The Glaucoma Puzzle: When the Pieces Don't Always Fit



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Mark Dunbar: Disclosure 2025-2026

- Optometry Consultant/Advisory Board
  - Carl Zeiss
  - Tarsus
  - Orasis
  - Astella
  - Apellis
  - Azura
  - Sun
  - B&L
  - Topcon
  - Visus
  - Sydnexis
  - Cloudbreak
  - Tenpoint

2

Why does glaucoma matter?

3

Glaucoma: 2nd leading cause of blindness in developed nations[1]

~40%
of patients have **moderate-to-severe visual field loss** by the time they are diagnosed[2]

~10%
of people with glaucoma lose vision over time, even if they are treated[3]

1. NEI/NIH.10 Things you should know about glaucoma. 2017. Available at https://nei.nih.gov/10things/you-should-know-about-glaucoma.
2. Gillespie BW, et al. *Invest Ophthalmol Vis Sci.* 2003;44:2613-2620. 3. GAO. Glaucoma Facts and Stats. Available at https://www.glaucoma.org/glaucoma/diagnosing-glaucoma-facts-and-stats.php.

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Underdiagnoses of Open-Angle Glaucoma

- Population studies suggest **over half** of all glaucoma cases in the US have not been diagnosed
  - Percentage of patients with undiagnosed glaucoma
    - Baltimore Eye Survey: 56%[1]
    - Proyecto VER: 62%[2]
- Many suffer severe visual field (VF) loss before diagnosis[3]

1. Sommer et al. *Arch Ophthalmol.* 1991.
2. Quigley et al. *Arch Ophthalmol.* 2001.
3. Gillespie et al. *Invest Ophthalmol Vis Sci.* 2003.

5

More People Will Need Help Lowering IOP Due to a Growing and Aging Population

- The US population is aging

10,000 people will turn 65 every day through 2030[2]

Patient populations who have higher risk of glaucoma will also be increasing[3]

African-American and Hispanic populations: Projected to increase from **17%** of the US population in 2012 to **34%** by 2050[3]

1. Colby SL, Ortman JM. US Census Bureau. 2015. Available at https://www.census.gov/content/dam/Census/library/publications/2015/demo/p25-1143.pdf. 2. Pew Research Center. 2010. Available at http://www.pewresearch.org/fact-tank/2014/02/24/baby-boomers-retire/. 3. Liu H, et al. Forecasts of glaucoma prevalence in the US. Available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3111613/table/T1/?report=objectonly. Accessed December 2, 2014.

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The Glaucoma Puzzle



- Why do people develop glaucoma?
  - Variable factors that put patients at risk for glaucoma
- How we diagnosis it?
  - When is it glaucoma?
  - isn't always straight forward



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How do we diagnose glaucoma?



- Measure the IOP
  - Is it normal?
    - Traditionally 10-21 mmHg
  - Is it elevated?
- Look at the optic nerve
  - Does it look normal?
  - Is there "cupping?
  - Is there asymmetry between the R and L eye?



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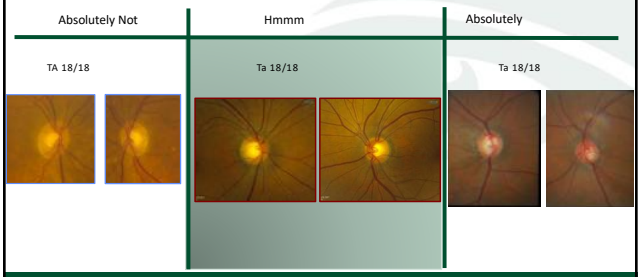
The Glaucoma Suspect

- Elevated IOP or
- Large or asymmetric optic cups

- Presence of a disc margin splinter hemorrhage
- Unexplained visual field defect consistent with glaucoma
- Strong family history of glaucoma

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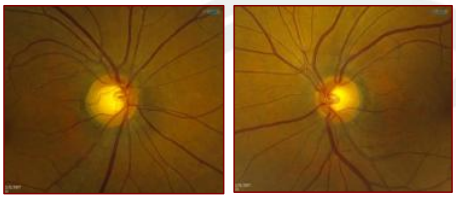
When is it glaucoma?



