On behalf of Vision Expo, we sincerely thank you for being with us this year.

Vision Expo Has Gone Green!

We have eliminated all paper session evaluation forms. Please be sure to complete your electronic session evaluations online when you login to request your CE Letter for each course you attended! Your feedback is important to us as our Education Planning Committee considers content and speakers for future meetings to provide you with the best education possible.

VISION EXPO

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Strategies for Better Diagnosis of Glaucoma

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Disclosures

- Allergan
- Bausch & Lomb
- Carl Zeiss Meditec
- Glaukos
- M&S Technologies
- Santen
- Thea

3

What is glaucoma? What makes someone a suspect?

- Chronic, *progressive* disease of retinal ganglion cells
  - Characteristic optic nerve changes
  - Characteristic visual field changes
  - Potential for blindness
  - Elevated IOP is often present, but does not define the disease
- Suspect:
  - Suspicious optic disc
  - Abnormal visual field
  - Elevated IOP
  - Other risk factors

4

The Glaucoma Evaluation

- History
- VA
- Pupils
- SLE
- Tonometry
- Pachymetry
- Corneal hysteresis
- Gonioscopy
- Dilated exam with careful ONH/RNFL evaluation
- Perimetry
- Optical Coherence Tomography (OCT) of RNFL/macular ganglion cell

5

Pertinent History

- Related to Diagnosis:
  - Family history of glaucoma
  - Corticosteroid use
  - Ocular injury
  - Uveitis
  - Vascular disease (DM, HTN, vasospastic disease)
- Related to management:
  - Family history
  - Medications
  - Allergies

6

Let's talk IOP

- No clear boundary at which glaucoma will develop
- Higher IOP = increased risk of developing glaucoma
  - Asymmetry >2mm is not common in healthy eyes
  - Extremely asymmetric IOP = think secondary cause/unilateral disease
- Not everyone with elevated IOP will develop glaucoma
  - Ocular Hypertension Treatment Study (OHTS)
- Glaucoma can occur in patients with IOP always in the "normal" range
  - Normal Tension Glaucoma
    - LOTS of differentials!
    - Get many IOP readings

7

Is there more than IOP and CCT?

Ocular Response Analyzer (Reichert)

Corneal Hysteresis

- Refers to specific number from this instrument
- *Reflects* the ability of the corneal tissue to dissipate energy
- Hysteresis (biomechanical property) is different than corneal thickness (geometric attribute)
- May provide additional diagnostic/risk information

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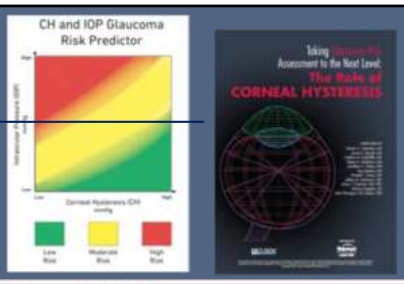

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Implications of Corneal Hysteresis

- Baseline lower CH measurements were significantly associated with increased risk of developing glaucomatous visual field defects over time.
- Each 1mm lower CH was associated with an increase of 21% risk of developing glaucoma during follow up.
- CH is an independent risk factor for developing glaucoma.

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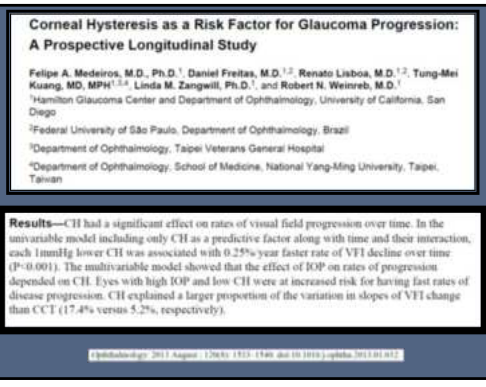

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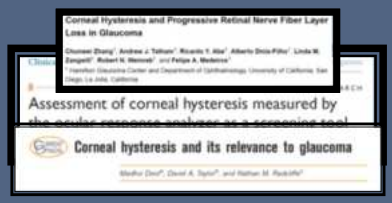

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Always assess the angle!

- Gonioscopy:
  - Open or Closed?
- Open:
  - Secondary causes of elevated IOP evident? Treatment may differ
- Closed:
  - What type of angle closure?
    - Pupillary block
      - PACS
      - PAC
      - PACG
    - Non-pupillary block – primary (plateau iris)
    - Secondary:
      - Anterior pulling (PAS, NVG, ICE)
      - Posterior pushing (medication-induced, post-surgical "malignant" glaucoma)

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Don't forget the ONH exam!

