

**GLAUCOMA DIAGNOSIS:
PUTTING IT ALL TOGETHER**

**Greg Caldwell, OD
Joseph Sowka, OD**

Joe: 954-298-0970 Greg: 814-931-2030

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**IOP MEASUREMENT AND
CONSIDERATIONS**

Gold Standard.....



But can we do better?

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GLAUCOMA RISK FACTORS

- IOP
- Age
- Race
- Family History
- Corneal thickness
- Diabetes
- Hypertension
- Hypotension
- OPP
- Sleep apnea
- CSF pressure
- Corneal hysteresis

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PACHYMETRY

- Correct IOP or not?
- OCT vs Ultrasound?

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**WHAT IS MORE IMPORTANT?
TARGET IOP OR PEAK IOP?**

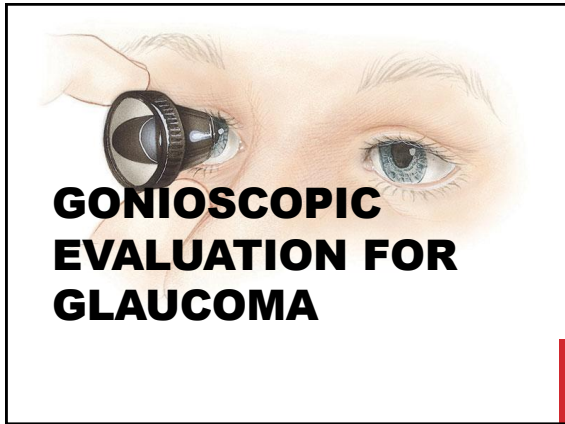
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**GONIOSCOPY: REQUIRED OR
NOT? WHEN? HOW OFTEN?**

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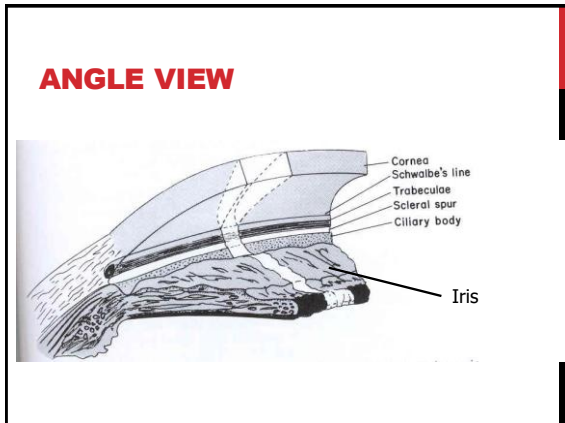
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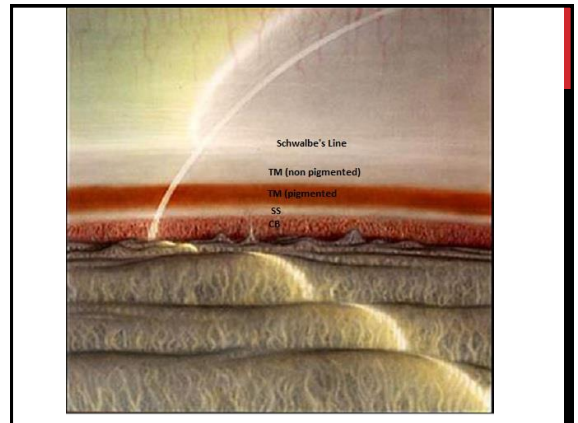
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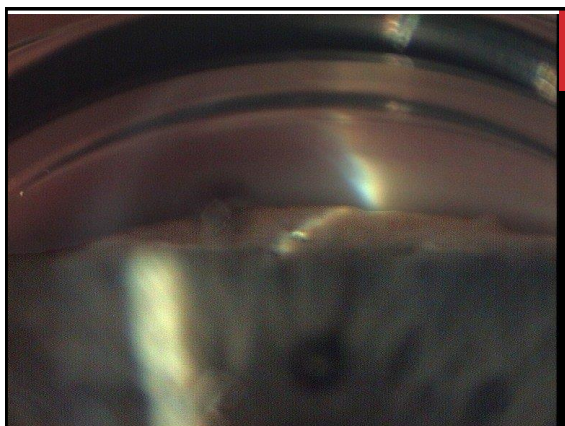
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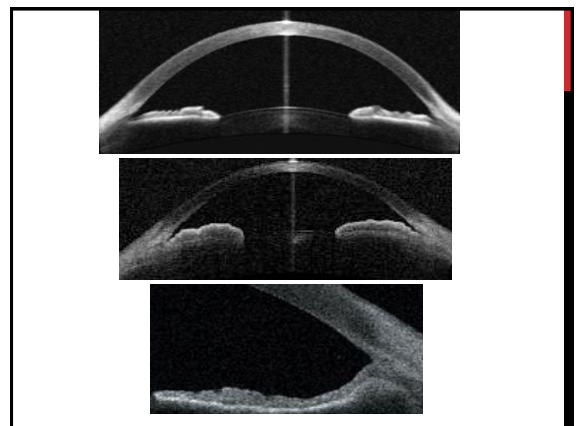
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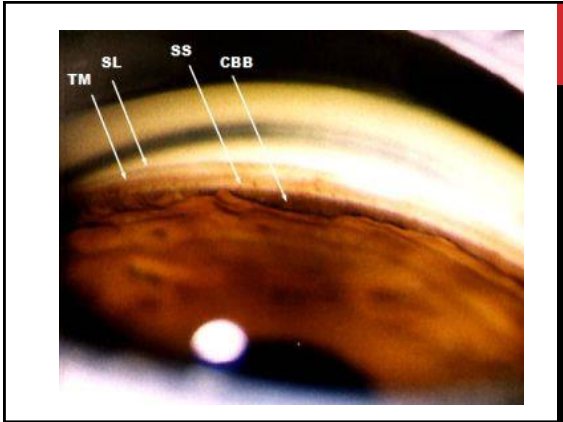
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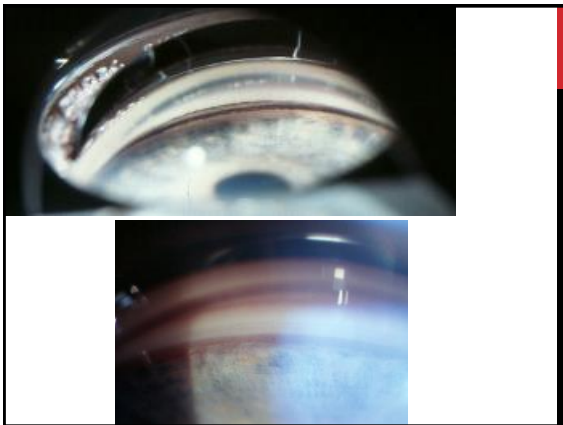
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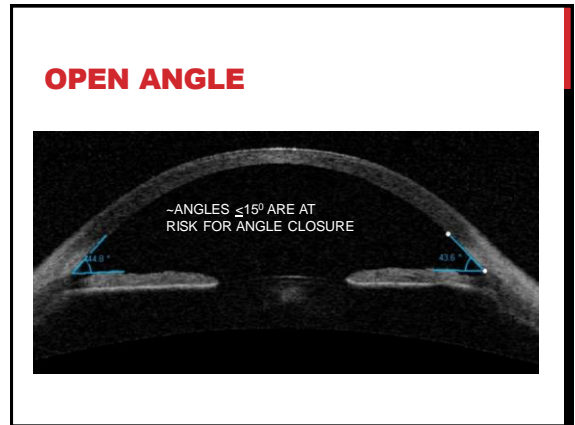
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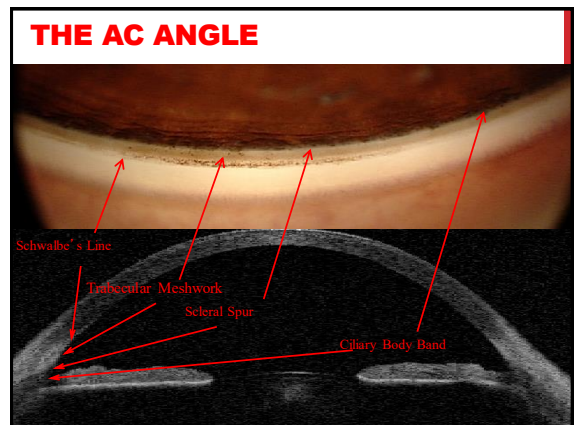


