

Imaging Interpretation for the Comprehensive Eye Care Professional

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Glaucoma Statistics

- High percent of undiagnosed cases
 - Over 50% of open-angle glaucoma cases in the USA
 - Many undiagnosed patients have undergone prior eye exams
- Worsening problem as the proportion of older Americans increases
 - January 22nd, 2016: Project blindness projects significant increase in glaucoma
 - By 2032 there will be a 50% increase in glaucoma cases



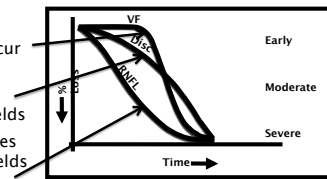
Challenges of Glaucoma

- Risk factors are not widely known among patients
 - Many do not know it runs in families or is more common in African and Hispanic ancestry
- The structural changes in early glaucoma can be difficult to distinguish
 - Wide variation of optic disc size in both normal and glaucoma patients
- Patients can't tell that they have it
 - Most do not notice loss of function until they are nearly blind



Structural / Functional Relationship in Glaucoma as the Disease Progresses

- Visual Field changes occur late in the disease
- The Optic disc often changes before visual fields
- The RNFL usually changes before both the visual fields and optic disc



Glaucoma Progression

- “Once the diagnosis of glaucoma has been made, the **MOST IMPORTANT** remaining question is whether the disease is stable and the therapy/compliance are sufficient, or whether the disease is progressive and the therapy in relation to the life expectancy has to be intensified.”

Progression of Glaucoma, World Glaucoma Association, 2011 Kugler Publications



Progression of Glaucoma

“Although most glaucoma patients will show some evidence of progression if followed long enough, the rate of deterioration can be highly variable among them. While most patients progress slowly, others have aggressive disease with fast deterioration which can eventually result in blindness or substantial impairment unless appropriate interventions take place”



WGA Consensus Statements on Structure & Function

- Both ON structure *and* function should be evaluated for detection of progression
- Currently, no specific test can be regarded as the perfect standard for determination of progression
- Progression detected by functional means will not always be corroborated using structural tests, and vice-versa



WGA Consensus Statements

- A statistically significant change in structure and/or function is not always clinically relevant.
- Life expectancy should be considered when evaluating the clinical relevance of a structural and/or functional change in glaucoma.
- Structural and/or functional testing should be conducted throughout the duration of the disease.
 - Detection of progression is more difficult in eyes with advanced disease



Detection & Measurement of Change (Structure & Function)

- **Event Analysis (EA):** change that exceeds a certain predefined threshold compared to the baseline value; generally determined by measurement reproducibility
- **Trend Analysis:** change over a designated time period using regression analysis. Generally takes more exams to obtain a reliable slope



Structural Changes - WGA

- The agreement for progression among ONH, RNFL, and macular parameters is poor
- The rates of change vary considering within and between glaucoma patients
- Differences in technologies and scan protocols could influence the detection of progression



Clinical Exam of the Optic Nerve Head Utility and Limitations

- Disc exam at the first visit – normal or abnormal?
 - Disc exams are subjective, or at best semi-quantitative
 - The wide variety of disc appearances requires long experience and expert judgment to separate normal from abnormal
 - Disc diameter must be taken into account