- Five characteristics of glaucomatous optic nerve damage:
  - Large C/D ratio *for the size of the optic nerve*
  - Neuroretinal rim thinning (ISNT)
  - Retinal nerve fiber layer loss
    - Diffuse
    - Focal
  - Optic disc hemorrhage
  - Beta-zone peripapillary atrophy (PPA)

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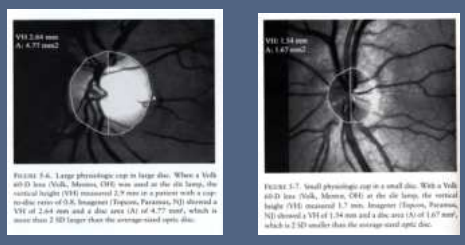
VARIATION IN DISC SIZE



Glaucoma Handbook by Litwak

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Disc Size Algorithm

	-2SD	-1SD	Mean	+1SD	+2SD
Vertical Height (mm)	1.6	1.8	2.0	2.2	2.4
C/D Ratio	0	0.2	0.4	0.6	0.8

(Tony Litwak, OD)

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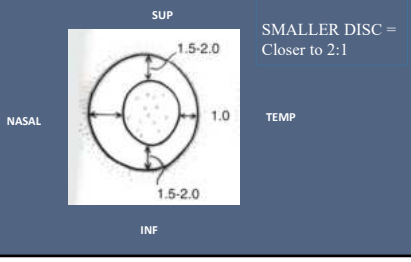
"ISNT RULE"

LARGE DISC = Closer to 1.5:1

SMALLER DISC = Closer to 2:1



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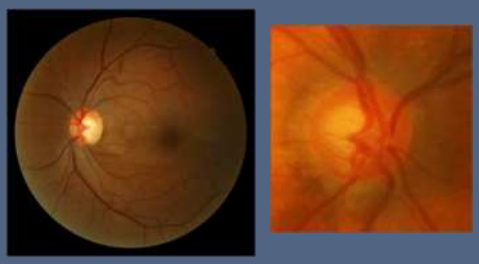
FOCAL LOSS (NOTCH)



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EVALUATION OF RETINAL NERVE FIBER LAYER (RNFL)

- Defects in RNFL may precede glaucomatous visual field loss and structural changes in ONH
- Can help to differentiate physiologic cupping from glaucomatous cupping

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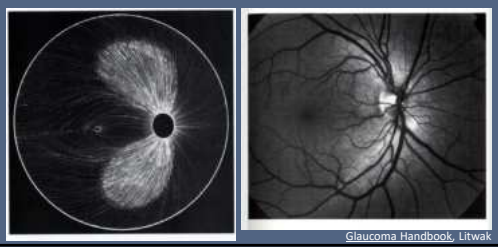
ANATOMY OF THE NERVE FIBER LAYER

- RNFL is thickest (and brightest) in superior and inferior arcades
- RNFL is thinner (dimmer) in papillomacular bundle and nasal bundles
- "BRIGHT-DIMMMER-BRIGHT" pattern



Glaucoma Handbook, Litwak

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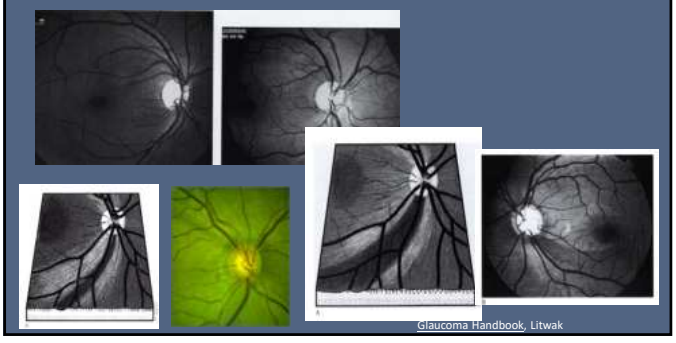
RNFL Drop Out



Glaucoma Handbook, Litwak

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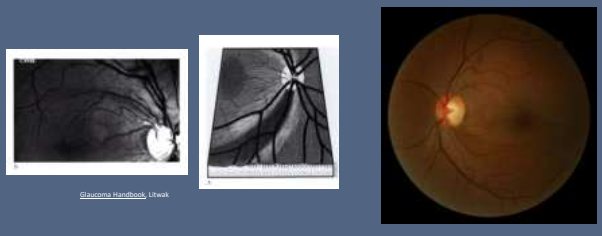
RNFL Drop Out

- Focal Loss (less common): slits and wedges



Glaucoma Handbook, Litwak

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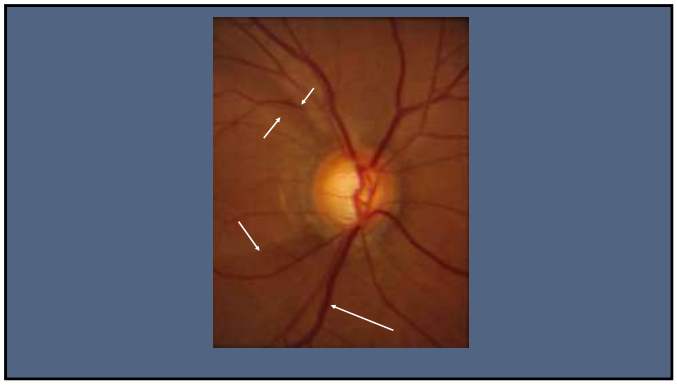

