

## OCT and OCT Angiography in Retinal Disease

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Disclosure Statement  
(next slide)

1

### 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: Aerie, Alcon, Allergan, BioTissue, OptoVue
- ~ Advisory Board: Allergan, Maculogix, Sight Sciences, Sun, Takeda
- ~ Envolve: PA Medical Director, Credential Committee
- ~ Optometric Education Consultants: Scottsdale, St. Paul, Quebec City, Nashville, and Orlando/Disney OCT Users meeting; Owner



2

Resource: OCT Community for OCT and OCTA



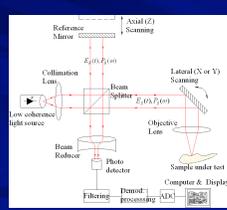
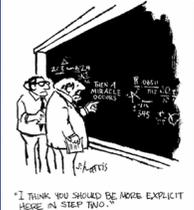
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### Book Resources




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### Optical Coherence Tomography Course Design

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## OCT and OCT Angiography

**Both are Becoming Equally Important in  
Diagnosis, Management, and Treatment**

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### 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
    - Able to see photoreceptor morphology (inner/outer segment)
  - \* 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

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### 4 Basic Categories: Diseases of the....

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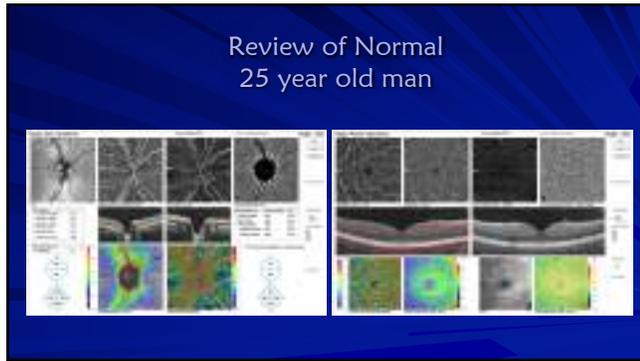
1044	Inner limiting membrane	1045	Inner wall/innermost lamellae	1046	Inner wall/outer lamellae
1047	Inner plexiform layer	1048	External plexiform layer	1049	External plexiform layer
1050	Inner nuclear layer	1051	Outer nuclear layer	1052	Outer nuclear layer
1053	Outer plexiform layer	1054	Photoreceptor layer	1055	Photoreceptor layer
1056	Retinal pigment epithelium	1057	Retinal pigment epithelium	1058	Retinal pigment epithelium
1059	Choroid	1060	Choroid	1061	Choroid

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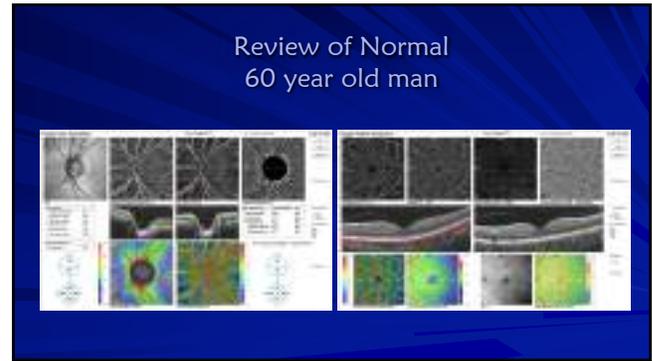
### Normal Retinal Vasculature

- Superficial Capillary Plexus: 3µm Below ILM -- 15 µm Below ILM
- Deep Capillary Plexus: 15µm Below ILM -- 70 µm Below ILM
- Outer Retina: 70µm Below PL -- 30 µm Below RPE Reference
- Choriocapillaris: 30 µm Below RPE Reference -- 60 µm Below RPE Reference

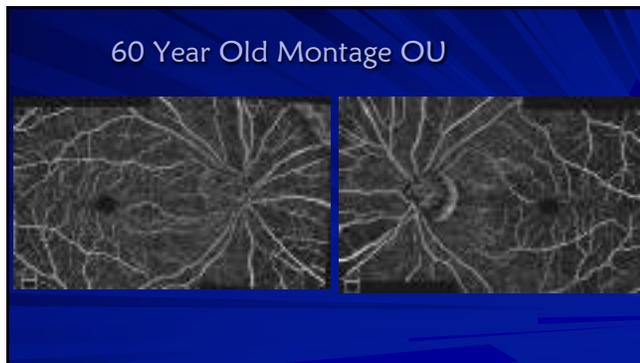
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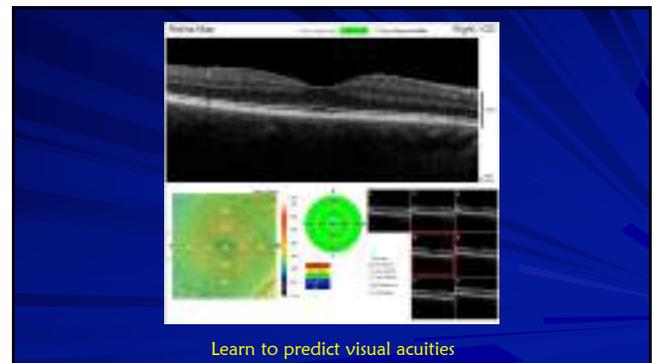
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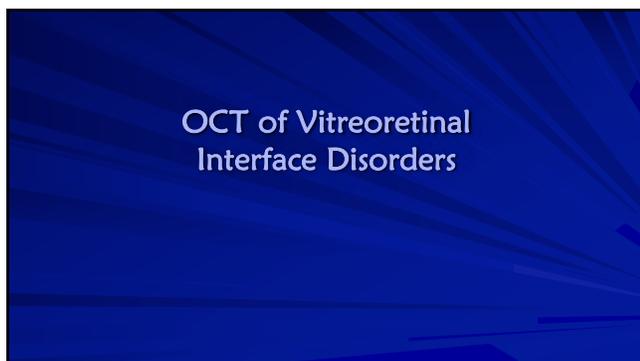
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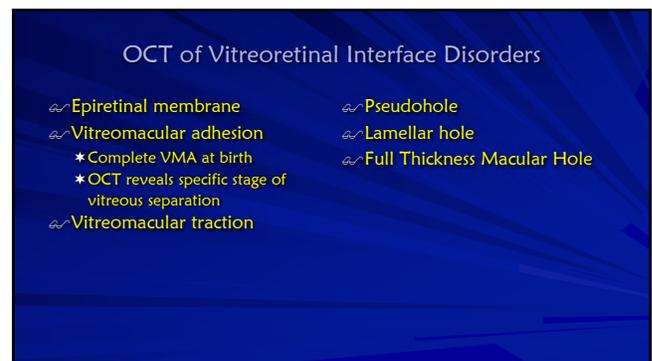
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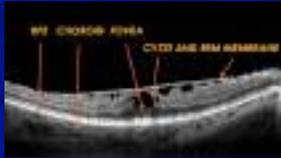
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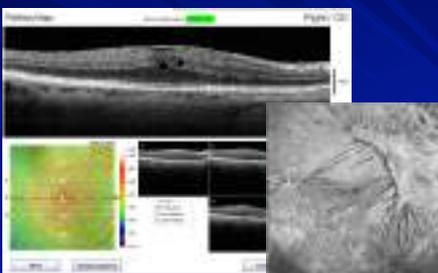
### Epiretinal Membrane

- ~ 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
- ~ Amelior grid may elicit metamorphosis from surface wrinkling or macular edema
- ~ Treatment: Monitor until severe then retinal consult, possible vitrectomy with membrane peeling



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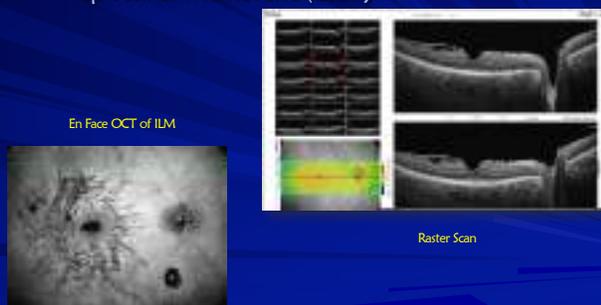
### Epiretinal Membrane (ERM)



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### Epiretinal Membrane (ERM)

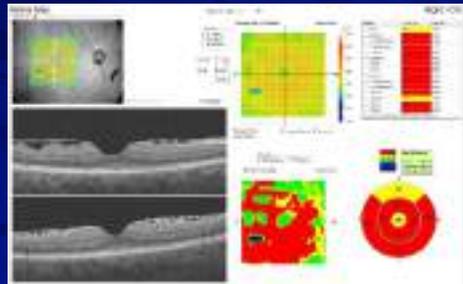
En Face OCT of ILM



Raster Scan

22

### Epiretinal Membrane (ERM)



Retina Map

23

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

**Main Diagnostic Measures:** Optical coherence tomography-based diagnostic definitions and classification of vitreomacular adhesion, vitreomacular traction (VMT), and macular hole.