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OCT AND THE ANGLE

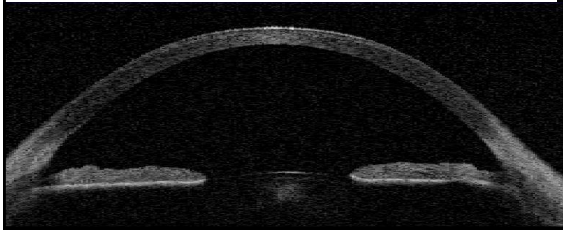
- Don't know what constitutes 'occludable'
- Gonio can be difficult to interpret- OCT is harder
 - How to use information?
 - Not standard of care
- Does not show pigment, recession, blood, neo, PAS
- Generally cannot image entire angle
 - Gonio allows entire angle to be seen
- Be aware of artifacts

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STRUCTURES NOW WITHOUT THE ARROWS?



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FINAL THOUGHTS

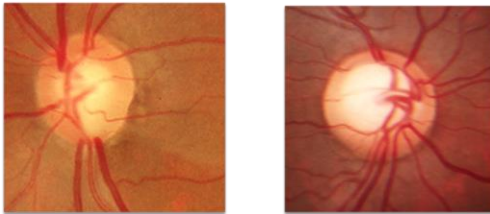
- Gonioscopy is actually a poor screening tool
- The angle status changes upon the amount of ambient lighting.
- When a patient presents with either very high IOP or an acute pressure elevation...
- You should routinely do gonioscopy on every phakic eye over +2.50 diopters
- A 4-mirror flanged lens gives excellent optics but does not allow for indentation gonioscopy. A non-flanged lens allows for indentation gonioscopy, but the view is more challenging.
- Do not try to diagnose and manage glaucoma without doing gonioscopy.

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EVALUATING THE DISC IN GLAUCOMA

Characteristic glaucomatous neuropathy

- Focal rim damage, not generalized concentric enlargement

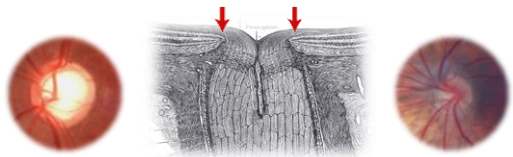


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GLAUCOMA SUSPECT BASED UPON DISC APPEARANCE

Larger discs will have larger cups, but rims are intact

- *Glaucoma is over-diagnosed in larger discs and under-diagnosed in smaller discs*



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You talk about glaucoma in cup-to-disc ratios

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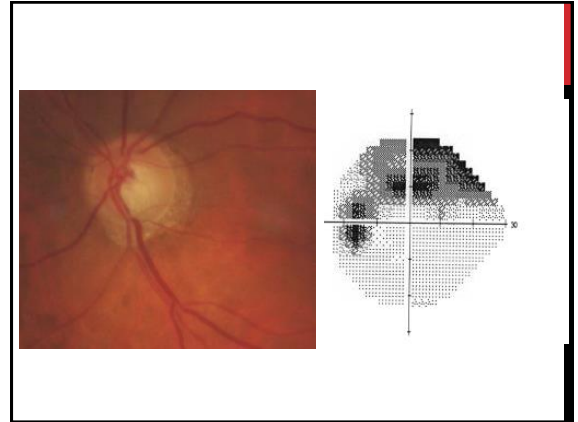
CRITICAL DISC EVALUATION

- Size
- Rim color
- Focal rim defects (notching)
- Hemorrhages
- RNFL defects
- Parapapillary atrophy