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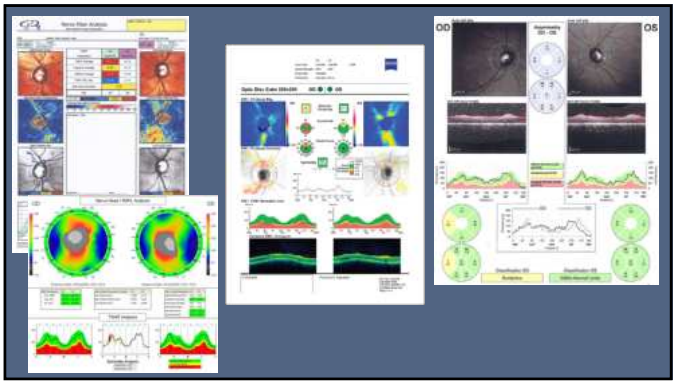

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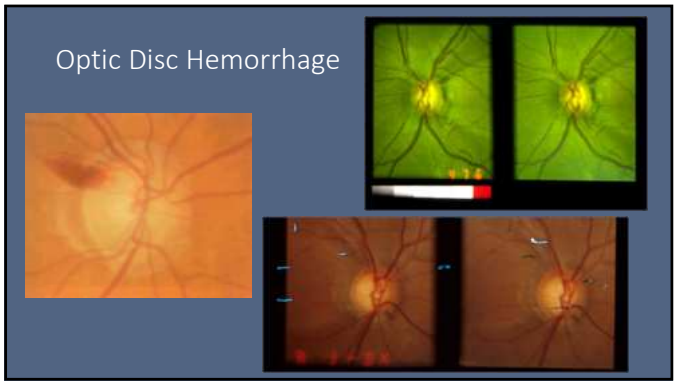

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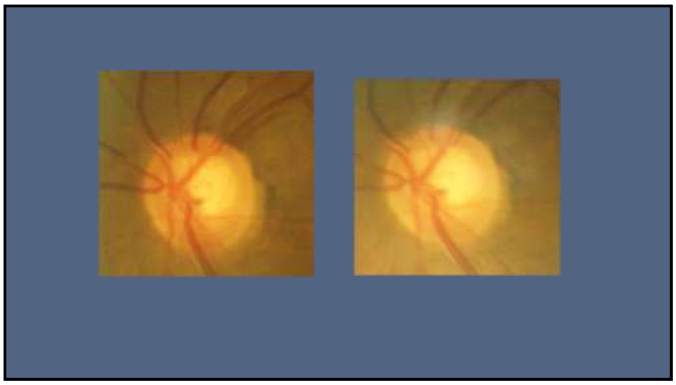

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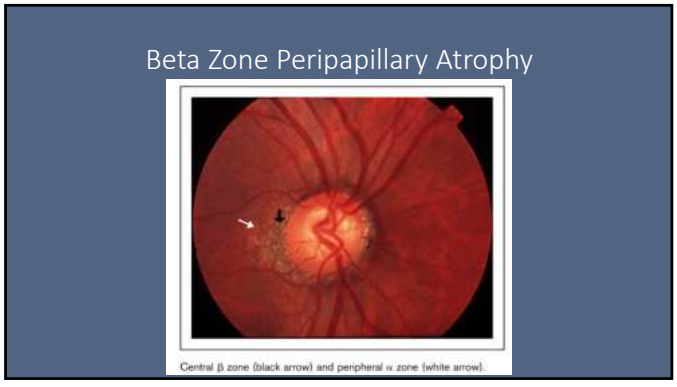

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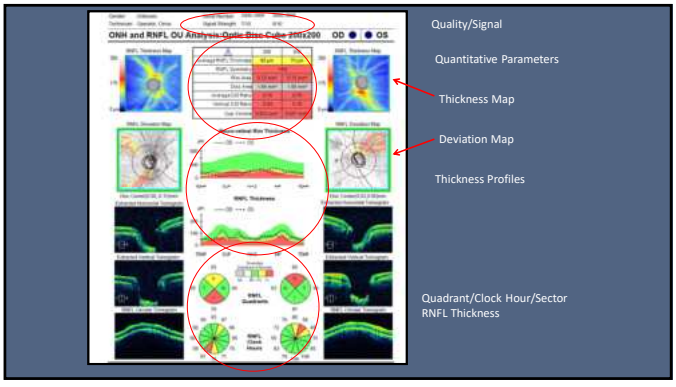

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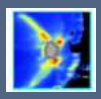
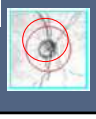
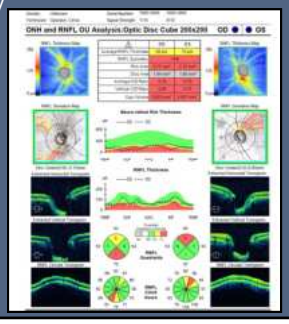
Systematic Strategy

- Quality
  - Signal Strength
  - Circle Placement
  - Movement?