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Difference in the Size Between Each Eye

Berta: 65 y/o Hispanic Female: Followed for OHTN

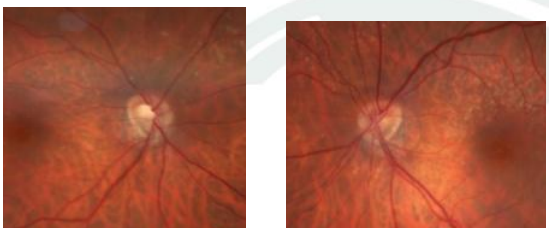


2005-2014: TA 20-24

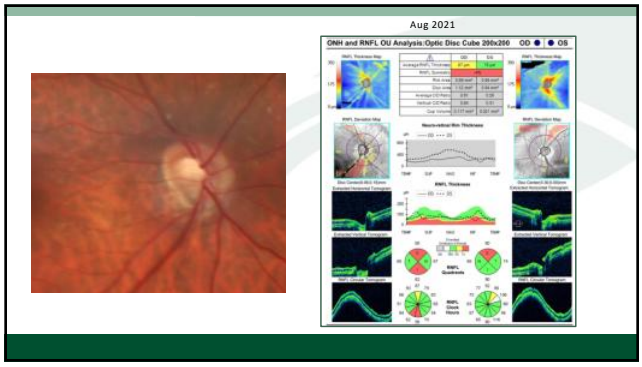
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81 yo White Male: GL Suspect Based on ON

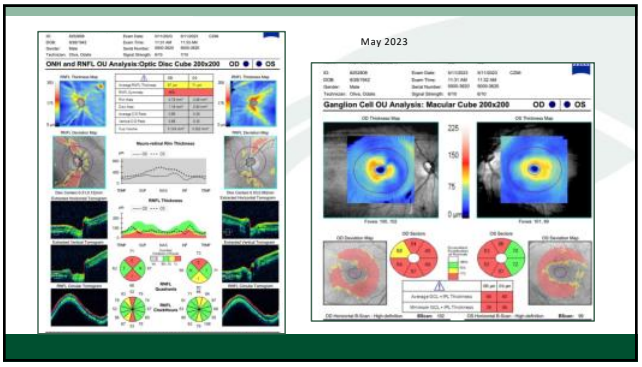
TA: 12-18



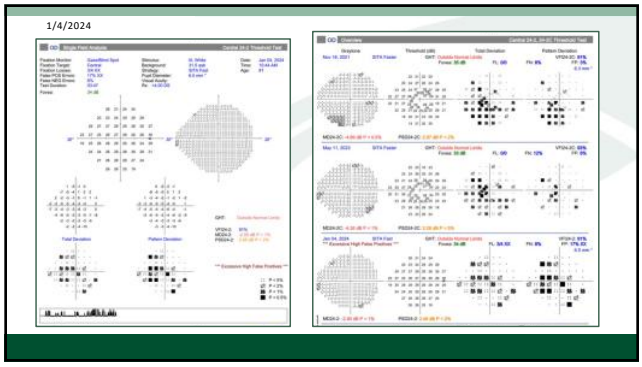
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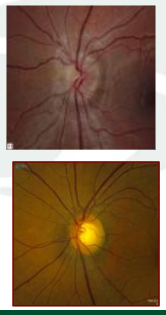
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Optic Nerve Cup

- Highly variable even in normal patients
- Most people are 0.3 to 0.4
  - Jonas **V:** 0.42 (0 - .79); **H:** 0.50 (0 - .84)
- Racial differences in disc size
  - Baltimore .56 (blacks) .49 (whites)
- Larger discs larger cups



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Here are the difficulties?

- Individual variability of the optic nerve



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Physiologic vs. GL Damage

Physiologic

- Smaller
- Horizontally oval
- Uniform rim
- Similiar to shape of nerve
- R=L

GL Cupping

- Larger
- Vertically oval
- Non uniform rim
- May be asymmetric

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Classic Findings Suggestive of Glaucoma

- Obvious large cup
- Vertical elongation of the cup
- Focal Notch
- Thinning of neuroretinal rim
- Superficial splinter hemorrhage
- Baring of vessels
- Cup/disc ratio asymmetry



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How do we diagnose it?

If we are suspicious or concerned…

- OCT: RNFL and ganglion cell layer
- Visual field
- Fundus photograph

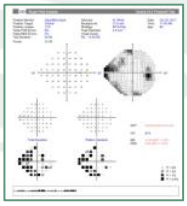
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Diagnosing Glaucoma Until 2000

- Stereoscopic evaluation of the optic nerve







- Goldmann visual field -> Automatic visual fields
  - Humphrey visual fields

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How do you handle a problem like Maria…

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57 yo Haitian Female

2009

- Exam for refractive needs – computer glasses
- Has been considered a glaucoma suspect
- Father was blind from glaucoma
- VA: 20/20
- TA 19/16
- Pach: 525 u

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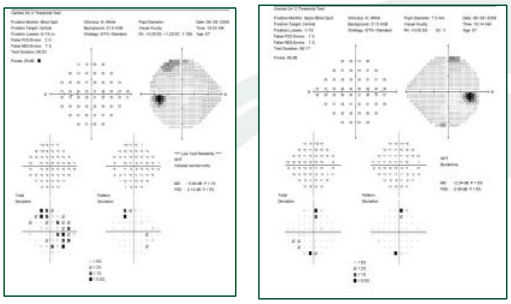




