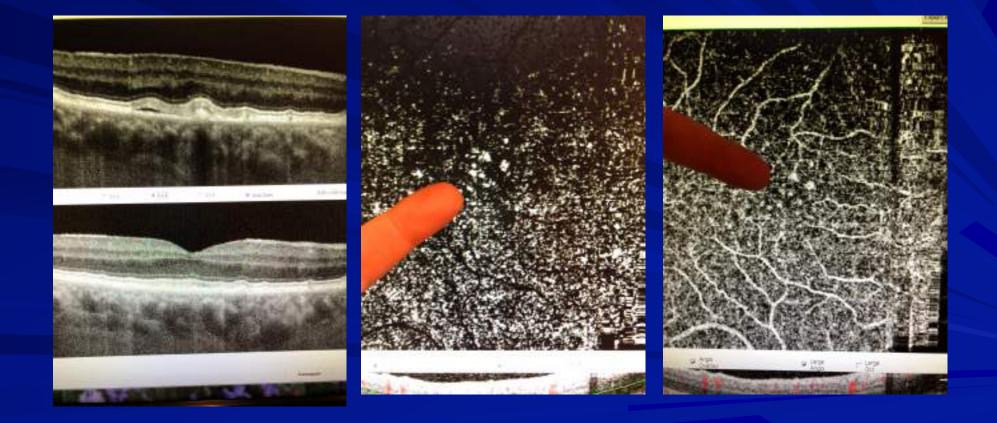
- ► Microaneurysms
- Enlarged FAZ

### Diabetes

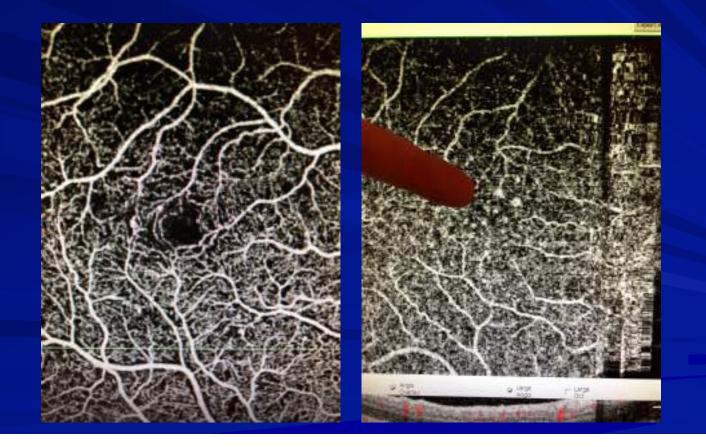




### Wet AMD



### Glad to Have it in the Office Disappointing without Quantitative Measurements



### AngioAnalytics

AngioAnalytics is the world's first OCTA metrics

#### A The package includes the following tools:

- \* Foveal Avascular Zone (FAZ) measurements
  - TAZ area, perimeter, A-circularity index and foveal vessel density

#### \* Flow and Non-Flow Area measurements

 Measure the area of abnormal flow by outlining a region for vessel detection. The extracted Flow Area measurement is based on the Outer Retina slab (OPL ~ BRM)

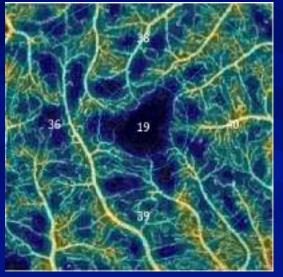
#### \* Vessel Density mapping

Measures the vessel density of the superficial and deep plexi of the retina as well as the radial peripapillary capillary layer of the optic disc

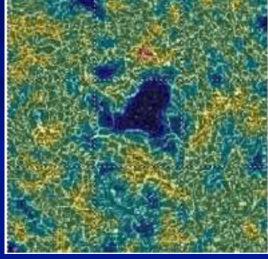
### Clinical Applications of AngioAnalytics

Identify early vascular changes in diabetic eyes
 Assess disease progression
 Compare structure and vasculature in glaucoma
 Assess rate of change in optic disc vessel density

### AngioAnalytics Vessel Density Mapping

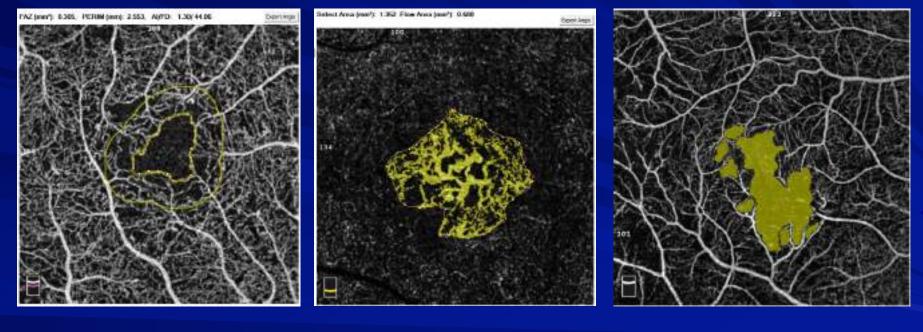


Vessel Density Superficial Plexus



Vessel Density Deep Plexus Vessel Density Radial Peripapillary Capillaries

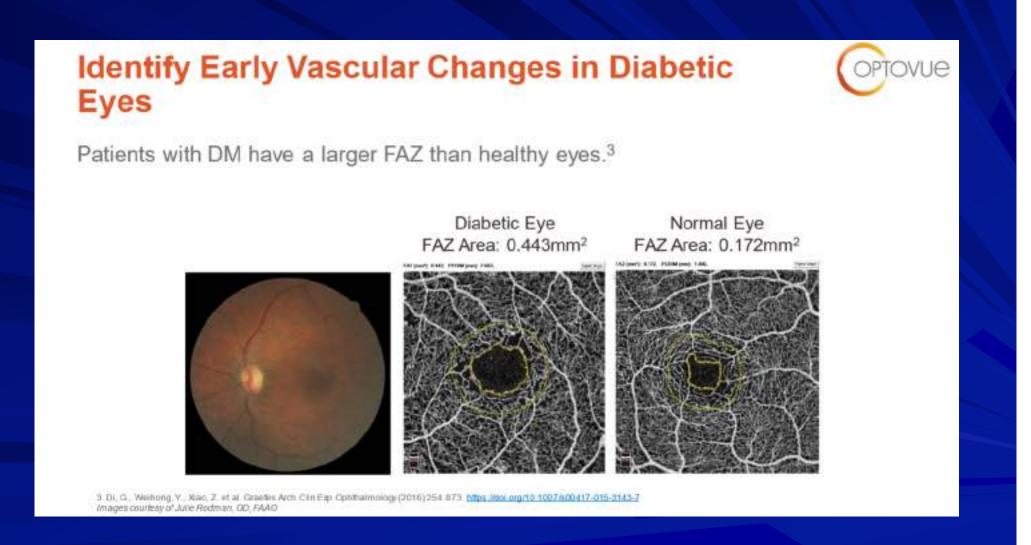
#### AngioAnalytics FAZ, Flow & Non-Flow Area Measurements



Foveal Avascular Zone Metrics

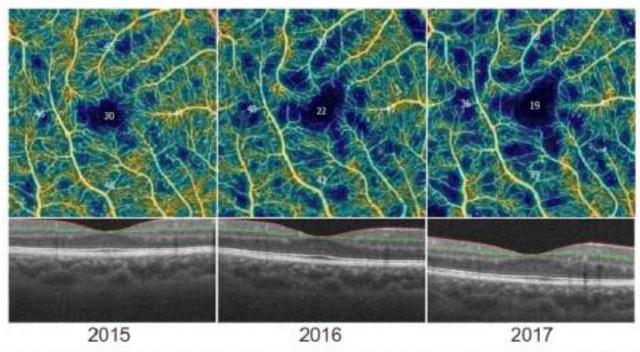
**Flow Area Measurements** 

**Non-Flow Area Measurements** 



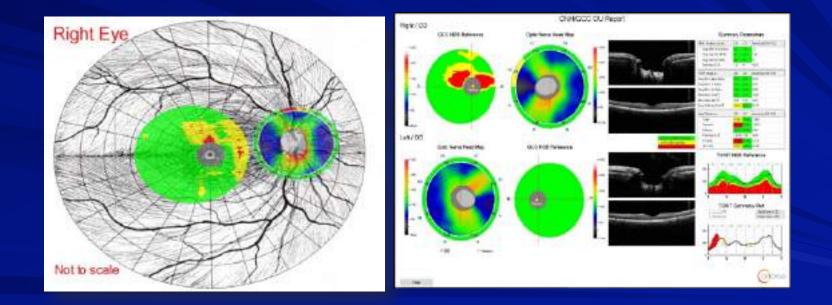
### Assess Disease Progression with Multiscan View

Vessel Density Decreases Significantly with Disease Severity<sup>4</sup>



 Nesper PL, Roberts PK, Onishi AC, et al. Quantitying Microvascutar Abnormalities With Increasing Severity of Diabetic Retinopathy Using Optical Coherence Tomography Angiography. Investigative Ophthalmology & Visual Science. 2017;58(6):Bi0307-Bi0315. doi:10.1167/jows.17-21787.

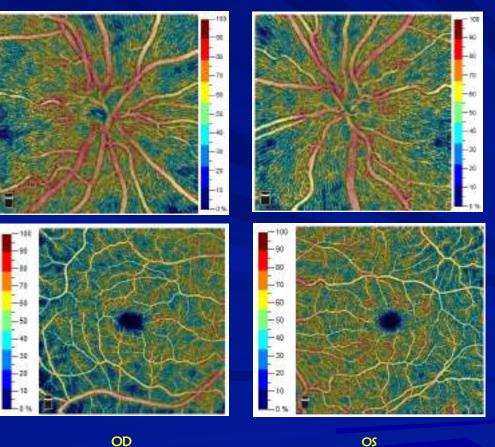
# Next Generation Glaucoma Analysis with OCT + OCTA



### Learn What Normal Looks Like

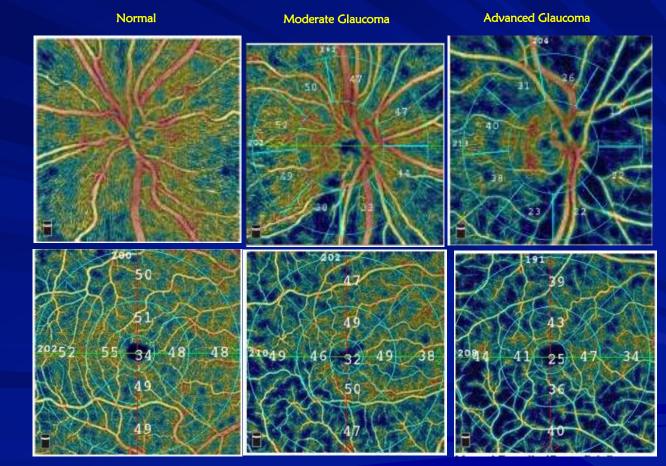
Disc: Radial Peripapillary Capillaries

Retina: **Superficial Vascular** Complex



OD

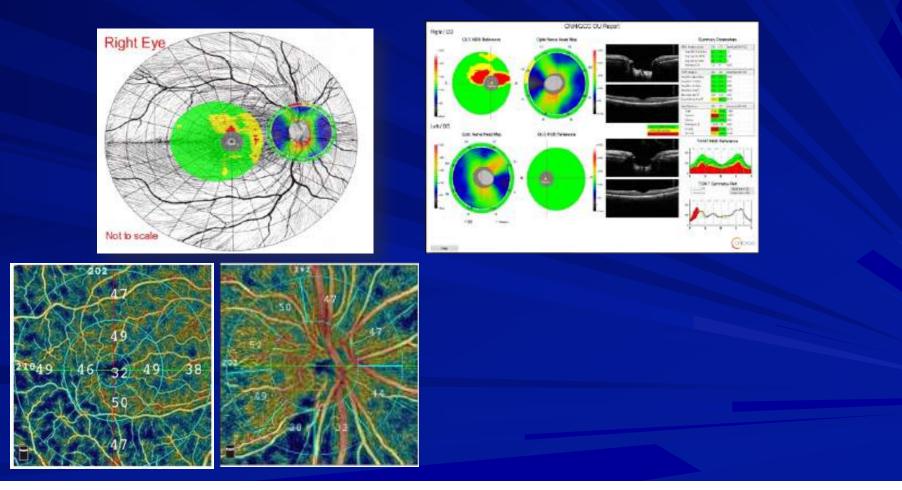
### What Does Glaucoma Look Like?



