Course Title:

OCT: The Optometrist's MREye

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Financial Disclosures

- No financial disclosures

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Optical Coherence Tomography-OCT

- Has changed the way the eye is examined & treated.
- Has revolutionized the diagnosis & therapy of eye disease.
- Allows for earlier and more sensitive diagnosis.
- Allows for better understanding of disease mechanisms

- So how did we get here?

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OCT timeline

- 1991 James Fujimoto at MIT
- Original research instrument 400 A-scans / second
- Current SD-OCT: around 27,000 to 50,000 A-scans / sec
- Current Swept Source-OCT up to 249,000 A-scans / sec. Commercial units about 100,000 per second
- OCT angiography

- First commercial OCT sold in 1996
- Now 8 commercial manufacturers of OCT's

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OCT timeline

- Time Domain……then…..
- Spectral Domain……now….
- Swept Source and OCT dyeless angiography

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Swept Source OCT

- Twice as fast (twice as many A-scans / second) as SD OCT
- Allows for wide field imaging (12mm vs. 6-9 mm). Easily gets ONH and macula in the same scan
- Longer wavelength of light, so can image much more effectively through media opacities, and penetrates much better into the choroid (2.6 mm depth vs. 2.3mm)

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OCT

- *in vivo* histology
- Working mechanism: similar to B scan (optical vs. acoustic reflectivity) but uses infrared light
- Resolution:3-5 microns with SD and SS technology
- Different optical reflectivity in various tissue structures: false color map. Often best to view in black and white for fine detail

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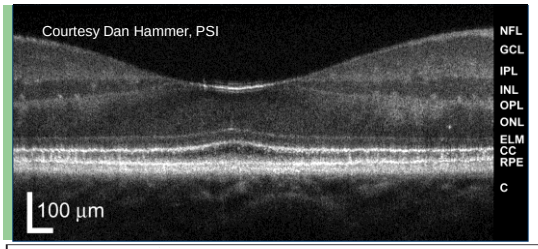

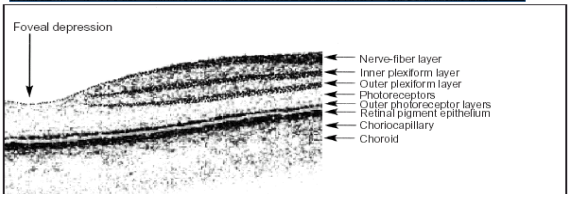

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Image quality

- Poor signal strength equates to unreliable readings, only use 7 and above
- Images and reliability can be negatively impacted by media opacities, high myopia, patient movement, highly abnormal disc sizes, and segmentation errors (very important!)
- Beware “red disease”
- Average RNFL loss of about 1 micron / year

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Signal Quality

Cirrus OCT (Zeiss)	Signal Strength	≥ 6
Spectralis (Heidelberg)	Quality Score	≥ 20
RTVue (Optovue)	Signal Strength Index	≥ 30

Tip – Low signal strength leads to artifactual thinning of RNFL

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Importance of normative database

- Typically take demographic factors into account, but not refractive error. This can be very important with high myopes, who will have thinner NFL than their counterparts with equal demographics
- Composition of normative database also very important

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Cirrus normative database for example

- 284 individuals
- Age 18 to 84
- Refractive error +8.00 to -12:00
- 43% Caucasian
- 24% Asian
- 18% African American
- 12% Hispanic
- 1% Indian
- Small amount of others combined

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Normative Databases

	Visionix RTVue Avanti	Zeiss Cirrus	Spectralis-Glaucoma Module Premium Edition
Study Sites	6 USA 3 Japan 1 India 1 England	6 USA 1 China	Not Reported
# of Subjects	480	284	330
Subject Ethnicity	Caucasian- 34% Asian- 22% African Decent- 19% Hispanic- 12% Indian/ Middle East- 12%	Caucasian- 43% Asian- 24% African Decent- 18% Hispanic- 12% Indian/ Middle East- 1%	Caucasian- 66% Asian- 7% African Decent- 12% Hispanic- 14%
Subject Age (years)	18-84	19-84	20-90
Subject Refraction	+8D- -8D	+8D- -12D	+6D- -6D

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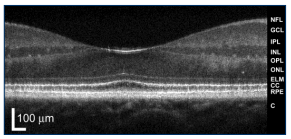
PIL / Ellipsoid zone

Very important!

- Line seen at junction of inner and outer segments of the photoreceptors
- Extremely useful for evaluating disease state and visual potential



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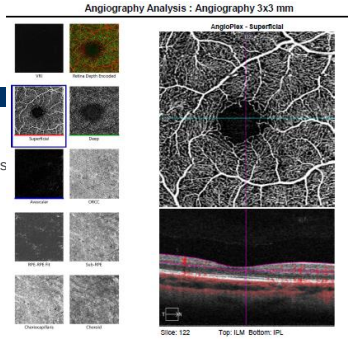
OCTA

- Enface "slices"
- Most important:
  - Superficial capillary plexus
  - Deep capillary plexus
  - Avascular zone
  - Choriocapillaris
- 3X3 vs 6X6 vs 8X8 vs 12X12 (trade detail for FOV)



SCHOOL OF OPTOMETRY

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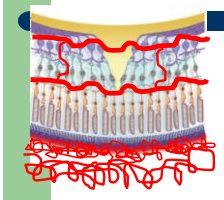

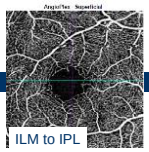

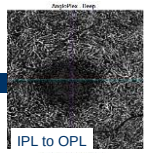

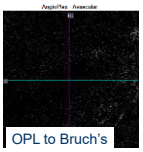

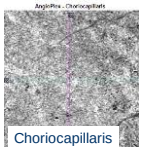

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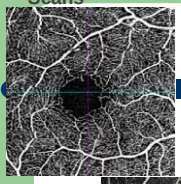
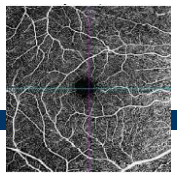
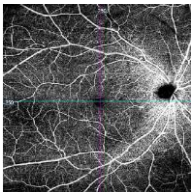
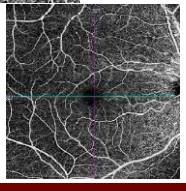
Scans









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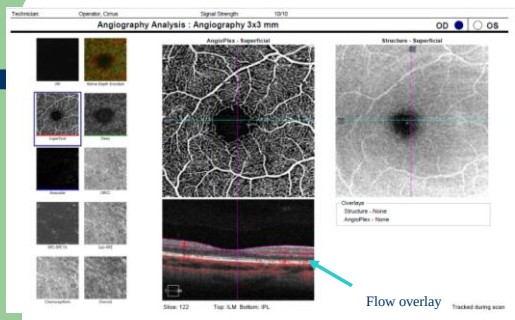

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What is OCTA really good for?

– Inner Retina • Outer Retina • Optic Nerve Head

- Diabetes
- Vein Occlusions
- Mac Tel
- Sickle Cell
- Hypertension
- Coats

- CSCR
- AMD
- CNVM due to other causes (myopia / histo / trauma)
- Some dystrophies can develop CNV (Bests, etc.)