**Results:** Vitreomacular adhesion is defined as **partial-thickness separation** with remaining vitreomacular attachment and unipolarized basal neovascular features. It is an OCT finding that is almost always the result of myopic 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 **subfoveolar, macular schisis, cystoid macular edema, and subretinal fluid**. Vitreomacular traction can be subdivided by the diameter of vitreous attachment to the major surface as measured by OCT, with attachment  $\leq 1500 \mu\text{m}$  or less defined as  **focal** and attachment of more than  $1500 \mu\text{m}$  as  **broad**. When associated with other macular disease, VMT is classified as **concomitant**. Full-thickness macular hole (FTMH) is defined as a **foveolar** 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 pathologic vitreoretinopathy other than VMT. Full-thickness macular hole is subdivided 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.

24

### VMA versus VMT Focal or Broad Attachment



25

### Vitreomacular Adhesion (VMA)

**Optical Coherence Tomography-Based Definition and Classification of Vitreomacular Adhesion**

Vitreomacular adhesion is a partial vitreous detachment and is defined, as with other terms in this report, by anatomical features obtained with OCT. In Gattuso's, Grubod's, and Johnson's classification scheme, VMA is the equivalent of a stage 1 PVD. Most eyes have complete vitreomacular adhesion or VMA, with the exception of neovascular adhesion and VMA in a neovascular eye. In the OCT-based classification scheme, however, VMA represents a specific stage of vitreous separation wherein partial detachment of the vitreous in the perifoveal area has occurred.

26

### Focal versus Broad in VMA and VMT

Consider the patient on each being when considering the definition of VMA. First, the anatomical adherence of VMA has been described from histopathology. Second, specific classification systems and terms for partial vitreous detachment have been established to date. If the adherent vitreous is focal (1) or broad (2) then it is either a focal or broad VMA. The VMA is defined as focal or broad based on the extent of the vitreous adherence to the retina. In addition, the focal or broad and complete or incomplete based on the extent of VMA to the partially detached vitreous and in some cases, the extent of the vitreous detachment. When considering the extent of vitreous adherence, the primary factor is whether the adherence is strictly parallel to the normal plane of separation (PDS). The degree of adherence is based on the extent and topographic extent only for partial vitreous detachment (PVD). VMA and broad VMA are also defined by the extent of vitreous adherence to the retina. The term VMA also may have other associated descriptive characteristics, including topographic description (Fig. 11-4). The presence of paraneovascular neovascularization (PVD) is associated with VMA and broad VMA. The term VMA also may have other associated descriptive characteristics, including topographic description (Fig. 11-4). The presence of paraneovascular neovascularization (PVD) is associated with VMA and broad VMA. The term VMA also may have other associated descriptive characteristics, including topographic description (Fig. 11-4). The presence of paraneovascular neovascularization (PVD) is associated with VMA and broad VMA.

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### Which eye has the better visual prognosis?

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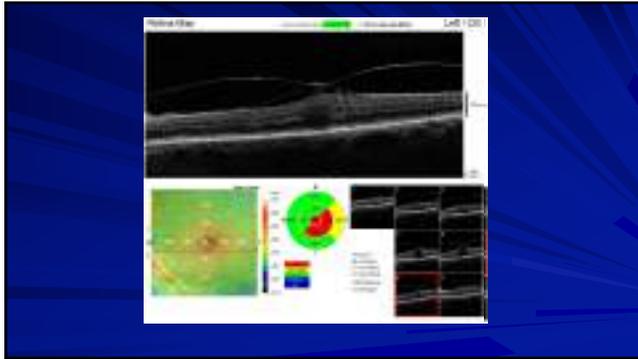
### Vitreomacular Traction Focal

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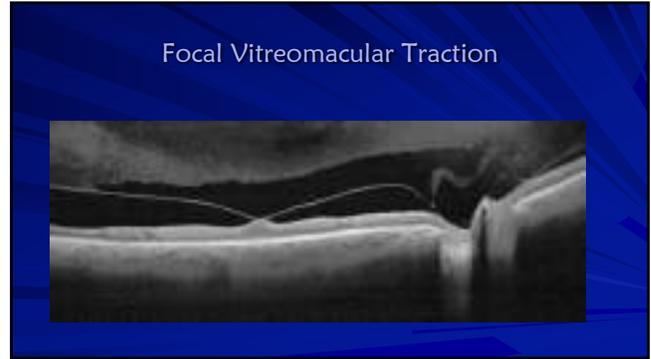
### Vitreomacular Traction (VMT) Focal

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### Full Thickness Macular Hole

**Mean Outcome Measures:** Optic coherence tomography-based systemic definitions and classification of vitreomacular adhesion, vitreomacular traction (VMT), and macular holes.

**Results:** Vitreomacular adhesion is defined as unroofed vitreous separation with remaining vitreomacular attachment and unroofed level (synaptic) features. It is an OCT finding that is almost always the result of normal vitreous aging, which may lead to pathological conditions. Vitreomacular traction is characterized by anomalous posterior vitreous detachment accompanied by anterior distortion of the fovea, which may include lamellolytic, macular schisis, 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  $\leq 1500 \mu\text{m}$  or less defined as focal and attachment of more than  $1500 \mu\text{m}$  as broad. When associated with other macular disease, VMT is classified as concomitant. Full-thickness macular hole (FTMH) is defined as a foveal defect 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 retinal events 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.

34

### Stage 1-4 Macular Holes

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Table 1. Systematic International Classification of Clinical Macular Hole Types and the Associated Vitreomacular Traction Configuration Pattern for Vitreomacular Adhesion, Traction, and Macular Hole

Full Thickness Macular Hole Stage or Feature	Associated Vitreomacular Traction/Adhesion Feature
Stage 1 (unroofed macula hole)	VMT
Stage 2 (small FTMH)	Soft or no VMT with VMT
Stage 3 (large hole)	Stages of VMT with VMT
Stage 4 (FTMH with FTMH)	Soft, medium, or hard FTMH without VMT

FTMH = full-thickness macular hole; FTMH = partial-thickness macular hole; VMT = vitreomacular traction; VMT = vitreomacular traction.

35

### Full Thickness Macular Hole

**ICD9-CM**

**Definition:** Full-thickness macular hole (FTMH) is a defect in the retina that extends through the full thickness of the retina.

**Classification:**

- Primary (idiopathic) full-thickness macular hole
- Secondary (trauma, infection, inflammation, radiation, or other causes)

**ICD9-CM Code:** 362.01 (Primary), 362.02 (Secondary)

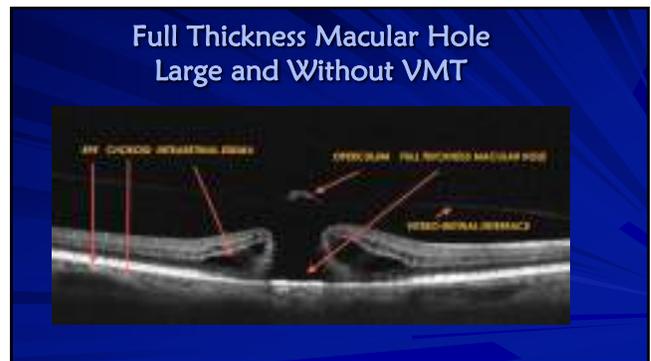
**ICD9-CM Subclassifications:**

- 362.011 (Primary, small)
- 362.012 (Primary, large)
- 362.021 (Secondary, small)
- 362.022 (Secondary, large)

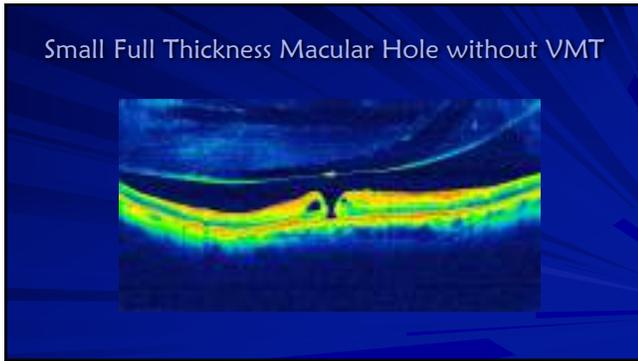
**ICD9-CM Excludes:**

- 362.00 (Macular hole, unspecified)
- 362.03 (Macular hole, unspecified)
- 362.04 (Macular hole, unspecified)
- 362.05 (Macular hole, unspecified)
- 362.06 (Macular hole, unspecified)
- 362.07 (Macular hole, unspecified)
- 362.08 (Macular hole, unspecified)
- 362.09 (Macular hole, unspecified)

36



37



38

### 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
    - Can spontaneously resolve

**Impending Macular Hole**

A typical clinical scenario is an individual developing a FTMH in one eye and OCT reveals VMA or VMT in the fellow eye. Studies have shown that when there is an abnormality in the development of PVD in the fellow eye, the finding of VMA in a fellow eye has been referred to as a stage 0 macular hole, but the term impending macular hole should be used instead to describe a case in which VMT is observed in one eye and VMT or VMA is observed on OCT in the fellow eye (Tables 2 and 3). The term impending macular hole, despite the connotation of inevitability, does not exclude the possibility of spontaneous resolution.