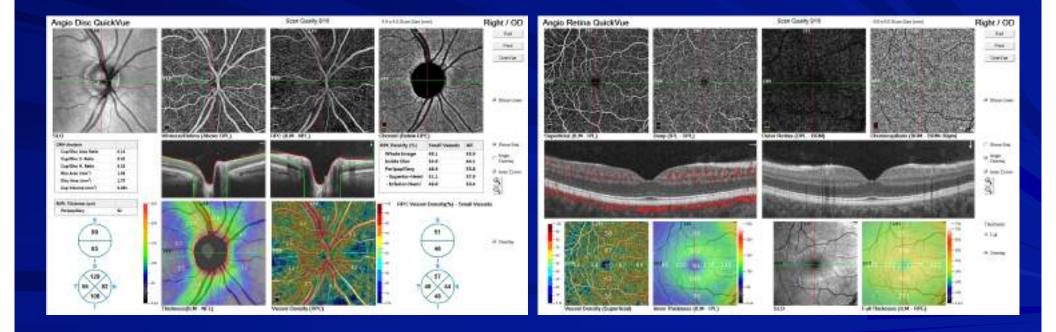
Disc

Retina

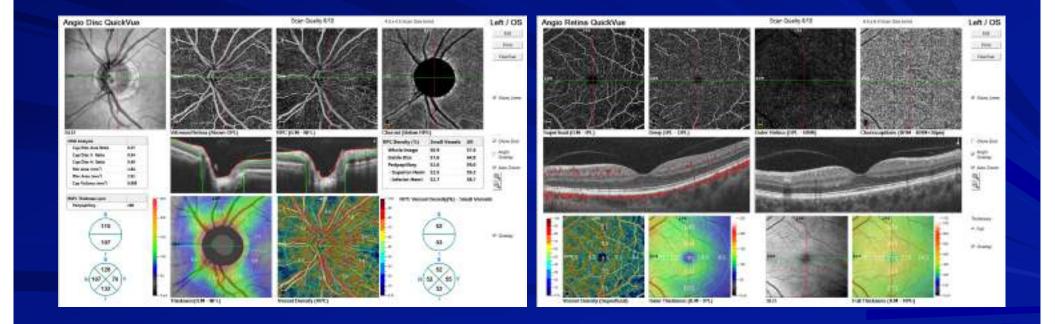
### Glaucoma



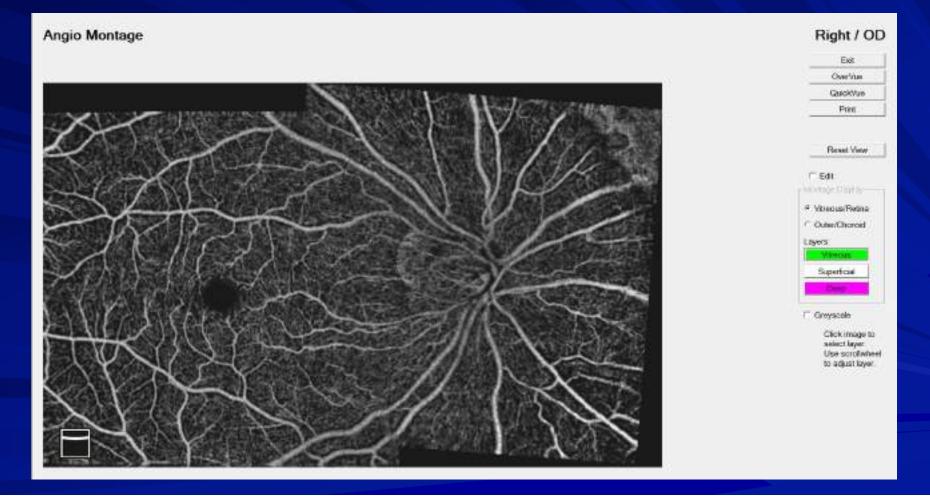
### Review of Normal 25 year old man



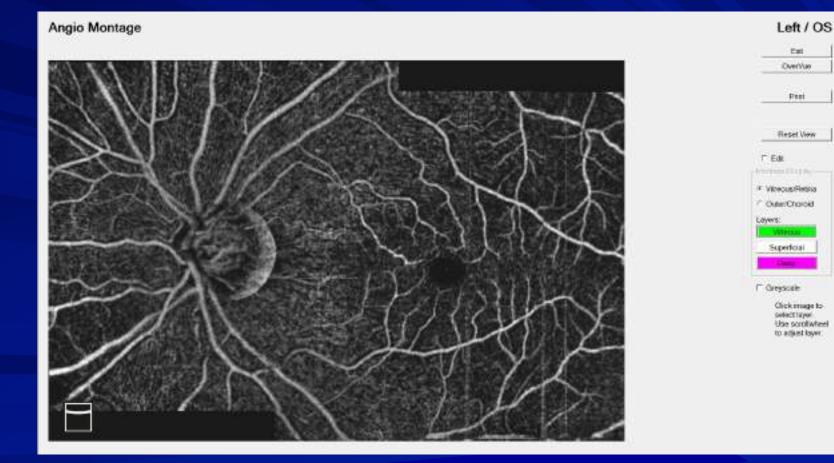
### Review of Normal 60 year old man



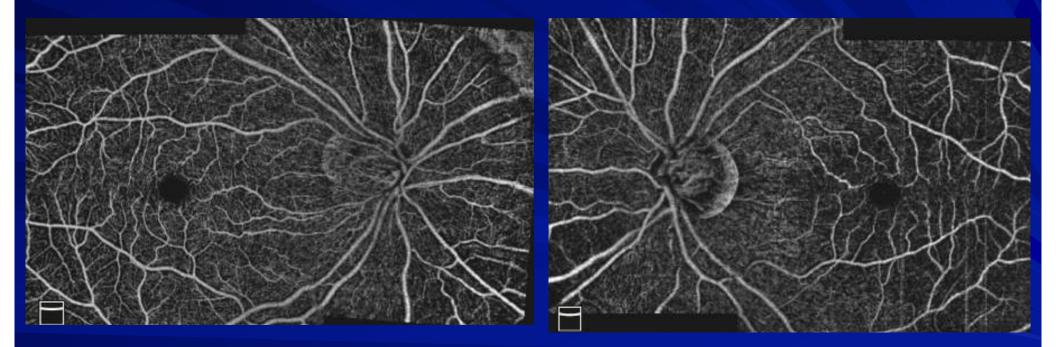
# 60 Year Old Montage OD



### 60 Year Old Montage OS



# 60 Year Old Montage OU

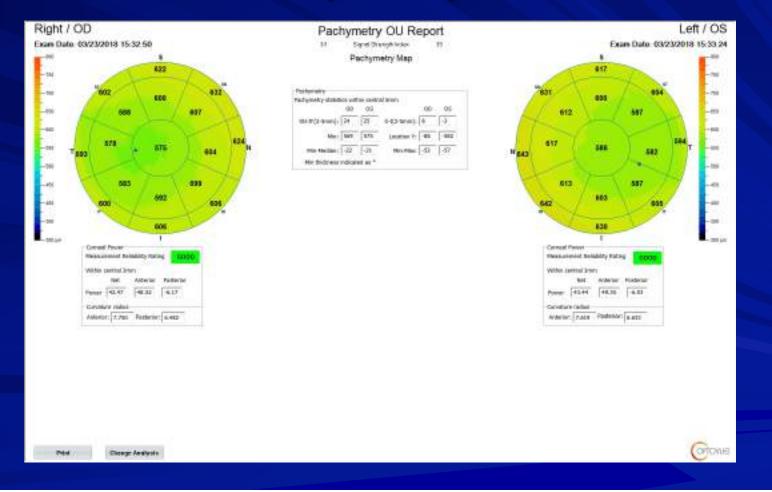


### 68 year old woman with glaucoma

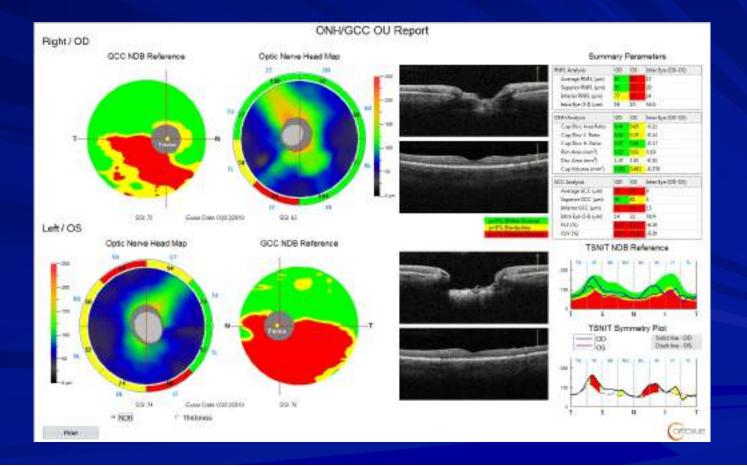
 Wants second opinion for glaucoma management
 Recently had cataract surgery OS with iStent
 \* September 25, 2017
 \* Dorzolamide 2% BID OS, Lumigan 0.01% QD OS
 Our practice recently performed cataract surgery and Kahook dual blade (KDB) MIGS
 \* July 24, 2018
 \* IOP<sub>GAT</sub>: 12 and 16 at 11:27 am

T = 5 VF = -3 - 25 - 19 VF = -3 - 23 - 18 gnis = - Phils = - Phils = - Phils = et = A - 3 - 98 - 15 T = 5hilt = 0KDB = 0

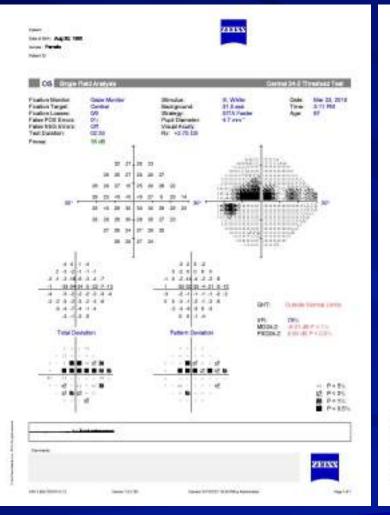
### OCT for Pachymetry in Glaucoma

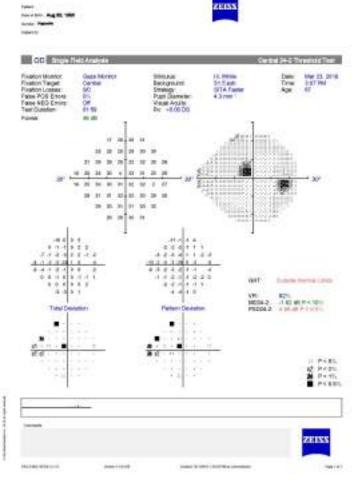


# OCT GCC and NFL

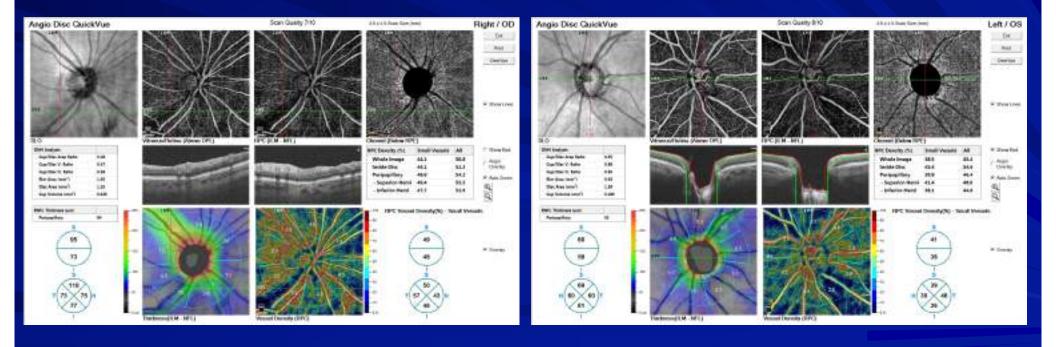


### Visual Fields

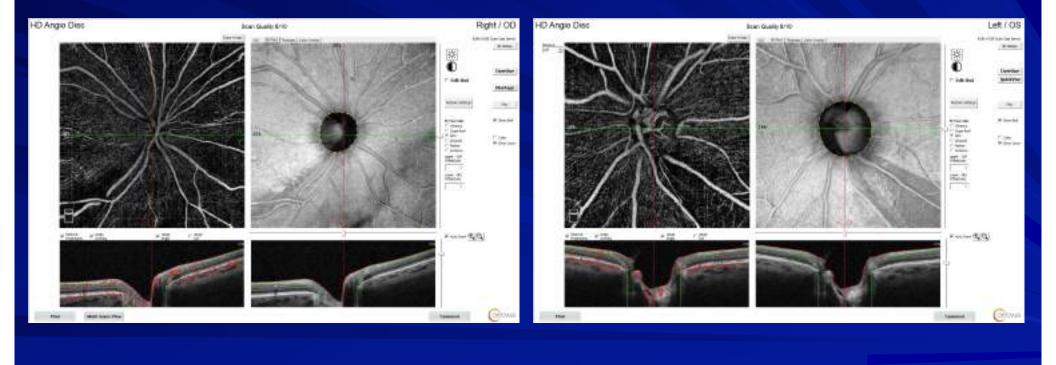




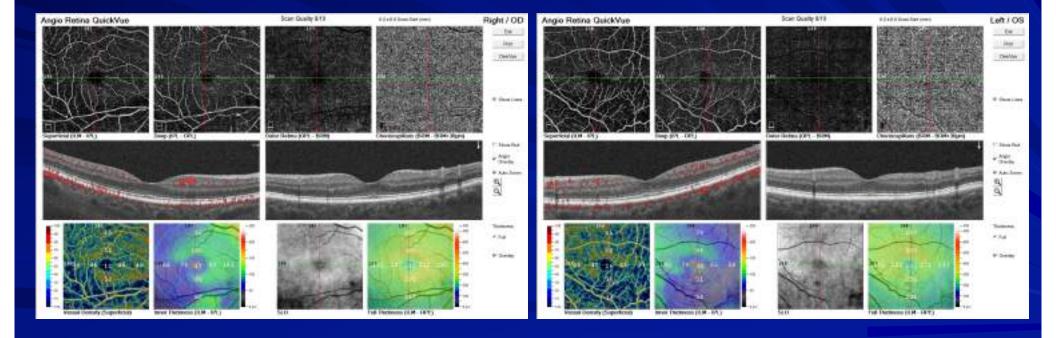
#### Angiography and AngioAnalytics of Disc