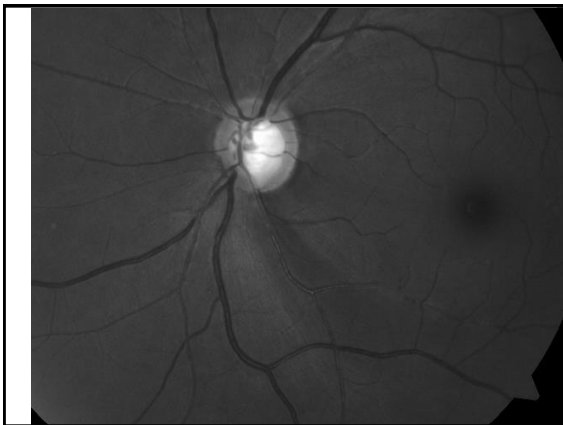
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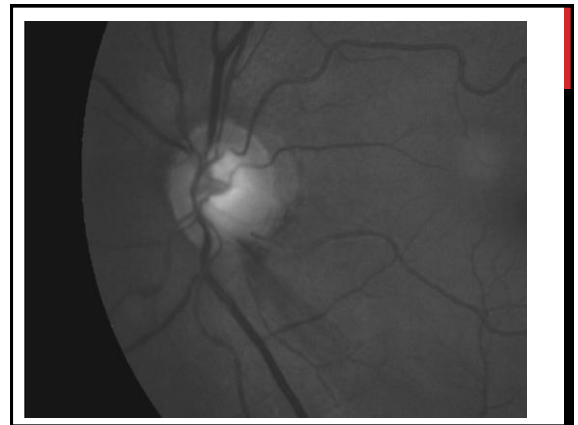
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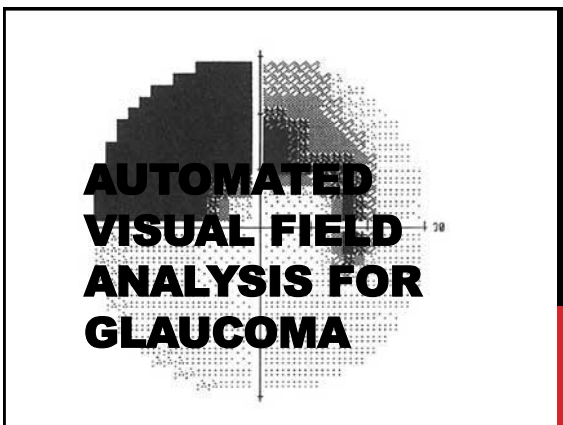
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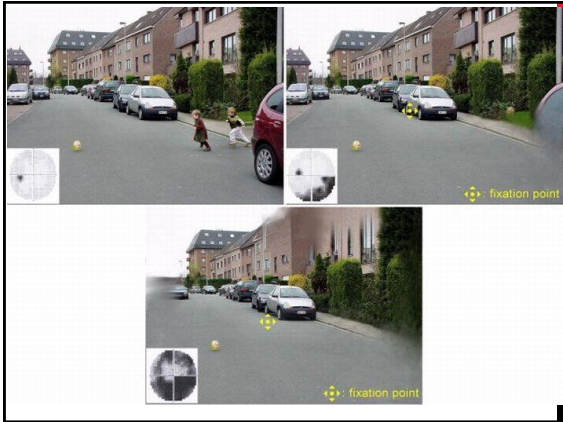
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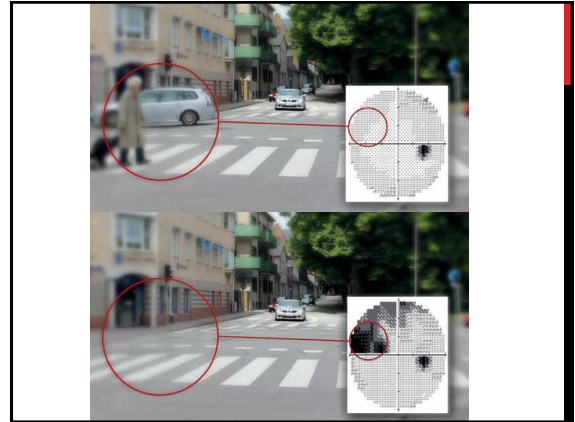
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SAP AND SITA

- SAP- Standard Automated Perimetry**
 - Determines the threshold (how dim of light) can be seen at various points
 - Various algorithms have been developed to determine this threshold using few to numerous individual points in a single visual field test
- SITA-Swedish Interactive Thresholding Algorithm**
 - Optimizes the determination of perimetry thresholds
 - Continuously estimating what the expected threshold is based on the patient's age and neighboring thresholds
 - Reduce the time necessary to acquire a visual field by up to 50%.
 - Decreases patient fatigue and increases reliability
 - SITA mode is now widely used in many computerized automated perimeters
- SITA- can be applied to:**
 - SAP- Standard Automated Perimetry
 - SWAP-Short Wavelength Automated Perimetry (SWAP)

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SITA STANDARD VERSUS SITA FAST

- SITA strategies are twice as fast as previous strategies**
- SITA fast takes 67% the time of SITA standard**
 - Sita fast has larger retest variability
- Primary difference is between the two strategies is the amount of certainty that is required before testing is stopped**
- SITA standard**
 - More precise
 - More tolerate of mistakes
 - Easier test as stimuli are brighter
- "SITA -Faster" now av**

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SITA FASTER – TESTS IN 2 MINUTES OR LESS WITHOUT COMPROMISE TO TEST RESULTS

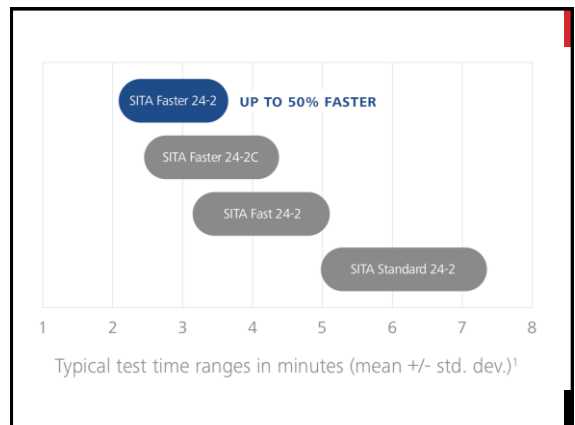
Two minute test for near normal patients