8/23/2009

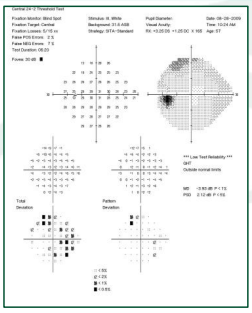
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2009



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Diagnosed as Glaucoma Suspect

- Observed -> No Treatment

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Fast Forward 2013

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11/4/2013: Ta 14/13

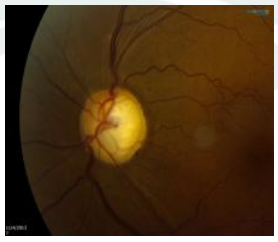


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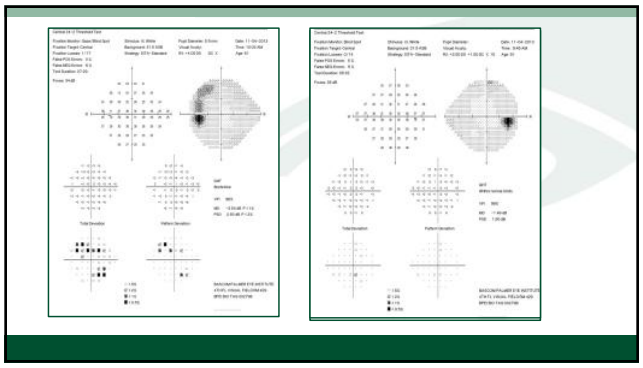
2009



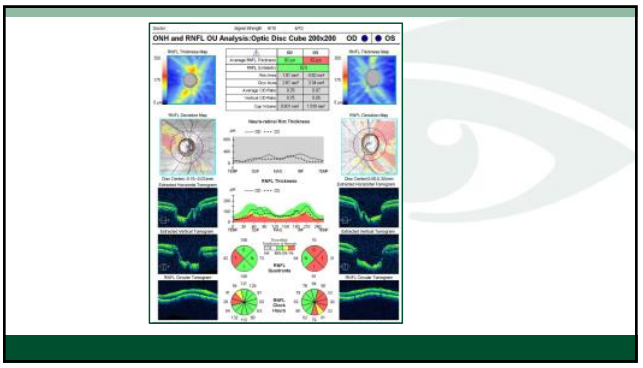
2013



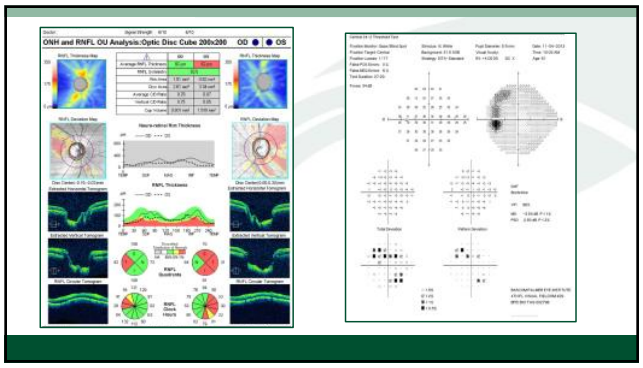
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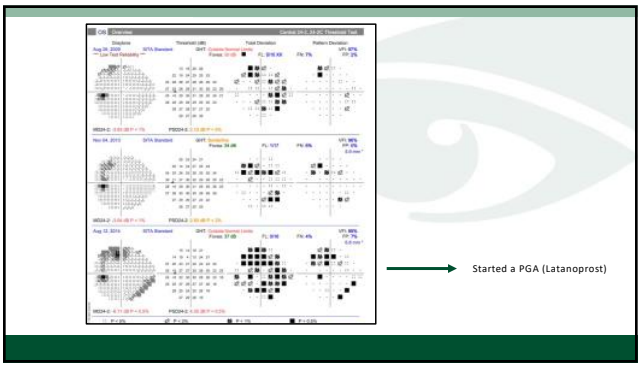
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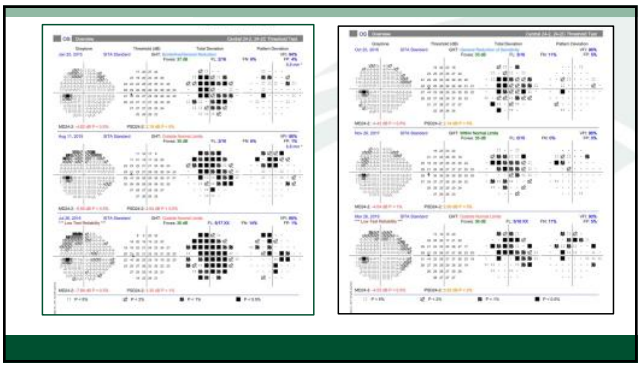
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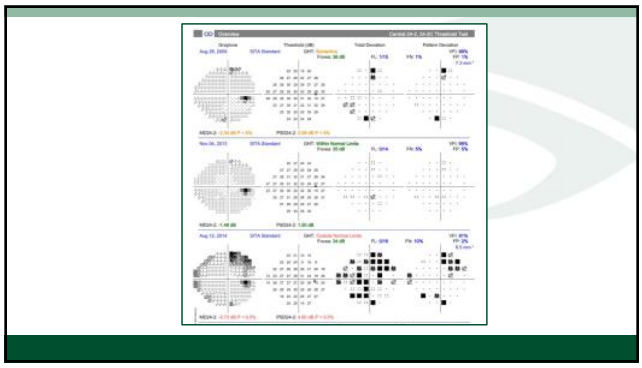
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Do you think Maria has glaucoma?