#### En Face Radial Peripapillary Capillaries (RPC)



#### Angiography and AngioAnalytics of Retina



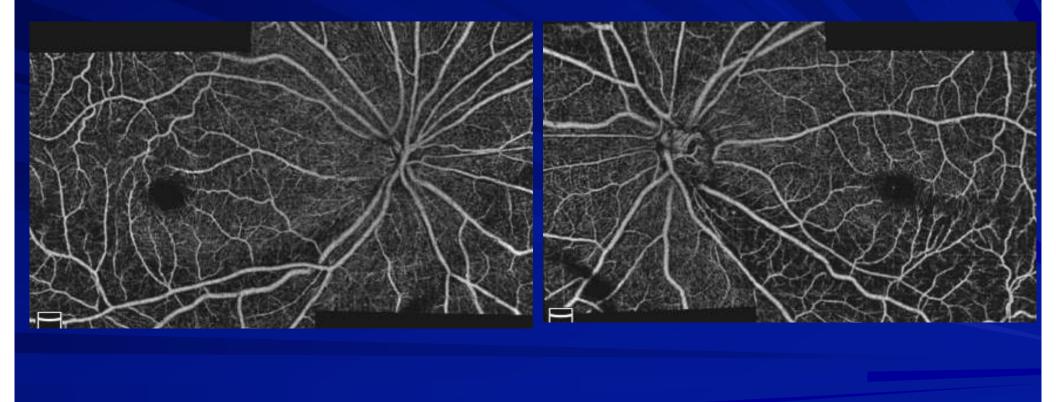
#### Montage OD



### Montage OS



### Montage OU

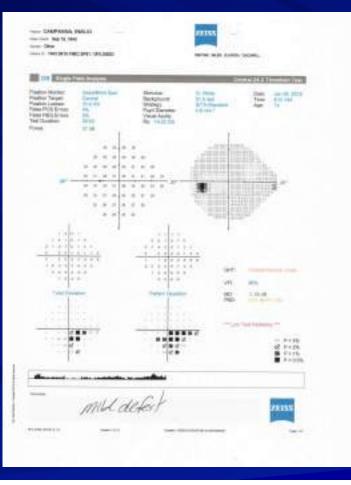


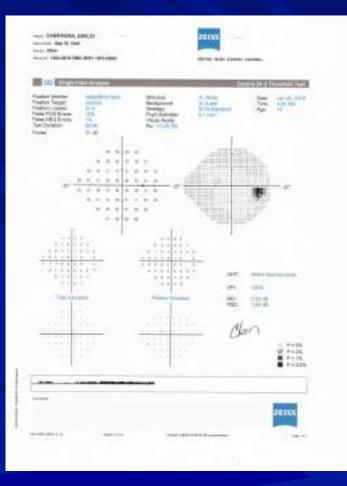
#### 74 year old man

A POAG, OS > OD
A Lumigan 0.01% QD OU
A Combigan BID OU

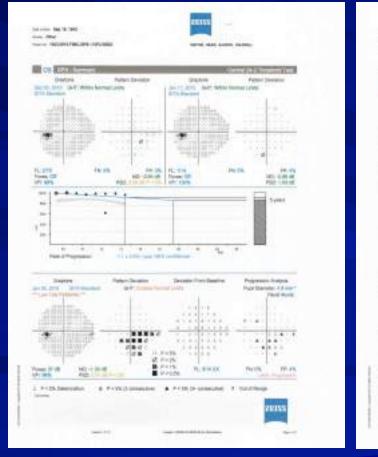
EXINC -1-11-2012 DFE - 8-15-14 9-14-29 7-13-18,9-9-14,1-0-15,9-37-16,9-26-17, 9-35-18 VF - +-11-12 177-15 1-13-14,1-0-15 1-17-16,9-26-17,1-26-18, OCT - 8-75-14 9-11-12 5-18,9-9-14 9-14-15,7-20-16,9-26-17,9-35-18 gnio - 4-11-14 1-14-13 5-10-16,5-21-18 Phobs - 3-04-97,5-14-13,5-30-17 P. As - 541/527 SCT-A-9-25-18 Bealtic 38/35 Test 520

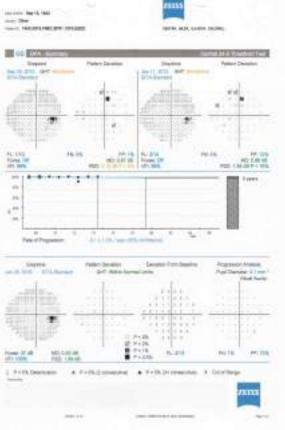
#### VF OD and OS 1-26-2018



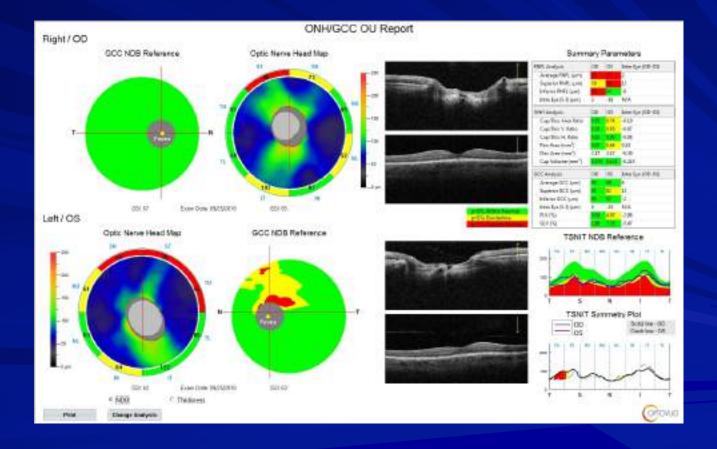


#### VF OD and OS GPA 1-26-2018

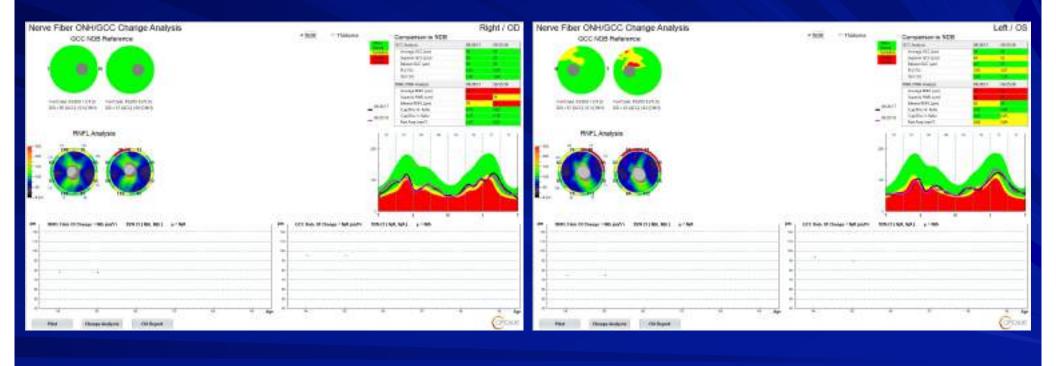


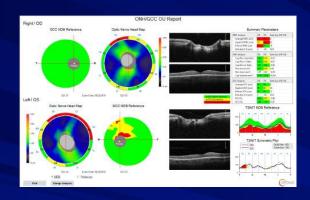


#### OCT NFL and GCC 9-25-2018

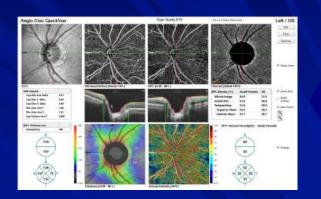


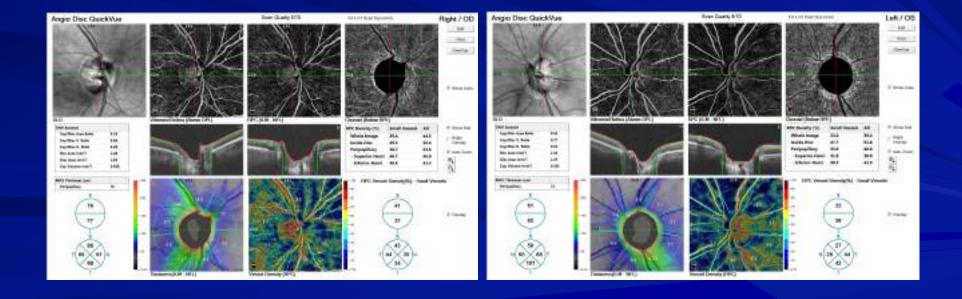
#### Change Analysis NFL-GCC

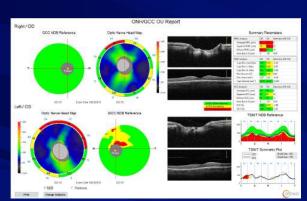




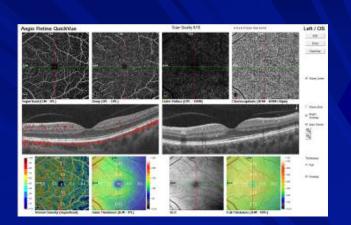
#### OCT-A 9-25-2018 POAG OS > OD

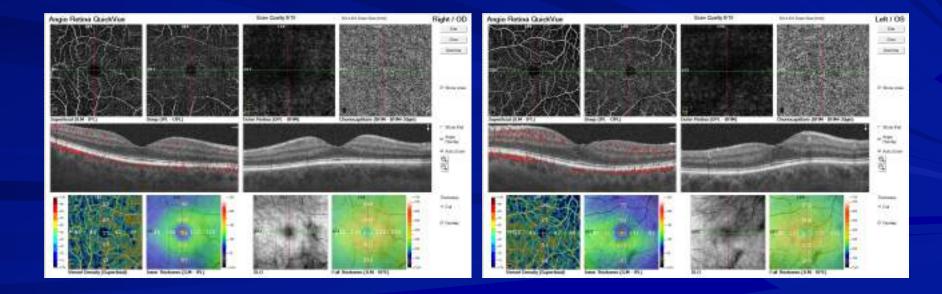






#### OCT-A 9-25-2018 POAG OS > OD

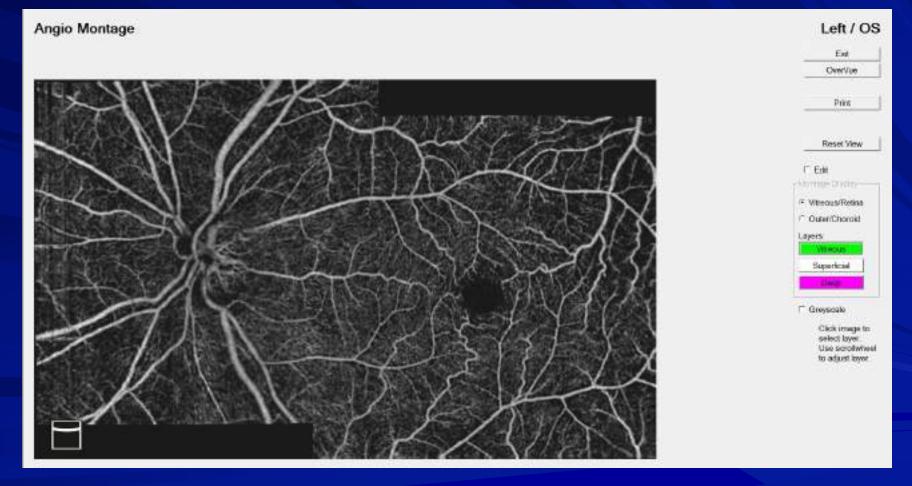




#### Montage OD

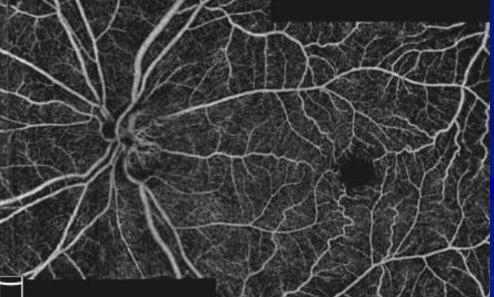


## Montage OS



## Montage OU





# They do read their EHR communication

Page 1 of 1

#### Drs. Centar & Imler

From: Date: Tnesday, September 25, 2018 1:07 PM To: -centarimler@tatlasticbb.net> Subject:

To Whom it may concern:

I was reading my patient chart online, which was emailed to me right after my office visit today. I noticed they have my weight recorded as 344 pounds. That weight is incorrect because I'm now at 333, which has been holding steady between 332 and 334 for several months now.