- Neovascularization of the Disc
- NAION
- Glaucoma

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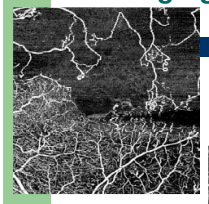
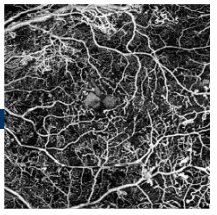
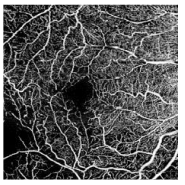
OCT angiography



Vein occlusion



PDR



NPDR

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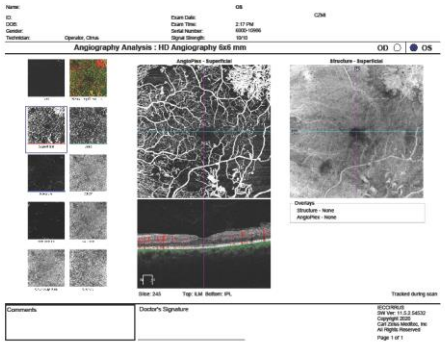
PDR



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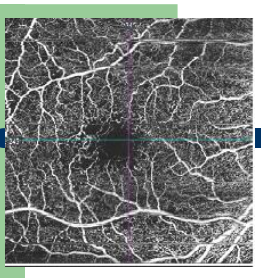
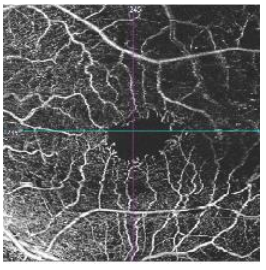


Irregular FAZ with MA's



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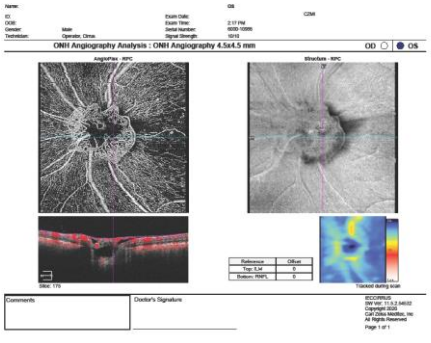

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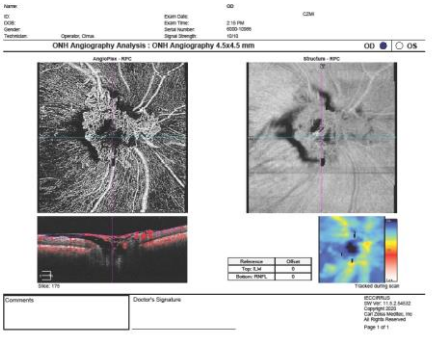

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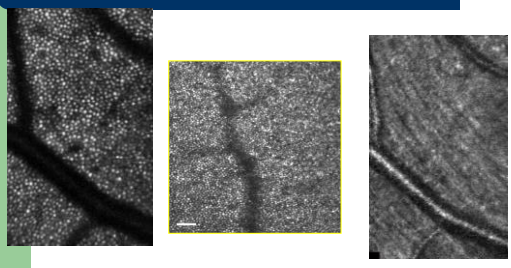
Adaptive Optics (Images courtesy of Dr. Steve Burns)



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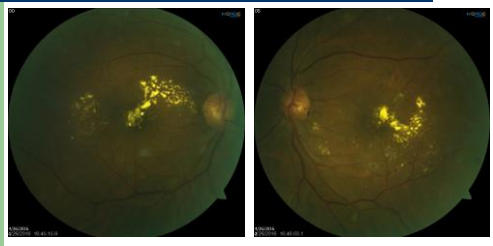
Diabetic Macular edema



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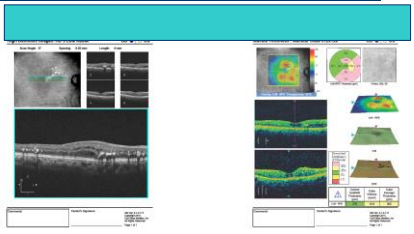
Diabetic Macular edema



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RP WITH CME

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RP WITH CME OCT

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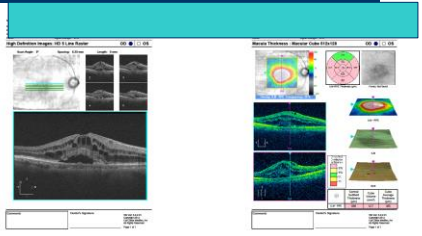
Post-op CME



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Vitreoretinal Interface Disorders

- Idiopathic Epiretinal Membrane
- Vitreomacular Traction Syndrome
- Idiopathic Macular Hole
- Full thickness Macular Hole

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Macular hole sizes (full thickness)

- Small <= 250 microns
- Medium 250-400 microns
- Large 400-550 microns
- XL 550-800
- XXL 800-1000
- Giant over 1000
- “CLOSE” study
- Horizontal diameter at narrowest point

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New grading system

- VMA with no change in foveal contour: Stage 0
- VMT with disruption of foveal contour: Stage 1
- VMT with small or medium FT hole: Stage 2
- VMT with medium or large full thickness hole: Stage 3
- Any full thickness hole without VMT: stage 4
- Lamellar hole
- Psuedohole from ERM

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VAST study : How common is VMA / VMT?

- 1950 eyes
- Age 40-89 years
- Phakic
- No pre-existing maculopathy
- No history of vitrectomy or Jetrea
- VMA prevalence of 39%
- VMT prevalence of 1%
- Most common in 40’s and 50’s, then decreases with age (25% VMA & 2% VMT over age 63)

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VAST study

- Not significantly associated with sex, refractive error, or visual acuity status
- AA 55% less than Caucasians

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ERM

- Membranous growth of glial cells on retina surface
- Can be asymptomatic or very bothersome
- Metamorphopsia is common
- More common after PVD
- Tractional macular holes, cysts, CME, neurosensory RD’s; retinal and choroidal folds, etc.

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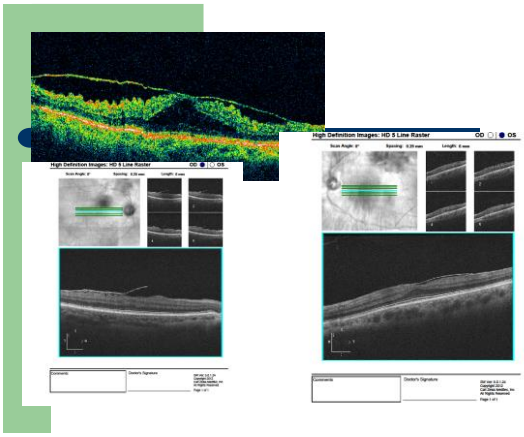

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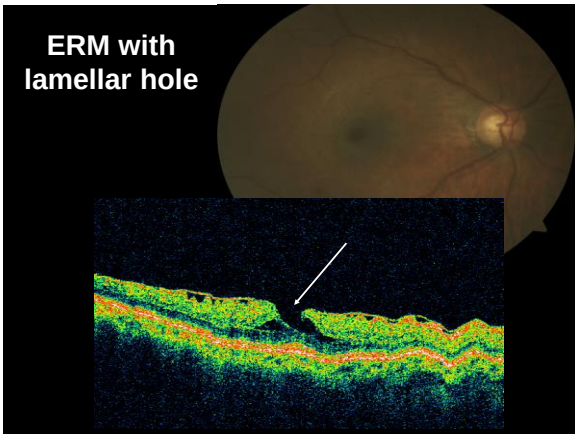

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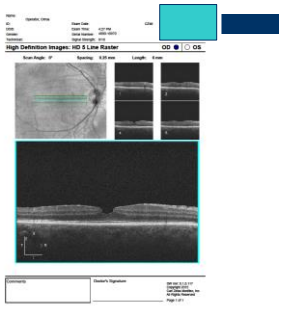
ERM with pseudohole



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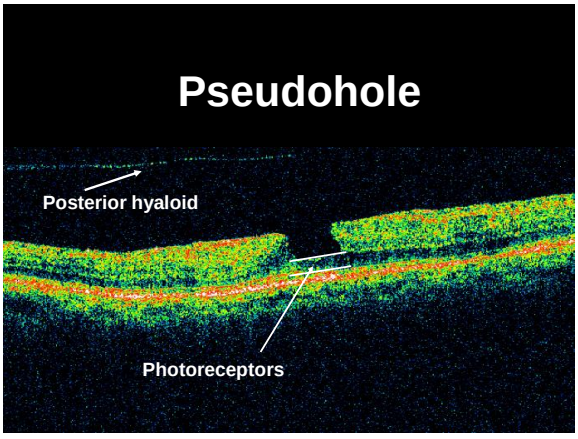