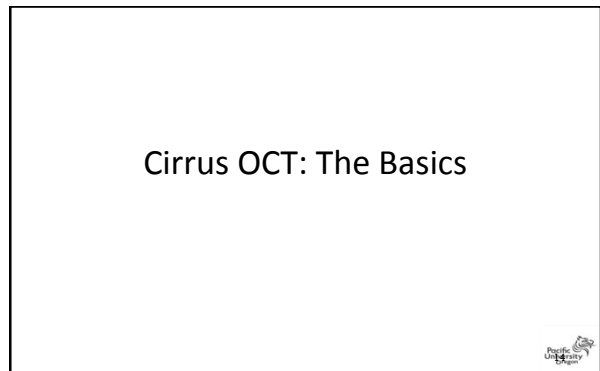
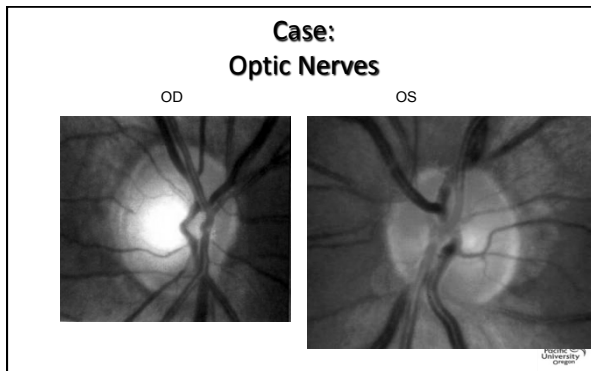


Case

72 year old glaucoma suspect
 Cup-to-disc ratio asymmetry
 Highest untreated IOP 24 mm Hg OU
 Anterior chamber angles open OU
 Clear visual fields

- Central corneal thickness
 - 533 microns OD
 - 545 microns OS
- No prior ocular history or surgery
- No family history of glaucoma
- Good general health except for elevated cholesterol





Cirrus RNFL Analysis

OPTIC DISC CUBE SCAN
The 6mm x 6mm cube is captured with 200 A-scans per B-scan, 200 B-scans.

CALCULATION CIRCLE
AutoCenter™ function automatically centers the 1.73mm radius peripapillary calculation circle around the disc for precise placement and repeatable registration.

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RNFL/ONH Analysis

RNFL THICKNESS MAP shows the patterns and thickness of the nerve fiber layer within the full 6mm x 6mm area

ONH Analysis: rim/disc area, average C/D ratio, vertical C/D ratio and cup volume

RNFL DEVIATION MAP, overlaid on the OCT fundus image, illustrates precisely where RNFL thickness deviates from the normal range. Data points that are not within normal limits are indicated in red and yellow.

RNFL THICKNESS AND COMPARISON TO NORMATIVE DATABASE is shown in circle, quadrants and clock hour display

RNFL THICKNESS along the calculation circle is displayed in graphic format and compared to age-matched normative data

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Cirrus RNFL and ONH Analysis Elements

	OD	OS
Average RNFL Thickness	73 µm	61 µm
RNFL, Symmetry	90%	
Rim Area	1.12 mm ²	0.72 mm ²
Disc Area	1.58 mm ²	1.72 mm ²
Average C/D Ratio	0.53	0.75
Vertical C/D Ratio	0.69	0.77
Cup Volume	0.636 mm ³	0.220 mm ³

Optic Nerve Head calculations are presented in a combined report with RNFL thickness data. Key parameters are compared to normative data and displayed in table format

RNFL Thickness

- RNFL Peripapillary Thickness profile, OU
- compared to normative data

Neuro-retinal Rim Thickness

Neuro-retinal Rim Thickness profile, OU - compared to normative data

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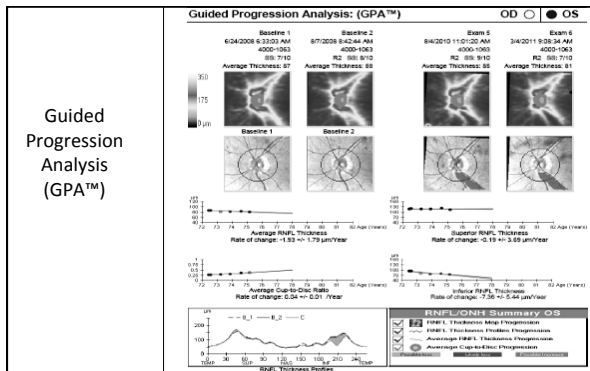
Cirrus HD-OCT GPA Analysis