Sincerely,

Sent from my iPhone=

#### 49 year old man

Ocular Hypertension since 2014

 No treatment

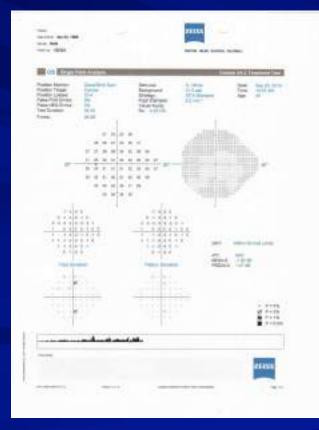
 Pigment Dispersion
 Baseline IOP or Tmax 26/26

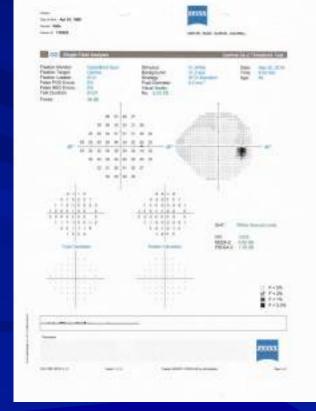
 2014—March 2018

 Today 30/32, new Tmax 9-25-18

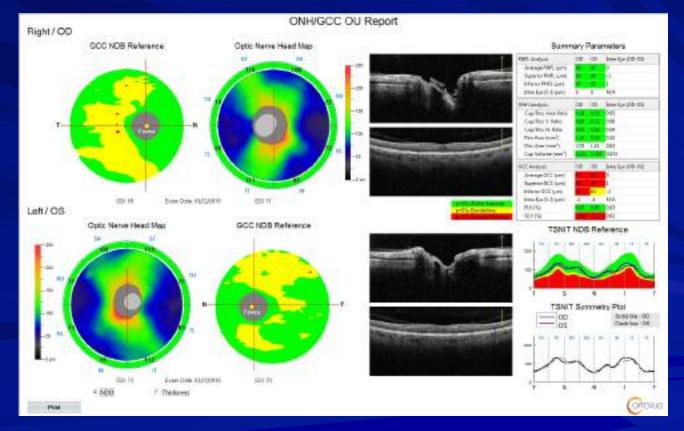
DFE - 3-22-18 VF - 9-25-18 057 - 3-22-18 0,000 - 1-10-15 Photos -Pichs - 585/589 OCT-A-9/25/18 Biseline 26/26 1-3-14 scient 20/32 9-25-18 Agment dispersion From NX - mother?

#### VF 24-2 Sita-Faster 9-25-2018

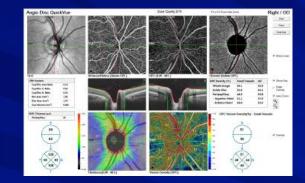


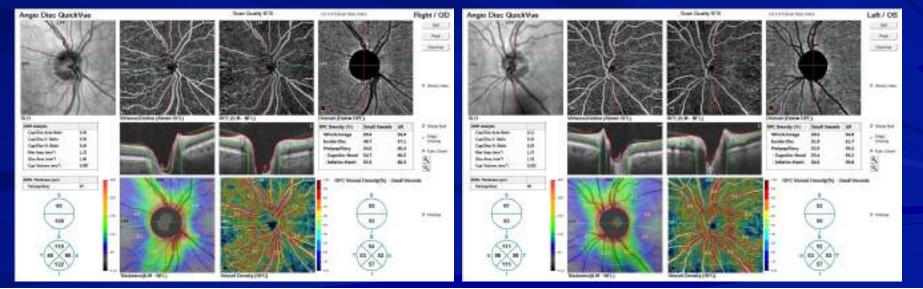


# OCT NFL and GCC 3-22-18

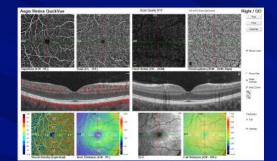


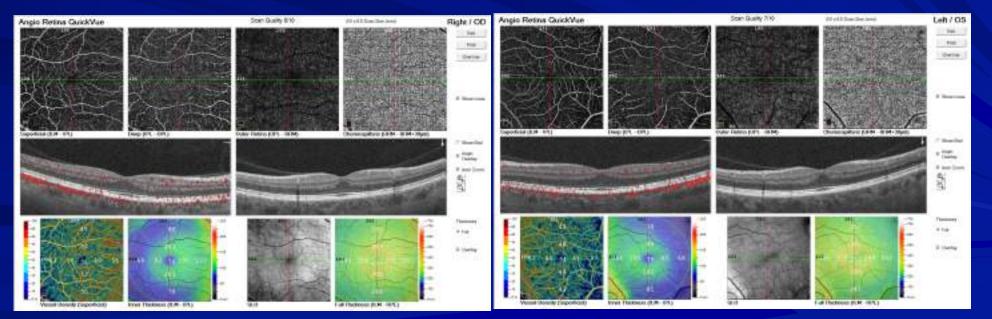
#### OCT-A 9-25-2018



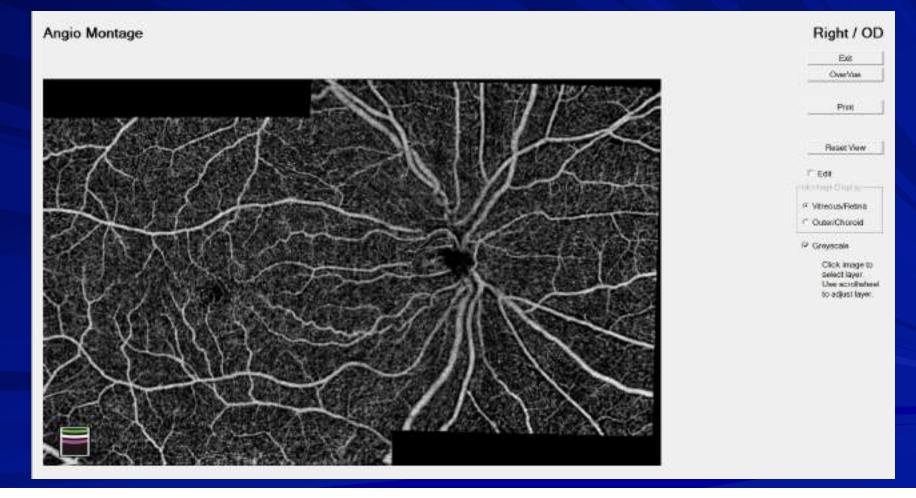


#### OCT-A 9-25-2018

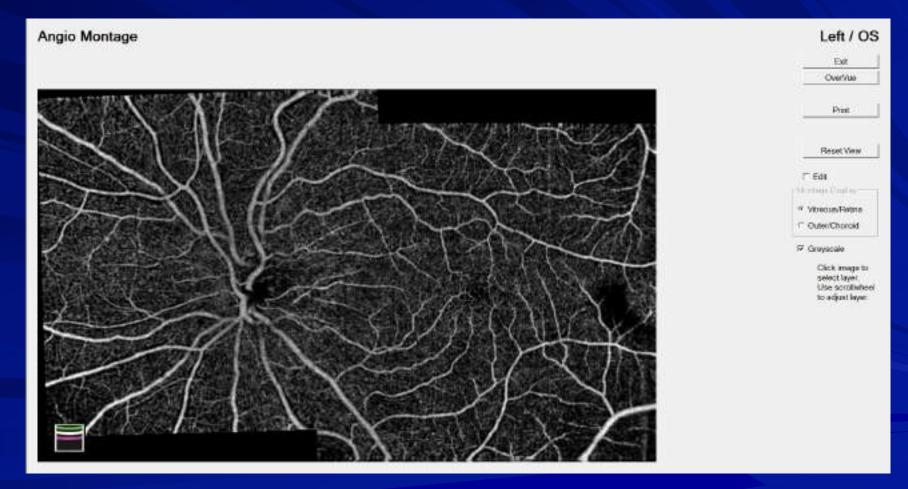




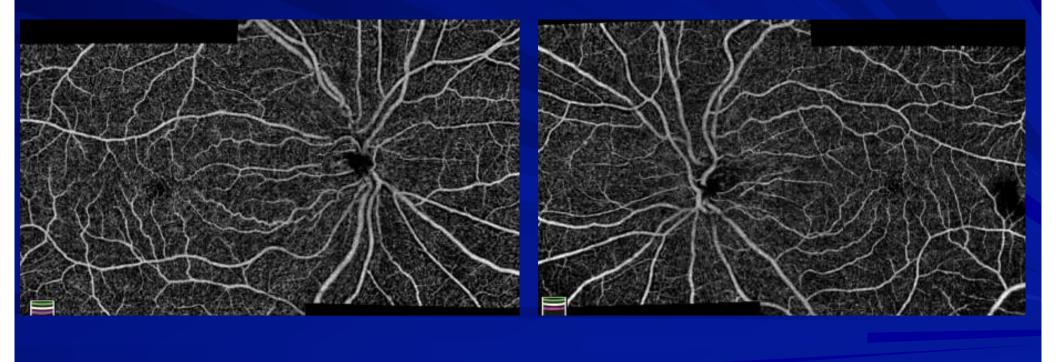
#### Montage OD



### Montage OS



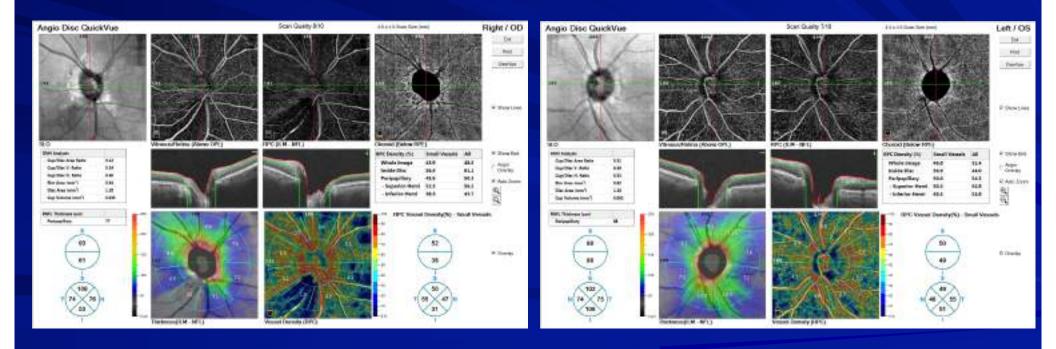
# Montage OU



# How Does OCTA Change the Way You See Glaucoma?

Shows early changes in the retina and optic disc
 Adds new information to the diagnosis
 Aids in progression detection