- ~50% faster than SITA Standard; ~30% faster than SITA Fast
- Clinically equivalent to SITA Fast and Standard
- Same SITA algorithm and normative data as Standard and Fast
- Removes unnecessary "dead time" during the test
- No Blind Spot or False Negatives
 - Uses Gaze Monitoring and False Positives for test quality monitoring

Mixed SITA GPA Reports

- Allows mixing all SITA test strategies for GPA reports
- Helps immediately adopt SITA Faster
- Clinical equivalence of tests allows intermixing

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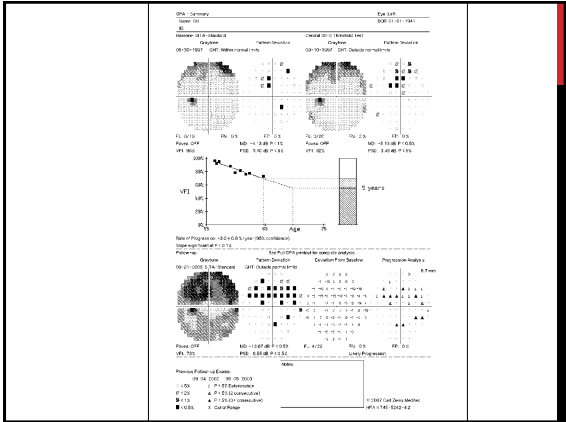


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INTERPRETING VISUAL FIELDS

- **No longer reliable or unreliable**
 - A continuum from highly reliable to marginally informative
- **False positives**
 - More destructive to interpretation than formerly believed
- **False negatives**
 - Expected to be abnormal in a glaucomatous visual field
 - Even in attentive tester
- **Gaze tracker**
 - Typically a better indicator than blind spot
- **Progression is not present or absent**
 - Is the rate of change acceptable

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ISSUES IN IMAGING

- **OCT technology is readily available and present in contemporary practice**
- **No one single parameter is more important than the others.**
- **Never base a clinical decision based upon only one piece of data.**
- **OCT is not a Silicon Valley Rumpelstilskin. You cannot put in straw and get out gold**

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ISSUES IN IMAGING

Interpretation is a three-step process

- 1. Understand what the printout says**
- 2. Apply experience and value judgement**
- 3. Correlate to the clinical findings**

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ISSUES IN IMAGING

- **You cannot make a diagnosis of glaucoma based solely upon imaging results.**
- **The use and overemphasis of imaging technology to the exclusion of additional clinical findings and assessment of risk will put patients in peril.**
- **Exactly how much confidence should an OCT give you as to whether or not a patient has glaucoma?**
 - Depends how much confidence you had before you imaged the patient.

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ISSUES IN IMAGING

- **Normative Database**
- **Signal Quality**
- **Blink/Saccades**
- **Segmentation Errors**
- **Media Opacities**
- **Axial Length**

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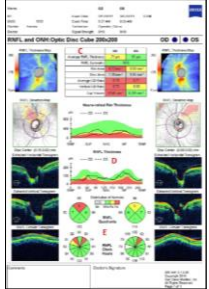
OCT DATABASE INFORMATION

- **Spectralis: 201 patients**
 - All Caucasian
 - Age 18-78
 - New database more representative of US population
- **Cirrus: 284 eyes**
 - Age 19-84
 - Ethnic Groups: Caucasian, Asian, African-American, Hispanic
- **RTVue: 600 eyes**
 - Disc Size
 - African-American, Chinese, Japanese, Caucasian, Hispanic, Indian

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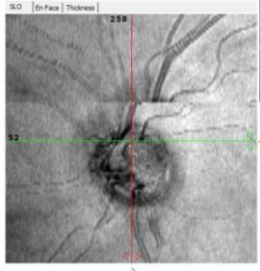
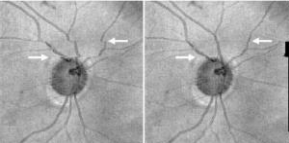
WHAT TO LOOK FOR WHEN INTERPRETING OCT SCANS

- Quality score
- Illumination
- Focus clarity
- Image centered
- Any signs of eye movement
- Segmentation accuracy
- B Scan Centration
- Missing data
- Media issues
- Maculopathy for GCC scans

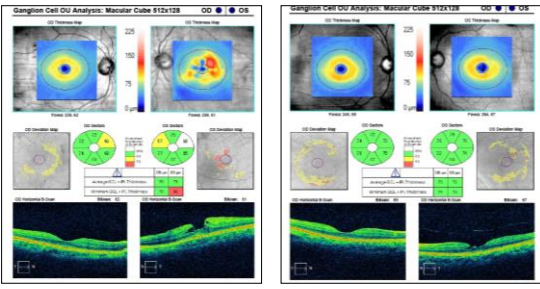


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EYE MOVEMENT

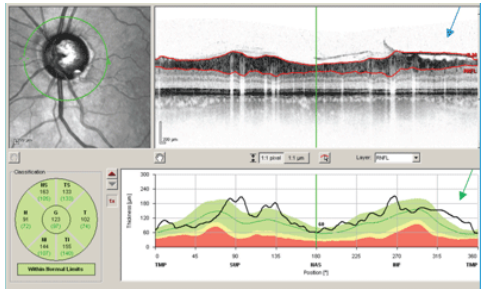



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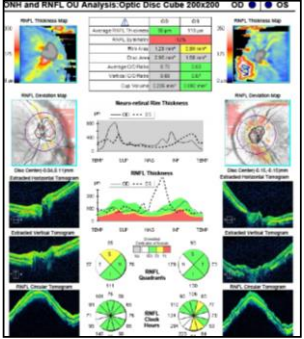
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Spectralis

