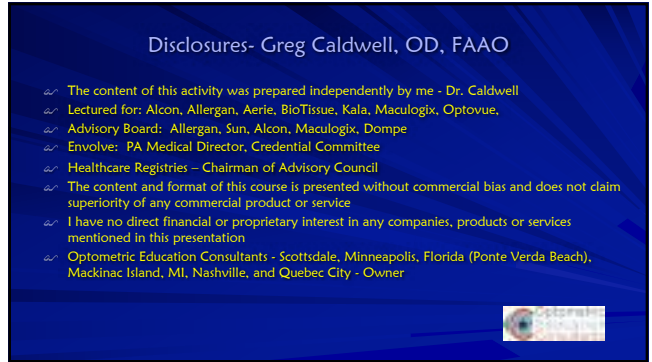




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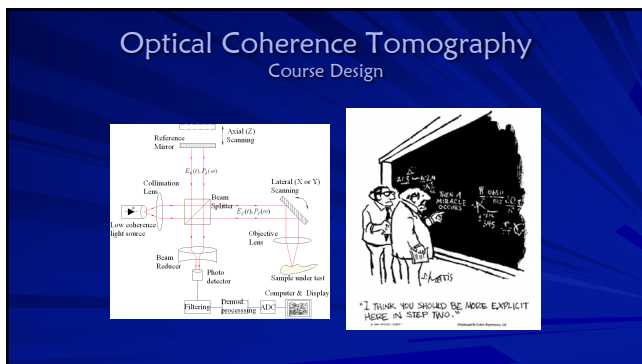
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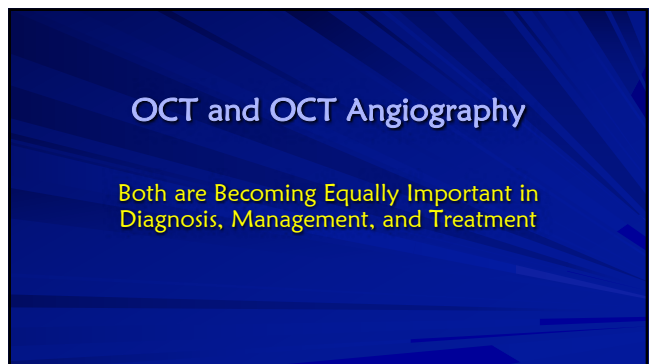
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7

Optical Coherence Tomography

- ~ OCT is an optical signal acquisition and processing method
- ~ Time domain OCT
 - * 15-16 microns of resolution
 - * Stratus (Zeiss)
- ~ Spectral domain (SD-OCT) or Fourier domain OCT
 - * Spatially encoded frequency domain OCT (SEFD-OCT)
 - * 5-6 microns of resolution
 - o 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
- ~ May have the possibility to assess retinal pathology like a pathologist

8

OCT Angiography: the Next Chapter in Posterior Imaging

- ~ Images retinal microvasculature without dye injection
- ~ Displays structure and function from a single imaging system

9

4 Basic Categories: Diseases of the....

10

11

VH: Inner Vitreous Hyaloid	IS: Inner Segment	OS: Outer Segment
PL: Pigment Epithelium Layer	PS: Photoreceptor Segment	PE: Pigment Epithelium
IL: Inner Limiting Layer	OS: Outer Segment	OS: Outer Segment
IL: Inner Limiting Layer	OS: Outer Segment	OS: Outer Segment

12

Normal Retinal Vasculature

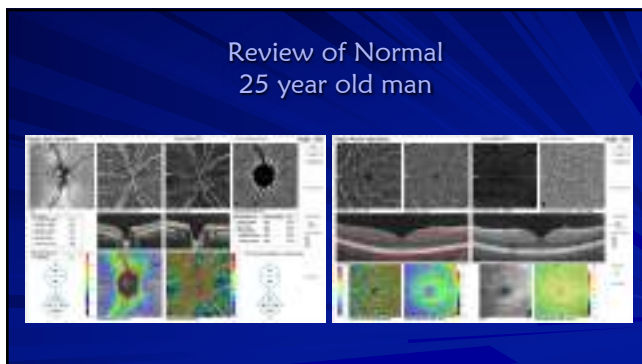
Superficial Capillary Plexus: 3µm Below ILM → 15 µm Below PL

Deep Capillary Plexus: 15µm Below ILM → 70 µm Below PL

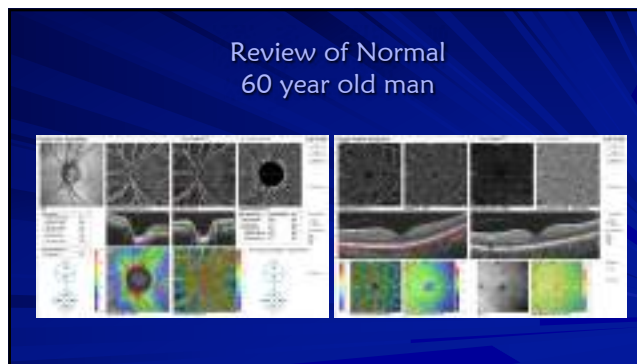
Outer Retina: 70µm Below PL → 30 µm Below RPE Reference

Choriocapillaris: 30 µm Below RPE Reference → 60 µm Below RPE Reference

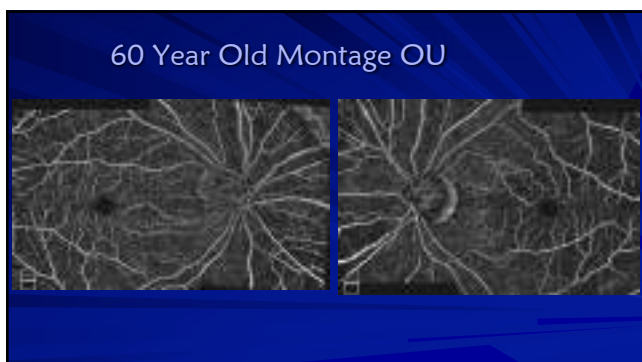
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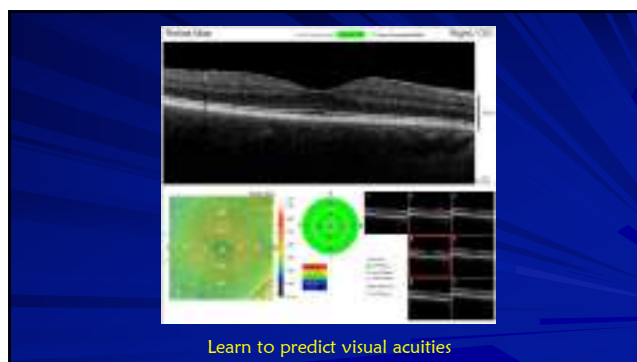
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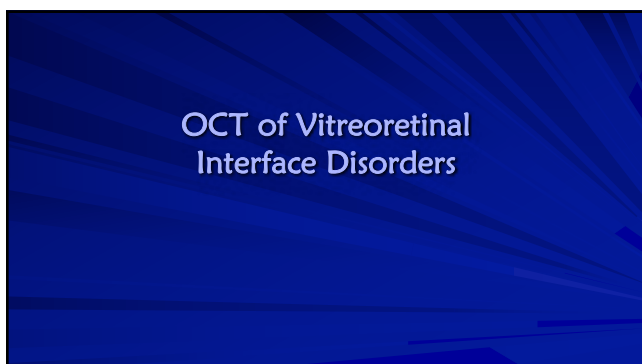
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19


OCT of Vitreoretinal Interface Disorders

- ~ Epiretinal membrane
- ~ Vitreomacular adhesion
 - * Complete VMA at birth
 - * OCT reveals specific stage of vitreous separation
- ~ Vitreomacular traction
- ~ Pseudohole
- ~ Lamellar hole
- ~ Full Thickness Macular Hole

20


Epiretinal Membrane

- ~ Other names: premacular fibroplasia, preretinal gliosis, macular pucker, surface wrinkling retinopathy
- ~ Believed to be the result of proliferation of retinal glial cells on the internal limiting membrane that escaped through breaks in the internal limiting membrane
- ~ May create macular edema
- ~ Amsler grid may elicit metamorphopsia from surface wrinkling or macular edema
- ~ Treatment: Monitor until severe then retinal consult, possible vitrectomy with membrane peeling