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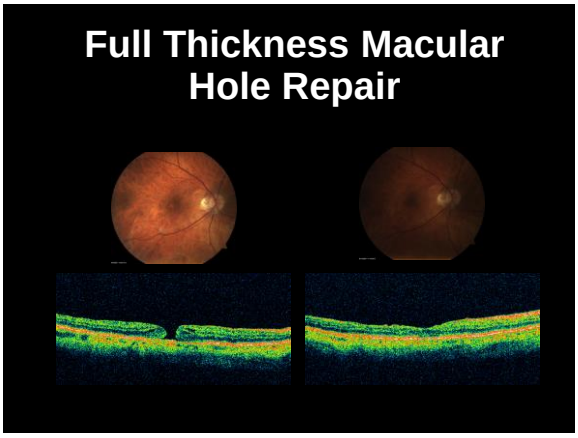

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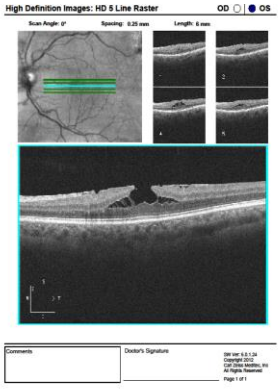
20/25!

- ERM / schisis



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ERM with schisis

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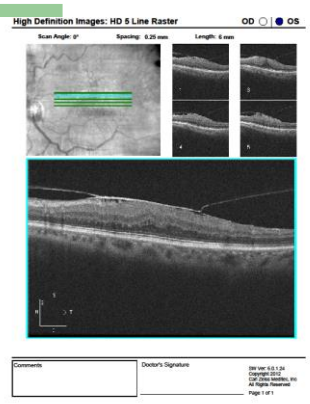

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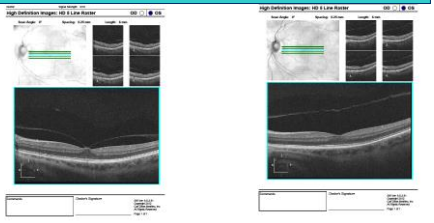
VFTS spontaneous resolution after 3 months



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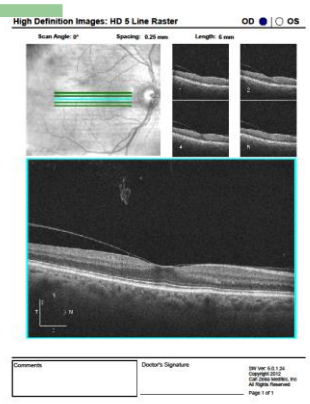

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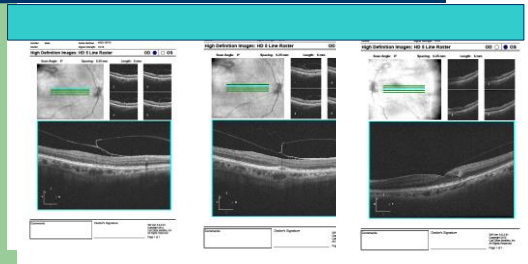
VMA on an ERM



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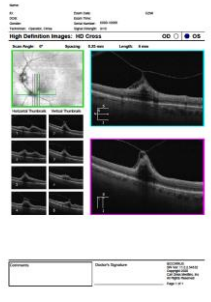
Vitreal adhesion on ERM



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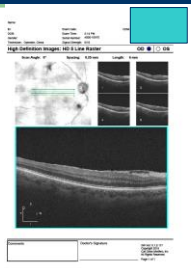
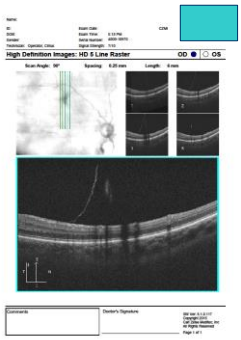
PVD pulling ERM





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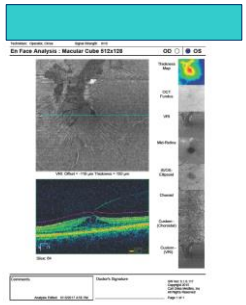
VMA / ERM enface



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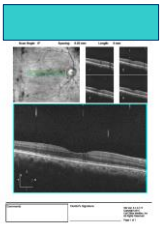
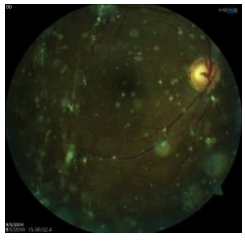
Asteroid Hyalosis





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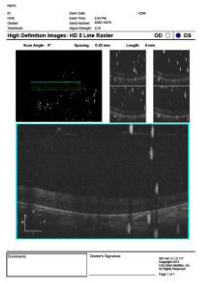
Asteriod Hyalosis Nanophthalmos



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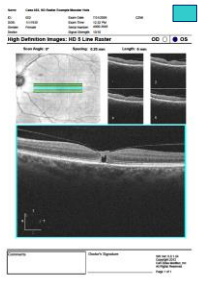
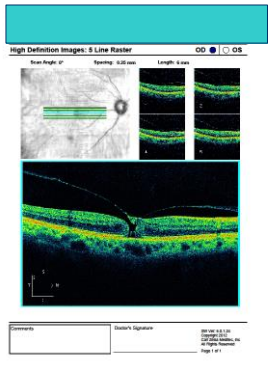
VFTS





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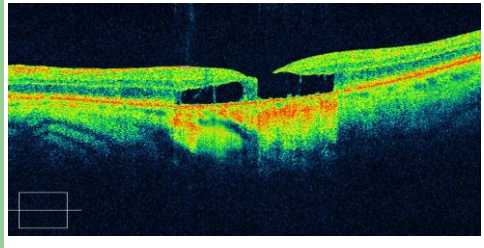
Full Thickness Macular Hole



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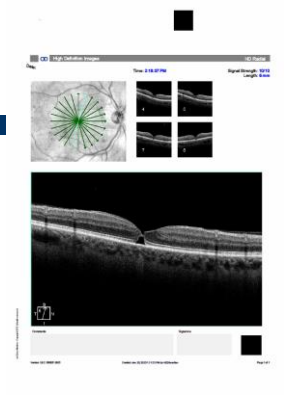
Macular hole



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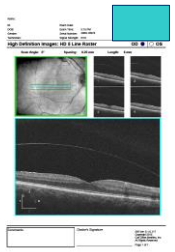
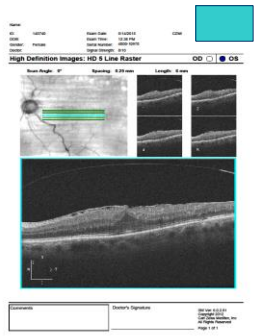
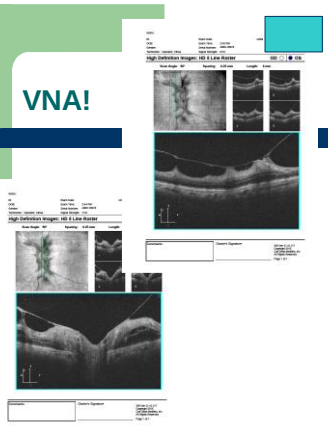
Anti-VMA!

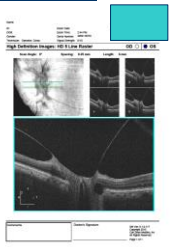




56

VNA!