Image Progression Map

- Two baseline exams are required
- Third exam is compared to the two baseline exams
 - Sub pixel map demonstrates change from baseline:
 - Yellow pixels denote change from both baseline exams
- Third and fourth exams are compared to both baselines:
 - yellow pixels denote change from both baselines
 - change identified in three of the four comparisons is indicated by red pixels

Change refers to statistically significant change, defined as change that exceeds the known variability of a given pixel based on population studies

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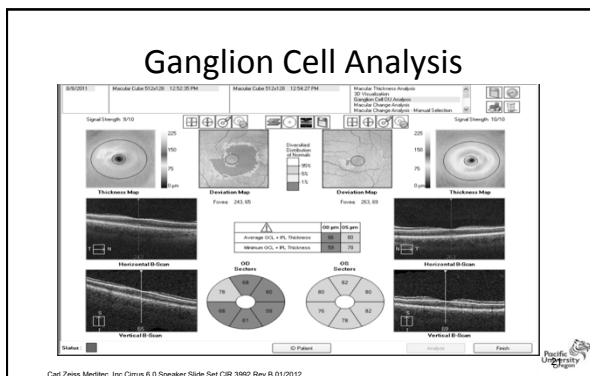
Guided Progression Analysis (GPA™)

Ganglion Cell Analysis

- Measures thickness for the sum of the ganglion cell layer and inner plexiform layer (GCL + IPL layers)
 - RNFL distribution in the macula depends on individual anatomy, while the GCL+IPL appears regular and elliptical for most normals
 - Deviations from normal are more easily appreciated in the thickness map by the practitioner, and arcuate defects seen in the deviation map may be less likely to be due to anatomical variations.



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Be Careful: Red Disease

FALSE POSITIVES

- A red OCT that is believed to be glaucoma but may be indicative of another disease or just red as a result of poor imaging quality
- Anatomic anomalies:
 - Tilted disc
 - PPA
- Media opacities
 - Reduce image quality
- ONH masqueraders
 - Optic neuritis, AION etc



Be Careful: Green is Clean

FALSE NEGATIVE

- A green OCT that is believed to be normal but actually has clinically detectable evidence of glaucoma found by methods of testing other than just looking at the colors on the OCT

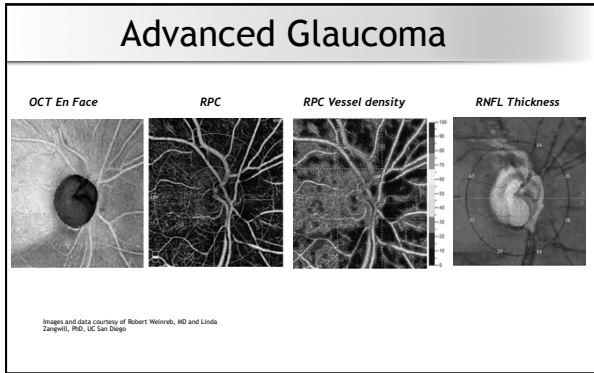
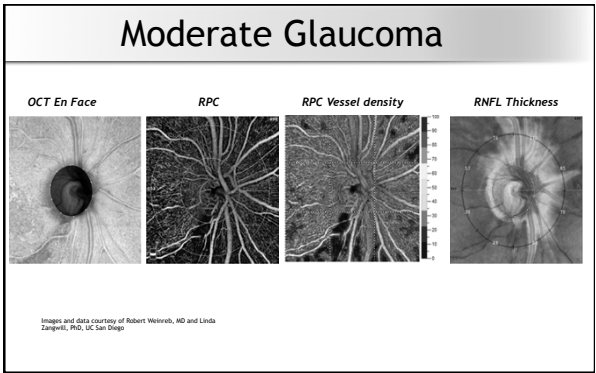
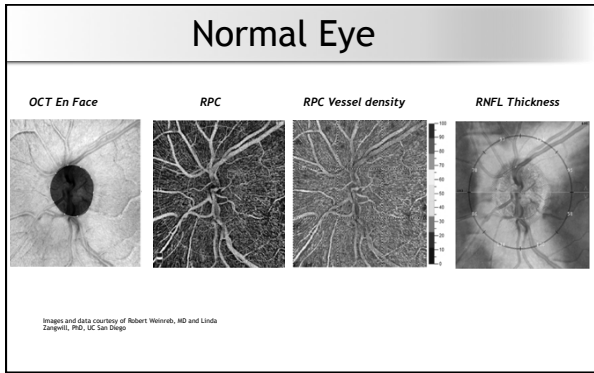
The CCT should match the:

- clinical optic nerve evaluation
- clinical retinal nerve fiber layer evaluation
- visual field



The Future of Glaucoma Diagnosis and Management???





Cases

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Case 1: Case History

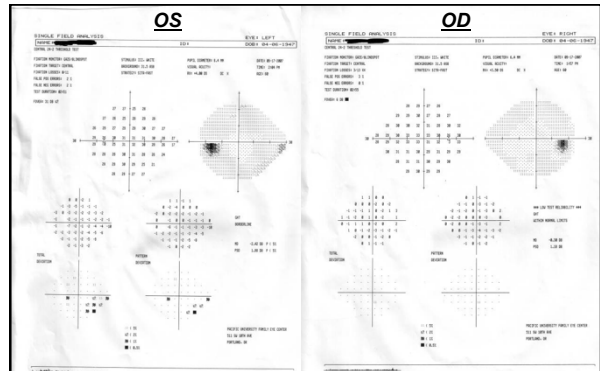
- 55 black male complaining about decreased vision at near
- Positive medical history of hypertension for 10 years, currently medicated.
- Mother has glaucoma

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Entrance Skills

<ul style="list-style-type: none"> • Va's: 20/20 OD, OS • Pupils: PERRL • EOM's: FROM • CVF: full to finger count • IOP's: 16, 16 OD, OS 	<ul style="list-style-type: none"> ▪ Pachy: 540, 550 OD, OS ▪ Fundus eval: see photos • OD: c/d 0.45/0.45 • OS: c/d 0.6/0.6 ▪ HVF: see photos
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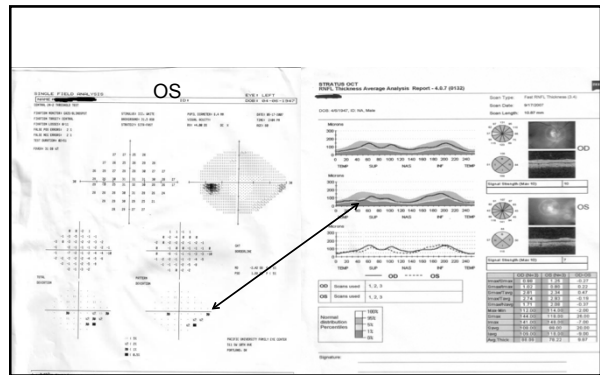


Consider the below PSD plots.

OS

OD

Predict what TSNIT graphs you would obtain for this patient.



What we did.

- We discussed with the patient:
 - appears he has early glaucomatous changes
 - early nasal step OS,
 - reduced NFL OS
 - positive family history
 - educated patient that we could monitor him very closely every 3 months and watch for further change, and then begin treatment at that time
 - or he could begin treatment