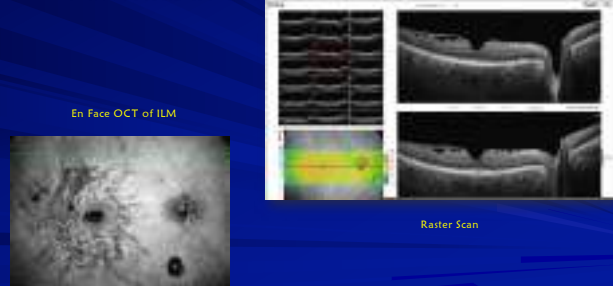
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Epiretinal Membrane (ERM)



22

Epiretinal Membrane (ERM)

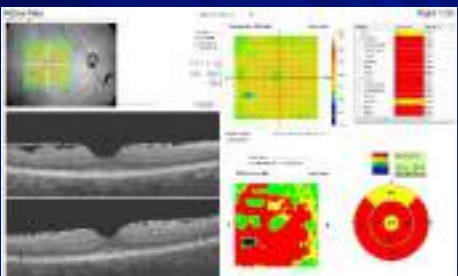


En Face OCT of ILM

Raster Scan

23

Epiretinal Membrane (ERM)



Retina Map

24

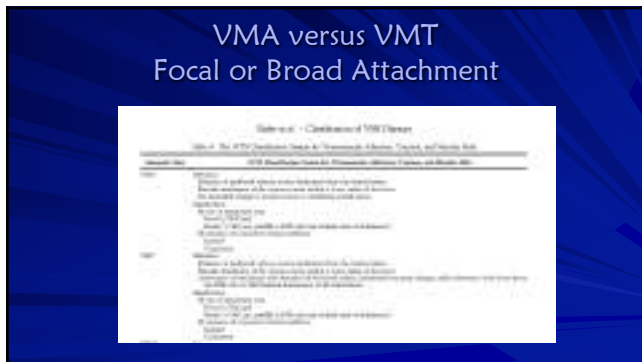
The International Vitreomacular Traction Study Group Classification of Vitreomacular Adhesion, Traction, and Macular Hole

Main Outcome Measure: Optical coherence tomography-based anatomic definitions and classification of vitreomacular adhesion, vitreomacular traction (VMT), and macular holes.

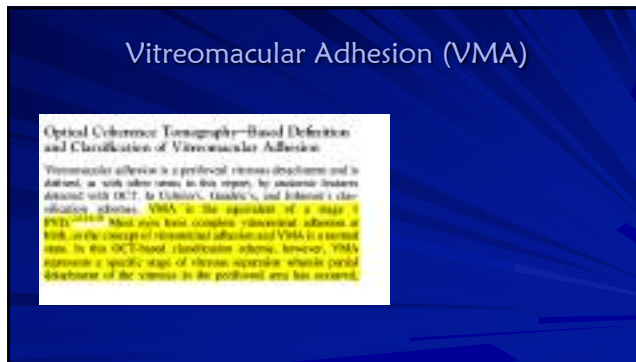
Results: Vitreomacular adhesion is defined as **preformed vitreous separation** with **intact vitreomacular attachment** and **unperturbed foveal morphologic features**. It is an OCT finding that is almost always the result of normal vitreous aging, which may lead to pathologic conditions. Vitreomacular traction is characterized by **anomalous posterior vitreous detachment** accompanied by **anatomic distortion of the fovea**, which may include **shallow dysplasia, retinal tears, cystoid macular edema, and subretinal fluid**. Vitreomacular traction can be subclassified by the **diameter of vitreous attachment to the macular surface** as measured by OCT, with attachment of **1500 µm or less** defined as **partial** and attachment of **more than 1500 µm** as **broad** (lines associated with other macular disease). **VMT is classified as complete**. **Full-thickness macular hole (FTMH)** is defined as a **foveal lesion with interruption of all retinal layers from the internal limiting membrane to the retinal pigment epithelium**. Full thickness macular hole is **primary** if caused by vitreous traction or **secondary** if directly the result of pathological characteristics other than VMT. Full-thickness macular hole is subclassified by size of the hole as determined by OCT and the presence or absence of VMT.

Conclusions: This classification system will support systematic diagnosis and management by creating a clinically applicable system that is predictive of therapeutic outcomes and is useful for the execution and analysis of clinical studies.

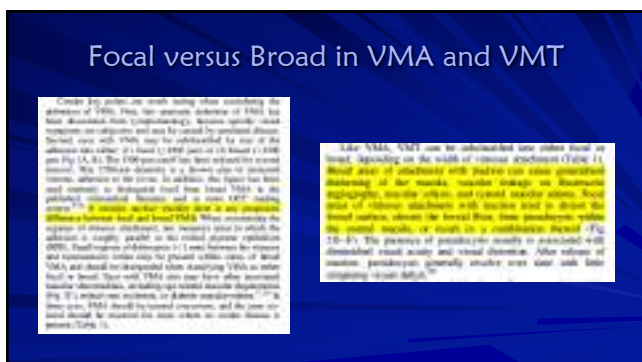
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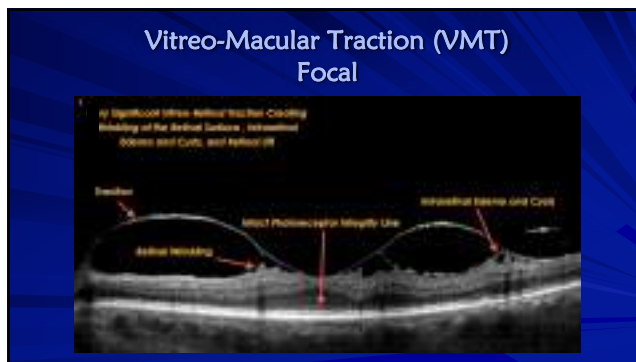
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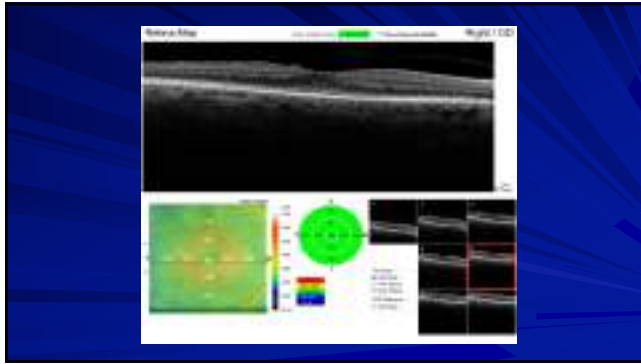
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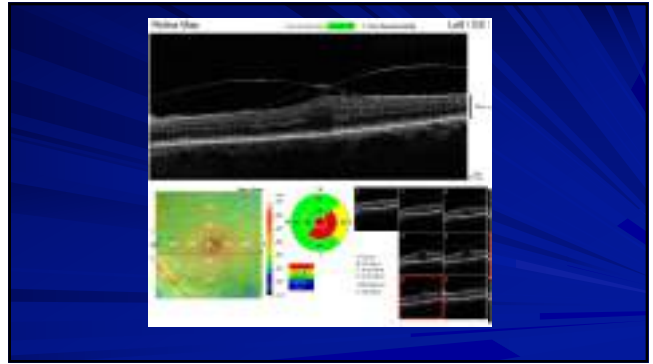
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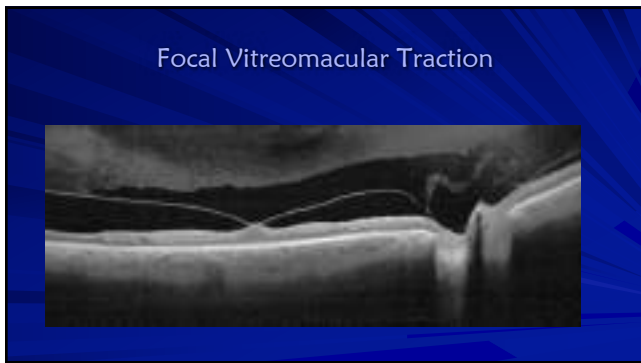
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34

Full Thickness Macular Hole

Main Outcome Measures: Clinical coherence tomography-based anatomic definitions and classification of vitreomacular adhesion, vitreomacular traction (VMT), and macular holes.