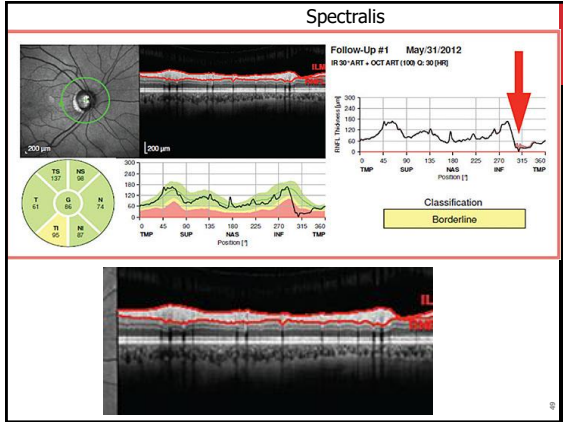


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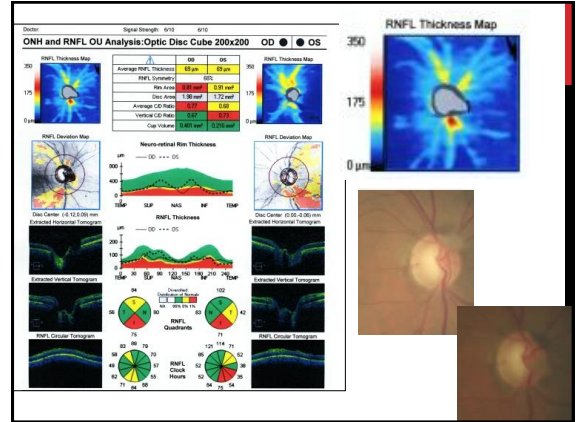
IF YOU THINK DEVICES MEASURE TISSUE ACCURATELY EVERY TIME...



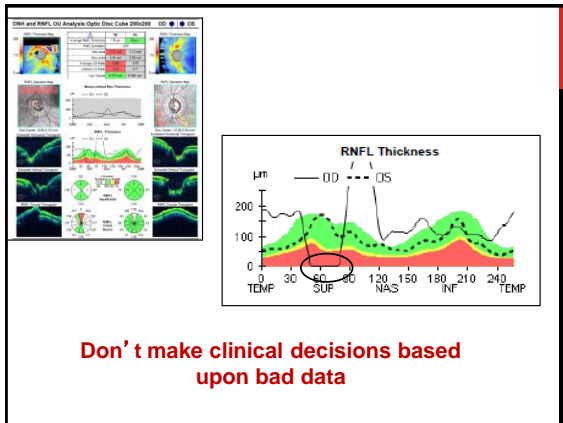
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Don't make clinical decisions based upon bad data

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The diagnostic imaging doesn't agree with my diagnosis? Now what?

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ANSWER:

- Things have to make sense. If the imaging findings to not fit with the anatomic and functional correlates of pathophysiologic change, trust your own knowledge and judgment.
- When in doubt, repeat the imaging study and the visual field or both.

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RED DISEASE – A NEW CLINICAL NON-ENTITY

- A supratentorial, non-glaucomatous masquerade disease
- Afflicts the educated patient (especially with Internet access) with good health care plans and/or wealth
- Debilitating to the patient and painful for the visual care provider to treat

NS Sherlock. *Journal of Irreproducible Results and Senseless Studies*. 2005.

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SCANNING LASER OPHTHALMOSCOPY EXAMPLE OF RED DISEASE

First Visit Follow up visit #1 Follow up visit #2

HRT3 Optic Nerve Head Changes
How long did this change take?

55

WITHIN 15 MINUTES! HRT DISC SIZING ARTIFACT

Disc Size: 1.83 mm² (average) Disc Size: 1.33 mm² (small) Disc Size: 0.96 mm² (small)

56

WHAT DO YOU MAKE OF THESE...?

GARBAGE IN, GARBAGE OUT.

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OCT RNFL NORMAL...

Parameter	Value	Reference Range
Average RNFL Thickness	102 µm	88-126 µm
Disc Size	1.83 mm ²	1.50-2.25 mm ²
Average ION	1.21 µm	0.95-1.47 µm
Vertical ION	1.21 µm	0.95-1.47 µm
Cup Volume	0.234 mm ³	0.00-0.50 mm ³

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...but markedly abnormal GCC OS

Same patient, same day, same quality, GCC now normal

Signal strength: 10/10 OD, OS on both images

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GREEN DISEASE- AN INSIDIOUS CLINICAL ENTITY

A glaucomatous process masquerading as non-disease

Afflicts inexperienced, poorly-educated, and lazy doctors who simply want a machine to make all clinical decisions for them

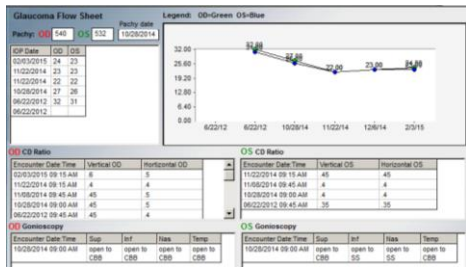
Debilitating to the patient and painful for the visual care provider, but a boon for malpractice attorneys

NS Sherlock. *Journal of Irreproducible Results and Senseless Studies.* 2015.

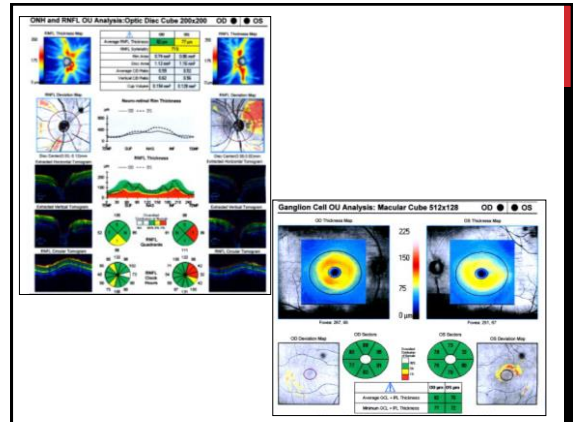
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HELP! THE DIAGNOSTIC IMAGING DOESN'T AGREE WITH MY DIAGNOSIS!