#### Glaucoma versus Other Optic Neuropathy



#### Next Generation Diabetes and Retina Analysis with OCT + OCTA

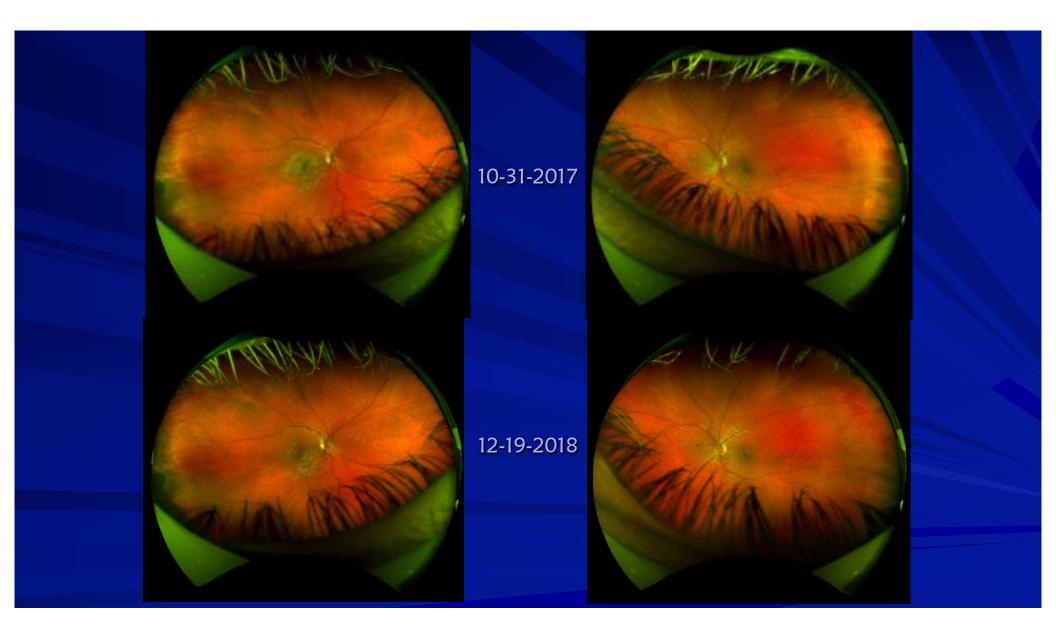
#### 29 year old man with diabetes

Yearly diabetic exam, reports no changes to vision
Type 1 DM
S: 190 this AM, last HbA1c 8.6
Vision 20/20
Anterior segment: normal
Posterior segment:
Non-proliferative DR
Hemes and exudates

\* No CSME

#### A Billed for:

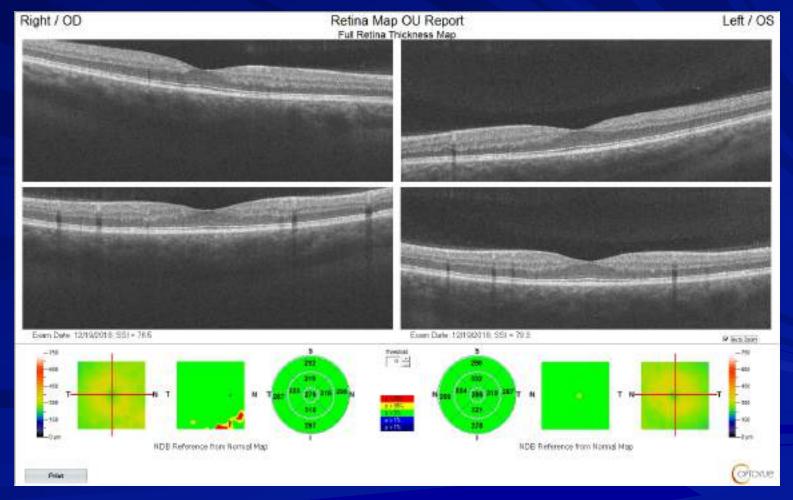
- **\*** Exam- 99214
- \* Optomap, OCT-Wellness, and OCT-A (Angiography)



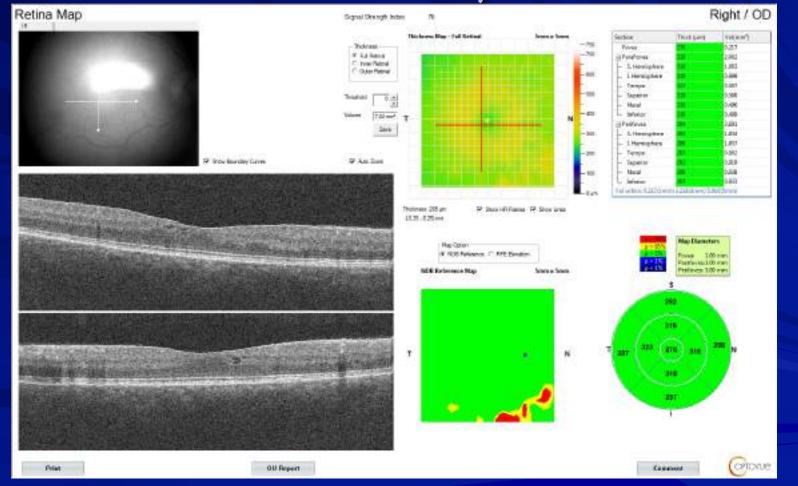




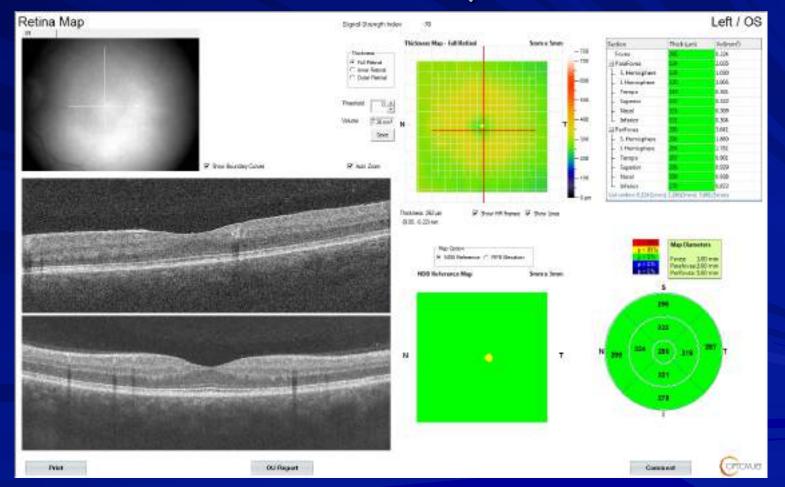
#### 12-19-18



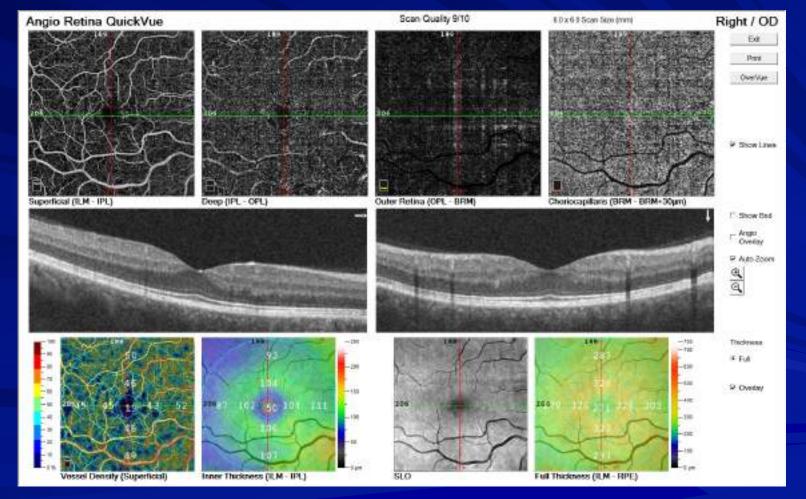
#### 12-19-18 what do you see?

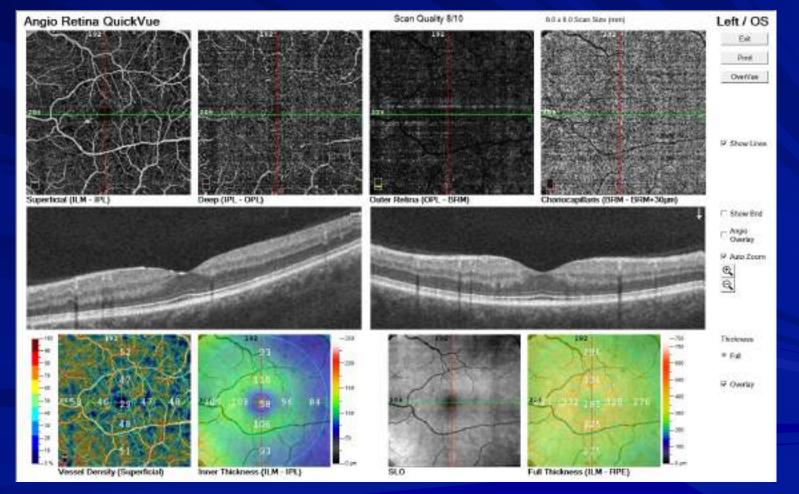


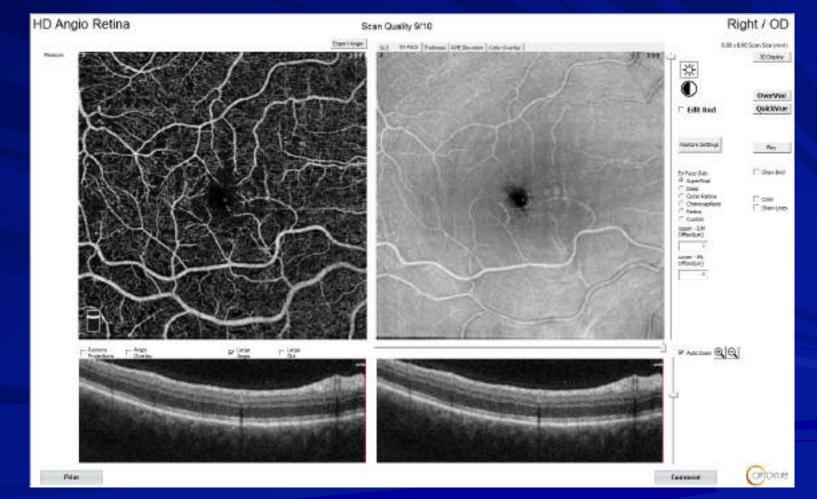
#### 12-19-18 what do you see?

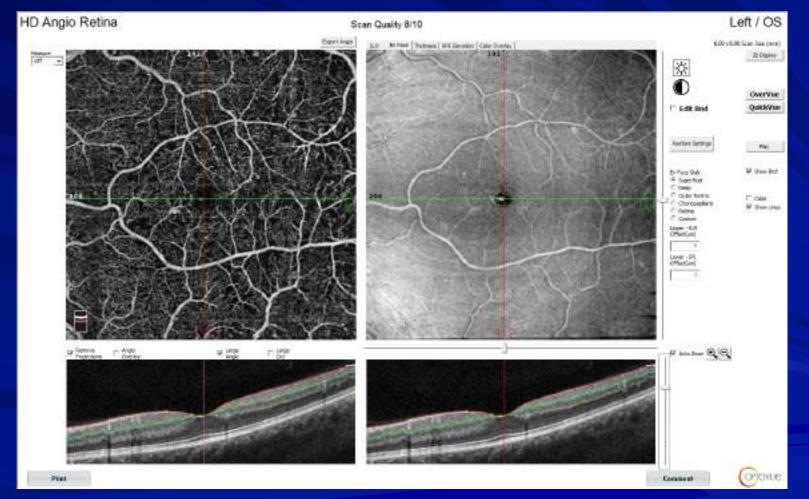


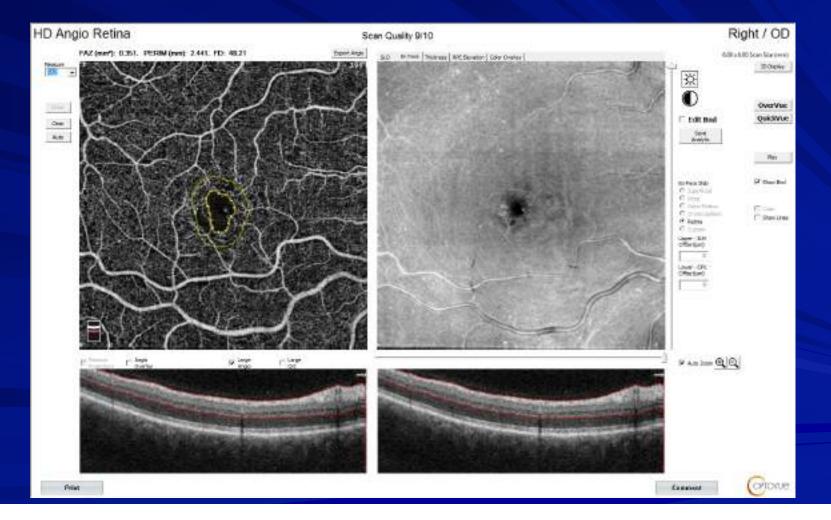
#### 12-19-2018

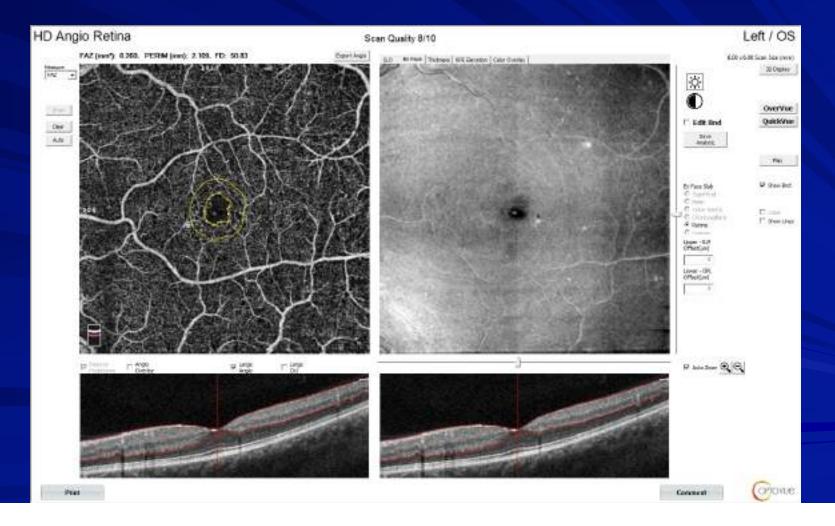












# OCT and OCT-A

Treatment?
 Certainly useful, beneficial, essential, and important in following the patient with diabetes
 Improved HbA1c