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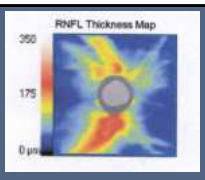
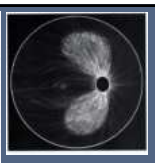
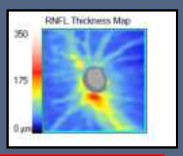
Systematic Strategy

- Thickness Map
- Deviation Map



IMPORTANCE OF BLOOD VESSELS!!!!

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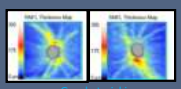
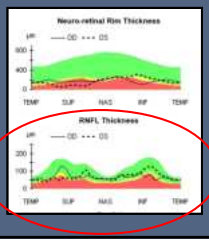
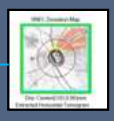
Systematic Strategy

- Thickness Profiles
  - Compared to normative data


Good at picking up notches in NRR





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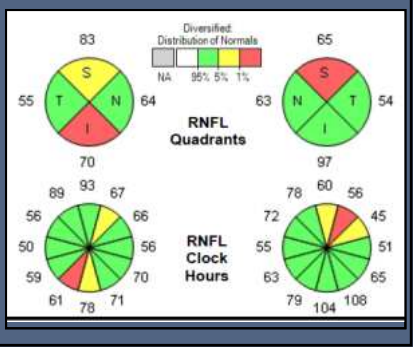
Systematic Strategy

- Quadrant and Clock Hour RNFL analysis



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Systematic Strategy

- Quantitative Parameters
  - Average RNFL
    - Measures average thickness around calculation circle
    - Affected by blood vessels, astrocytes, glial cells
    - Global measure (will miss focal loss)
  - RNFL Symmetry

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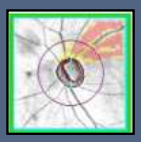
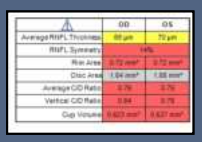
Systematic Strategy

- Quantitative Parameters
  - Rim Area
    - Uses Bruch's membrane as edge of disc
    - Range 0.75-2.38mm (avg 1.31)
  - Disc Area
    - Range 1.06-3.38 mm2 (avg 1.83)
    - Small: <1.63
    - Med 1.63-1.97
    - Large >1.97
  - C/D ratio
  - Cup Volume

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Newest Addition to Glaucoma Diagnosis Arsenal: Macular Imaging

- 1998: Zeimer et al reported on macular thickness loss in patients with known glaucomatous damage
- 2003: Greenfield reported correlation between total macular thickness and MD on VF in glaucoma patients (time domain OCT)
- 2013: Hood et al – extensive investigation of segmented "RGC+" (RGC + IPL) layer and description of the "Macular Vulnerability Zone" (MVZ)

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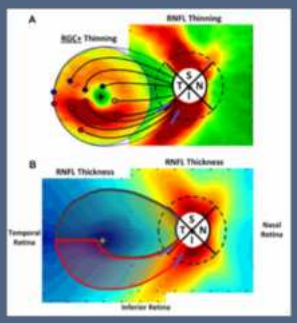

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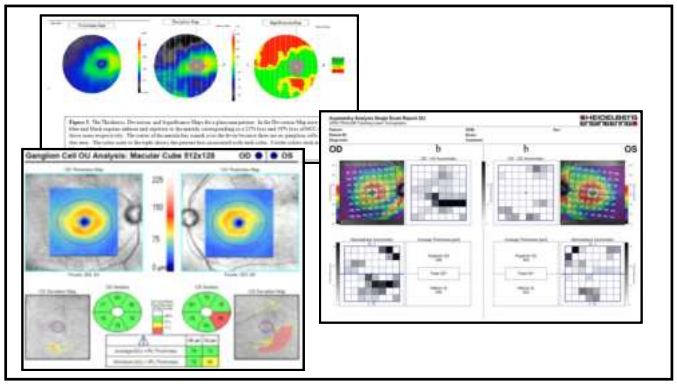

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Advantages of Macular Analysis

- Macula contains ~50% of retinal ganglion cells
  - Glaucoma is a disease of these cells
  - Macular thinning/irregularity cannot be detected during clinical exam
- More reproducible measure (if not using retinal nerve fiber layer) than peripapillary RNFL
  - Fewer blood vessels an other cell components
  - Less anatomic variation compared to optic disc/peripapillary region
- Better superior/inferior symmetry and symmetry between eyes than peripapillary RNFL

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Disadvantages of Macular Imaging

- Macular imaging is not helpful in glaucoma cases in which patients have concurrent macular disease
  - AMD
  - ERM
  - CME
  - DME
  - Macular hole

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What are the most important parameters?