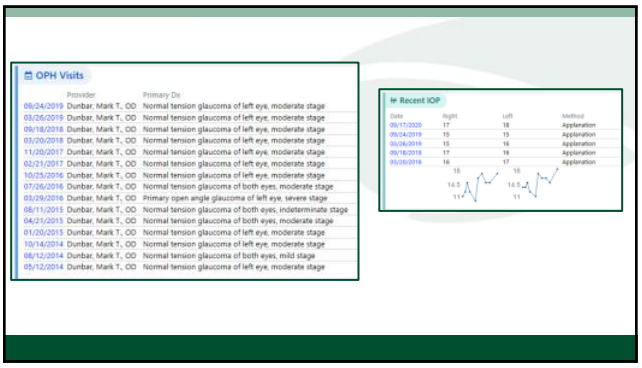
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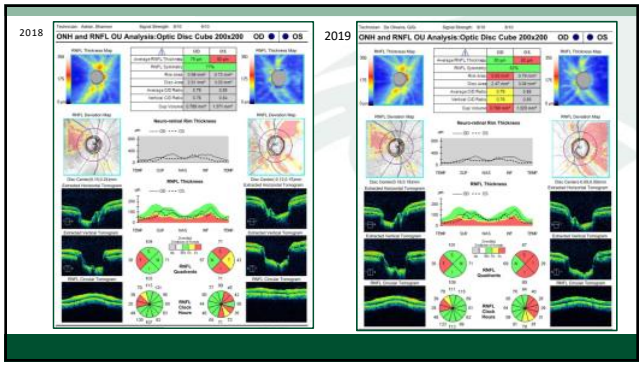
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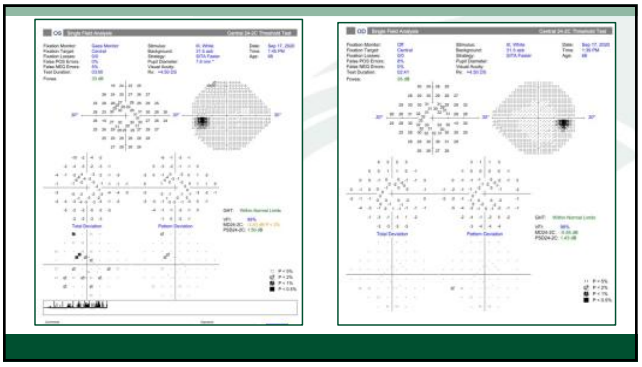
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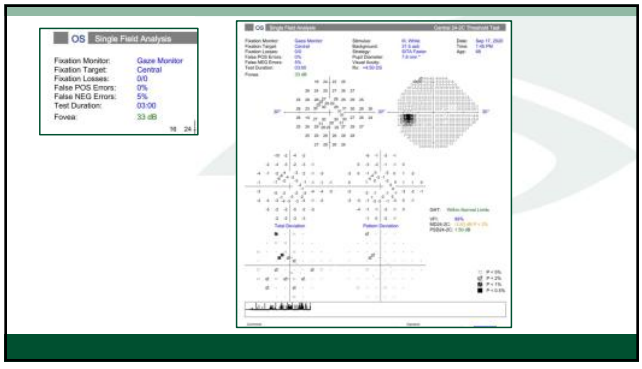
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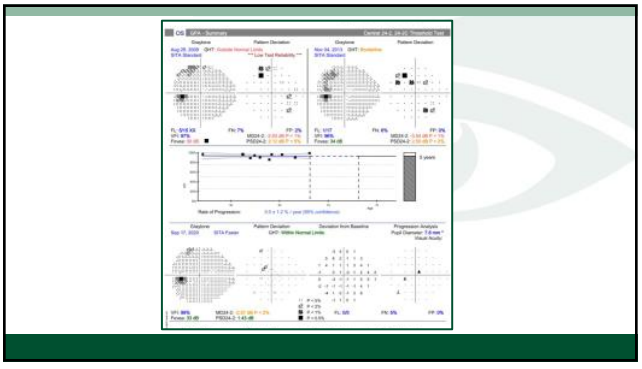
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Does she have glaucoma?