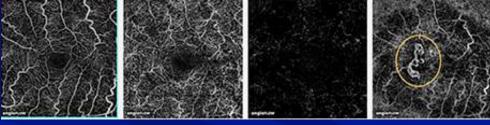
# Type 1 "Occult" CNV

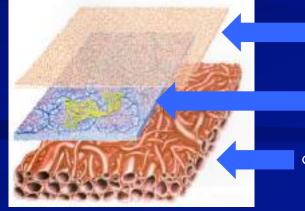


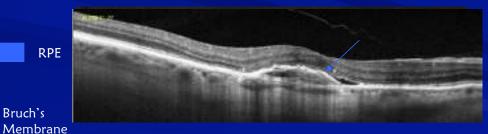
- New vessels develop in the choroid
- New vessels located below RPE and above Bruch's membrane

# Type 1 "Occult" CNV

Ger New vessels develop in the choroid Gr New vessels located BELOW RPE and ABOVE Bruch's membrane



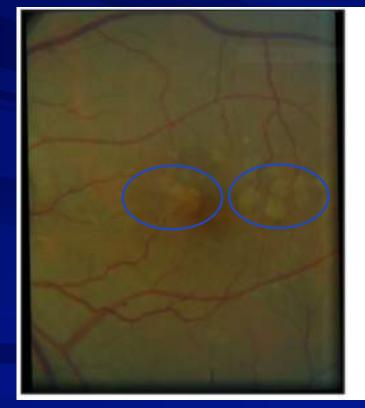




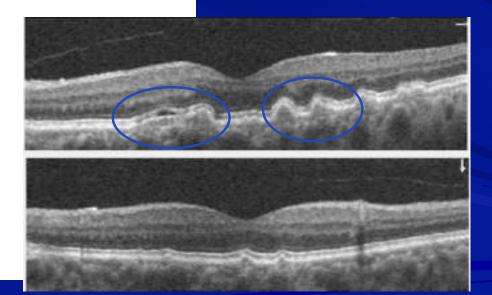
Choroid

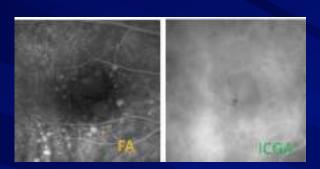
Bruch's

# CNV?



72 y/o Hispanic male 20/30 History of "Dry AMD"

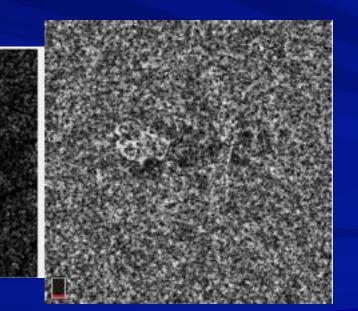


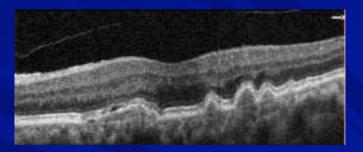


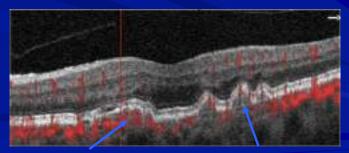
VAGUE???

1.50

# Multimodal imaging and OCTA





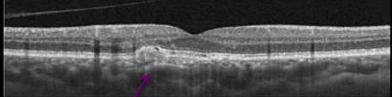


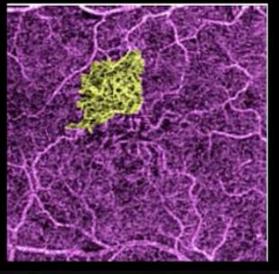
Vascularized

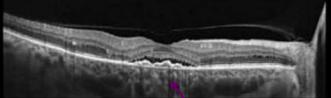
Non-vascularized

### Type 1 CNV: Below RPE, Wider than Type 2, Avascular Zone Usually Not Involved

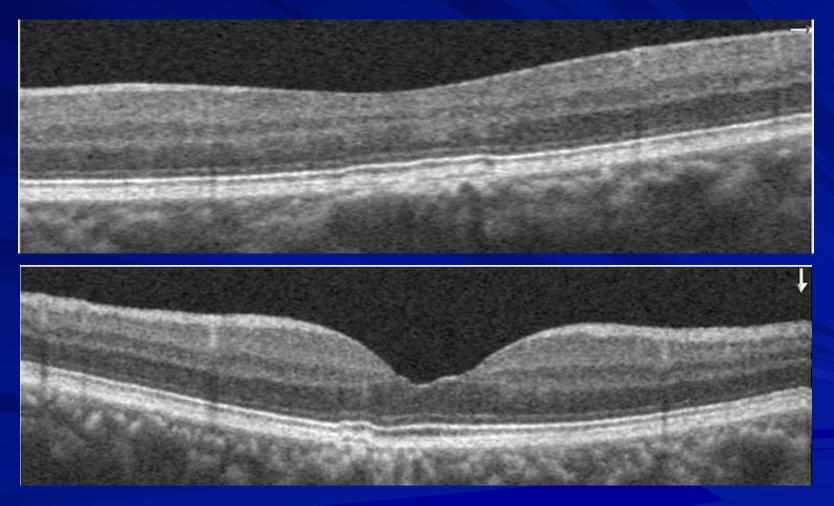


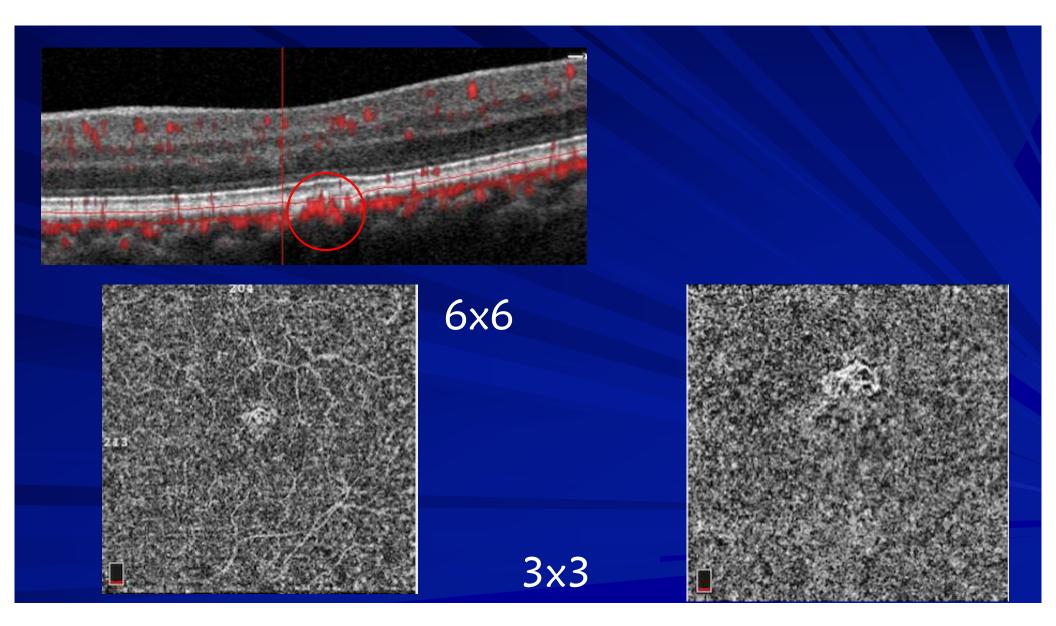




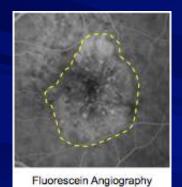


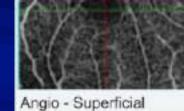
### And the not so obvious ones...

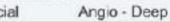


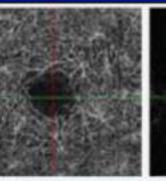


# Case example: 70 y/o WM, AMD

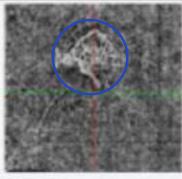




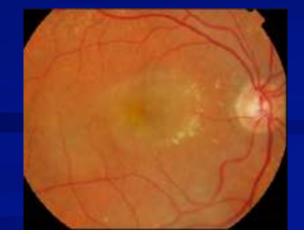


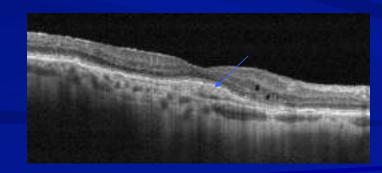


Angio - Outer Retina



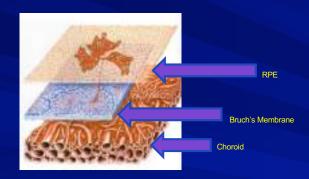
Angio - Choroid Capillary



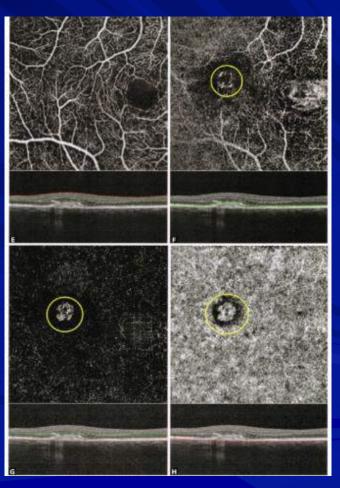


Below the RPE

# Type 2 "Classic" CNV



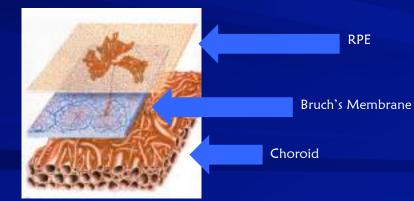
New vessels develop in choroid
New vessels located above the RPE and above Bruch's membrane

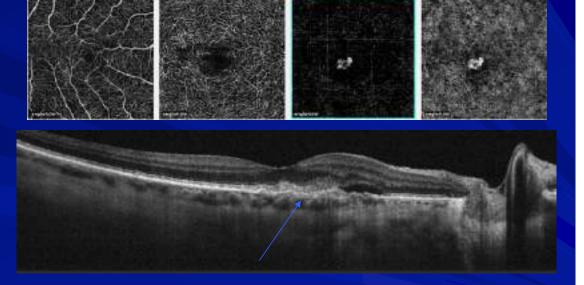


# Type 2 "Classic" CNV

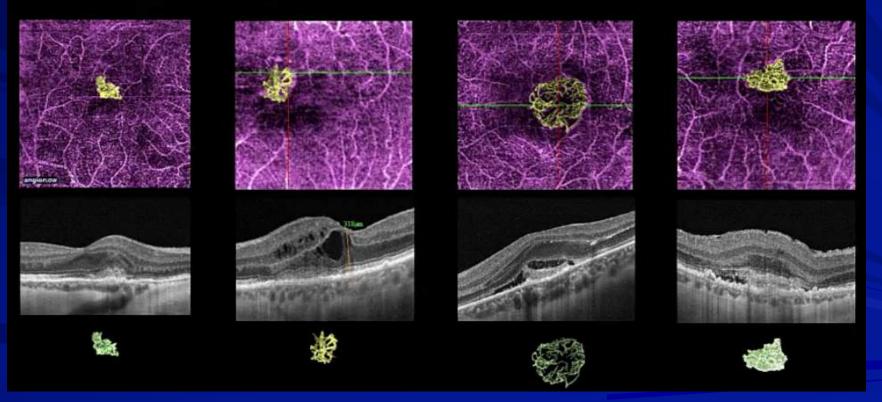
RPE

Ar New vessels develop in choroid Show vessels located ABOVE the RPE and ABOVE Bruch's membrane