Diagnostic Precision of Retinal Nerve Fiber Layer and Macular Thickness Asymmetry Parameters for Identifying Early Primary Open-Angle Glaucoma

MICHAEL SULLIVAN-MEE, CLAUDIA C. BUEGG, DENISE PENSYL, KATHY HALVERSON, AND CLIFFORD QUALLS

American Journal of Ophthalmology September 2013

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Most Important Diagnostic Parameters

- Intereye (OD/OS) macular thickness asymmetry 5 microns
- Intraeye (sup/inf of same eye) macular thickness 9 microns
- Intereye (OD/OS) average RNFL thickness 9 microns
- Total RNFL thickness 78 microns or less

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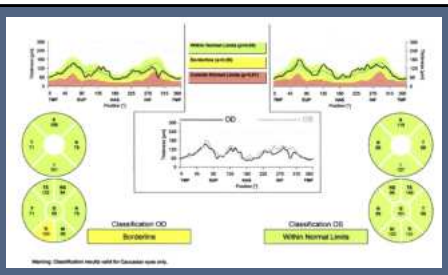

Intereye (OD/OS) asymmetry of global RNFL = 11 microns (9*)

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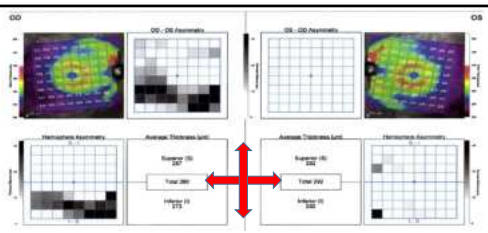

Intereye (OD/OS) macular thickness asymmetry = 12 microns (5*)

Intra eye (sup/inf) asymmetry OD = 14 microns (9*)
Intra eye (sup/inf) asymmetry OS = 0 microns (9*)

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Case: Leo

- 71yo AAM
- Referral for glaucoma suspicion, based on age/race/IOP
- POH: Unremarkable
- PMH: (+) DM2 and HTN
- FOH: Unremarkable
- VA: 20/20 OD, OS
- SLE: Normal OU, mild cataract OU
- IOP: 23mmHg OD, OS
- CCT: 587 microns OD 582microns OS

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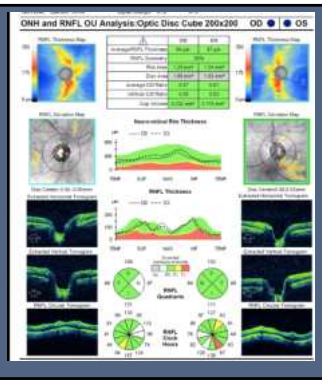

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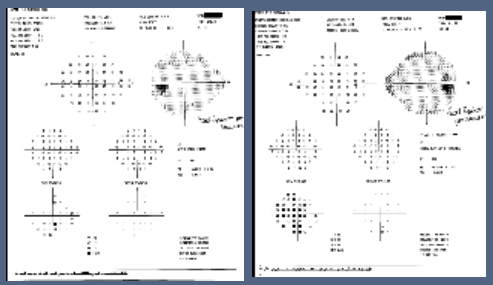

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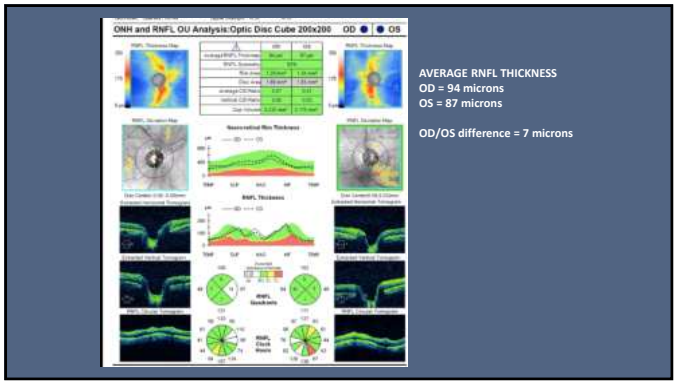

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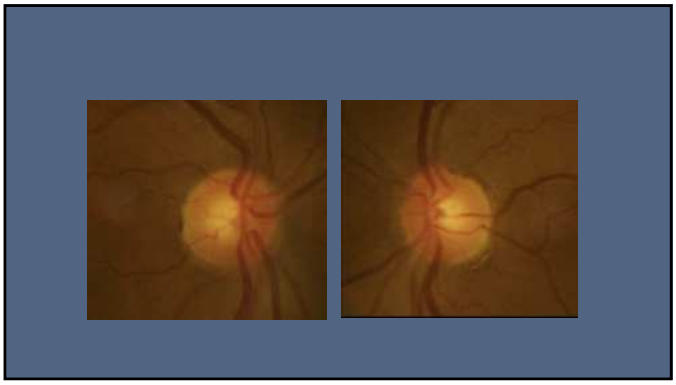