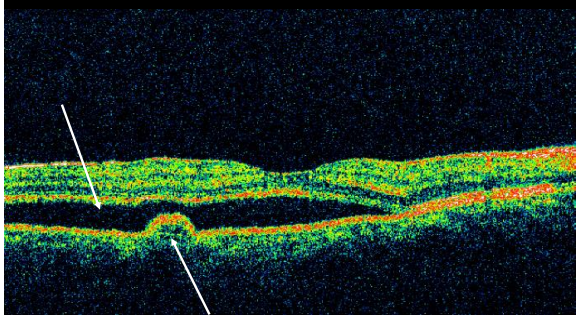


57

Central Serous Retinopathy

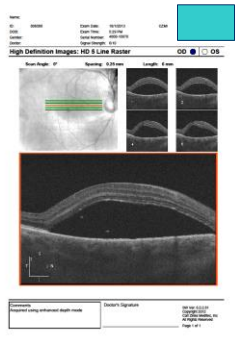
58

CSR with PED



59

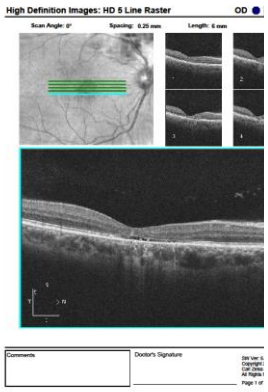
CSR



60

Old CSR

- ICSC has abnormally thick choroid on SD OCT EDI: Normal is 320 microns when young, 230 @ 50, 160 @ 70
- One of the pachychoroid diseases



61

Pachychoroid diseases

Image courtesy of Dr. Sherrol Reynolds

- All share attenuated choriocapillaris, dilated choroidal veins, thickened choroid ,RPE dysfunction, and potential for CNV
- Pachychoroid Pigment Epitheliopathy
- CSCR
- Peripapillary Pachychoroid
- Polypoidal Choroidal Vasculopathy
- Focal Choroidal Excavation

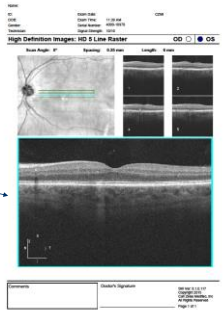
62

Pachychoroid pigment epitheliopathy

63

Pachychoroid pigment epitheliopathy

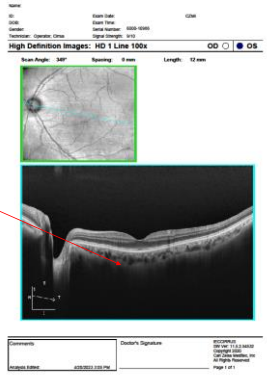
Choroidal-scleral junction



64

HD 100X line

- Choriod-sclera junction



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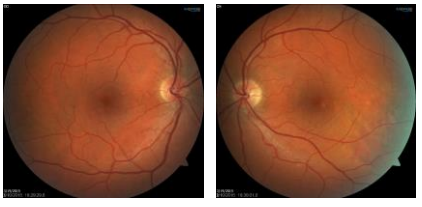
CSR FAF



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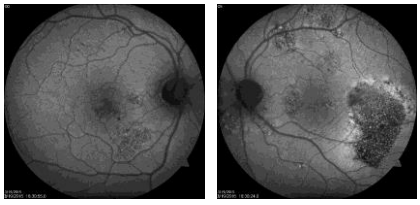
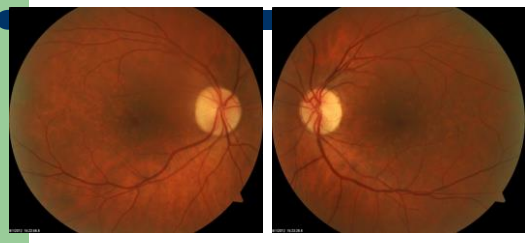
CSR FAF



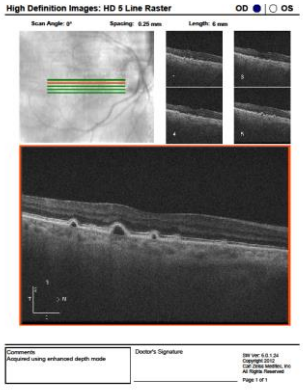
67

“drops of water on a windshield”



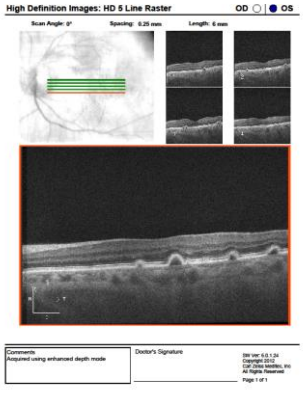
68

SD-OCT



69

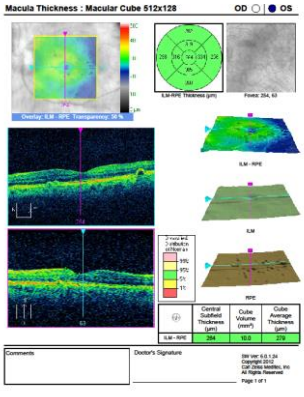
SD-OCT



70

SD-OCT

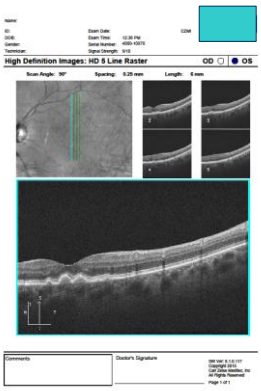
- Idiopathic Multiple PED Syndrome



71

Macular Degeneration

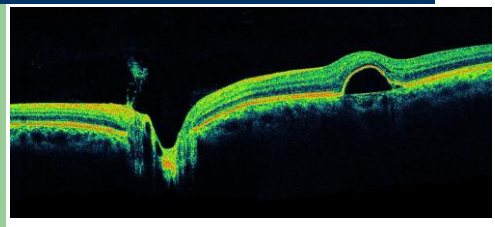
72



AMD Drusen

73

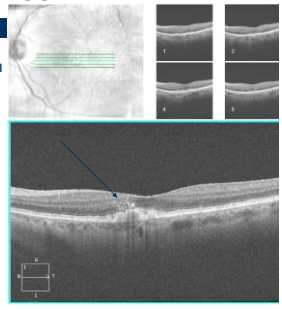
PED



74

Hyper-reflective foci

- Dot shaped intraretinal lesions at the apex of drusen
- Often correspond to focal hyperpigmentation
- Start in the outer retina and migrate inward
- Likely represent pigment granules
- Ancillary AREDS II OCT study showed them to be associated with a 5X risk of geographic AMD in two years. No extra risk of CNV

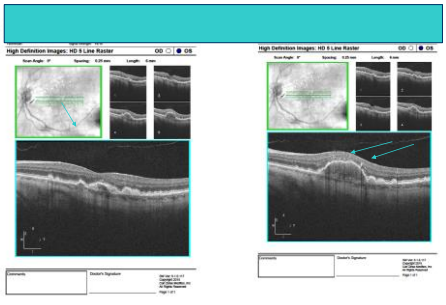


75

Hyper-reflective foci

76

Hyper-reflective foci



77

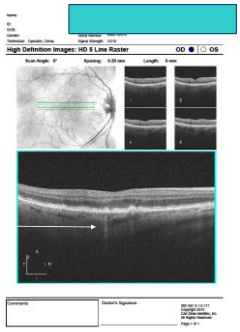
Nascent geographic atrophy

- Thinning of the OPL and INL with a hyporeflective wedge
- No photoreceptor or RPE loss
- Strongly associated with impending GA
- No extra risk of CNV