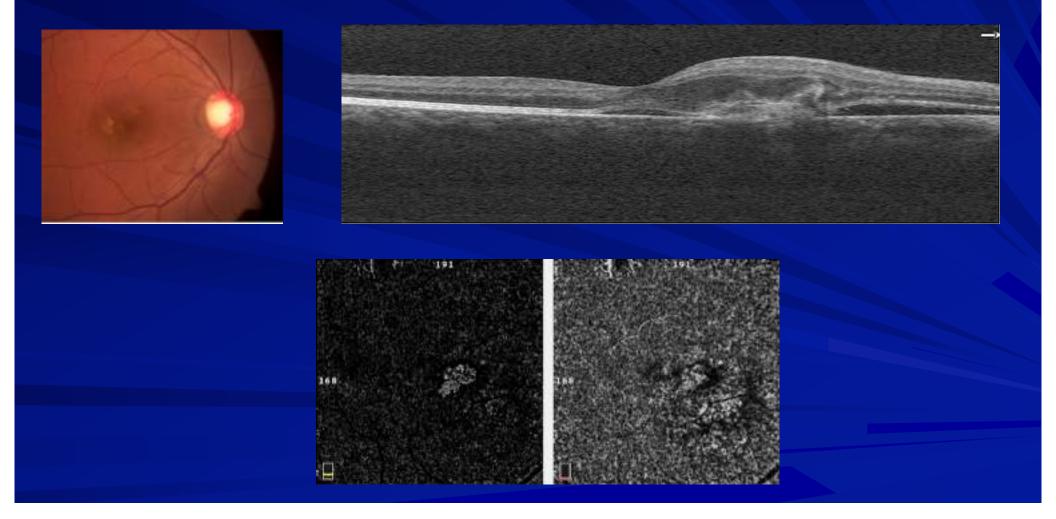




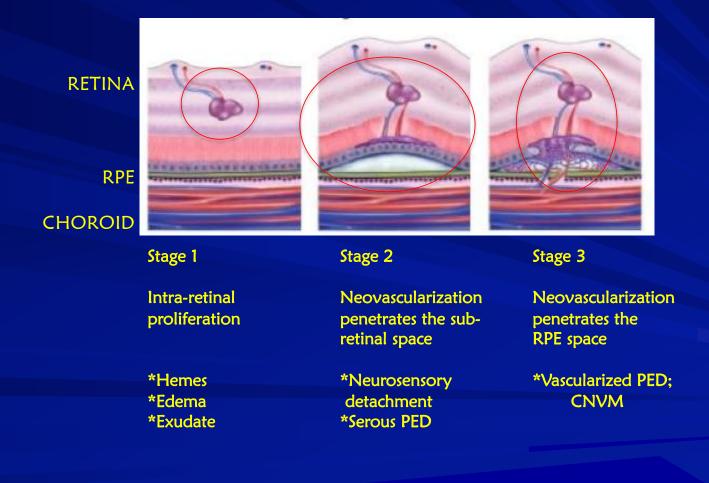
#### Type 2 CNV: Above RPE, Smaller than Type 1, Avascular Zone Always Involved. Very Heterogeneous Shapes

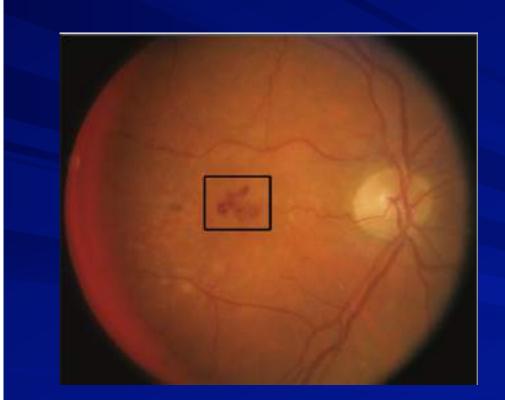


# 48 y/o WM 2 week history of "dark spot" OD



# **Retinal Angiomatous Proliferation**







https://www.researchgate.net/figure/In-retinal-angiomatous-proliferation-fluorescein-angiography-FA-shows-a-hot-spot-in\_fig8\_264903506

https://jamanetwork.com/journals/jamaophthalmology/fullarticle/42089

### Inspect the SD-OCT carefully!!

HYPER-REFLECTIVE lesion above pigment epithelial detachment

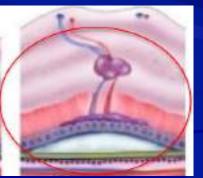
VA 20/40

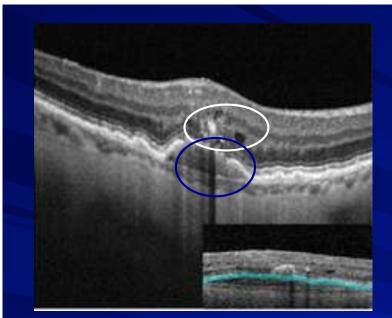
Stage 2

Intraretinal cysts

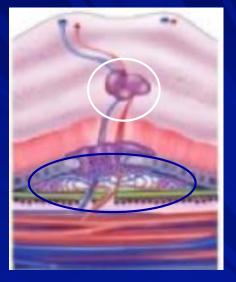
Serous pigment epithelial detachment/ neurosensory detachment

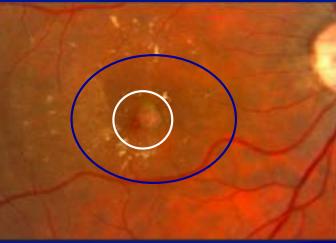






# Stage 3

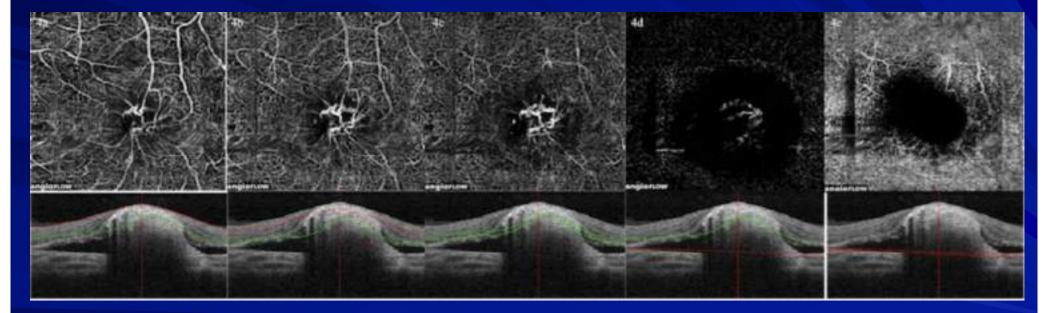




http://imagebank.asrs.org/file/26943/retinal-angiomatous-proliferation https://www-ncbi-nlm-nih-gov.ezproxylocal.library.nova.edu/pubmed/29019795

# What about the OCTA?

Type 3 CNV: Intraretinal Anastomosis: THROUGH RPE



OCT angiography demonstrates retinal angiomatous

proliferation and chorioretinal anastomosis of type 3

ana Baana) - Varshitha Homanth, - Sastraok Mulkatikar - Ro Auli Gupta - Mangat B. Degra - Aanad Gupta

neovascularization

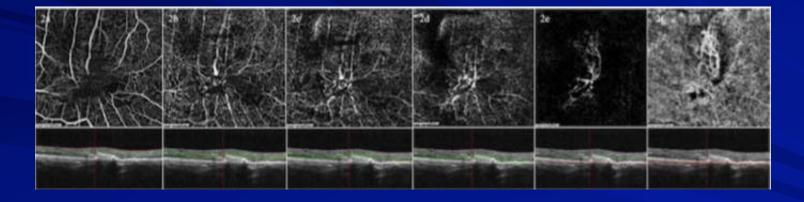
Inner retina (SCP+DCP) to Outer retina (Avascular/choriocapillaris)

### What about the OCTA?

OCT angiography demonstrates retinal angiomatous proliferation and choricretinal anastomosis of type 3 neovascularization

Recent Brannel - Varshifter (Semanth : Sentrant Multiacitar - Romanikog Singh -Yishadi Gopia - Mangar B. Dagra - Annud Gopia

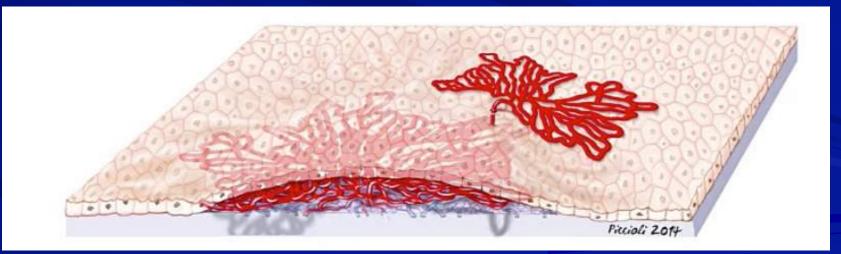
#### Type 3 CNV: Retinal/Choroidal Anastomosis: INTO CHOROID



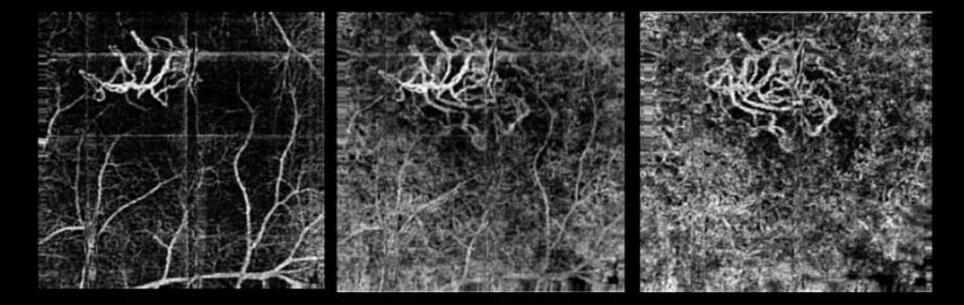
Inner retina (SCP+DCP) to Outer retina (Avascular/choriocapillaris)

## Type 4 "Mixed" - Subretinal and Sub-RPE

Two or more CNV layers
 One above the RPE, one below the RPE
 High flow lesions



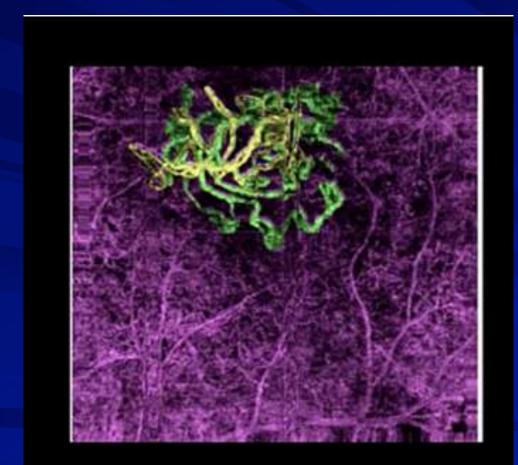
# Type 4 CNV : Initially Located Below the RPE, NV Spreads into the Outer Retina