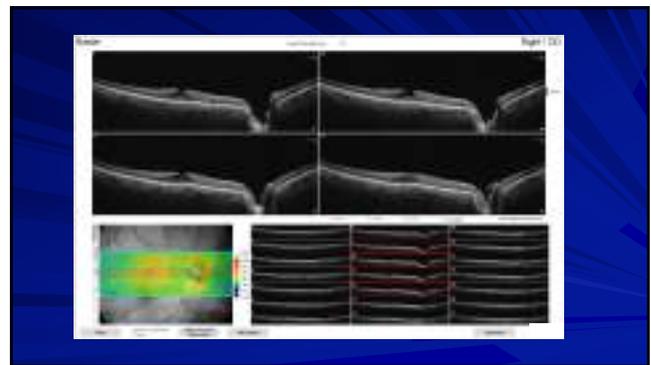
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### Macula Hole?

**Latent Macular Hole**

Latent macular holes (LMH) is a partial thickness (not full) hole that typically appears on biomicroscopy as a round or oval, well-demarcated, reddish lesion. Clinical detection of early LMH may be difficult using funduscopy alone. Advanced OCT based devices of 1,000 A-scans, the following: (1) no tangential foveal contour; (2) a defect in the inner foveal wall with depth about half of normal; (3) anomalous splitting (schisis), typically between the outer plexiform and outer nuclear layers; and (4) translocation of anomalous photoreceptor layer. Latent macular holes can be distinguished from FTMH on OCT test by the presence of intact photoreceptors at the base (Fig. 28).