Results: Vitreomacular adhesion is defined as peripheral vitreous separation with remaining vitreomacular attachment and unperturbed foveal morphologic features. It is an OCT finding that is almost always the result of normal vitreous aging, which may lead to pathologic conditions. Vitreomacular traction is characterized by pronounced vitreous detachment accompanied by anatomic distortion of the fovea, which may include pseudoholes, macular edema, cystoid macular edema, and subretinal fluid. Vitreomacular traction can be subclassified by the diameter of vitreous attachment to the macular surface as measured by OCT, with attachment of 1500 μm or less defined as focal and attachment of more than 1500 μm as broad. Foci associated with other macular disease. VMT is classified as one-step. Full-thickness macular hole (FTMH) is defined as a foveal lesion with interruption of all retinal layers from the internal limiting membrane to the retinal pigment epithelium. Full-thickness macular hole is primary if caused by vitreous traction or secondary if directly the result of pathological characteristics other than VMT. Full-thickness macular hole is subclassified by size of the hole as determined by OCT and the presence or absence of VMT.

Conclusions: This classification system will support systematic diagnosis and management by creating a clinically applicable system that is predictive of therapeutic outcomes and is useful for the execution and analysis of clinical studies.

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Stage 1-4 Macular Holes

Ophthalmology Volume 130, Number 12, December 2017

Table 1. Consensus Terminology/Classification of Macular Hole Size, Stage, and the Associated Vitreomacular Traction Status: Classification System for Vitreomacular Adhesion, Traction, and Macular Holes

Full Thickness Macular Hole Stage or Diameter	Associated Vitreomacular Traction Status/Classification System
Stage 1	VMA
Stage 2	VMA
Stage 3	Stage 3 macular hole (FTMH) with VMT
Stage 4	Stage 4 macular hole (FTMH) with VMT
Stage 5	Stage 5 macular hole (FTMH) without VMT

Abbreviations: VMA, vitreomacular adhesion; FTMH, full-thickness macular hole; VMT, vitreomacular traction.

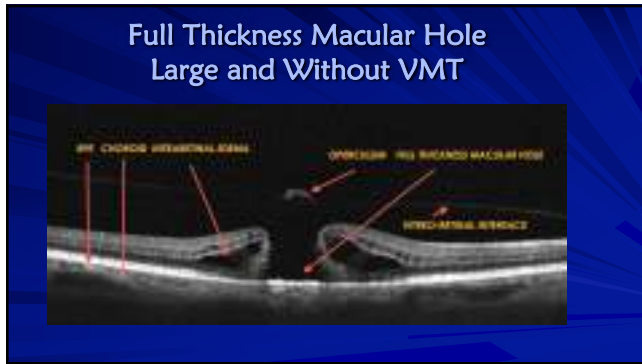
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Full Thickness Macular Hole

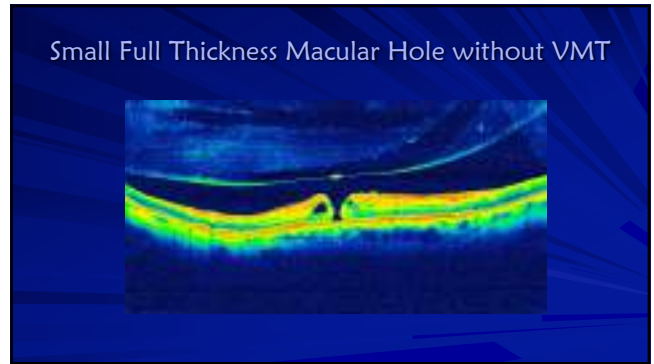
FTMH

- Definition: Full-thickness break through the innermost 5 retinal layers from the ILM to the RPE
- Classification:
 - Stage 1: 100-400 μm
 - Stage 2: 400-800 μm
 - Stage 3: 800-1000 μm
 - Stage 4: 1000-1500 μm
 - Stage 5: >1500 μm
- Notes:
 - Stage 1-4: VMT
 - Stage 5: VMT
 - Stage 1-4: VMT
 - Stage 5: VMT
 - Stage 1-4: VMT
 - Stage 5: VMT

37



38



39

Poll 3: The other eye has a full thickness macular hole. For the other eye do you prefer?

- A. Stage 0 (zero) macular hole
- B. Impending macular hole

40

What About the Other Eye?

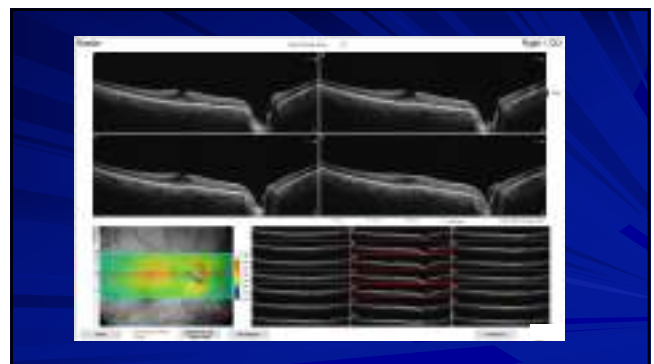
- ~ One eye has a full thickness macular hole
- ~ Stage 0 macular hole
 - * VMA
- ~ Impending macular hole
 - * VMT
 - * Despite the name
 - o Can spontaneously resolve

41

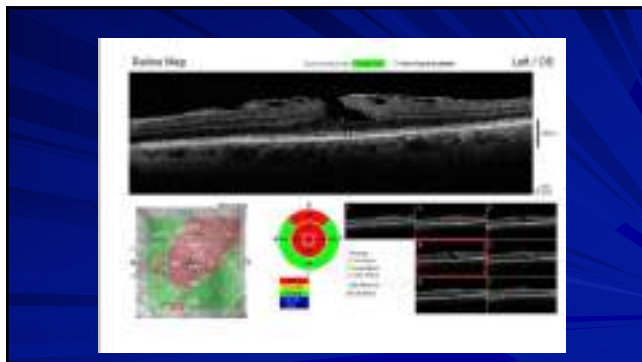
Macula Hole?

Lamellar Macular Hole
 Lamellar macular hole (LMH) is a partial thickness (partial thickness) hole typically superior or inferior to the fovea, and usually smaller than 400 micrometers. Clinical symptoms of early LMH may be difficult using fluorescein angiography. OCT based criteria of LMH include the following: (1) no complete foveal contour (2) a defect in the inner plexiform and/or outer plexiform layers (3) macular splitting (schisis), typically between the outer plexiform and outer nuclear layers, and (4) translocation of an outer photoreceptor layer. Lamellar macular holes can be distinguished from FTMH on OCT just by the presence of inner photoreceptors at the base (Fig. 28).