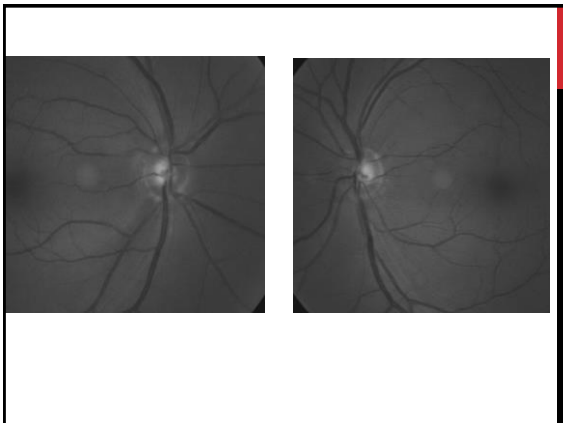
- 56 YOM- Glaucoma suspect since 2012



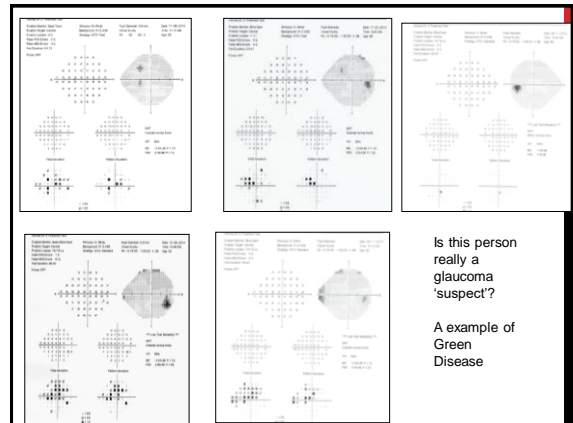
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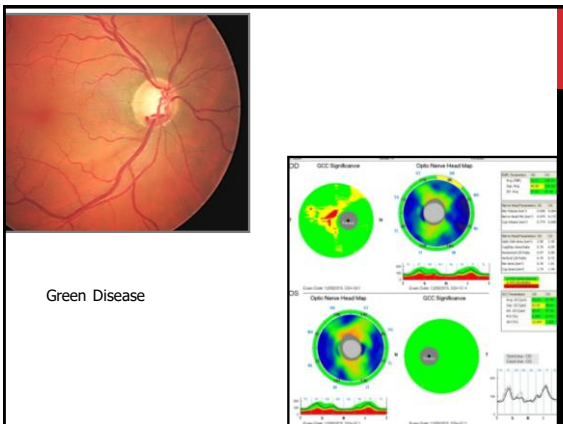
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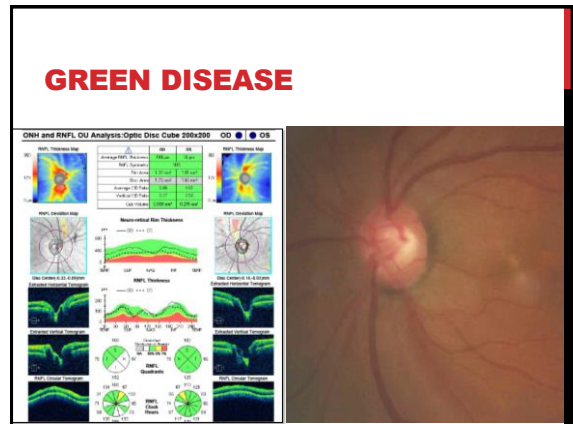
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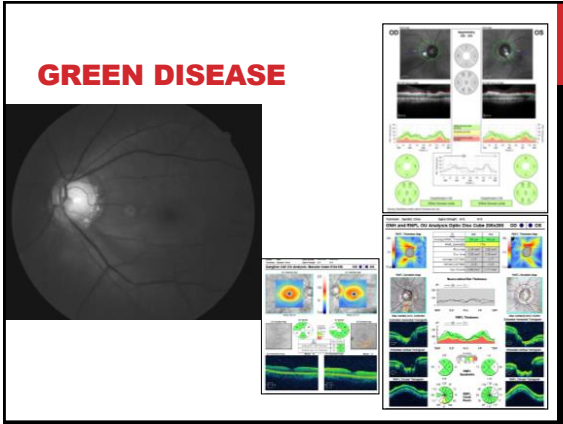
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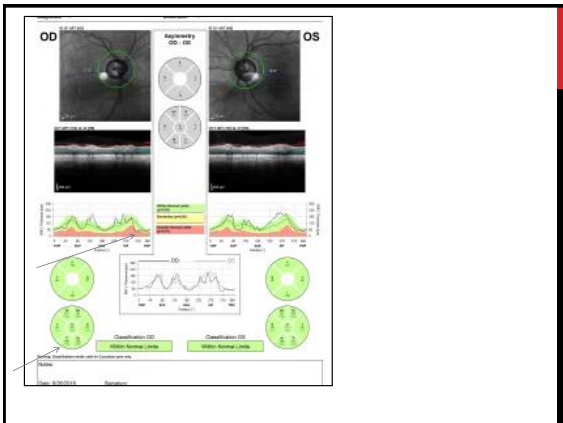
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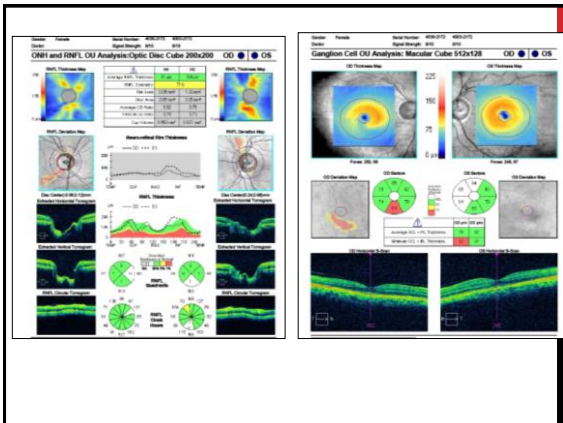
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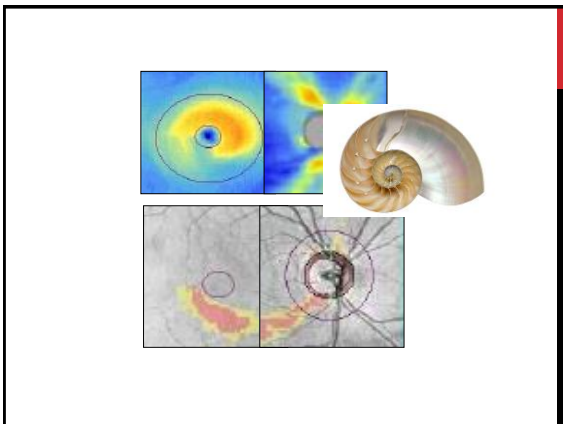
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- OCT IMAGING TAKE HOME POINTS**
- Serial overlays/imaging to determine baseline (intra-session) noise
 - Good signal strength
 - Good segmentation without errors
 - Optic nerve head exam for disc hemorrhage, pallor, myopic, and tilted nerve heads
 - Determine structure-function correlation
 - Follow all ancillary tests visual fields and optic nerve head photos for progression