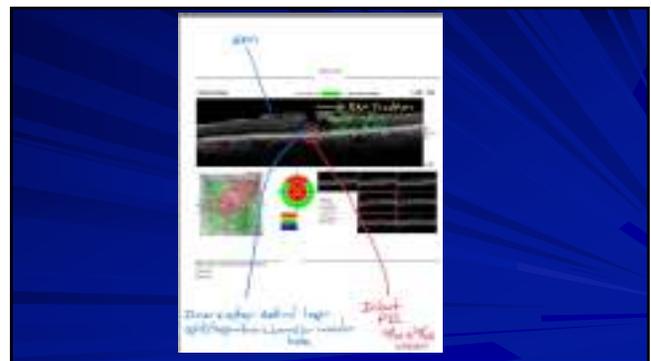
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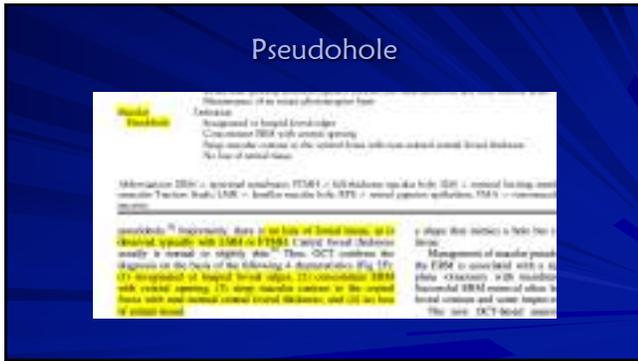
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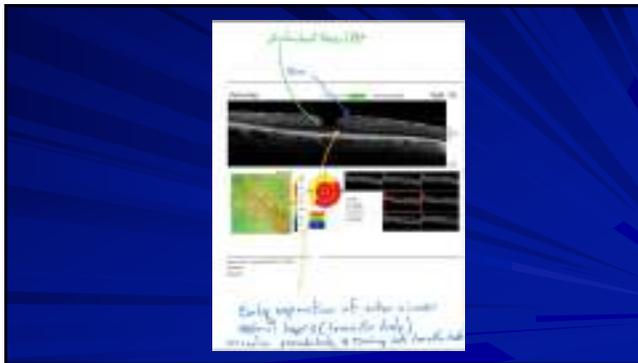
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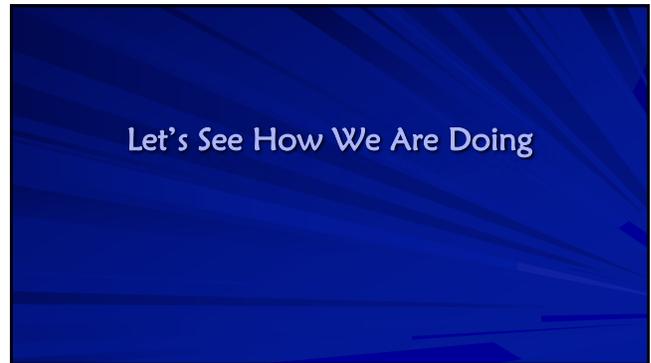
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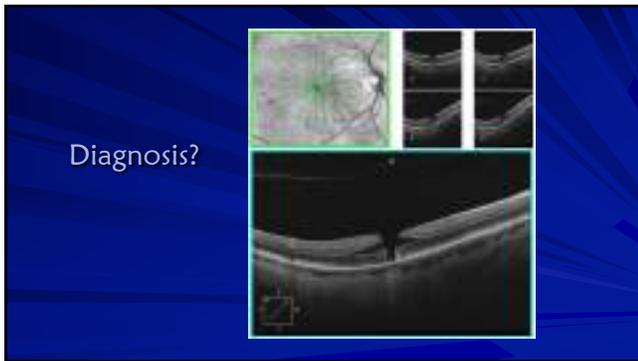
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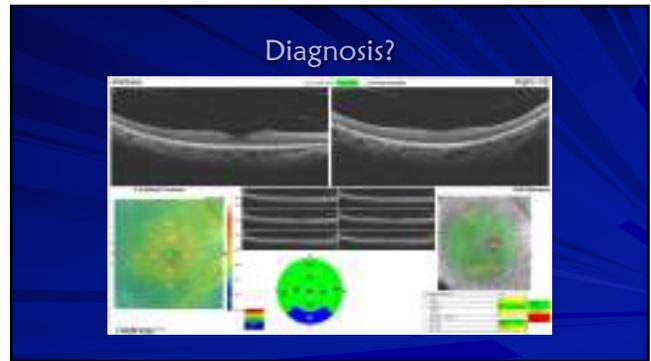
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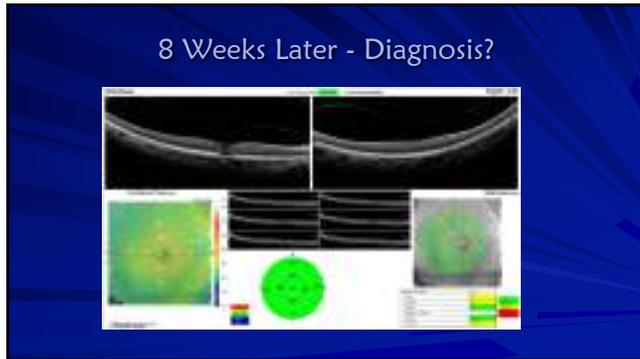
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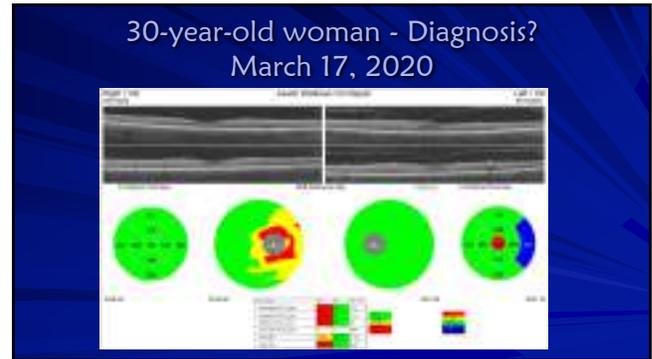
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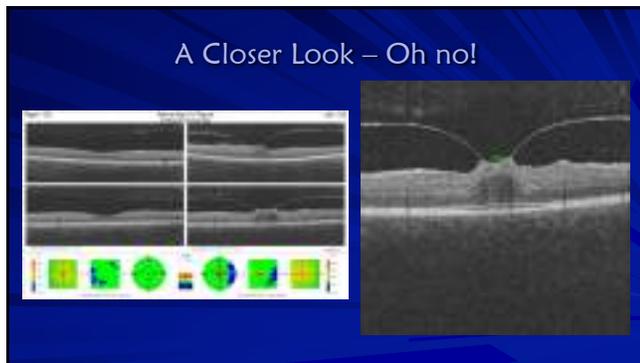
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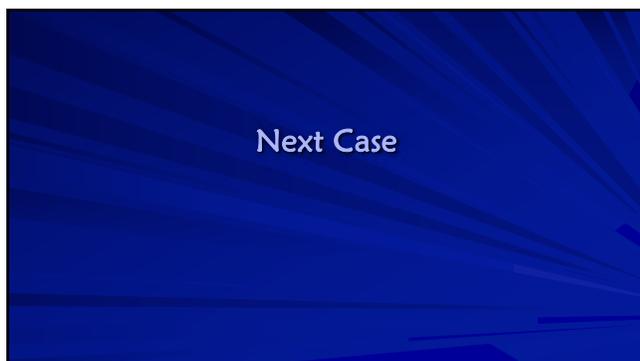
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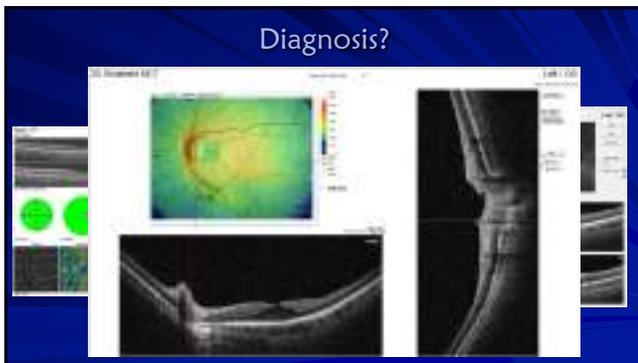
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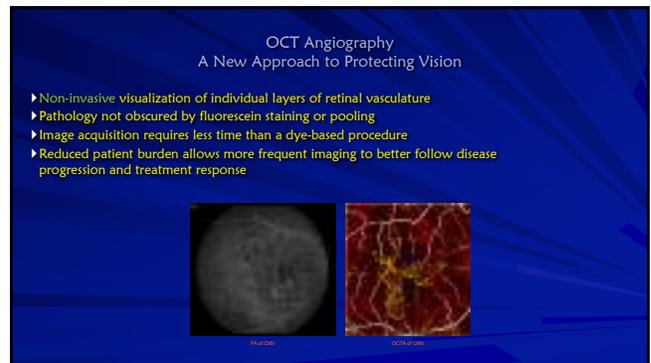
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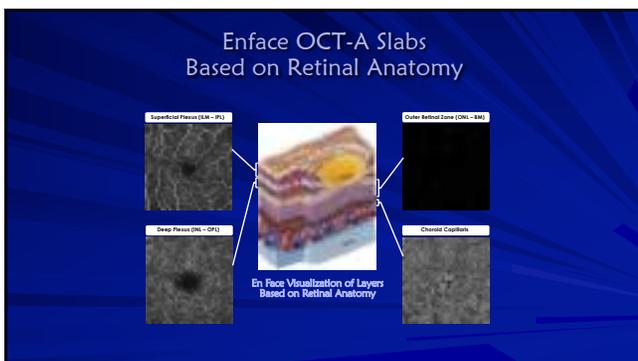