Does she need to be treated?

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80 yo White Female

- Presented for “annual eye exam”

HPI

80 yrs old, female New Patient here for annual check

Feels vision at distance was not as good as it has been, especially the LE

She uses glasses to see small prints, reports good vision at distance OU.
Denies pain, floaters or flashes of light.
S/p: CEIOL OU, YAG laser posterior capsulotomy OD (Baptist Hospital)
LEE: 02/2017 by M.D (w/DFE)

Mom had glaucoma and used drops

Generally does not wear glasses for driving

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80 yo White Female

Oct 2017

Base Eye Exam

Visual Acuity (Snellen - Linear)

	Right	Left
Dist sc	20/30 -1	20/30 -1
Dist ph sc	20/30+2	NI
Near sc	J3	J2
Near cc	J1+	J1+

Correction: Glasses

Tonometry (Tonopen, 10:00 AM)

	Right	Left
Pressure	15	15

Pupils

Pupils equally round reactive to light
No APD

Visual Fields (Counting fingers)

	Left	Right
Result	Full	Full

Extraocular Movement

	Right	Left
Result	Full, Ortho	Full, Ortho

Neuro/Psych

Oriented x3: Yes
Mood/Affect: Normal

Refraction

Wearing Rx

	Sphere	Cylinder
Right	+3.00	Sphere
Left	+3.00	Sphere

Type: SVL(near)

Cycloplegic Refraction

	Sphere	Cylinder	Axis	Dist	Add
Right	-1.00	+0.75	104	20/20	+2.75
Left	-1.00	+0.50	119	20/20	+2.75

Manifest Refraction

	Sphere	Cylinder	Dist	Add	Near
Right	+0.00	+0.00	20/30-1	+3.00	20/20
Left	+0.00	+0.00	20/30-1	+3.00	20/20

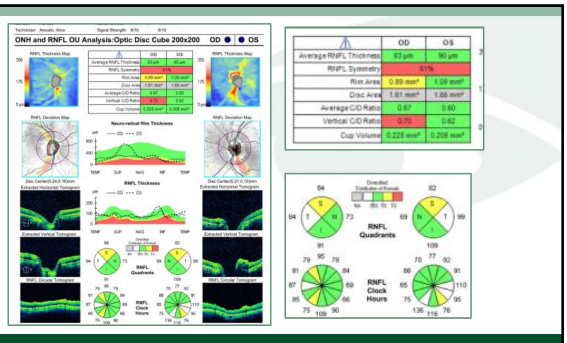
Final Rx

	Sphere	Cylinder	Axis	Add
Right	-1.00	+0.75	104	+2.75
Left	-1.00	+0.50	119	+2.75

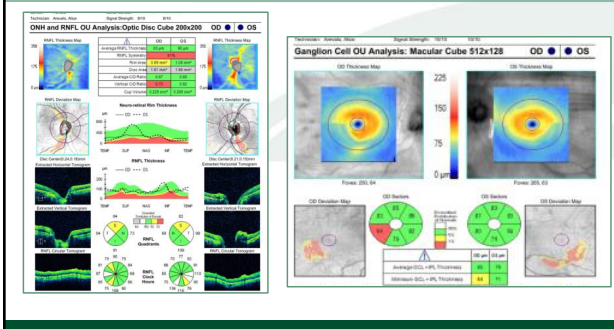
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So now what?

Is this low/normal tension glaucoma?

Would you begin treatment today?

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This is what I did…

Impression
1) Probable Normal Tension Glaucoma OU
   Inferior thinning OU
   Disc hemorrhage RE inferior
   OCT and GCC thin corresponding to clinical presentation
   TA ~ 15 OU
2) Pseudophakia OU
3) PVD OU

Plan
1) Ed and reassure
2) RTC 1-2 weeks for VF and IOP measurement
3) Will start Tx at next visit
4) Rx given for specs

50

1 week later: 10/25/17

Base Eye Exam

Visual Acuity (Snellen - Linear)

	Right	Left	Both
Dist cc	20/20	20/20 -2	20/20
Dist ph cc		NI	

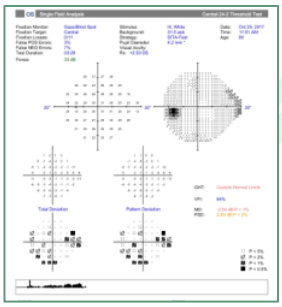
Tonometry (Tonopen, 12:06 PM)