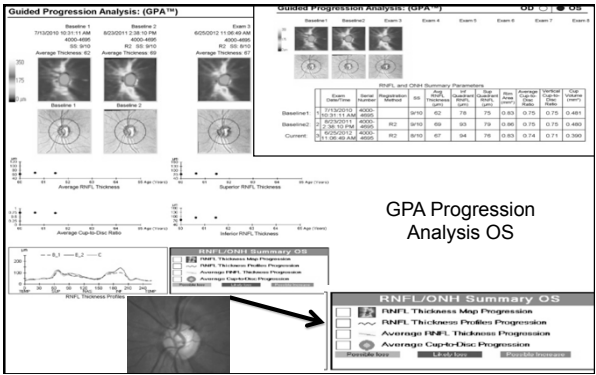
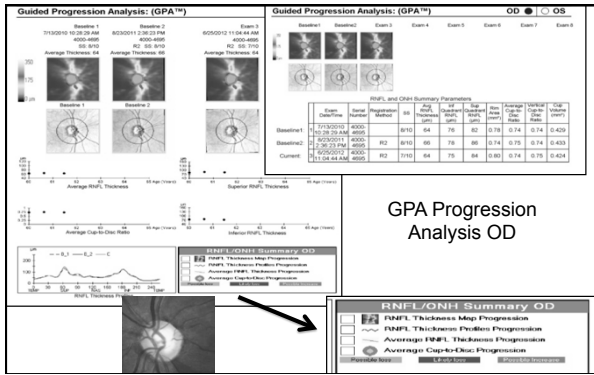
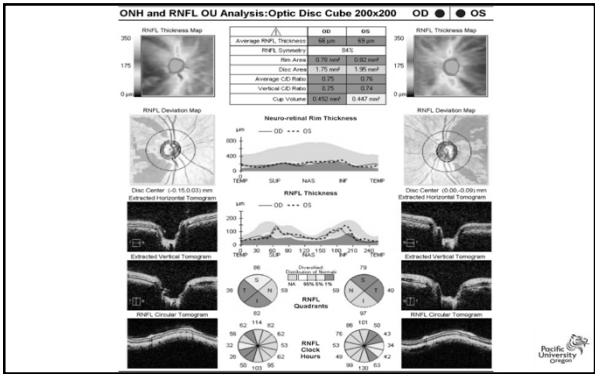
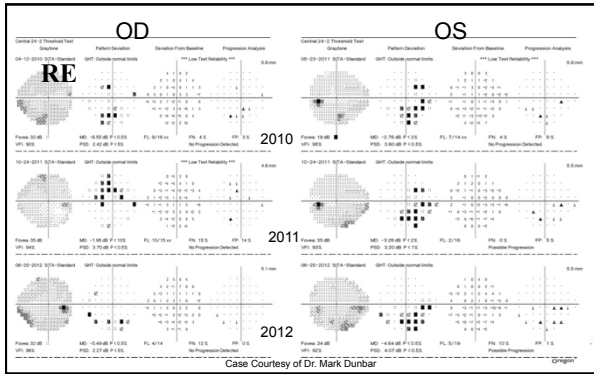
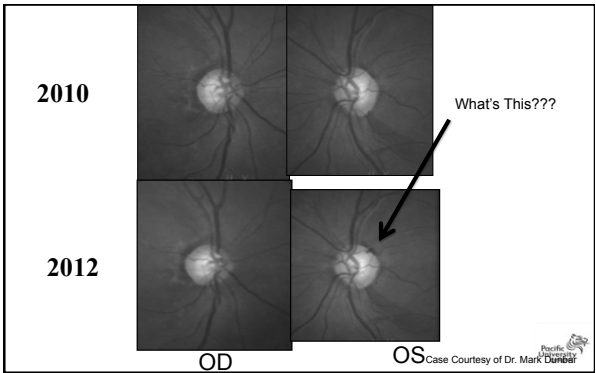
Treatment/Follow Up

- Patient chose to begin treatment
- We started him on Travatan Z qhs in the left eye
 - felt this would be the best medication for lowering his eye pressure without significant side effects related to his hypertension
- Patient returned 2 weeks later for a follow up and his IOP had decreased from 16 to 12 in the left eye.
- Patient asked whether there was potential to have glaucoma in his right eye
 - said it was possible and he decided he wanted to initiate treatment in his right eye as well.