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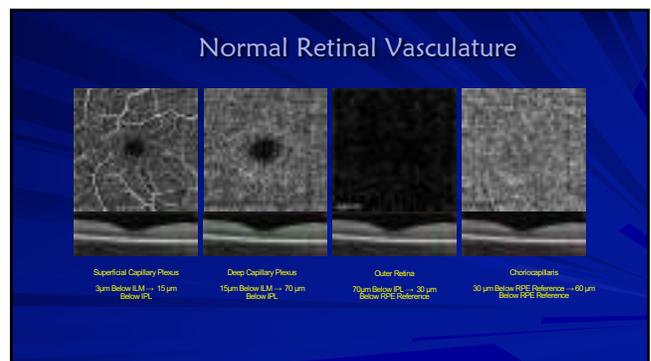
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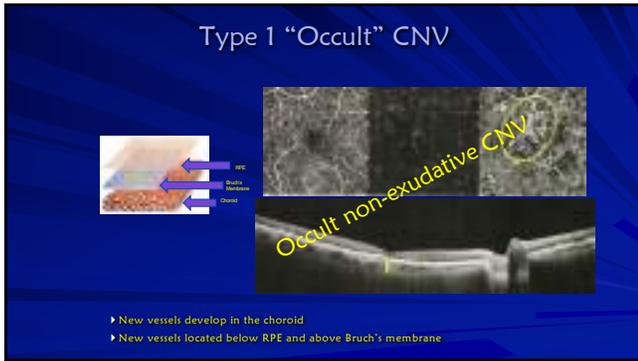
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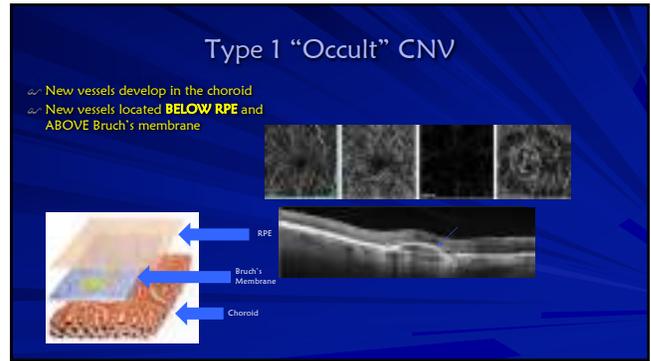
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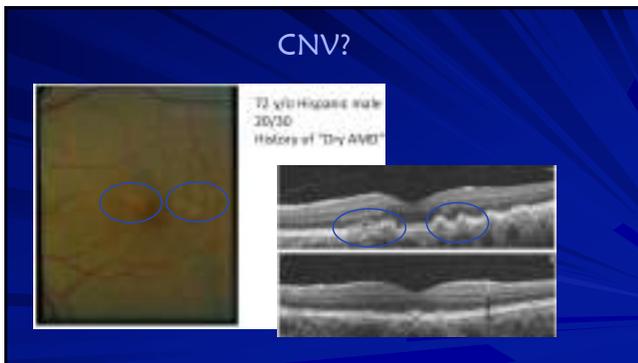
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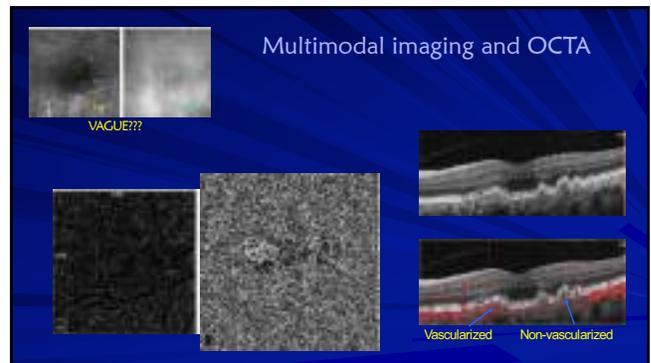
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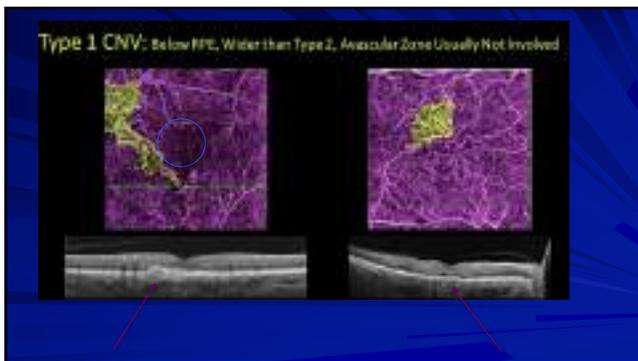
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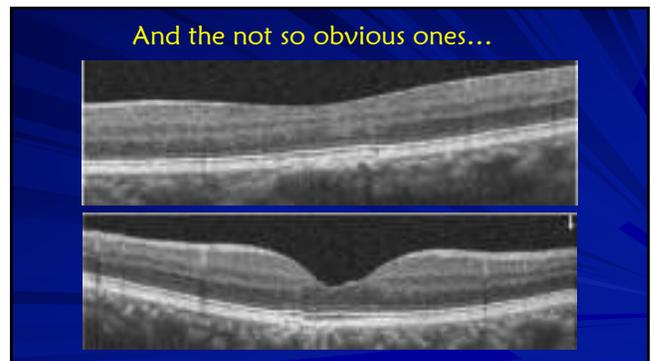
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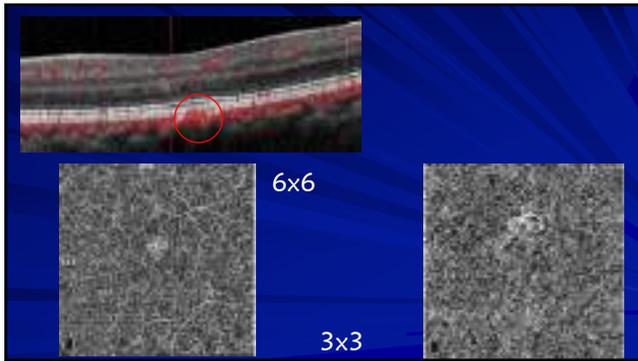
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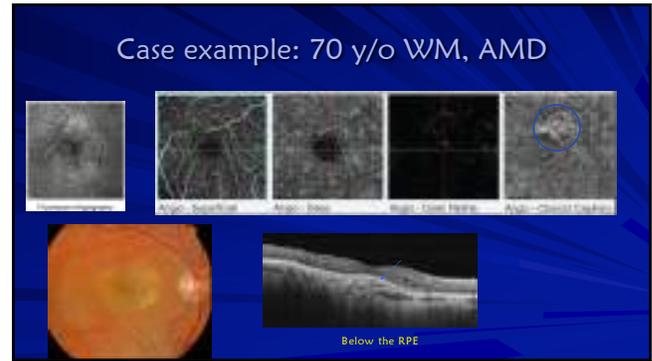
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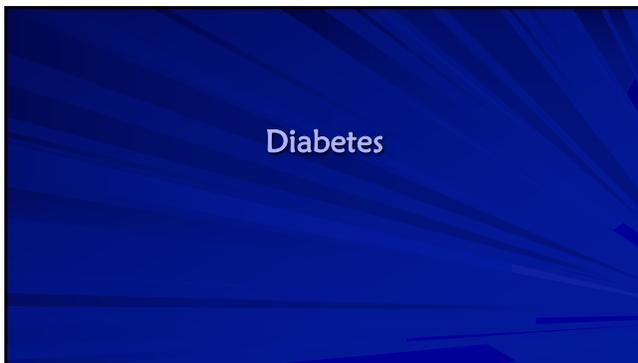
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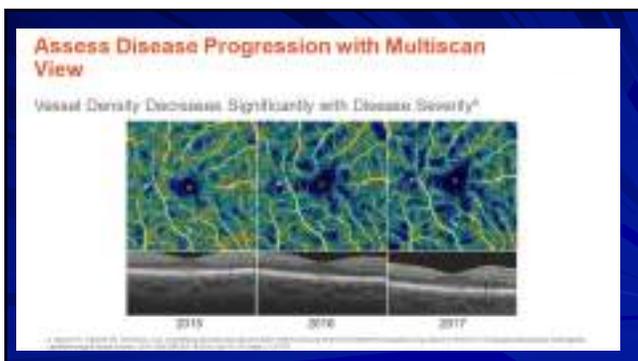
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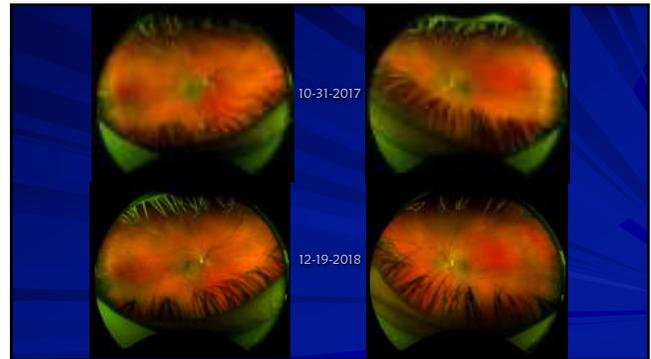