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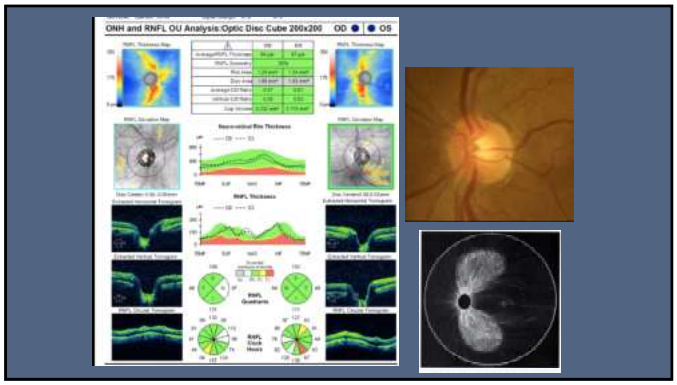

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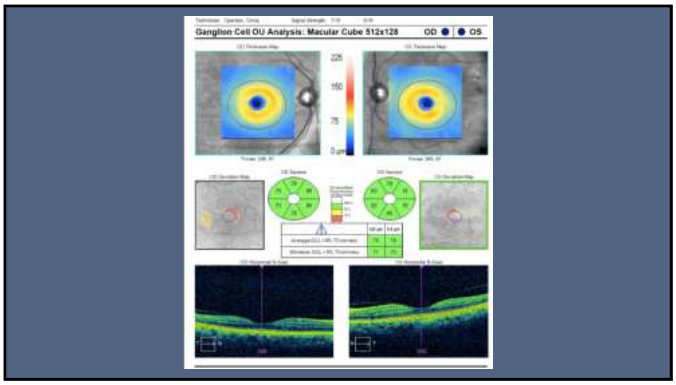

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Case: Tony

- 51yo hypertensive HM
- POH: LASIK OU (2000) , PRK OS (2014)
- FH: (+) glaucoma – grandmother

- BCVA: 20/20 OD, OS
- Pupils, motility, CVF: Full OD, OS
- Slit Lamp Exam: LASIK flaps OU, otherwise nl
- Angles: open to CB 360 OU
- Tmax: 17mmHg OU
- CCT: 523 OD 489 OS

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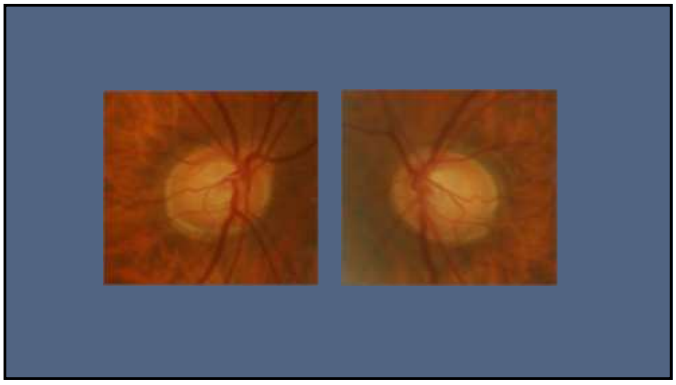

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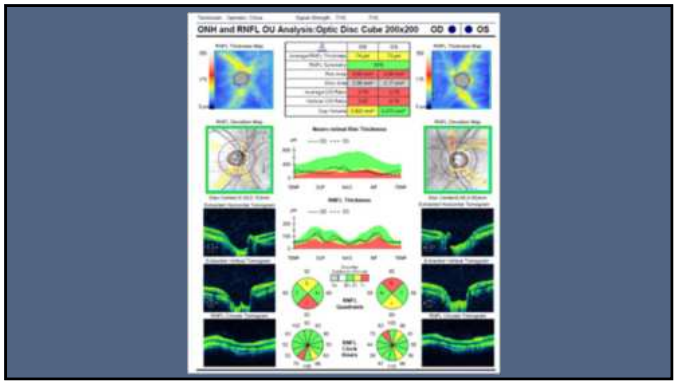

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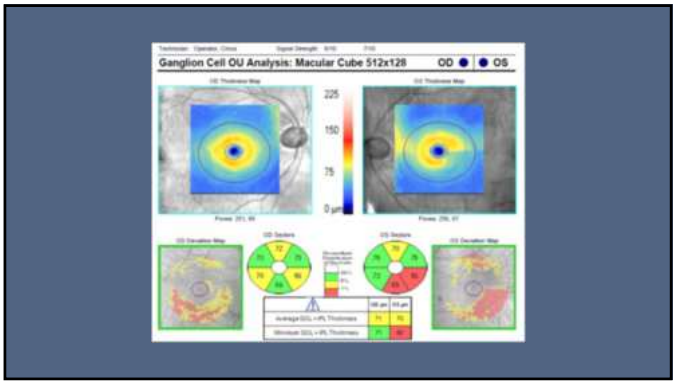