78

Sub-RPE hyper-reflective columns

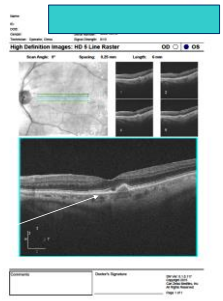
- Increased transmission of signal columns beneath the RPE (hyper-reflective)
- Overlying RPE appears intact
- May represent fine cracks in the RPE
- Opposite appearance of shadows cast by retinal blood vessels
- Extra risk of geographic disease and CNV



79

Drusen with subretinal fluid without evident CNV

- Subretinal fluid pockets around drusen
- Fluid does not extend higher than the peaks of the drusen
- No CNV on advanced testing (IVFA, ICG, OCTA)
- May be subclinical CNV or mechanical strain
- Increased risk of CNV

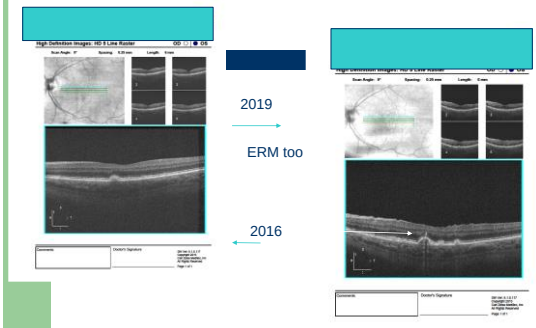


80

Drusen substructures

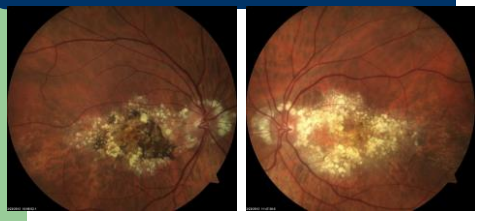
- Non-homogeneous internal reflectivity of soft drusen
- All look the same on examination / photos, but have differing OCT reflectivity
- May precede drusen regression
- Increased risk of GA but not CNV

81



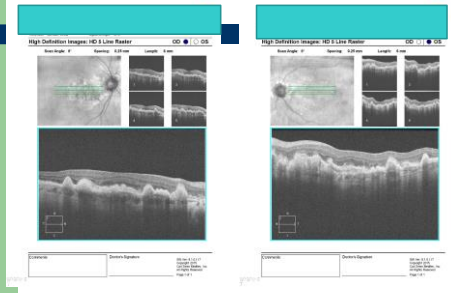
82

Doyne's Honeycomb dystrophy



83

Doyne's OCT

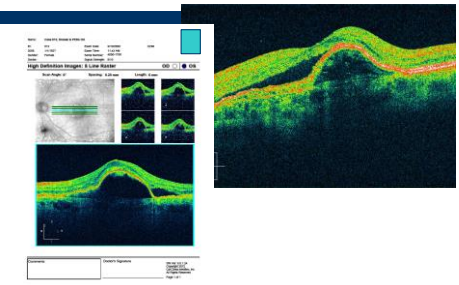


84

Another Doyne's Patient

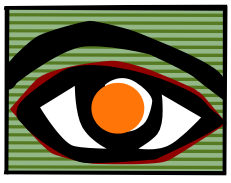
85

Subretinal fluid?



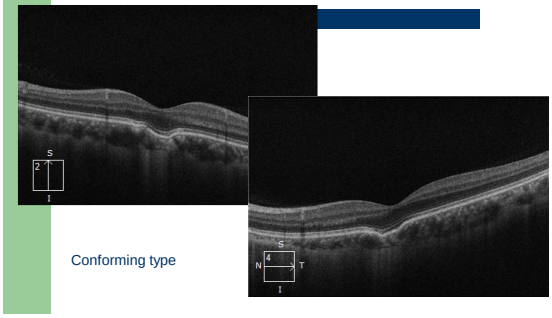
86

Miscellaneous Retinal Conditions



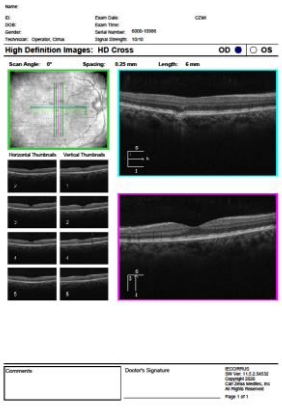
87

Focal choroidal excavation



Conforming type

88

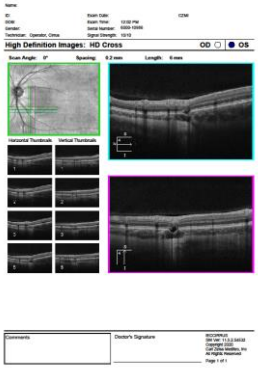


FCE

Conforming type

89

FCE



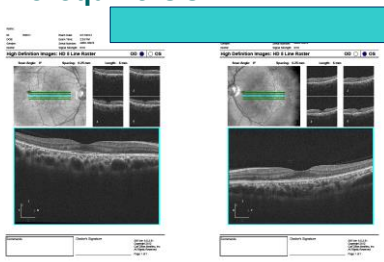
Non-conforming type

90

Chloroquine maculopathy

91

Chloroquine OCT

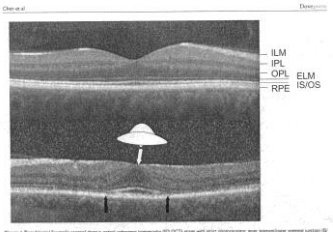


92

Plaquenil toxicity OCT

93

Plaquenil toxicity: Flying Saucer Sign



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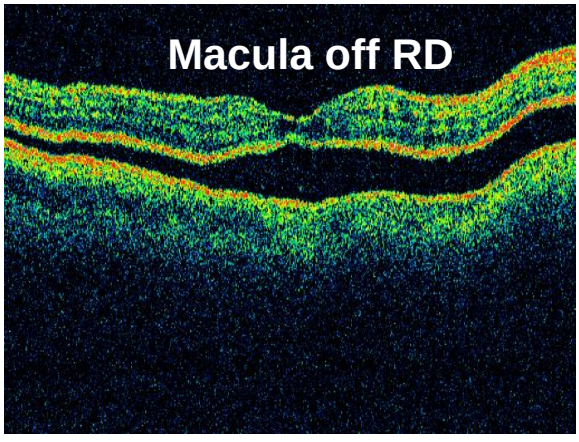
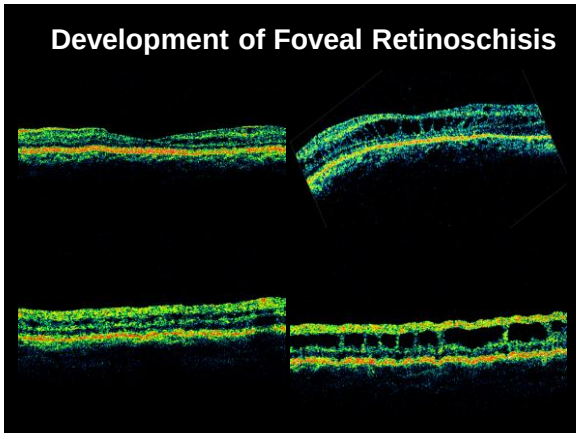


95

Fovea splitting RD

96



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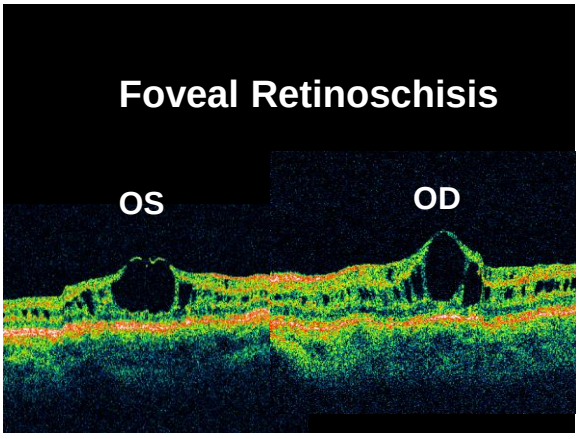