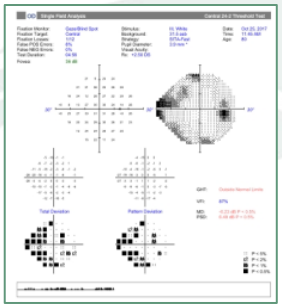
	Right	Left
Pressure	15	14

Pupils
OU: 3/2 mm, round, reactive to light
No APD seen

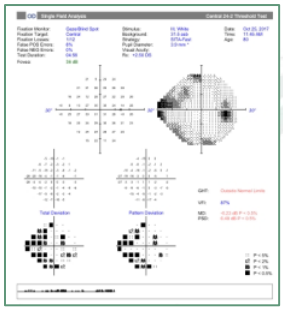
Neuro/Psych
Oriented x3: Yes
Mood/Affect: Normal

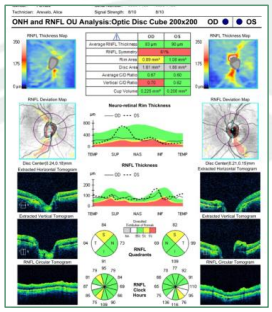
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Putting the Pieces of the Puzzle Together…

- The IOP is normal
- Abnormal optic nerve
  - Disc hemorrhage
- OCT shows RNFL thinning
  - Ganglion cell complex also shows thinning
- Visual field defect in a location where we see ON damage



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How do you manage this patient?

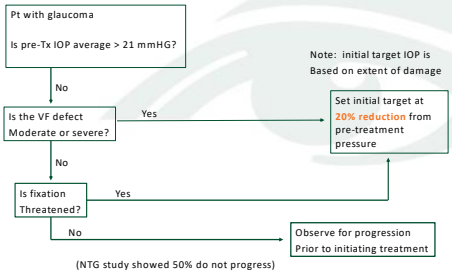
Normal Tension Glaucoma

Treatment?

- This is what I did
  - Latanoprost qhs OU
  - RTC 3 months
    - Should I bring her back sooner to check IOP?

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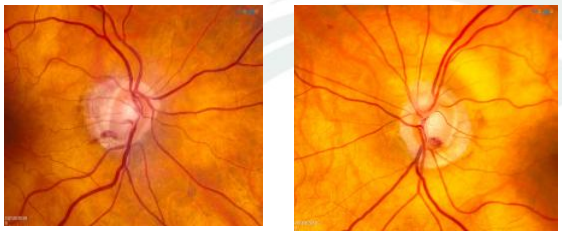
Setting an Initial Target Pressure: Normal Tension Glaucoma



(NTG study showed 50% do not progress)

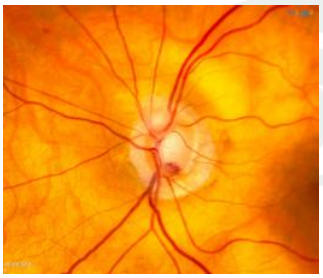
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This was her Oct 2018…



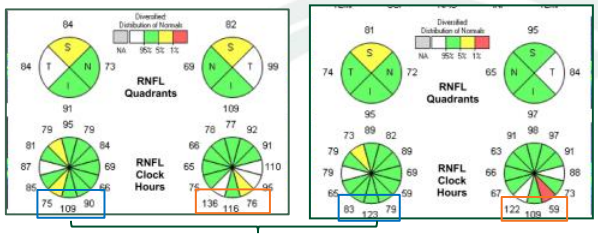
TA 12 OU

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Oct 2017 Oct 2018



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Where to we stand?

- NTG R>L Dx 1 year earlier
  - RE: Moderate GL
  - LE: Mild GL
- Put on a PGA with "good" IOP response
- But on follow up presents with disc hemorrhage in both eyes
- The OCT RNFL is not worse -> stable

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What would you do now?

1. Simply observe – come back in 3-4 months
2. Add a 2nd medication
3. Add a combination medication
4. Refer for SLT

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A Few Thoughts on Disc Heme





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In the OHTS Study what percentage of disc hemorrhages were MISSED by the doctor?

1. 24%
2. 44%
3. 64%
4. 84%

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Detection and Prognostic Significance of Optic Disc Hemorrhages during the Ocular Hypertension Treatment Study

Donald L. Budenz, MD, MPH,[2] Douglas R. Anderson, MD,[1] William J. Feuer, MS,[1] Julia A. Beiser, MS,[2] Joyce Schiffman, MS,[1] Richard K. Parrish II, MD,[1] Judy R. Piltz-Seymour, MD,[3] Mae O. Gordon, PhD,[2] Michael A. Kass, MD,[2] Ocular Hypertension Treatment Study Group

- Disc hemorrhages detected in 128 eyes of 123 participants
- 21 cases detected by both doctor and photos
- **107 cases (84%) were detected only by a review of photography**

Ophthalmology Dec 2006

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Of Note:

glaucoma, and smoking status. The occurrence of a disc hemorrhage increased the risk of developing POAG 6-fold in a univariate analysis (P<0.001; 95% confidence interval, 3.6–10.1) and 3.7-fold in a multivariate analysis that included baseline factors predictive of POAG (P<0.001; 95% confidence interval, 2.1–6.6). The 96-month cumulative incidence of POAG in the eyes without optic disc hemorrhage was 5.2%, compared with 13.6% in the eyes with optic disc hemorrhage. In eyes with a disc hemorrhage in which a POAG end point developed, the median time between the 2 events was 13 months.