Vesta: 61 y/o Haitian Female

- GL suspect 2001 – suspicious ON’s
- NTG since 2006
- Meds: Alphagan P bid OU, latanoprost qhs OU
- Medical Hx: HTN, HIV (+) for > 15 yrs
- VA: 6/6 (20/20)
- TA for the past 3 or 4 yrs: 9-13 mmHg OU
 - Last 2 visits 9 mmHg – today 13
 - Pachs: 450 microns

Case Courtesy of Dr. Mark Dunbar



Vesta: 61 y/o Hatian Female

- NTG OU with thin corneas
- OS:
 - Optic Nerve and HVF show trend towards progression....
- OCT shows no change

Case Courtesy Dr. Mark Dunbar



Vesta: 61 y/o Hatian Female

- How do you manage this patient?
 - Currently on latanoprost and alphagan OU
- This is what was done....
 - Stopped Alphagan P
 - Switch to Combigan bid OU
 - Continue with latanoprost qhs OU
 - RTC 1 mo

Case Courtesy of Dr. Mark Dunbar

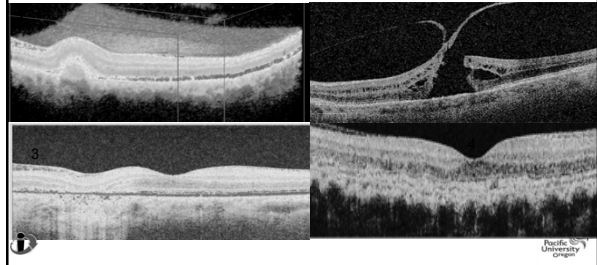


RETINA



Question

Which OCT goes with a patient undergoing hydroxychloroquine toxicity?



Revised Recommendations on Screening for Hydroxychloroquine Retinopathy

- 2002 recommendations for screening were published by Ophthalmology
- Revised recommendations on screening published in Ophthalmology 2011;118:415-42
 - Significant changes in light of new data on the prevalence of retinal toxicity and sensitivity of new diagnostic techniques
 - Risk of toxicity after years of use is higher than previously believed
 - Risk of toxicity approaches 1% for patients who exceed 5 years of exposure



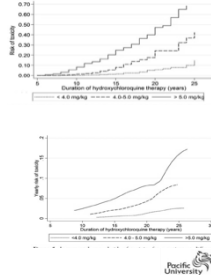
“New” New Recommendations

- **Recommendations on Screening for Chloroquine and Hydroxychloroquine Retinopathy – Ophthalmology 2016; 123:1386-1394**
 - Released March 2016 from American Academy of Ophthalmology
 - revised in light of new information about the prevalence of toxicity, risk factors, fundus distribution, and effectiveness of screening tools.



2016 Recommendations

- maximum daily HCQ use of 5.0 mg/kg real weight, which correlates better with risk than ideal weight.
- risk of toxicity is dependent on daily dose and duration of use.
 - at recommended doses:
 - risk of toxicity up to 5 years is under 1%
 - up to 10 years is under 2%
 - rises to almost 20% after 20 years. However, even after 20 years, a patient without toxicity has only a 4% risk of converting in the subsequent year.



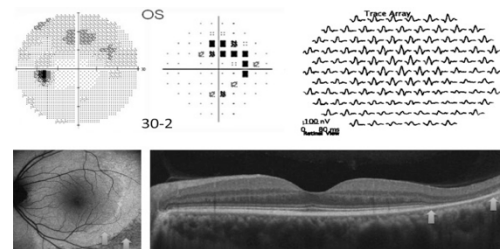
2016 Recommendations

- High dose and long duration of use are the most significant risks.
 - Other major factors are concomitant renal disease, or use of tamoxifen
- A baseline fundus examination should be performed to rule out preexisting maculopathy.
- Begin annual screening after 5 years for patients on acceptable doses and without major risk factors.