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29 year old man with diabetes

- ~ 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
    - Hemes and exudates
  - \* No CSME
- ~ Billed for:
  - \* Exam- 99214
  - \* Optomap, OCT-Wellness, and OCT-A (Angiography)

78



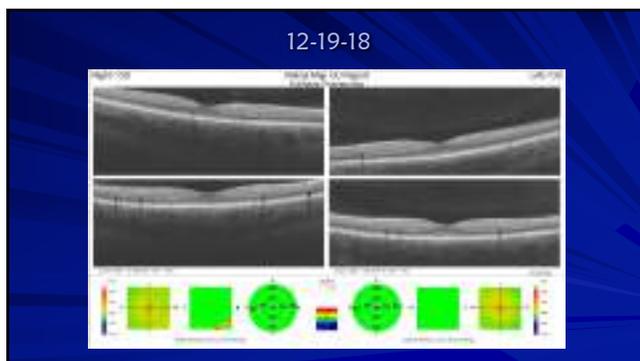
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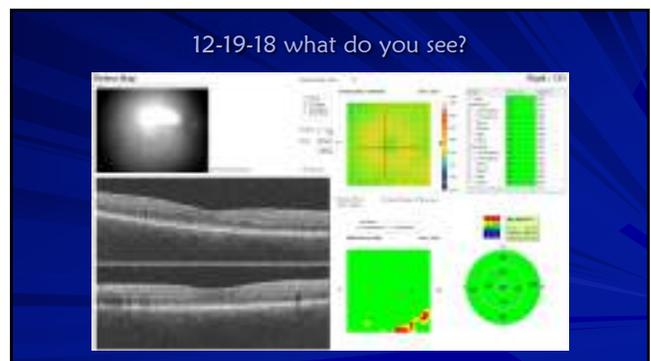
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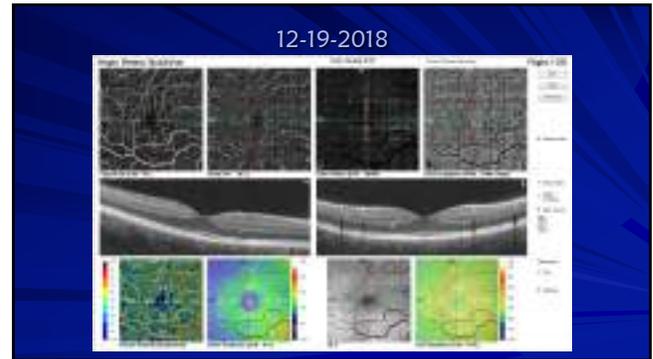
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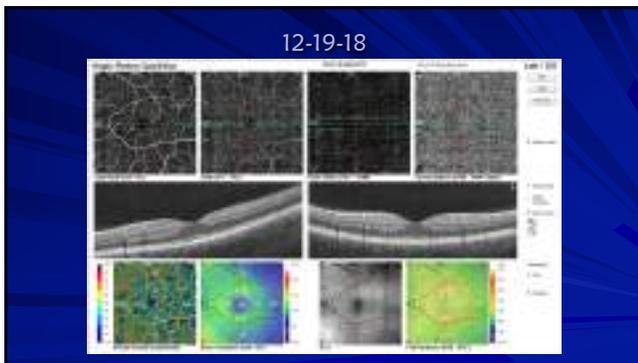
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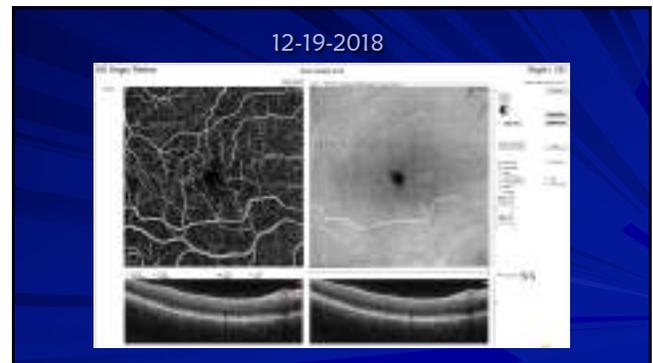
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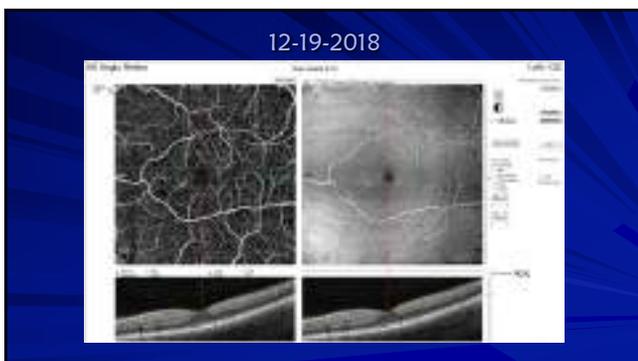
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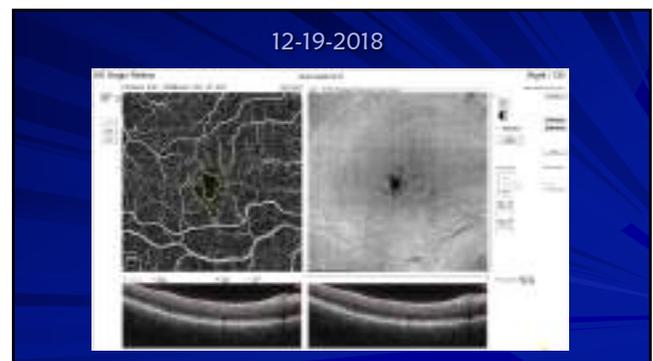
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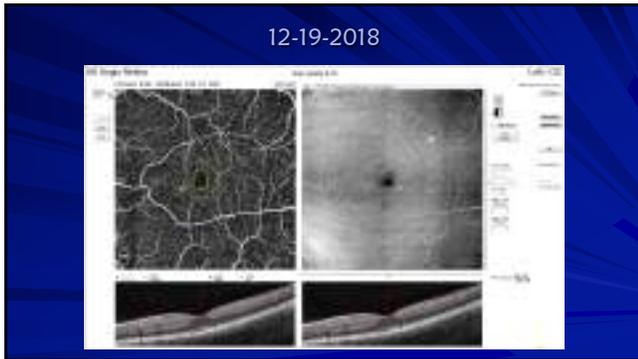
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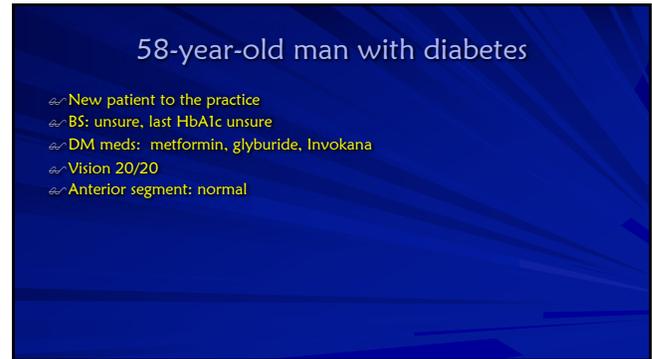
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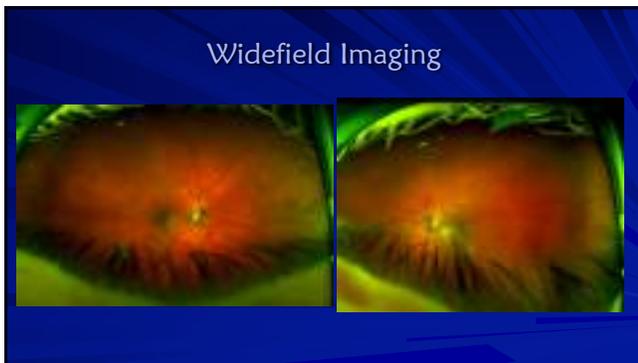
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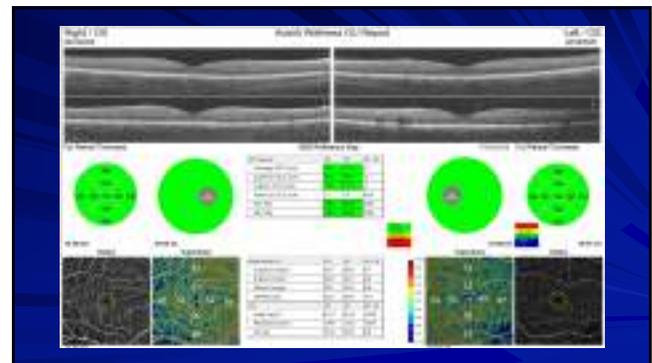
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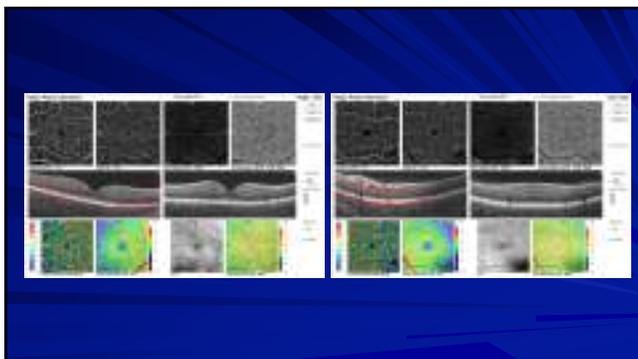
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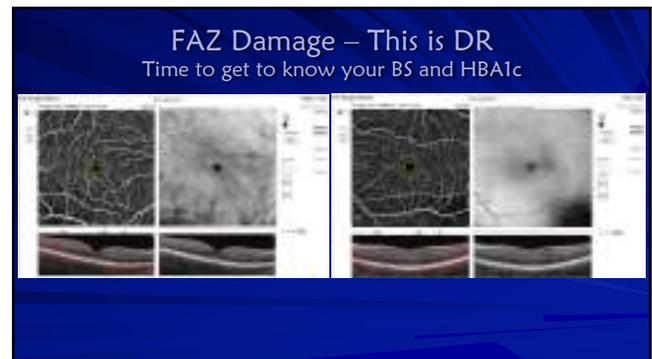
92



93



94

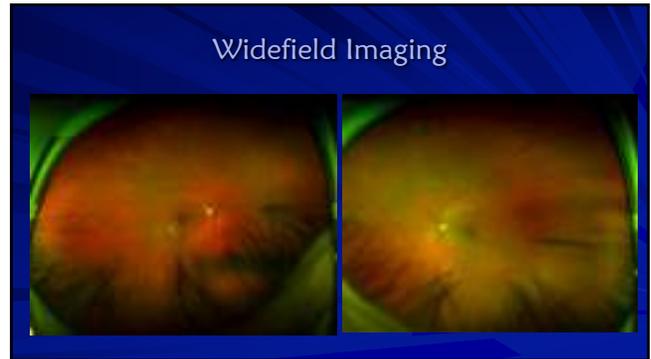


95

64-year-old man with diabetes

- BS: 134 this AM, last HbA1c 8.0
- DM meds: Novolog and Amaryl
- Vision 20/20
- Anterior segment: normal