Incidence of Progressing to POAG

- No Disc Heme: 5.2%
- **+ Disc Heme: 13.6% -> at 10 years 25.6% vs. 13%**
- Presence of a disc heme increase risk of developing POAG 6 fold

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13 Year Follow Up of Disc Hemorrhages in the OHTS

- ODH 179 eyes of 169 participants
- Incidence of POAG in eyes with ODH was **25.6% vs. 12.9%** in eyes without ODH
- ODH increased the risk of developing POAG
- Risk Factors for ODH:
  - Older age, thinner central corneal thickness, larger vertical cup to disc ratio, higher intraocular pressure, and self-reported black race

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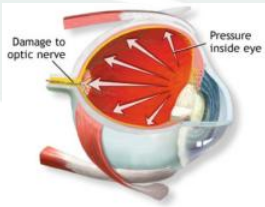
Perhaps the Bigger Question?

- How is it that a patient can continue to "progress" or develop a disc hemorrhage with a pressure ~ 12?
- What are the factors that result in progression?

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Does Pressure Matter?

- Collective experience tells us yes
- Experience higher IOP more damage
  - Unilateral cases or monocular pressure elevation
  - Asymmetric IOP with asymmetric damage
- Literature shows more stability with lower and more stable IOP control; more progression with higher IOP
- IOP not the best tool to diagnose but is a consideration

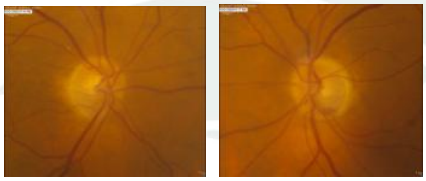


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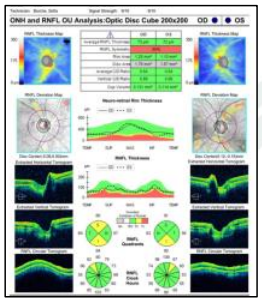
85 yo White Male

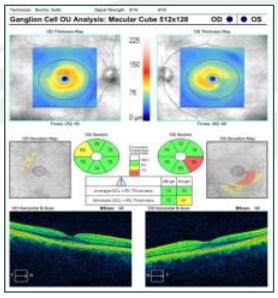
Oct 21, 2020

- Annual Visit
- Not seeing as well
- BCVA: 20/25 OU
- 1+ NSC OU
- Ta: 11/13

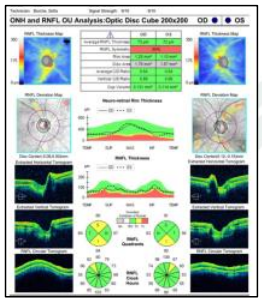


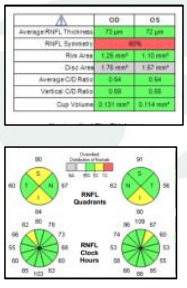
69





70





71

85 yo: Disc hemorrhage LE and low IOP

Your move:

- Treat or observe?
- Bring him back for a VF and an IOP check?

72

85 yo: Disc hemorrhage LE and low IOP

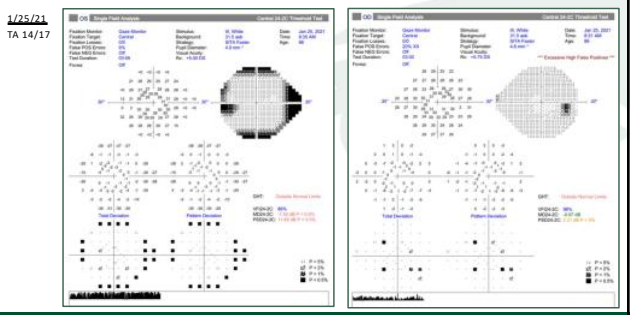
Your move:

- Treat or observe?
- Bring him back for a VF and an IOP check?

This is what I did…

- RTC 3 mo for IOP check and VF

73



74

Some thoughts…

- Disc heme in the LE inferior
- But OCT LE shows thinning superior
  - Overall LE seem thin
- VF shows general depression
  - but no corresponding field defect
  - Poor congruity

75

So what do you do…how do you manage him?

- Treat or not treat?