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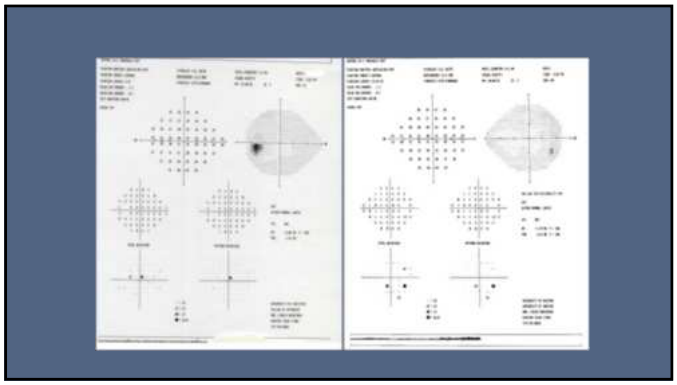

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What about the 10-2 VF?

- Central 8 degrees from the center of the foveal contains more than 30% of retinal ganglion cells
- 24-2 and 30-2 test strategies use a 6 degree test grid pattern; these points fall outside of the densist region of ganglion cells
- 10-2 test strategy uses a 2 degree test grid
- Recent research has shown that in some patients with small regions of macular gangion cell loss, 10-2 testing may be better able to detect VF loss

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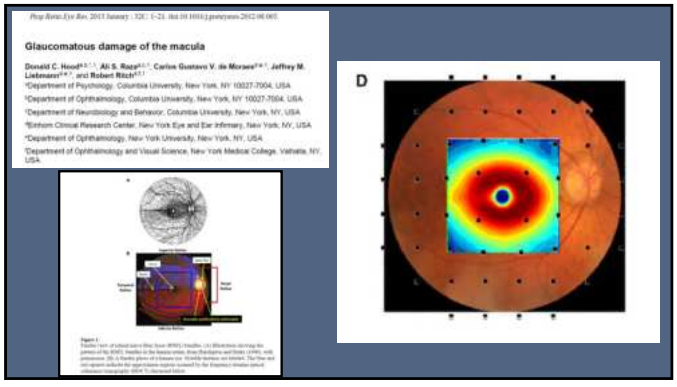

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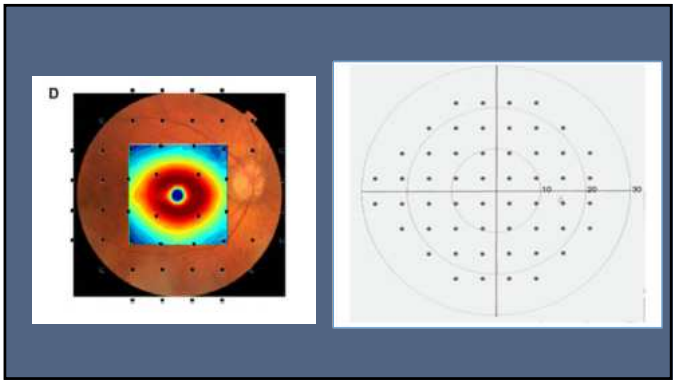

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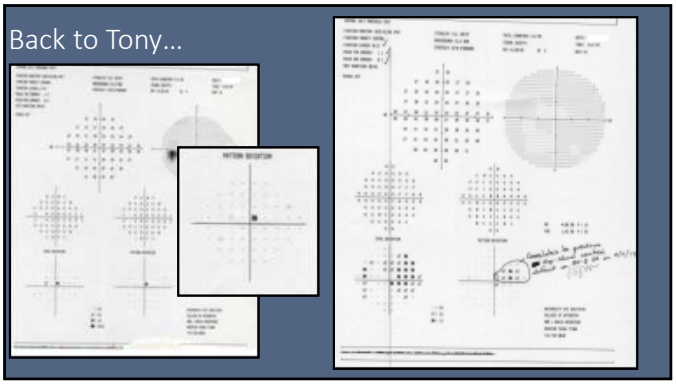
Back to Tony…



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Resulting SITA Faster 24-2C Pattern on HFA3

The 24-2C test pattern combines all 24-2 points + ten selected 10-2 points (shown in OD orientation)

Large Gray	24-2 pattern
Large Orange	Ten additional 24-2C points
Small Gray	10-2 pattern

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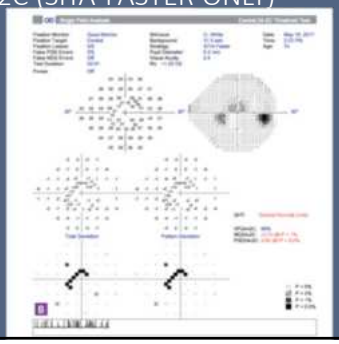
24-2C (SITA-FASTER ONLY)



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Macular Damage in Glaucoma (Take Home Message)

- Glaucoma damage to the macula is common
- Glaucoma damage to the macula can occur early in the disease
- Glaucoma damage to the macula is not visible on CLINICAL exam
- Glaucoma damage to the macula can be missed and/or underestimated by the standard 24-2 or 30-2 test grid
- ***New test patterns by perimetry manufacturers!!!