96



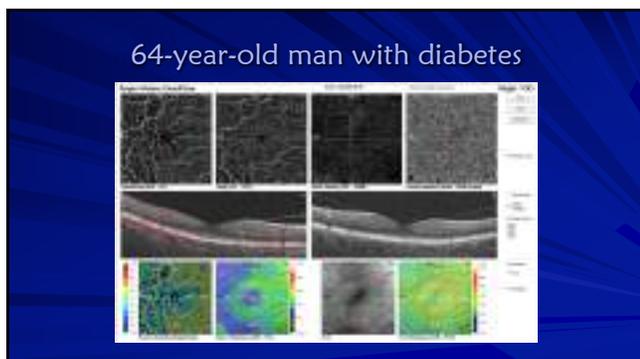
97



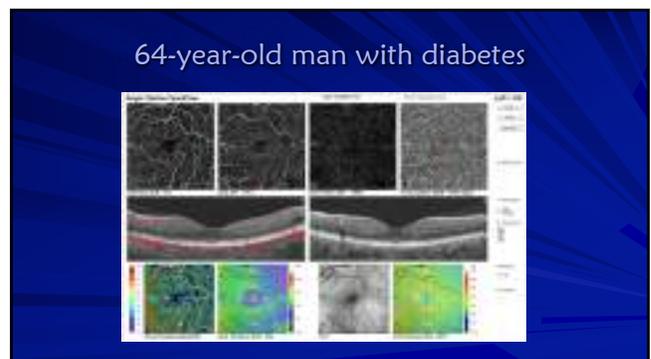
98



99



100



101



102



103



104

OCT and OCT-A

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

105

OCT and OCT Angiography

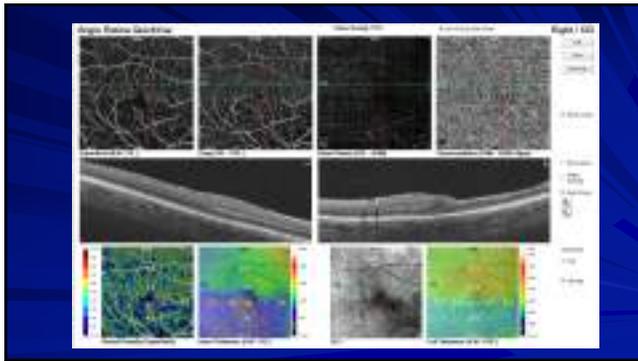
Solve the Case

106

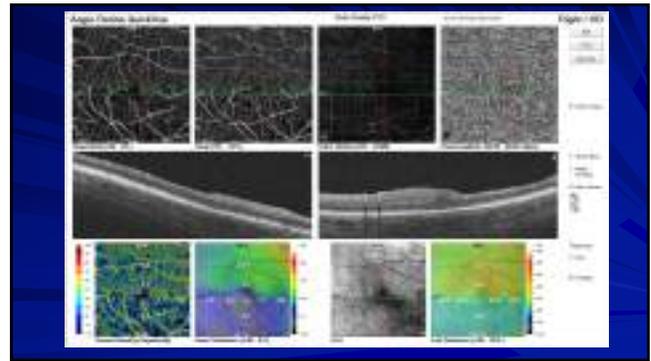
63 year old man

- ~ Complicated ERM surgery OD
  - \* Increased IOP
  - \* Vitreous hemorrhage
- ~ ERM peel 8-16-2018
  - \* My visit 11-20-18
    - IOP 18/13
- ~ Vision 20/20
  - \* But "can not see top part of vision in right eye"
- ~ Patient returned to me because the surgeon said it will take time for vision to return
- ~ OCT and OCT-A reveals the diagnosis and prognosis

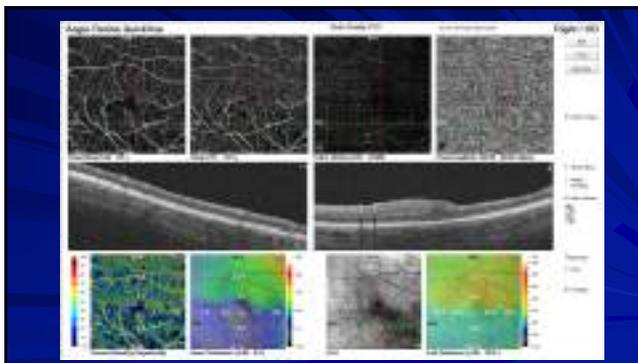
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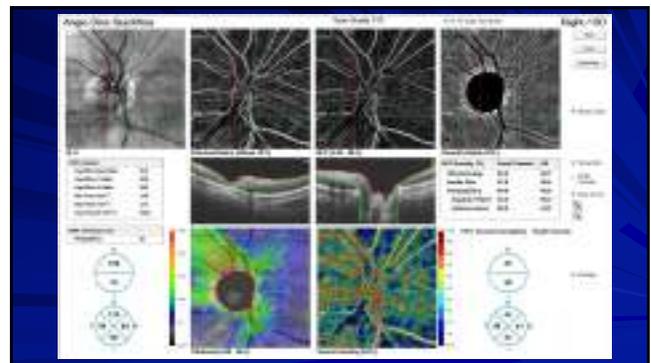
108



109



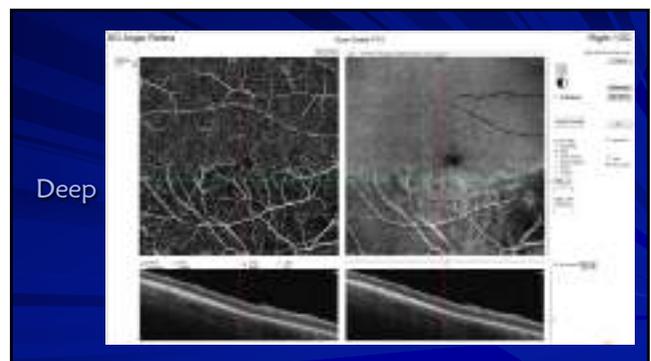
110



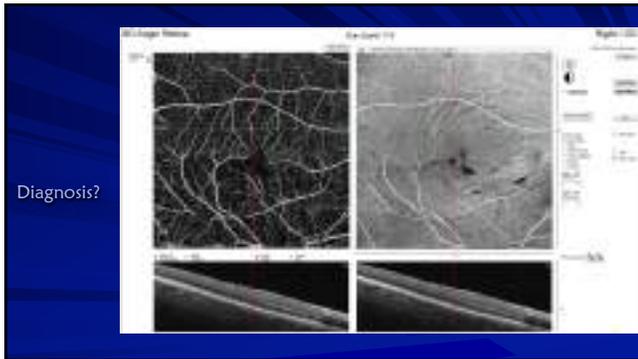
111



112



113



114

69 year old woman

- ~ In for 6 month diabetic check
- \* History of idiopathic juxtafoveal telangiectasia
- ~ BVA OD 20/80 OS 20/40
- ~ Thoughts are the macula changes DM and IJT?
- ~ OCT and OCT-A

115

Central Serous Retinopathy  
(Neurosensory Detachment)

Three fundus photographs showing the characteristic features of central serous retinopathy, including a pale, well-circumscribed area of neurosensory detachment in the macula.

116

Central Serous Retinopathy  
(Neurosensory Detachment)

An OCT scan showing a cross-section of the retina with a prominent, dome-shaped elevation of the neurosensory retina, characteristic of central serous retinopathy. Red arrows point to the detachment.

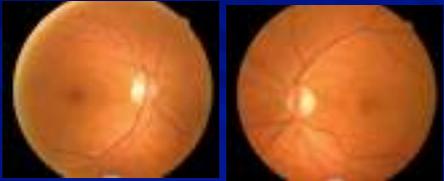
117

46 year old man

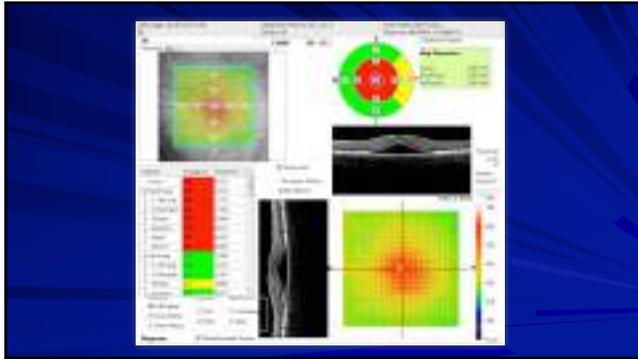
- ~ Complains of a perfect yellow circle in the center of his OS
- ~ The circle stays in the center of his vision even when he moves his eye
- ~ VA 20/20 OU
- ~ Refraction OD Plano OS +1.00 D
- \* Prior visit Plano OU

118

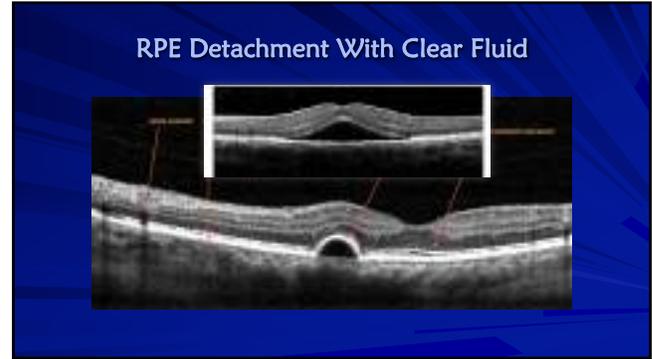
Photos

Two fundus photographs showing a bright, circular lesion in the macula, consistent with the patient's complaint of a yellow circle in the center of his vision.