Angio - Deep

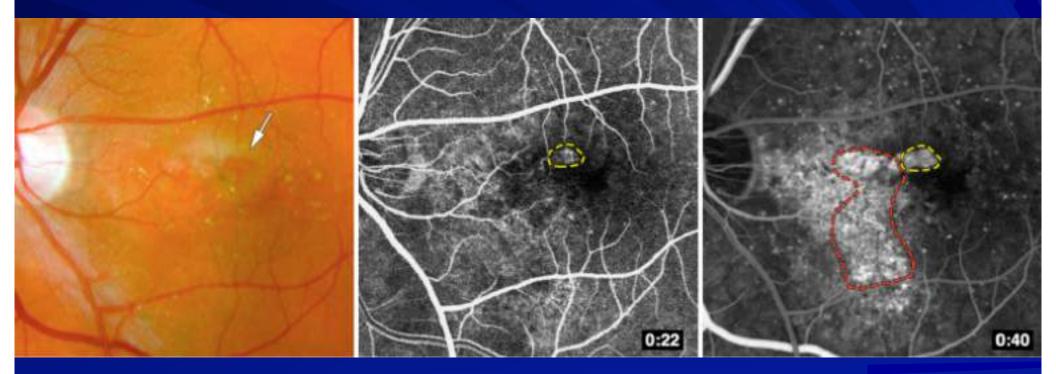
Angio - Outer Retina

Angio - Choroid Capillary



#### Green: Type 1 (Sub RPE) Yellow: Type 2 (Subretinal)

### Case Example: Multimodal imaging of 66 y/o Caucasian male

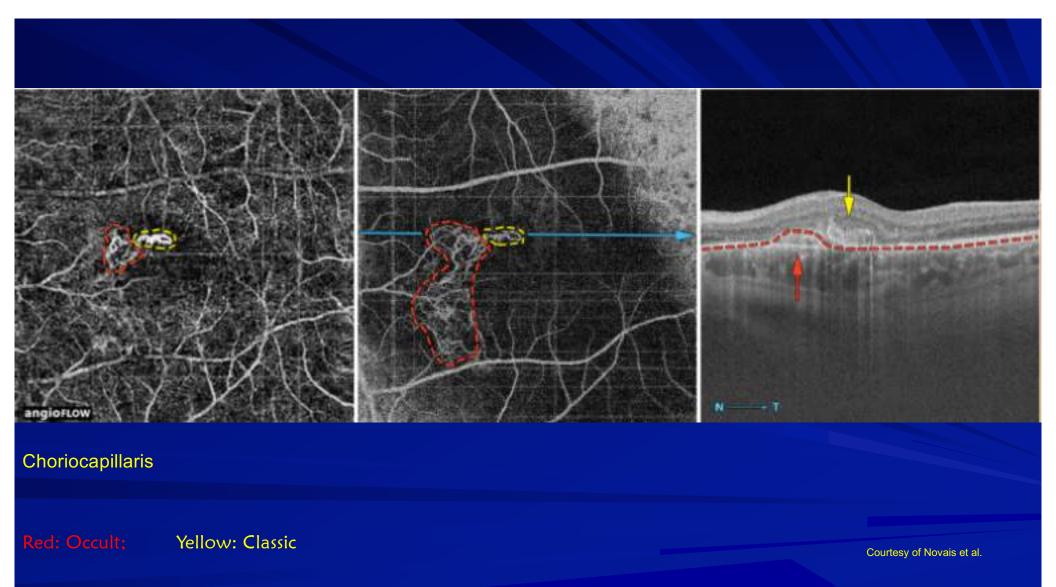


Fundus image and Occult

FFA: Early; Classic component

FFA: Late; Classic

Courtesy of Novais et al.



### OCT Angiography

Subclinical CNV or "Occult non-exudative CNV"

Risk of exudation at 12 months is 15.2 times greater compared to eyes without subclinical CNV Occult Non-Exudative CNV Patient A

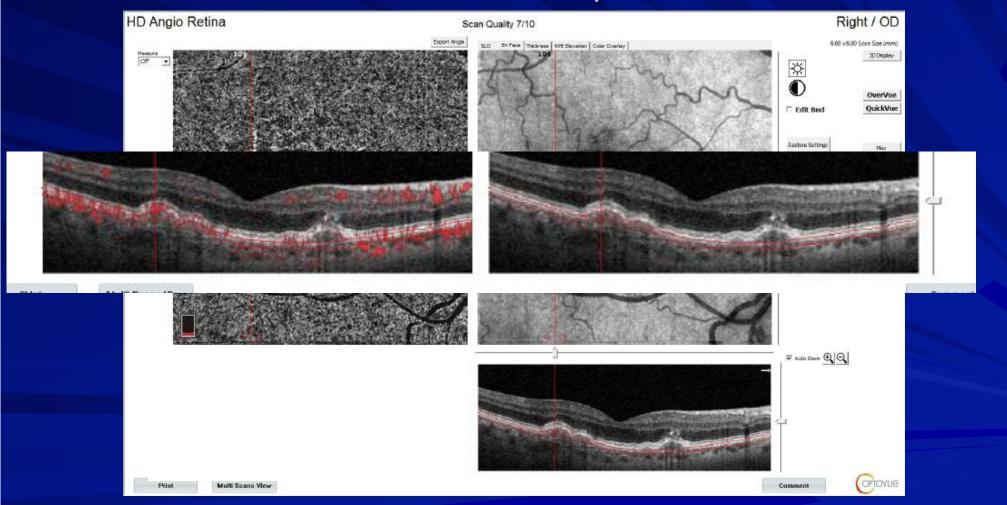


Occult Non-Exudative CNV Patient A

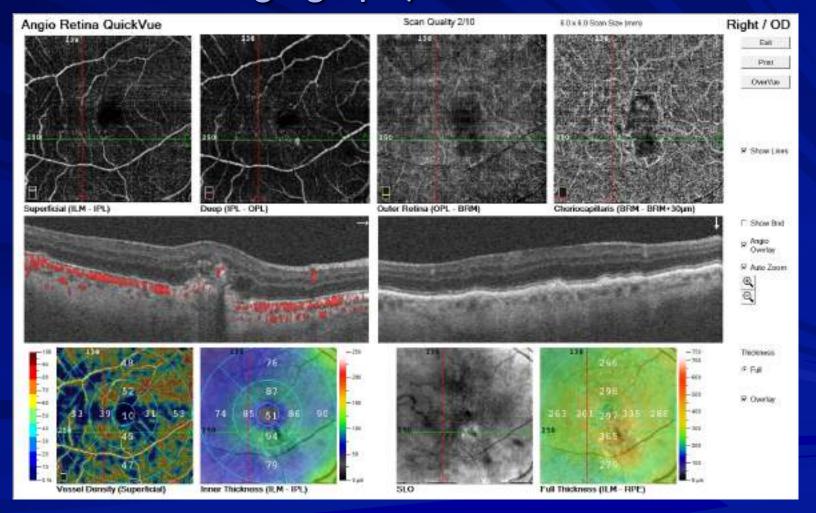


HD Angio Retina Right / OD Scan Quality 3/10 8.00 x 8.00 Scentics (meri Doorrienge | 3D Diatey BLD De Poise Historia Brig Skiratos Colo Overlar 滋 126 Cont . + OverVue . QuickVoc C Edk Brd Restance Settings Occult the . IN FACE 1880 C Repficiel P showing Deto Outer Rating Non-Exudative No.NCT R Choracapters C Bathe C 669 Cuton Upper - Bill Officiant) CNV 9 Descripter Patient A Locar 89H Offset(an) P argo Phase QQ P Resove C And 10.000 Concivue Helti Scara Vice. Connext **THE** 

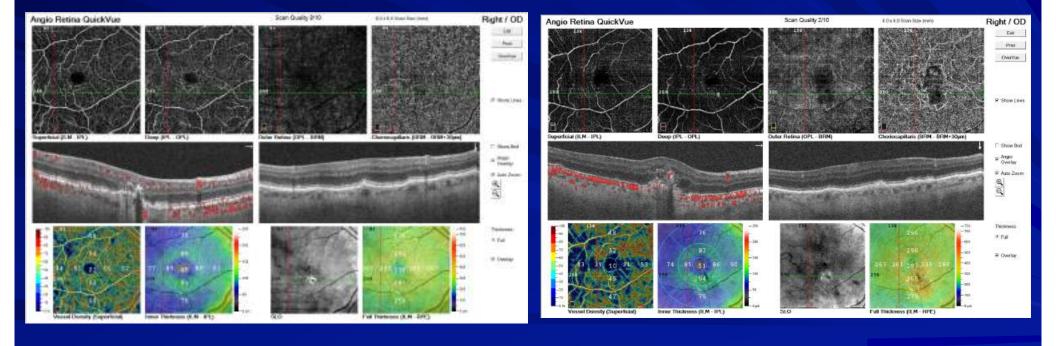
### Which is More Suspicious?



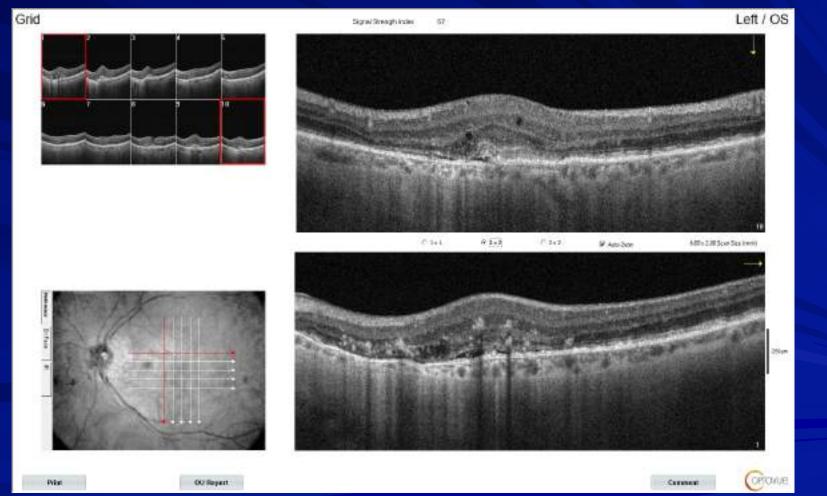
### OCT Angiography Evaluation AMD



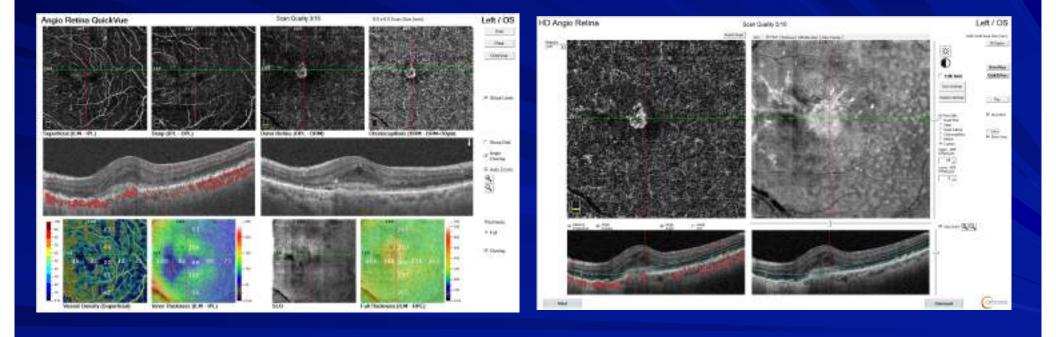
### OCT Angiography Evaluation AMD After and Before Bevacizumab (Avastin)



#### Evaluation AMD Patients for Neovascularization OCT Grid



### Evaluation AMD Patients for Neovascularization Using OCT Angiography



# Other Uses Endothelial Disease

Alzheimer Dementia

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#### Association of Preclinical Alzheimer Disease With Optical Coherence Tomographic Angiography Findings

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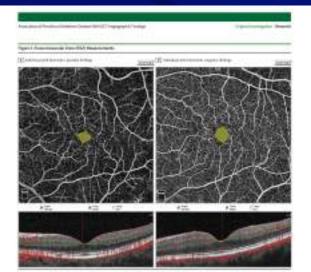
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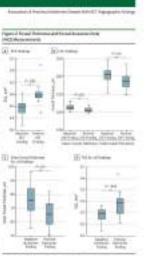
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likely these discrepancies are merely associated with the specificity of the individual test and are in line with a low rate of cliscondance.45-47 As such, any individual with a positive marker was considered to have biomarker-positive findings in the collective analysis.

A major limitation of our study is the small sample size, including a limited number of nonwhite individuals. An additional limitation is exclusion of individuals with known vascular disease from our study; we are therefore unable to determine whether these results are translatable to individuals. who may have retinal microvascular changes due to other causes. Also, inclusion only of those with preclinical, biomarker-positive disease limits comparison to those with cognitive changes or advanced AD. Recruitment is under way to evalu-

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changes in retinal vasculature.

#### Conclusions

At present, preclinical AD is diagnosable only by invasive, expensive, and time-consuming PET or CSF testing. Our data suggest that OCTA may enable guick, inexpensive, and noninvasive screening for individuals with preclinical AD based on FAZ enlargement. However, these findings could be owing to confounding factors unrelated to the FAZ enlargement. Longitudinal studies in larger cohorts would be needed to determine whether this finding has value in identifying preclinical AD, so that these individuals may receive appropriate care.

#### ARTICLE INFORMATION

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# Thank you!

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