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Headset Perimetry

- Portable
- Less Expensive
- Challenges

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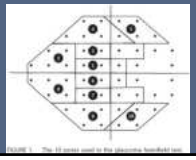
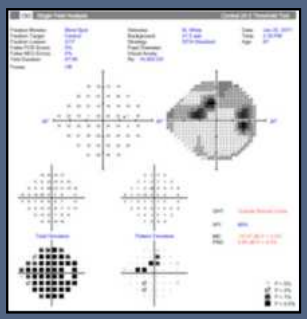
The Dreaded Visual Field

- Quick and Easy Strategy:
  - Reliability
  - Grayscale
  - Deviation Plots**
  - Global Indices – statistical significance?
  - Glaucoma Hemifield Test (GHT)





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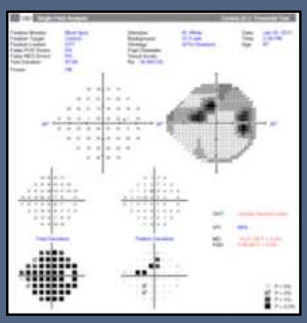

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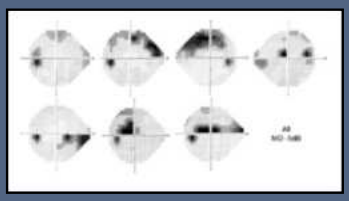
What are we looking for?

- Asymmetry superior-inferior
- Respect horizontal midline
- "point" back to blind spot
- Common nasal, arcuate bundle, paracentral



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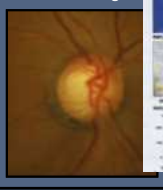
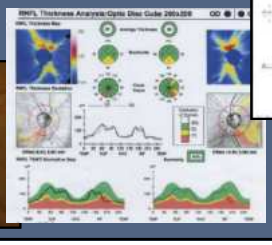
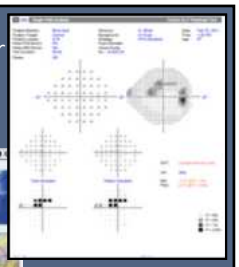
Putting It All Together

- Easy Diagnosis:
  - Elevated IOP
  - Structural changes
    - ONH findings
    - OCT findings
  - Functional changes







IOP 26mmHg

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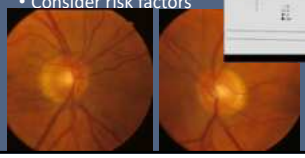
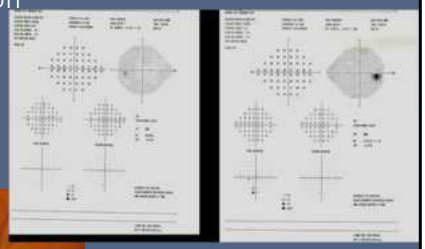
Ocular Hypertension

- Elevated IOP
- No structural changes
- No functional changes
- Consider risk factors





IOP 28mmHg OD, OS

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Trickier…

- Normal IOP + structural and/or functional changes
  - Artifact/learning curve and/or anomalous (not pathologic) findings
    - REPEAT TESTING
  - Glaucoma (NTG or POAG with undiscovered/masked IOP)
    - REPEAT TESTING, MULTIPLE IOP READINGS
  - Non-glaucomatous, but real damage
    - BRAO, isolated ischemic event (hypovolemic crisis)
    - Repeat testing, watch for progression before treating

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Somewhere in the middle

- IOP borderline/slightly elevated
- Questionable changes structure/function
- KEY: Corroboration of evidence
- If not enough evidence, watch for progression/declaration
  - Establish good baseline
  - Follow with repeat testing at appropriate intervals

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Thank You For Your Attention!

Questions?
Email: dmarrelli@uh.edu

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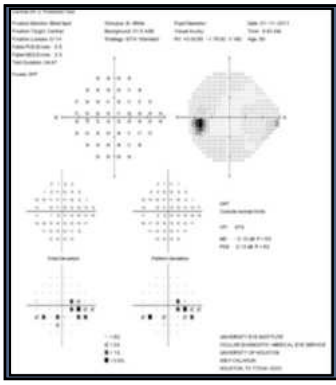

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