2016 Recommendations

- primary screening tests are automated visual fields plus spectral-domain optical coherence tomography (SD OCT)
- most patients of Asian descent will show initial damage in a more peripheral extramacular distribution near the arcades (require a 24-2 as opposed to 10-2 and OCT scans need to be analyzed further out)

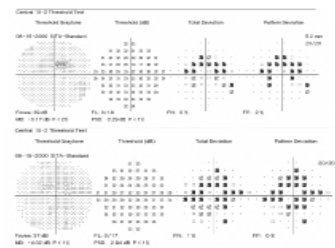


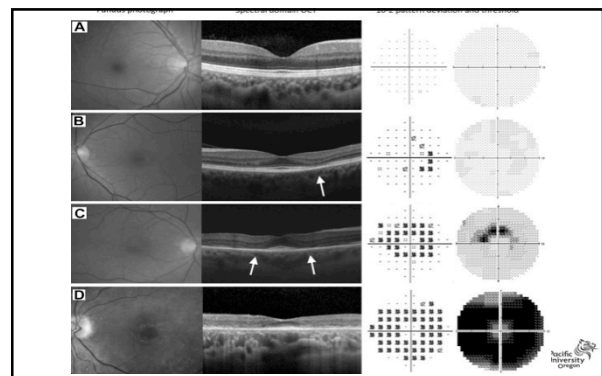
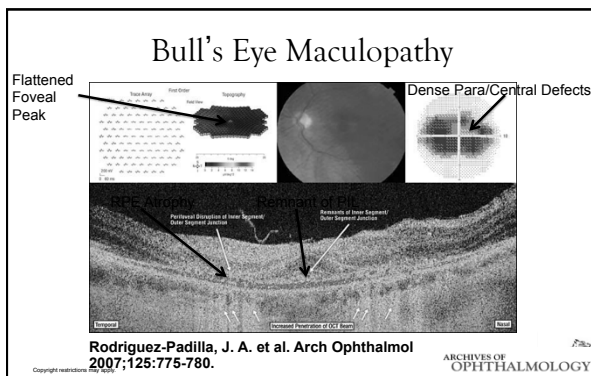
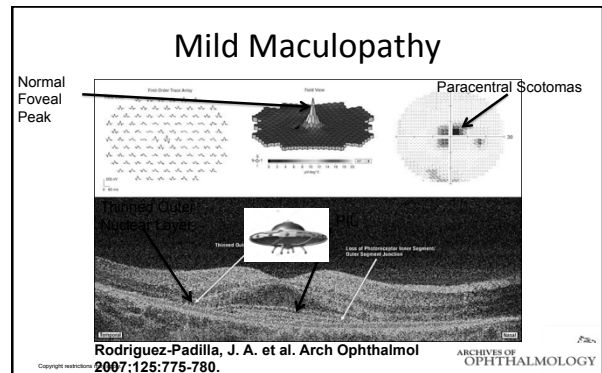
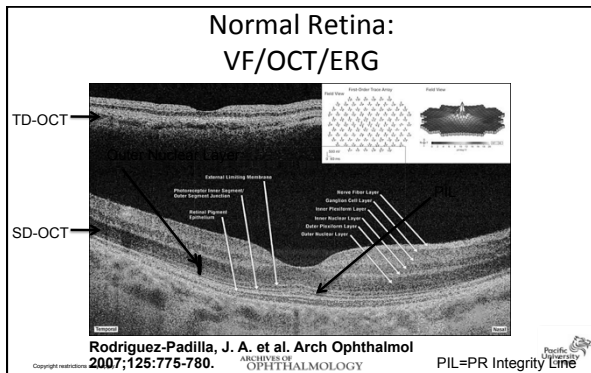
Revised Recommendations on Screening for Retinopathy

- Parafoveal loss of visual sensitivity may appear before changes are seen on fundus evaluation
 - Many instances where retinopathy was unrecognized for years as field changes were dismissed as “non-specific” until the damage was severe
 - 10-2 VF should always be repeated promptly when central or parafoveal changes are observed to determine if they are repeatable
 - Advanced toxicity shows well-developed paracentral scotoma



Paracentral Scotomas





Major Risk Factors

Table 1. Major Risk Factors for Toxic Retinopathy

Daily dosage	
HCQ	>5.0 mg/kg real weight
CQ	>2.3 mg/kg real weight
Duration of use	>5 Yrs, assuming no other risk factors
Renal disease	Subnormal glomerular filtration rate
Concomitant drugs	Tamoxifen use
Macular disease	May affect screening and susceptibility to HCQ/CQ

CQ = chloroquine; HCQ = hydroxychloroquine.