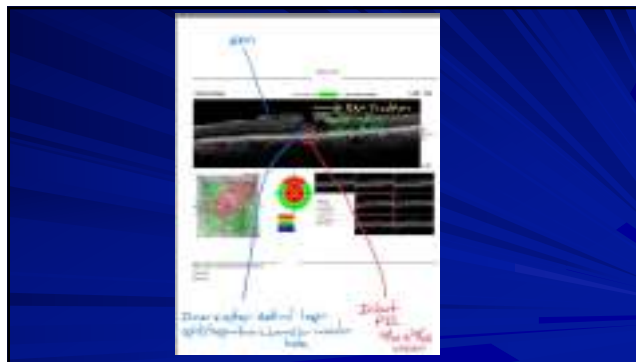
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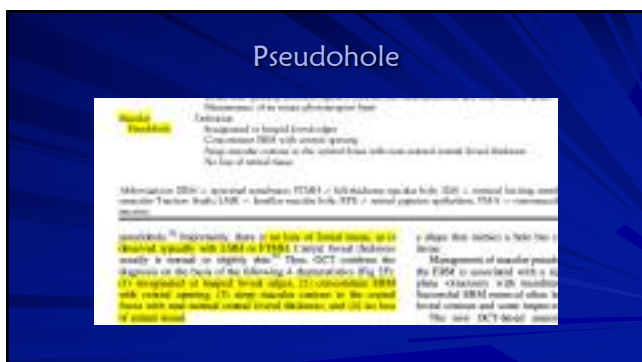
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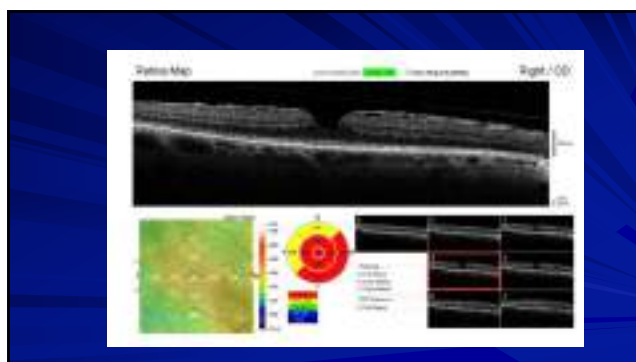
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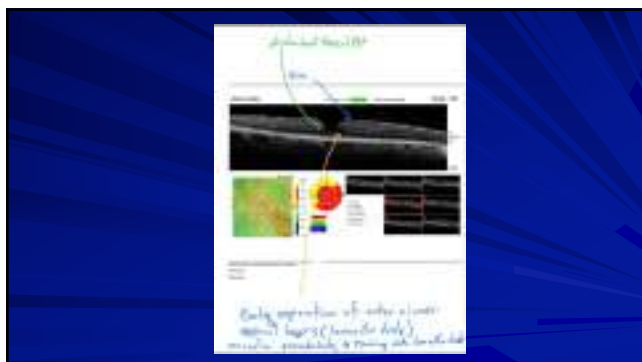
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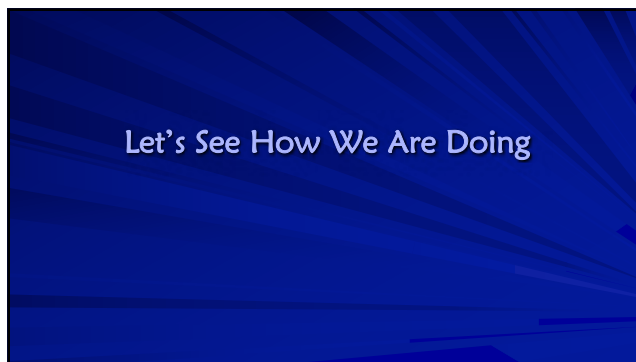
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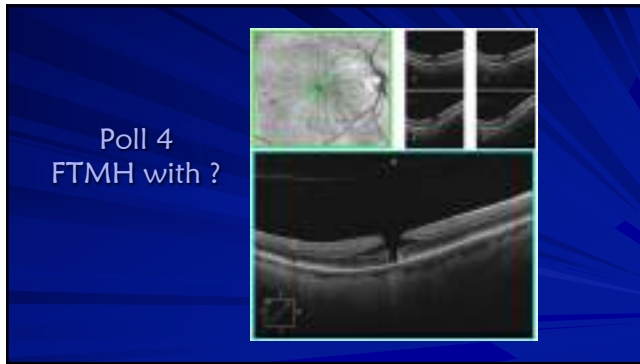
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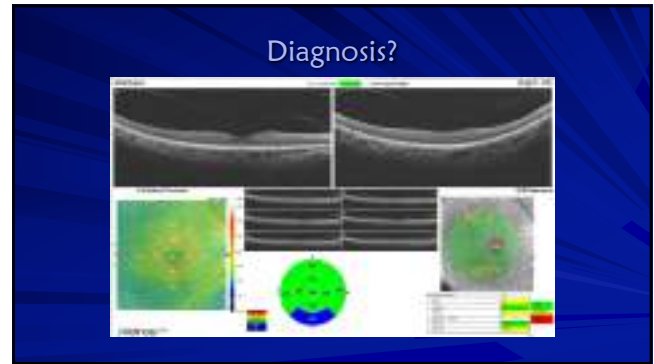
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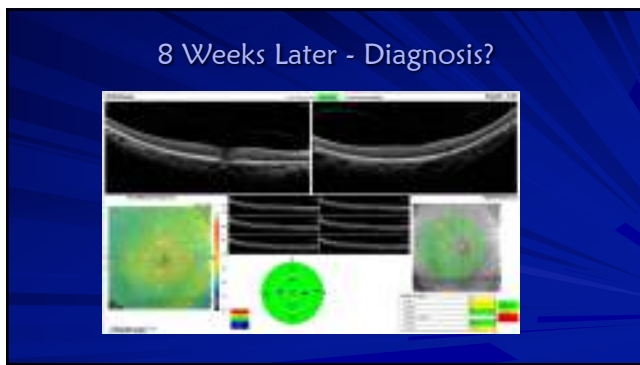
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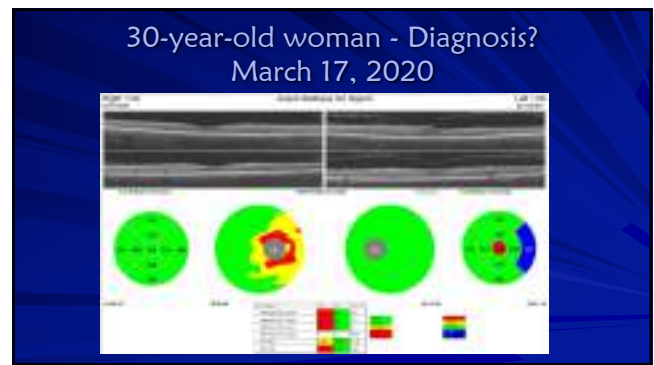
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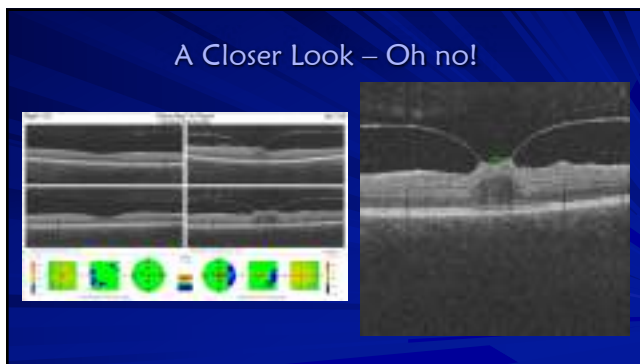
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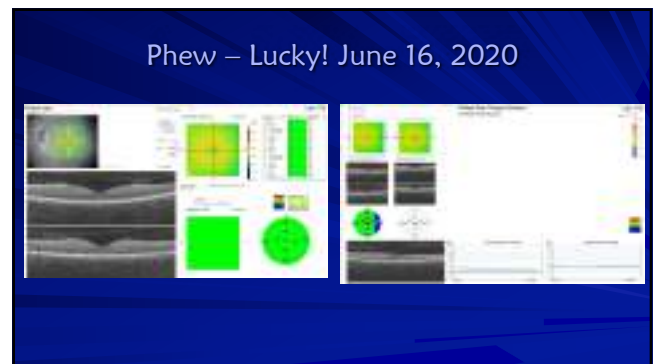
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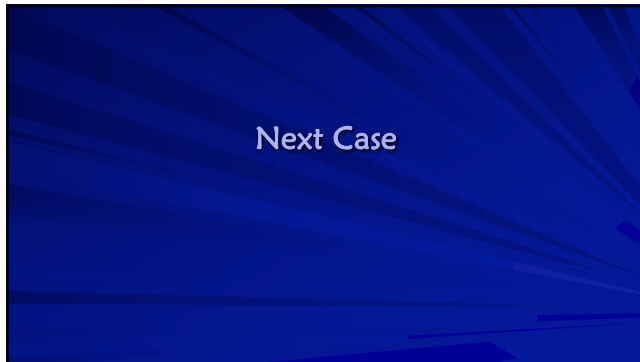
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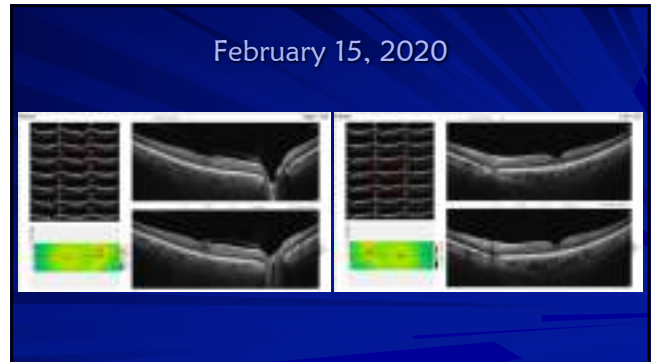
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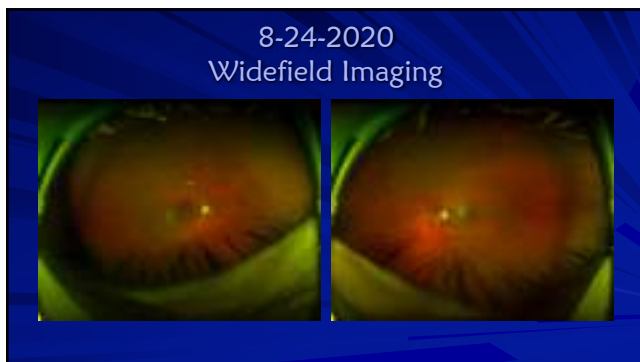
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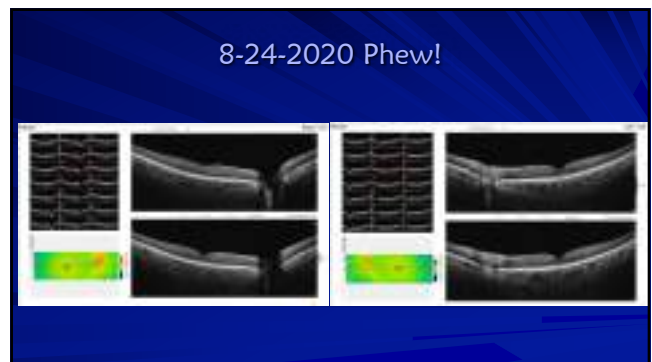
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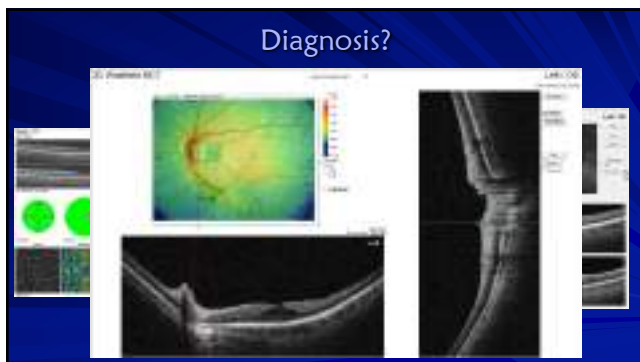
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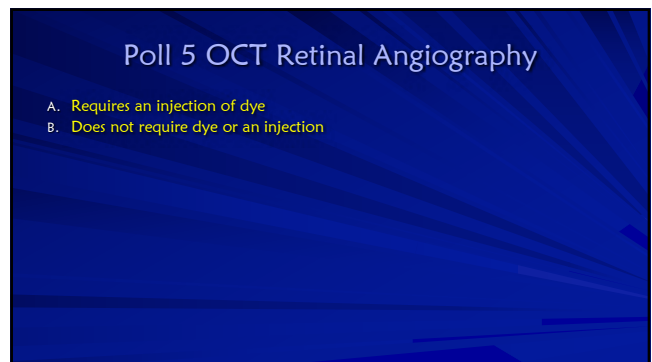
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61