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CAUTIONS ABOUT IMAGING

- No current technology is better than the human eye and common sense
- Beware of “Red Disease”
- Treat Real Disease and not Red Disease
- Don't miss Green Disease
- Know the limitations of the technology: normative database, reproducibility, resolution, quality of imaging
- Technologies come and go

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WHICH OF THESE 3 PATIENTS DO YOU MOST SUSPECT HAS GLAUCOMA?

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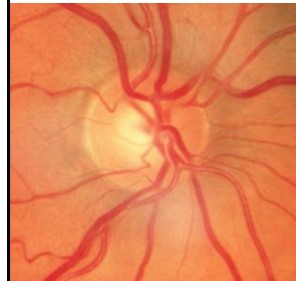
PATIENT 1: 28 YOF



- IOP: 11 mm
- CCT: 610

75

PATIENT 2: 56 YOM

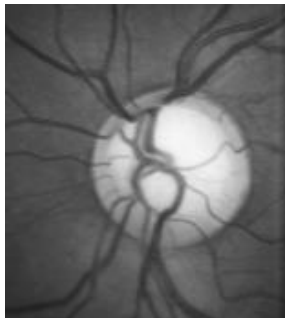


- IOP: 22 mm
- CCT: 598

76

PATIENT 3: 64 YOF

- IOP: 31 mm
- CCT: 490



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WHICH PATIENT HAS GLAUCOMA? 1? 2? 3?

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WHICH PATIENT HAS GLAUCOMA? 1? 2? 3?

- IOP: 11 mm
• CCT: 610
- IOP: 22 mm
• CCT: 598
- IOP: 31 mm
• CCT: 490

Pattern Deviation

Global Field Defect

MD: -12.04 dB P<0.001
PSD: 13.68 dB P<0.001

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RULE: WHEN DIAGNOSING GLAUCOMA, TAKE IOP OUT OF THE EQUATION

(When managing glaucoma, put IOP back into the equation...but that's another lecture.)

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WHO ARE THE GLAUCOMA SUSPECTS?

- Large cupping- normal IOP
- Large cupping- high IOP
- Normal cupping- high IOP

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IS THIS GLAUCOMA?

34 YO HF
"Highly suspicious" ONH OU
IOP statistically normal
• 13 mm Hg OU
Average CCT
Previously treated for NTG

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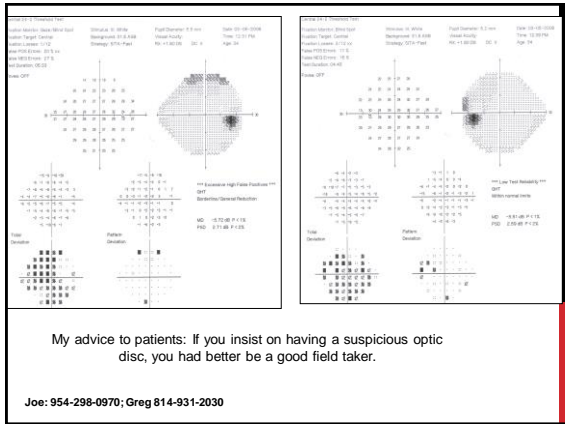
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Joe: 954-298-0970; Greg 814-931-2030

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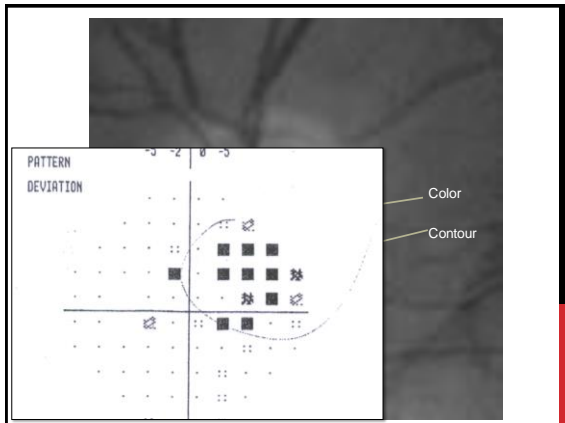
IS THIS GLAUCOMA?

78 YOWM
Annual exams with multiple doctors
IOP ranges from 17 – 21 mm Hg
CCT 570
Ocular health always “normal”
Small discs with indistinguishable cupping

- 0.2/0.2 – 0.3/0.3

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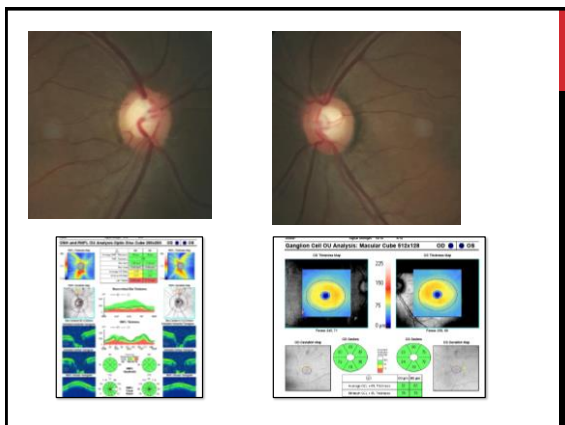
DON'T OVER-TEST

Two movie stills are shown. The top one is from the movie 'Moneyball' showing Brad Pitt. The bottom one shows a man in a cap talking on a mobile phone. Below the stills is a quote:

“When you get the answer you want, hang up”

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BUT DON'T UNDER-TEST, EITHER

A detailed screenshot of an OCT analysis software interface. It shows multiple panels with various graphs, tables, and color-coded maps. The interface includes labels for 'ONH and RNFL, OI Analysis: Optic Disc Cube 200x200' and 'OS'. The right side of the interface shows a fundus photograph of the optic disc.