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Screening Recommendations

Table 2. Screening Frequency


Baseline Screening	Fundus examination within first year of use Add visual fields and SD OCT if maculopathy is present
Annual Screening	Begin after 5 yrs of use Sooner in the presence of major risk factors

SD OCT = spectral-domain optical coherence tomography.

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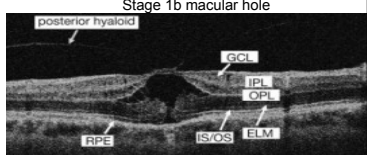
Macular hole

- Unilateral, decreased vision
 - Often in 60-80 year old women
 - Anyone w/ a history of trauma
- Symptoms:
 - Decreased vision, metamorphopsia
 - 20/200 for full thickness holes
- Signs:
 - Red hole in the macula
 - (+) Watzke-Allen sign



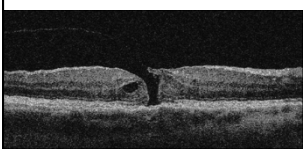
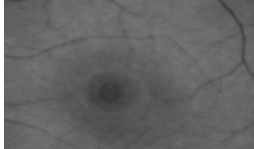
Macular hole

- Stages
 - Stage 1a -> impending hole. Normal foveal depression with yellow spot/dot in fovea.
 - Stage 1b -> Abnormal foveal depression with yellow ring.



Macular hole

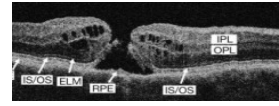
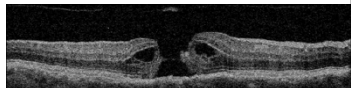
- Stages
 - Stage 2 -> Small full-thickness hole. 20/80 - 20/400.
 - Stage 3 -> Full-thickness hole w/ cuff of SRF. No PVD
 - Stage 4 -> Full-thickness hole with cuff of SRF, with complete PVD.

Stage 2 macular hole

Macular hole

- Stages
 - Stage 2 -> Small full-thickness hole. 20/80 - 20/400.
 - Stage 3 -> Full-thickness hole w/ cuff of SRF. No PVD
 - Stage 4 -> Full-thickness hole with cuff of SRF, with complete PVD.

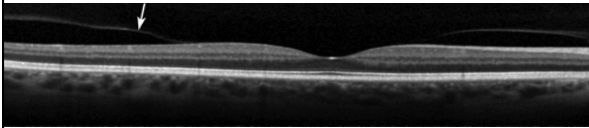

Stage 3 Macular hole

Stage 4 macular hole →

New Macular Hole Staging

Table 2. Correlation between Commonly Used Clinical Macular Hole Stages and the International Vitreomacular Traction Study Classification System for Vitreomacular Adhesion, Traction, and Macular Hole

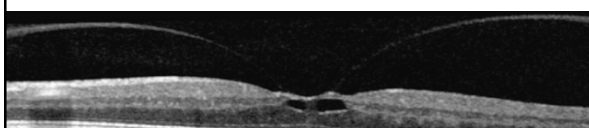

Full-Thickness Macular Hole Stages in Common Use	International Vitreomacular Traction Study Classification System
Stage 0	VMA
Stage 1: impending macular hole	VMT
Stage 2: small hole	Small or medium FTMH with VMT
Stage 3: large hole	Medium or large FTMH with VMT
Stage 4: FTMH with PVD	Small, medium, or large FTMH without VMT

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Small FTMH w/o traction

B

154 microns

237 microns

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Medium FTMH w/o traction

C

250-400 microns

New Macular Hole Staging

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Large FTMH with traction

D

> 400 microns

Thank You!

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