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

62

Enface OCT-A Slabs Based on Retinal Anatomy

En Face Visualization of Layers Based on Retinal Anatomy

63

Normal Retinal Vasculature

Superficial Capillary Plexus 4µm Below ILM - 15 µm Below IPL	Deep Capillary Plexus 15µm Below ILM - 70 µm Below IPL	Outer Retina 70µm Below IPL - 30 µm Below RPE Reference	Choriocapillaris 30 µm Below RPE Reference - 60 µm Below RPE Reference
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64

Type 1 "Occult" CNV

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

65

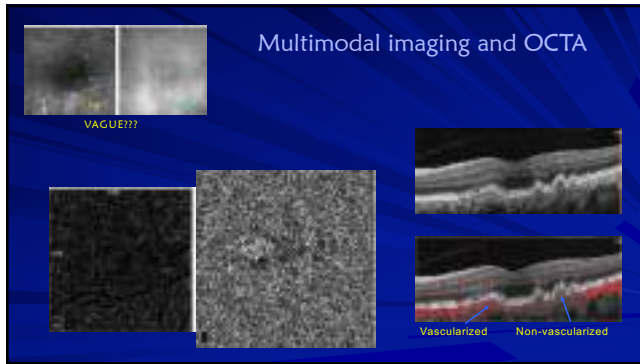
Type 1 "Occult" CNV

- ~ New vessels develop in the choroid
- ~ New vessels located **BELOW RPE** and **ABOVE** Bruch's membrane

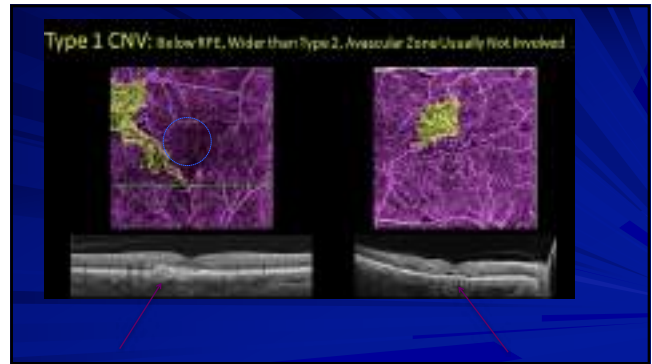
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CNV?

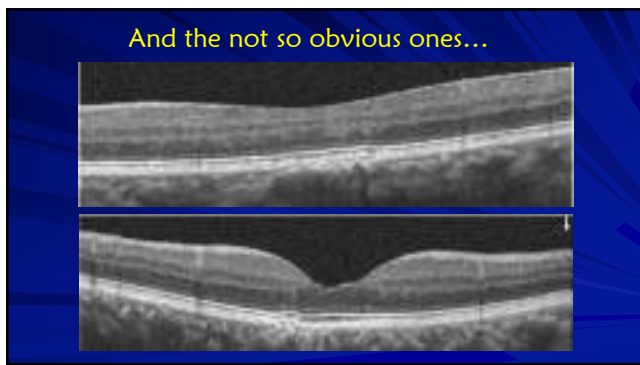
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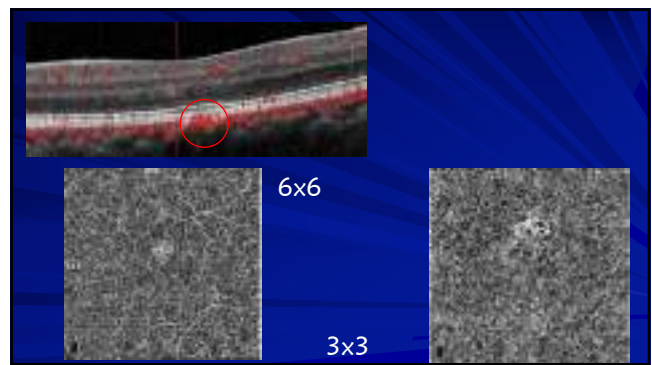
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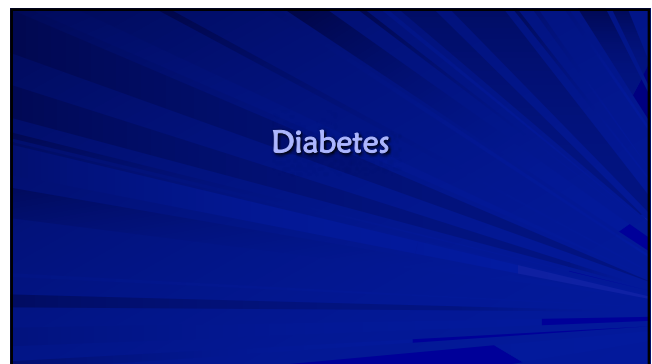
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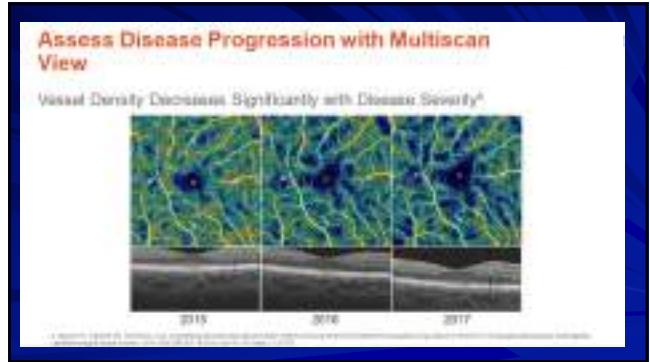
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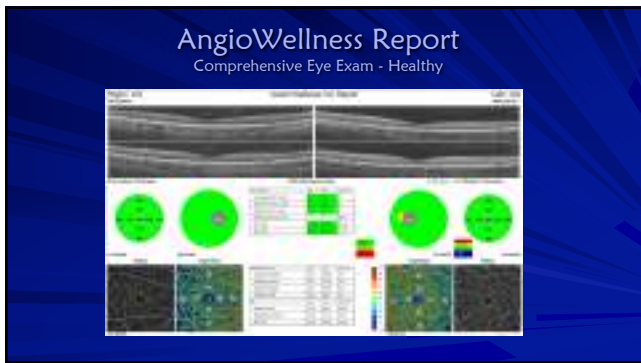
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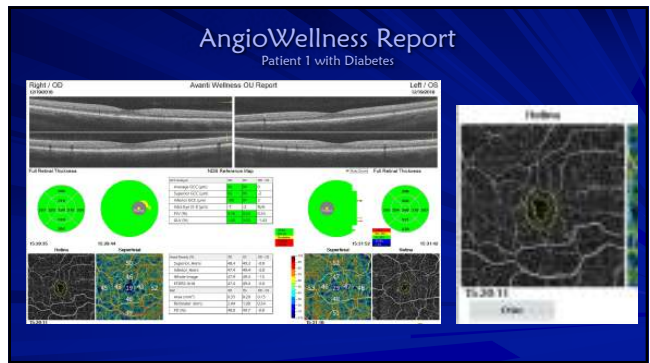
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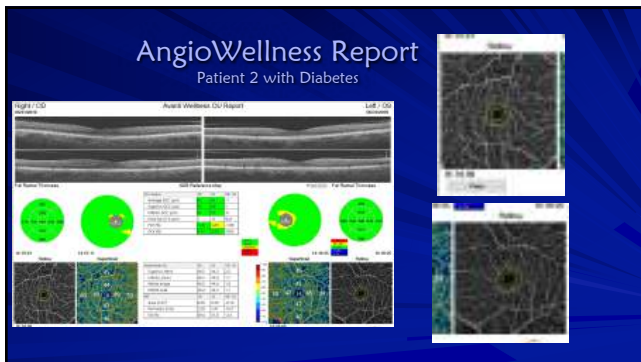
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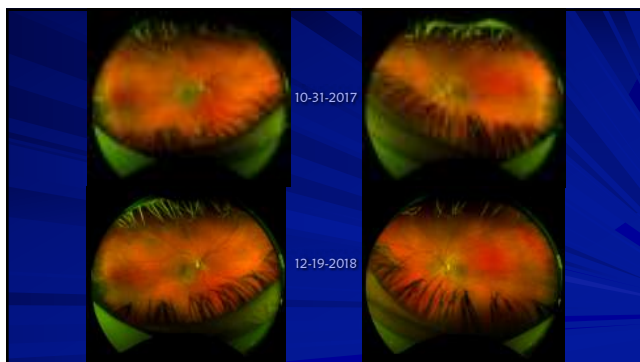