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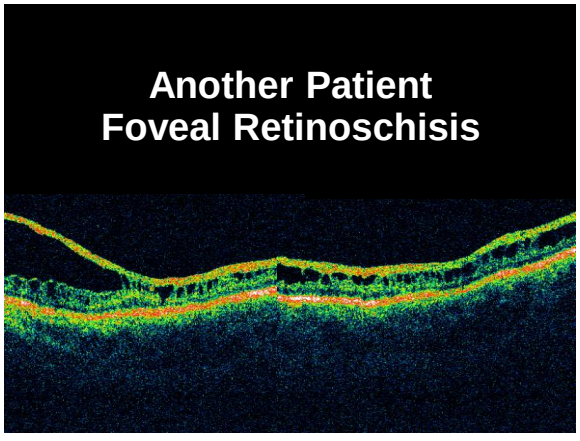

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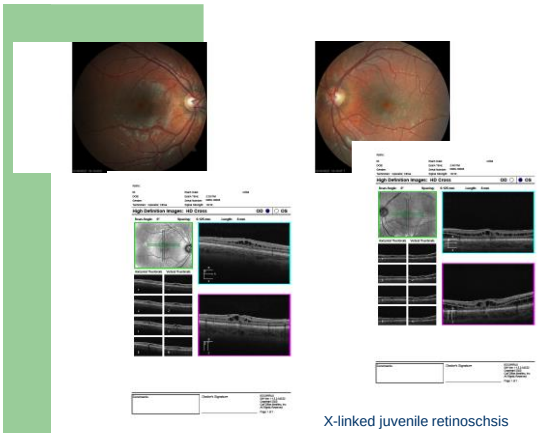
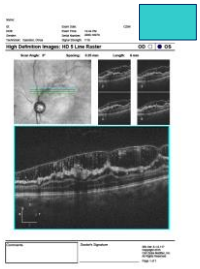


100

101

102

Mystery schisis case 2

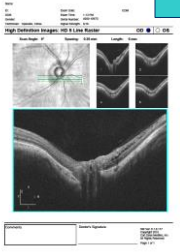


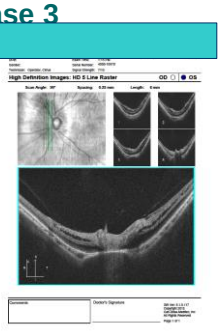
103

Mystery schisis case 3

104

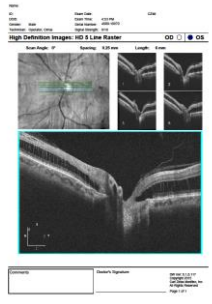
Mystery schisis case 3

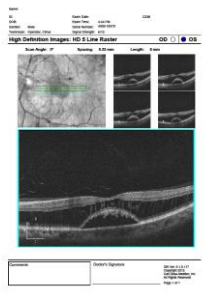




105

Mystery schisis case 4





106

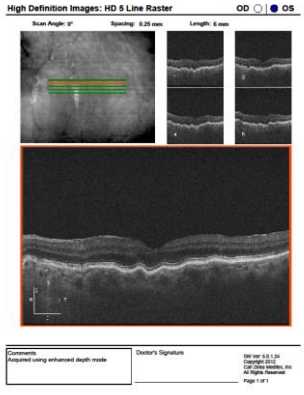
Peripapillary retinoschisis

- Underappreciated
- 3-5 % of glaucoma patients
- Macula rarely involved
- Can have a visible laminar pit or not
- Can be affected by IOP
- Can affect RNFL readings
- Can resolve
- Also seen in .5% or so of normal
- Seems not to affect VF

107

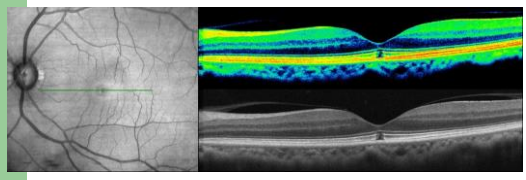
hypotony

- Choroidal Folds



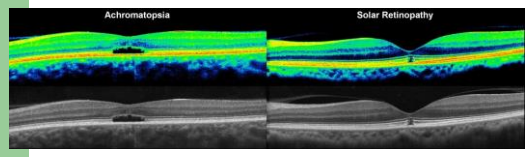
108

Solar maculopathy (images courtesy Dr. Jerome Sherman)



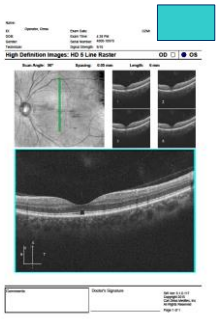
109

Solar maculopathy vs. Achromatopsia



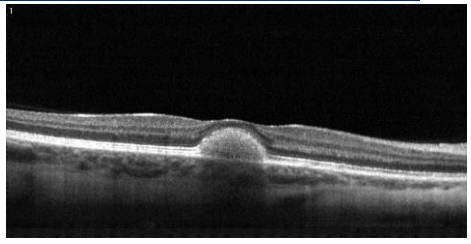
110

Solar maculopthy



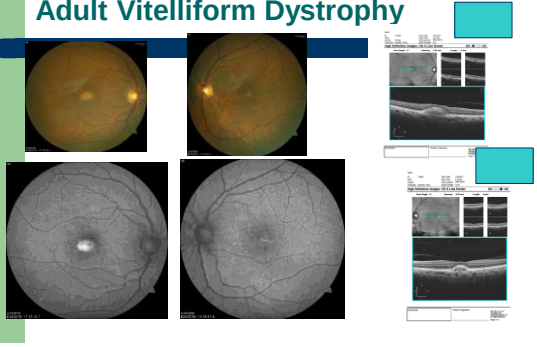
111

Best's dystrophy



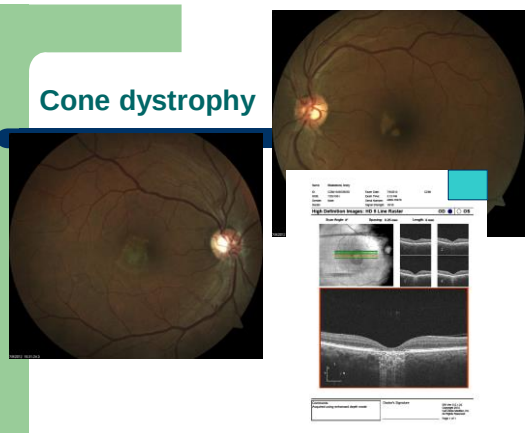
112

Adult Vitelliform Dystrophy



113

Cone dystrophy



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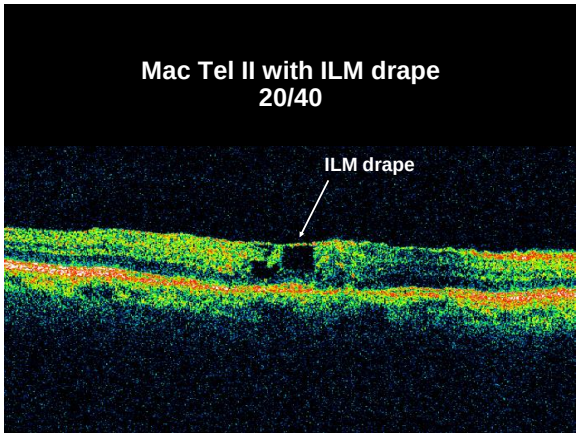
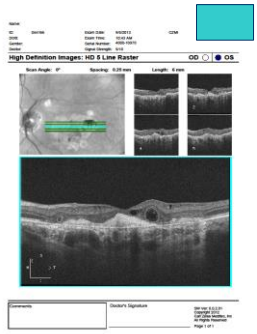