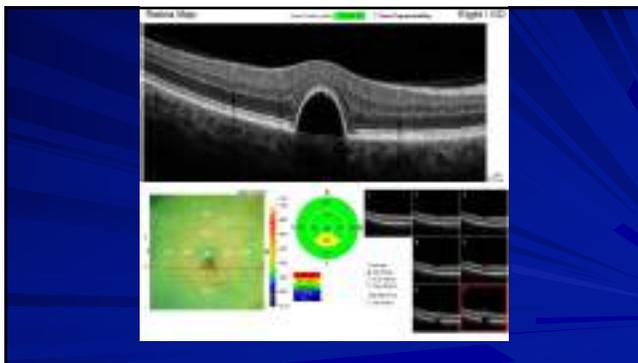
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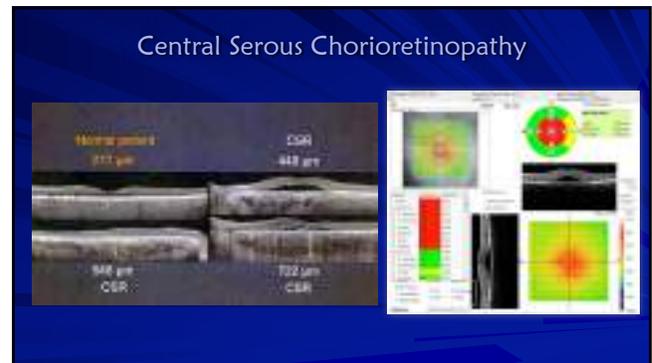
120



121



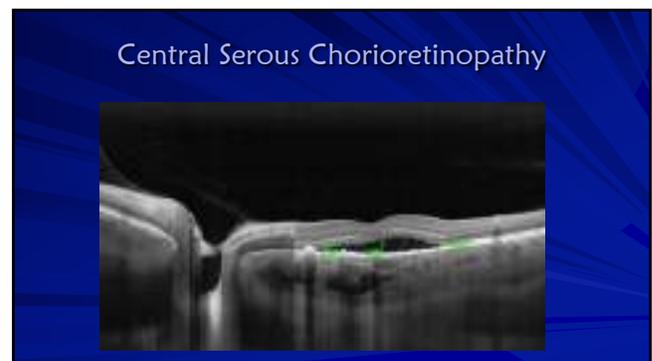
122



123



124



125

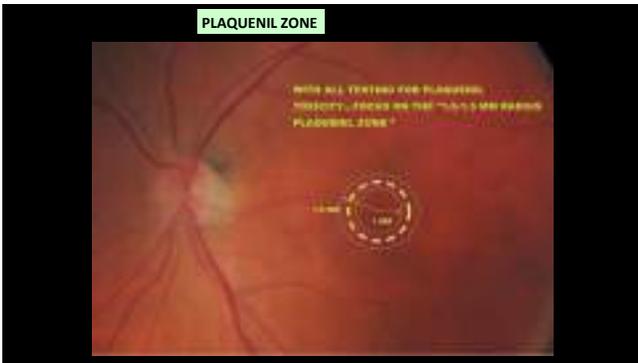


126

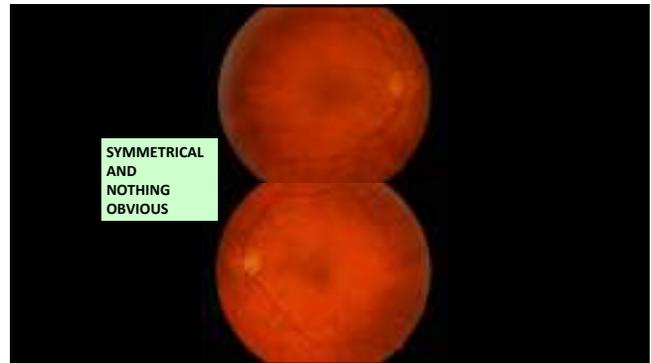
Revised Recommendations on Screening for Chloroquine and Hydroxychloroquine Retinopathy

- Last recommendations were 2002 by the American Academy of Ophthalmology
- Improved screening tools and new knowledge about prevalence of toxicity have prompted the change
  - 1% after 5.7 years of use or a cumulative dose of 1000 mg (Plaquenil)
- 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

127



128

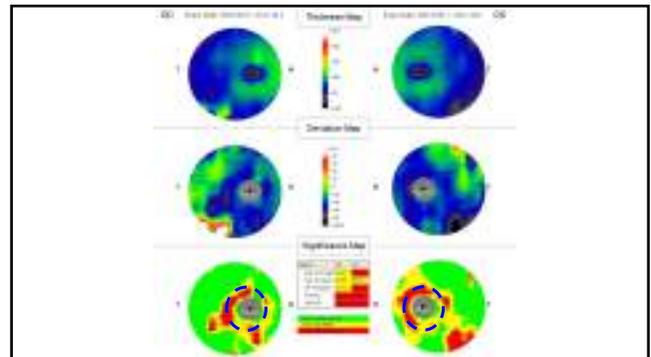


129

**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**

130



131

**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?**

132

**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?**

133

Figure 1 The flying saucer sign representing compromise of the perifoveal retinal tissue with maintenance of the foveal retinal tissue. From Chen S, Brown DM, Bird AC, et al. Spectral domain optical coherence tomography as an effective screening test for foveal/macular retinopathy (The "flying saucer" sign). *City Companion*. 2012; 4(1):1151-1158. Published online 2012 October 23. doi: 10.2147/OPTH.S14202

Along the depression of rising  
perifoveal tissue

thinning of perifoveal tissue

134

AUGUST 2014

135

AUGUST 2014

136

**WHAT DO YOU SEE ON THE SCANS?**

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

137

**WHAT DO YOU SEE ON THE SCANS?**

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

138

BILATERAL COMPROMISE OF THE PIL (WHITE ARROWS)  
 AFTER COLLAPSE OF PERIMACULAR RETINA (RED DASHED  
 ARROWS) WITH FLYING SAUCER ATTACK (BLUE ARROWS)

139

THE END GAME...ONCE YOU DISCONTINUE  
 PLAQUENIL IT STAYS AROUND A WHILE TO  
 CREATE DAMAGE..LONG 1/2 LIFE

WAY OUTTA THE BARN

140

71 yo woman

- ~ With Lupus and hypertension
- ~ Medications:
  - \* Colazapam
  - \* Plaquenil 200 mg BID, 15 years
  - \* 81 mg ASA
  - \* Prednisone
  - \* Losartin
- ~ VA 20/25 OD/OS (mild cataracts)
- ~ Patient was told to see an ophthalmologist in 2013

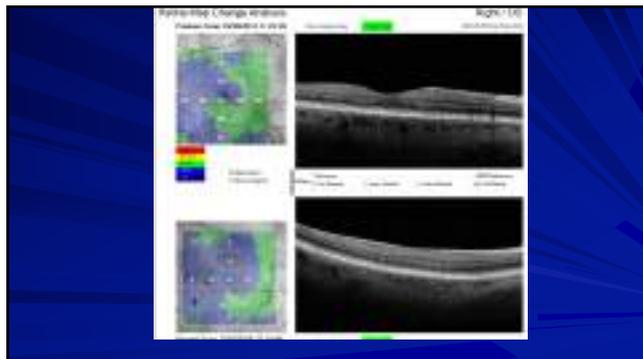
141

2016

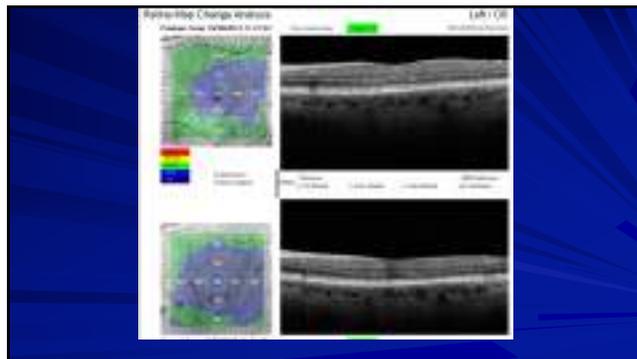
142

2016

143



144



145

Hope You Enjoyed  
Thank You!

Greg

146