80

29 year old man with diabetes

- ~ Yearly diabetic exam, reports no changes to vision
 - * Type 1 DM
- ~ BS: 190 this AM, last HbA1c 8.6
- ~ Vision 20/20
- ~ Anterior segment: normal
- ~ Posterior segment:
 - * Non-proliferative DR
 - Hemer and exudates
 - * No CSME
- ~ Billed for:
 - * Exam- 99214
 - * Optomap, OCT-Wellness, and OCT-A (Angiography)

81



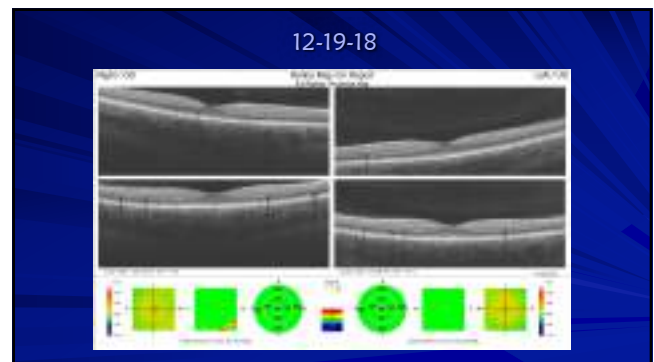
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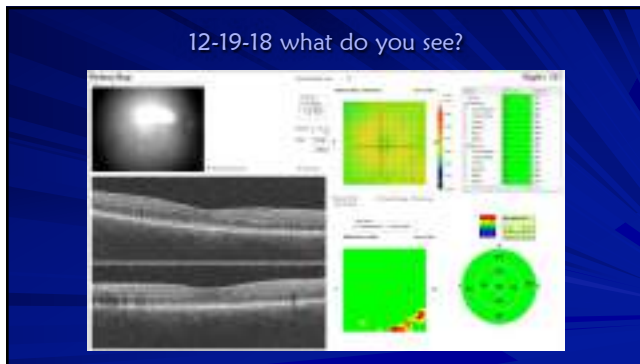
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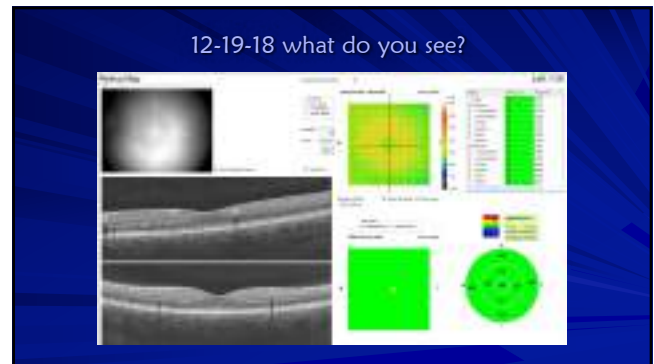
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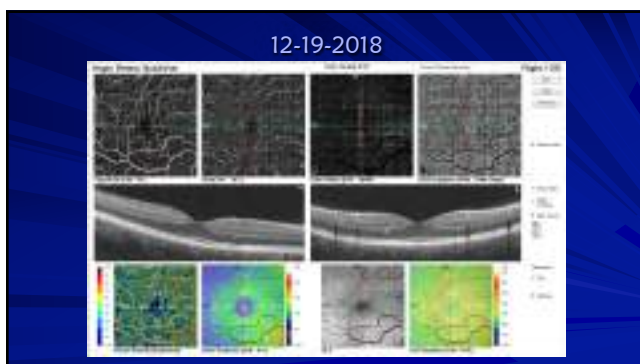
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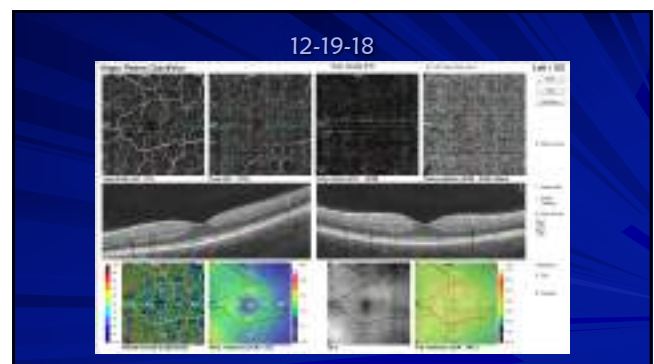
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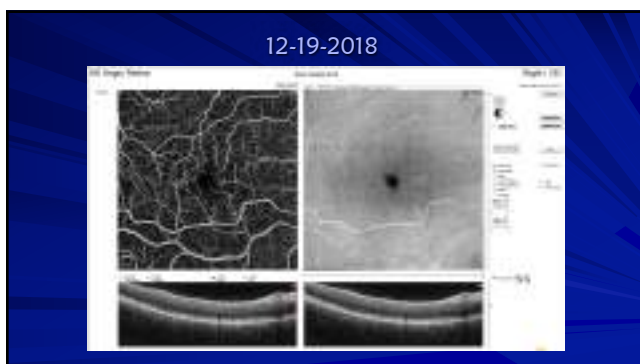
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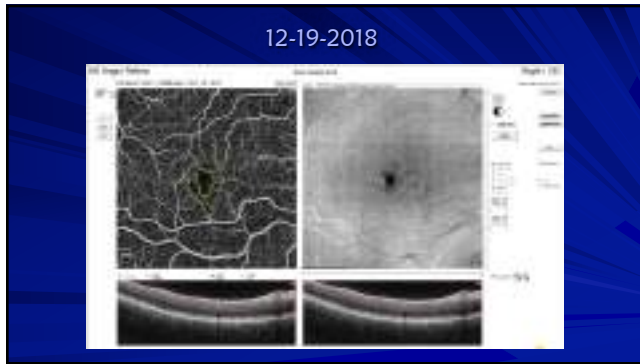
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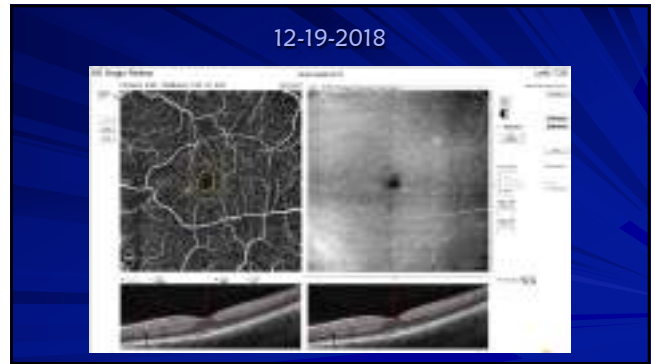
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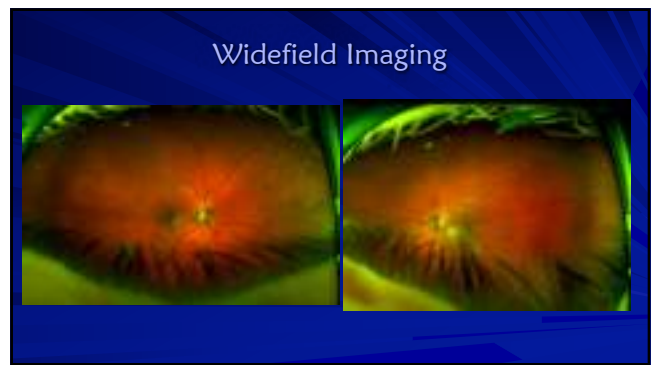