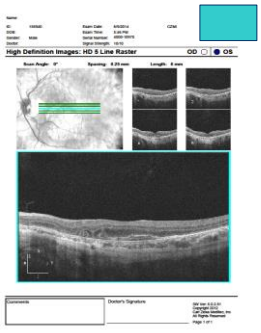
115

ORT's



116

ORT's



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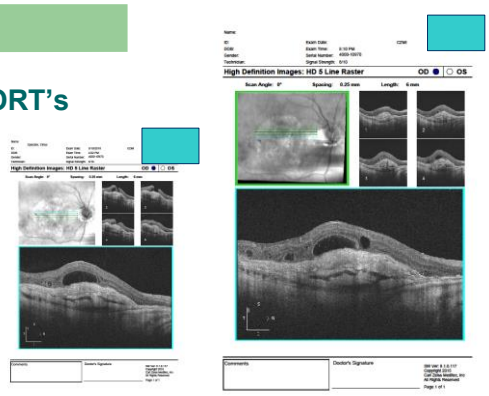

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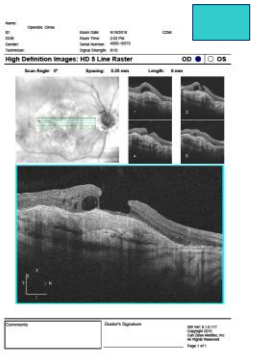
ORT's



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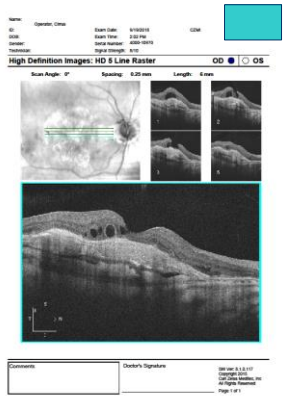
ORT's



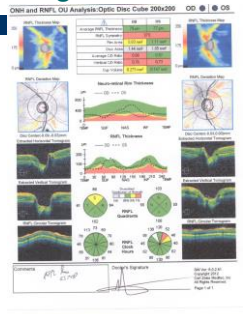
120

Optic nerve head and glaucoma

Granule Cell

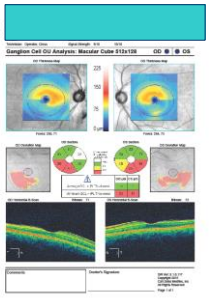
121

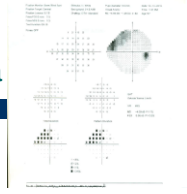
RNFL analysis with glaucoma

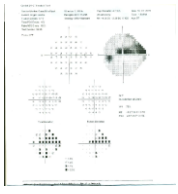


122

GCC loss in glaucoma

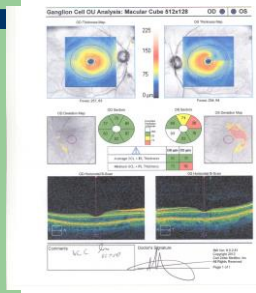


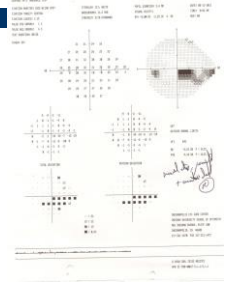




123

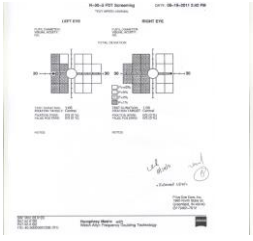
GCC and VF Loss comparison

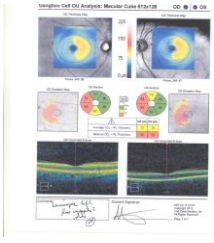




124

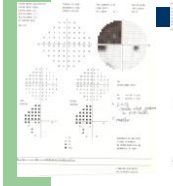
Stroke and GCC loss

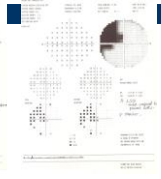


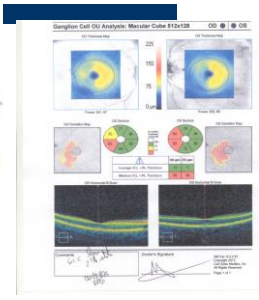


125

Stroke and GCC loss

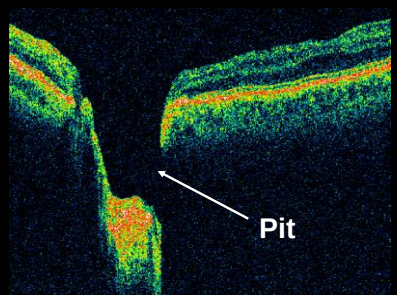






126

Optic Nerve Pit



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ONH Colobomas

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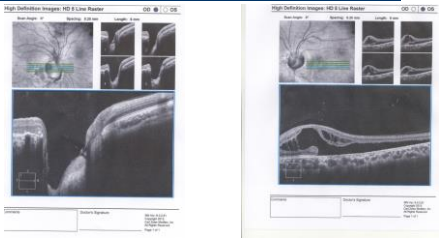
ONH Coloboma OCT



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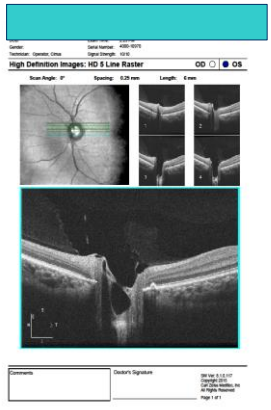
PARTIAL PVD



130

Papilledema- IIH

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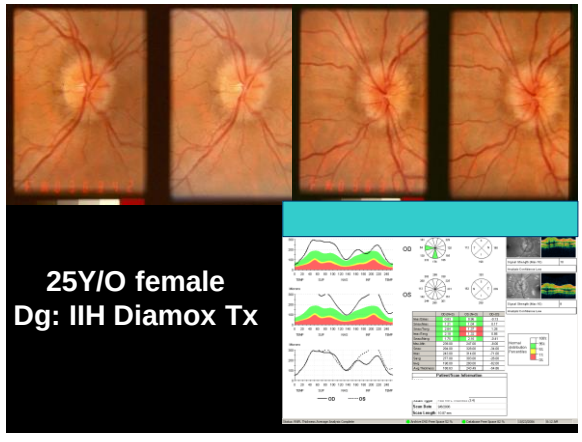

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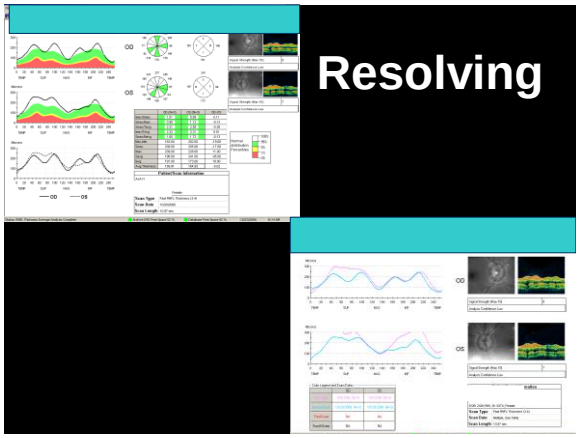
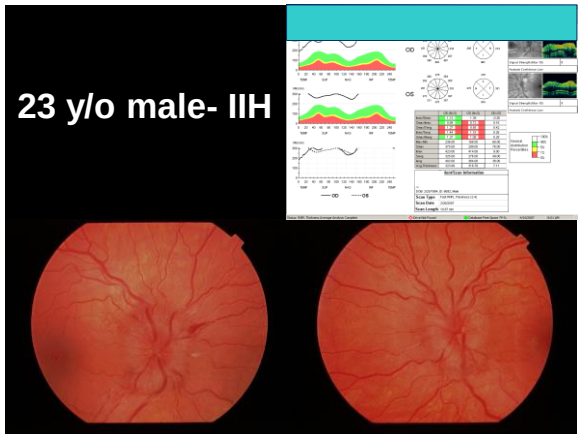