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WHO ARE THE GLAUCOMA SUSPECTS AND WHAT DO I DO?

- **Large cupping- normal IOP**
 - Does the nerve look glaucomatous?
 - Yes- photos, fields, pachymetry, gonio, OCT
 - No- OCT- if normal-done; if abnormal- fields- if normal- done, if abnormal- monitor
- **Large cupping- high IOP**
 - Does the nerve look glaucomatous?
 - Yes- photos, fields, pachymetry, gonio, OCT
 - No- OCT, photos, pachymetry, fields, gonio
- **Normal cupping- high IOP**
 - OCT, photos, pachymetry, fields, gonio

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LARGE CUPPING-NORMAL IOP

CONSULTATION REQUEST (check all that apply)

CORNEA GLAUCOMA OCULAR PLASTIC RETINA GENERAL
 NOTES: Pt. 16. 8/16 st. IOP 14 mm @ 11:4 GENERAL
 cd 4/16/2020

Annual exams

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LARGE CUPPING- UNKNOWN IOP- DIAGNOSED WITH GLAUCOMA

- 46 YOF
- Diagnosed and treated for glaucoma in Jamaica
- Brimonidine 0.1%; latanoprost/timolol FC OU
- IOP: 14 mm OD, 16 mm OS
- CCT: 530; 528
- 0.75/0.75 OU
- Fields unreliable- high FP

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	OD	OS
Average RNFL Thickness	129 μ m	114 μ m
RNFL Symmetry	33%	
Ret Area	1.50 mm ²	1.41 mm ²
Disc Area	4.25 mm ²	4.44 mm ²
Average C/D Ratio	0.80	0.82
Vertical C/D Ratio	0.75	0.75
Cup Volume	1.239 mm ³	1.552 mm ³

D/C all meds:
IOP: 17 mm OD, 18 mm OS

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LARGE CUPPING-HIGH IOP

56 YOF
IOP: 24 mm OH
CCT: 550 OD, 539 OS

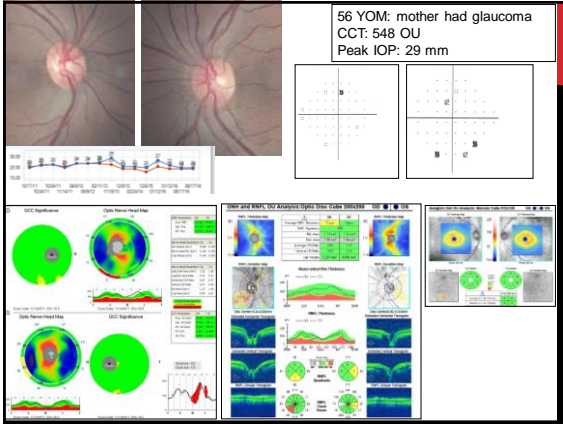
RTC 6 mos fields
Follow w/o treatment Q 6 mos

95

NORMAL CUPPING-HIGH IOP

IOP: 30 mm OD,
32 mm OS
Mother + glaucoma (10-2 field)
Rx: Latanoprost OU

96



97

Statute of limitation

Make a decision! Patients shouldn't be 'glaucoma suspects' for ten years. Either they have the disease or they don't.

Joe: 954-298-0970; Greg 814-931-2030

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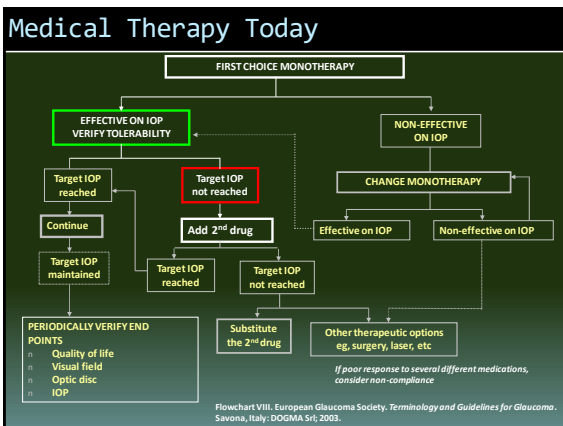
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THE GOOD OLD DAYS!

Climbing the Therapeutic Ladder

- Surgery
- Diamox
- Pilocarpine
- Propine
- Timoptic

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MEDICAL THERAPY OF GLAUCOMA

- When to initiate and amplify therapy
- Medical contraindications
- Monotherapy, polytherapy, adjunctive therapy
- Target pressures
 - Major glaucoma study guidelines
- When to judge efficacy
- Myth of monocular trials
- Climbing the therapeutic tree
- Synergy/ non-synergy

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WHAT IS MAXIMAL MEDICAL THERAPY?

- **A mutually agreed upon regimen between doctor and patient**
 - Some practitioners will not put patients on any more than two medications and others will use three or four
 - Patients may be accepting of multiple meds if surgery the next option
 - Laser trabeculoplasty is an option if medications are insufficient
 - Surgery is an option if medications and/or laser fail

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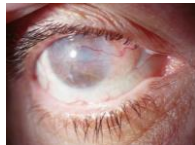
BIASES IN GLAUCOMA MANAGEMENT

- **Medications don't work as well as we think**
 - Average IOP reductions in clinical trials
 - Some respond much better and some don't respond at all
 - Tachyphylaxis
 - Adherence
- **Surgery is not as risky as we think**
 - CIGTS; TVT
 - Definite complications, but most self limited or easily managed

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MEDICAL THERAPY OF GLAUCOMA

- Unless the patient is at risk of imminent vision loss from an undiagnosed case of advanced glaucoma, get several untreated IOP readings over time before beginning therapy.
- There is absolutely no reason to heroically lower IOP in office in patients with chronic glaucoma.
- Treating a blind eye is recommended to avoid pain and maintain cosmesis



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