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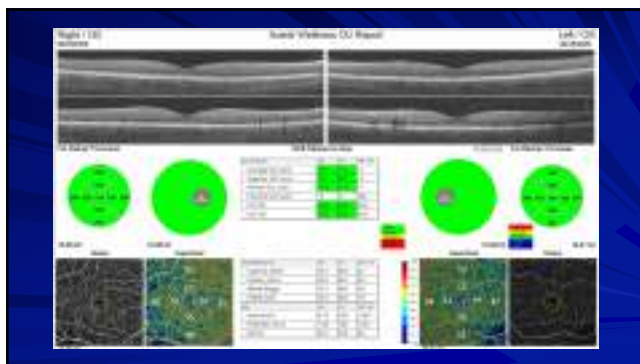
58-year-old man with diabetes

- New patient to the practice
- BS: unsure, last HbA1c unsure
- DM meds: metformin, glyburide, Invokana
- Vision 20/20
- Anterior segment: normal

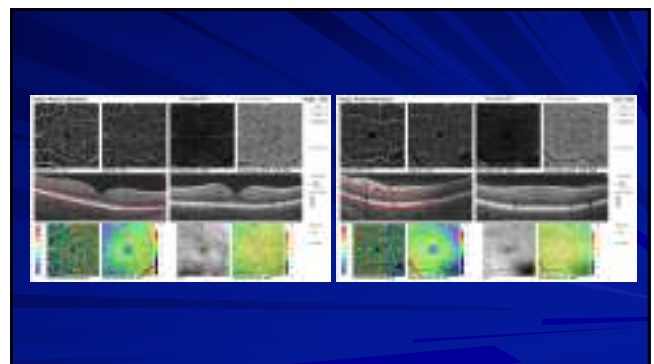
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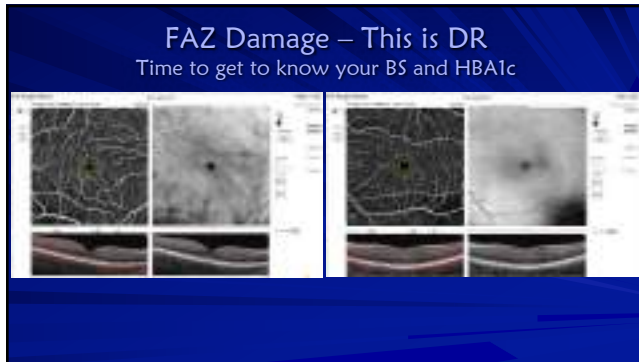
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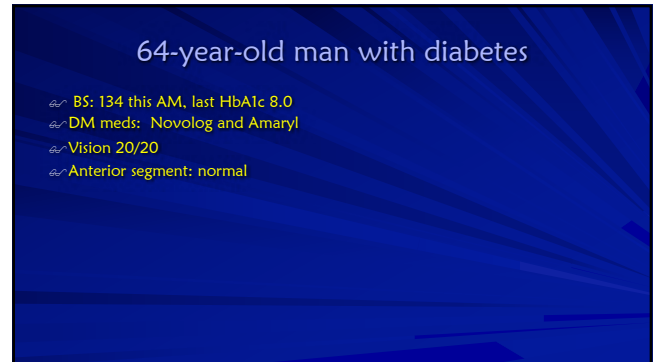
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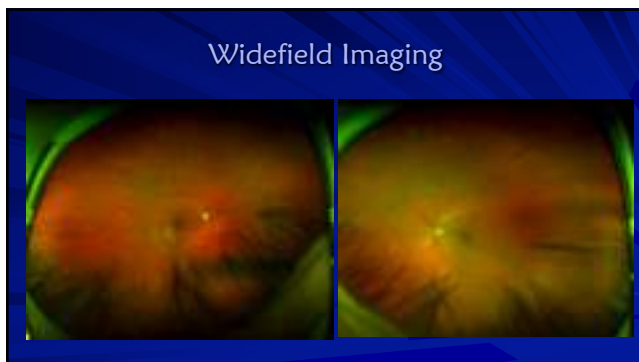
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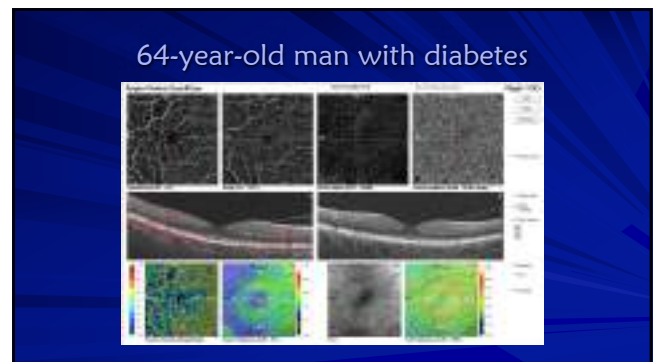
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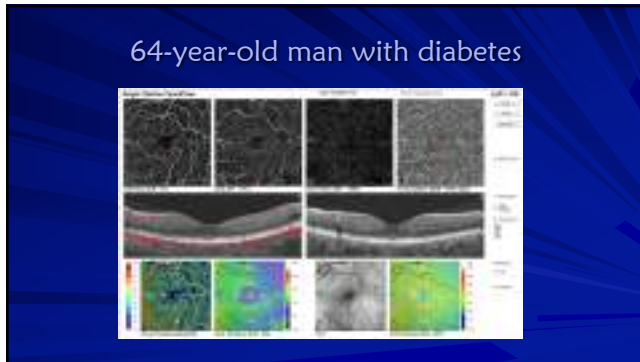
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102



103



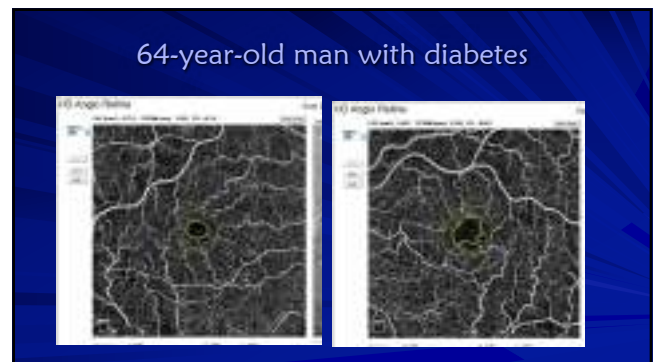
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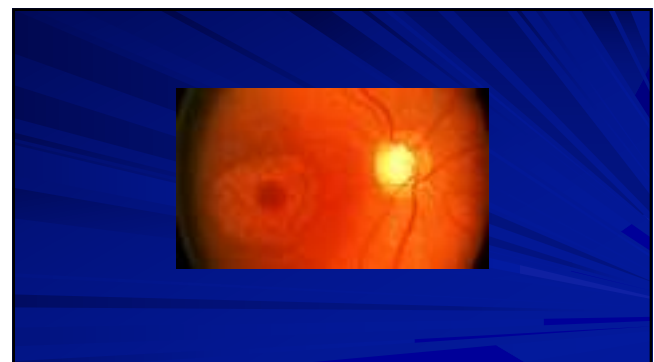