133



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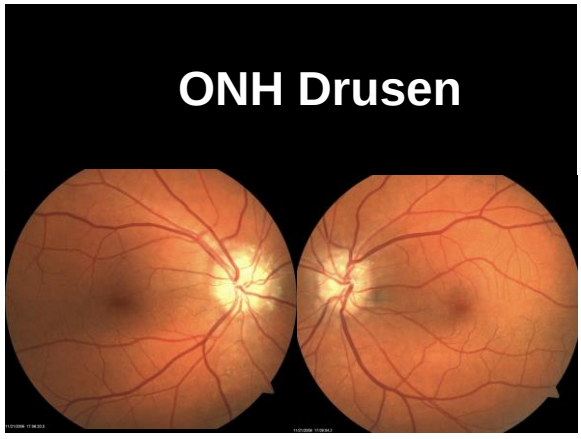

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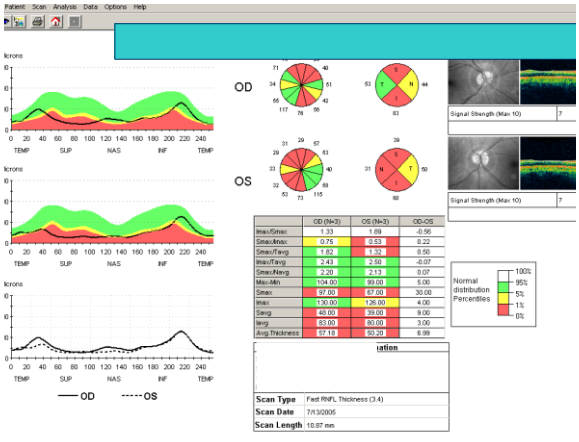

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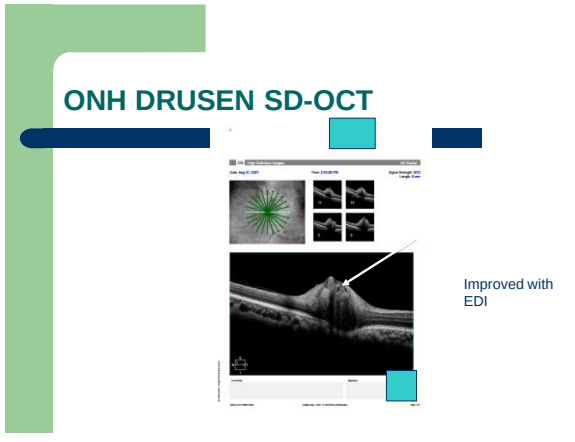

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ONH drusen detection with OCT

- Optic Disc Drusen Consortium Consensus……
- Always use EDI
- Blood vessels are more solid, cast a shadow, and can show as figure 8
- Drusen always prelaminar
- Drusen always hyporeflective
- Drusen often have a hyperfrelective border, especially superiorly

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ONH drusen detection with OCT

- Drusen can conglomerate, and these areas can have some internal reflectivity from borders

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Peripapillary Hyper-reflective Ovoid Mass-like structures (PHOMS)

- “Fomms”
- Seen best with EDI
- Only seen with OCT, nothing else
- Circular innertube like structure around the disc above Bruch’s membrane
- Herniated optic nerve fibers
- Seen in any condition that leads to nerve swelling or congestion
- ION, papilledema, disc drusen

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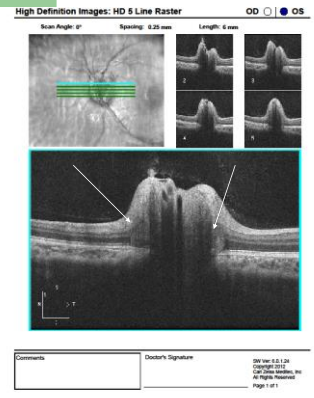
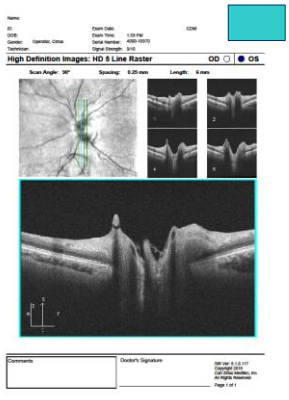


142

Candle neuropathy



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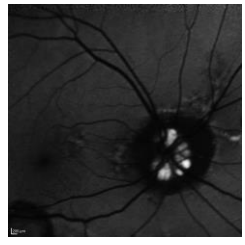
ONH drusen B-scan and FAF



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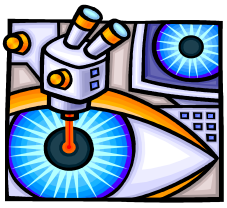
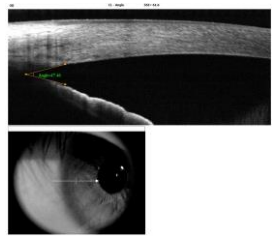
Anterior Segment OCT

- Many units available with anterior segment capability



145

Angle



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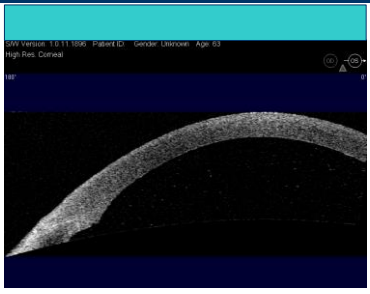
Cells in A/C



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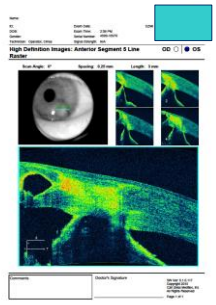
Glass FB and PAS



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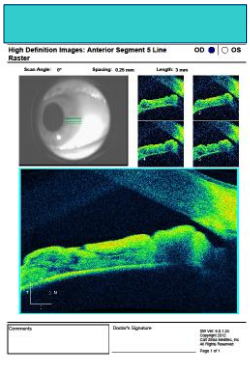

Plateau Iris

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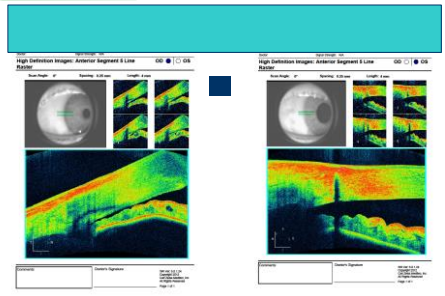

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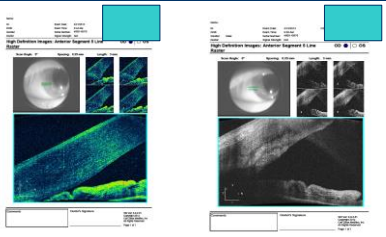
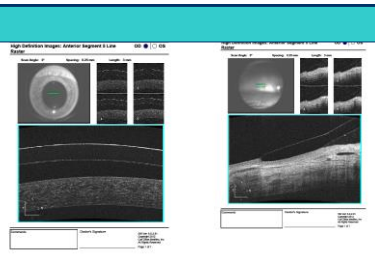
Wound leak with choroidals flat chamber



151

Scleral lens



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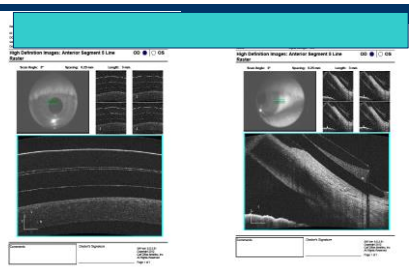
Two for the price of one!



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THE END!

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