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OCT and OCT-A

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


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Revised Recommendations on Screening for Chloroquine and Hydroxychloroquine Retinopathy

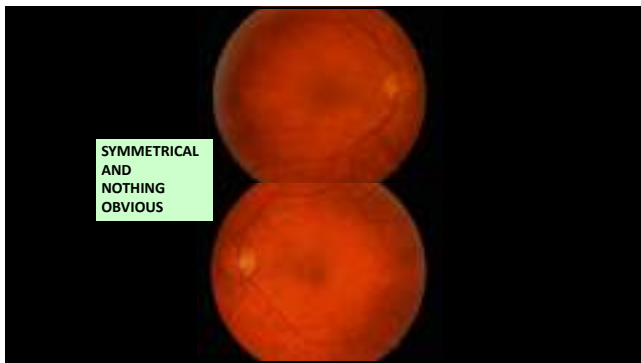
- ~ Last recommendations were 2002 by the American Academy of Ophthalmology
- ~ Improved screening tools and new knowledge about prevalence of toxicity have prompted the change
 - * **100 after 50 years of use or a cumulative dose of 100 years (100000)**
- ~ There is no treatment for this condition
 - * Therefore must be caught early
- ~ Screening for the earliest hints of functional or anatomic change
- ~ Plaquenil toxicity is not well understood



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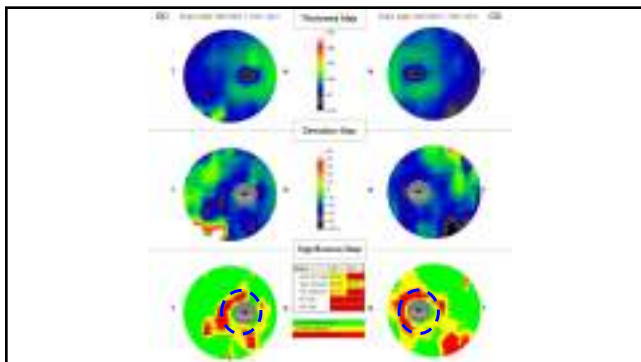


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1-1.5 MM PERIMACULAR GCC THINNING THE FIRST SIGN OF PLAQUENIL TOXICITY

WHY? THICKEST LAYER OF GANGLION CELLS AND SMALLEST GANGLION CELLS AT THAT LOCATION. VERY SENSITIVE TO TOXICITY

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WHAT DO YOU SEE ON THE SCANS?

- A. THINNING OF THE GCC IN THE PLAQUENIL ZONE
- B. MACULAR EDEMA
- C. COMPROMISED PVL
- D. NOTHING OF IMPORT

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WHAT DO YOU SEE ON THE SCANS?

A. THINNING OF THE GCC IN THE PLAQUENIL ZONE
 B. MACULAR EDEMA
 C. COMPROMISED PIL
 D. NOTHING OF IMPORT

DO YOU SEE ANY PROBLEM IN THE PLAQUENIL ZONE?

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Figure 1 The flying saucer sign representing compression of the perifoveal retinal tissue with retraction of the foveal retinal tissue. From Chen E, Brown GM, Wang HJ, et al. Spectral domain optical coherence tomography as an effective screening test for hydroxychloroquine retinopathy (the "flying saucer" sign). *Oculophthalmol*. 2010; 4: 1151-1158. Published online 2010 October 25. doi: 10.1177/1081224210381425

giving the impression of rising foveal tissue

thinning of perifoveal tissue

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WHAT DO YOU SEE ON THE SCANS?

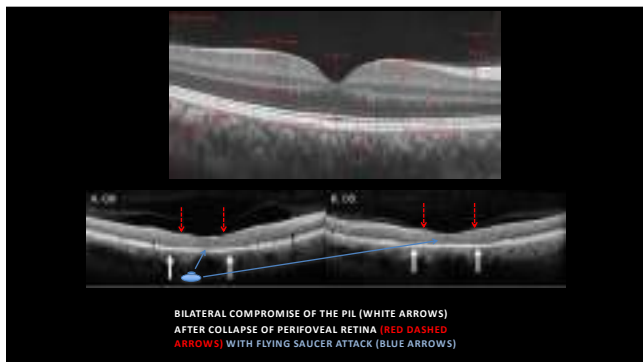
A. THE FLYING SAUCER SIGN
 B. MACULAR EDEMA
 C. INCREASED PERIMACULAR RETINAL THINNING
 D. A AND C

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WHAT DO YOU SEE ON THE SCANS?

A. THE FLYING SAUCER SIGN
 B. MACULAR EDEMA
 C. INCREASED PERIMACULAR RETINAL THINNING
 D. A AND C

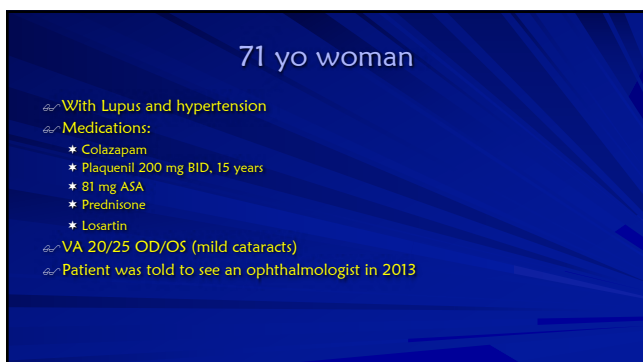
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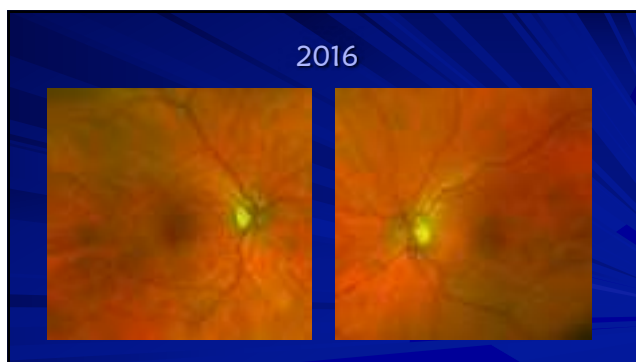
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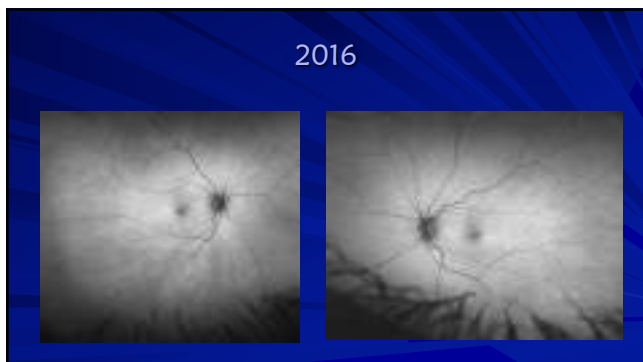
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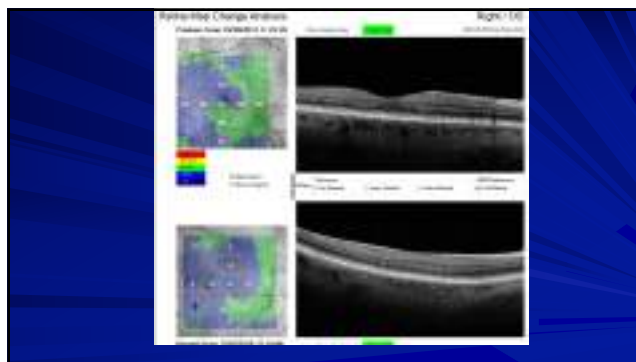
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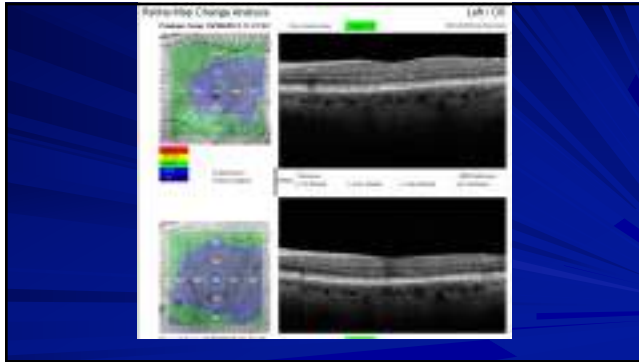
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 <p>Optometric Education Consultants</p>	<p>Questions?</p> <p>Thank you!</p> <p>OCT and OCT Angiography in Retinal Disease</p>
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