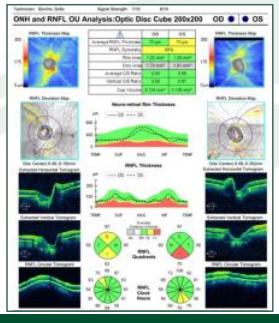
This is what I did…

- Started Latanoprost qhs LE

76

7/21/21

- Va: 20/25
- Latanoprost LE qhs
- Ta: 15/16



77

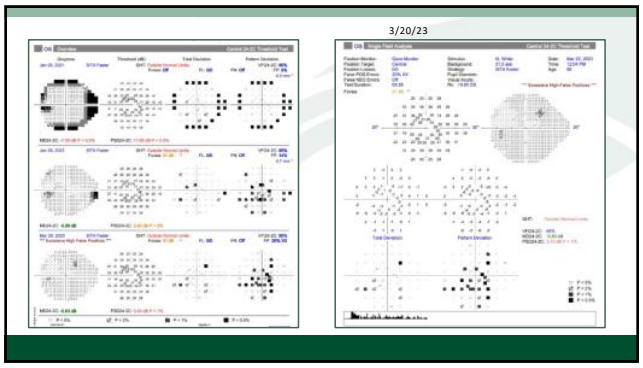
My Thoughts…

- Why is the pressure not lower…?
- I think the OCT is basically stable
  - But I don't think there has been enough time to determine change

Ultimately – I wish I wouldn't have started treatment

Do we keep him on the latanoprost, switch or stop…?

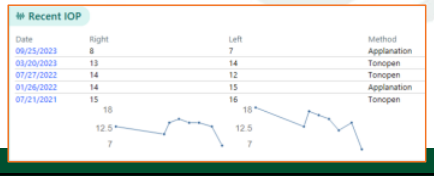
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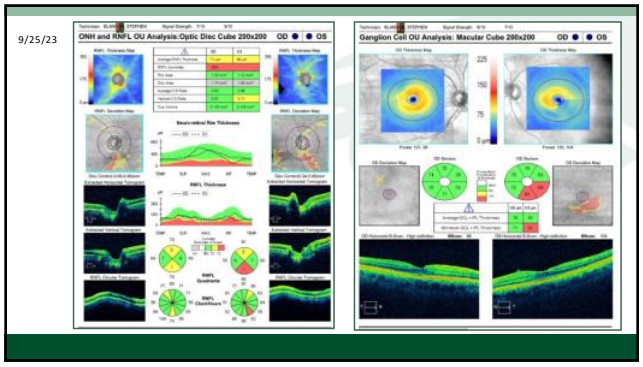
79

Fast Forward Sept 2023

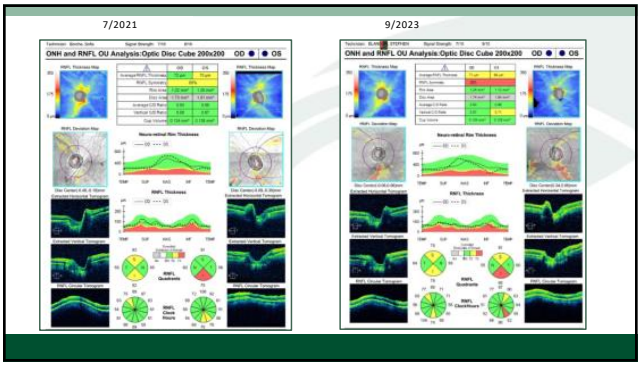
- New Disc heme LE
- Tap: 8/7
  - March 2023 Ta 13/14



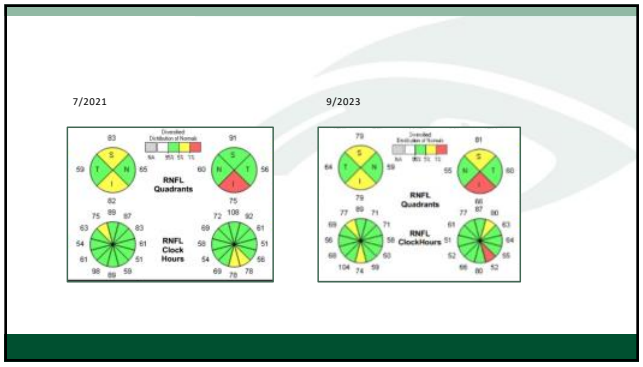
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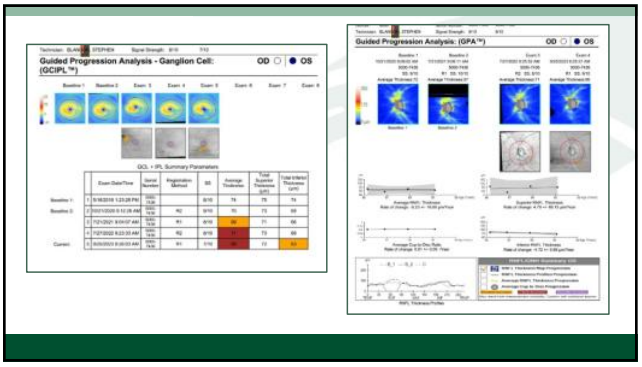
81



82



83



84

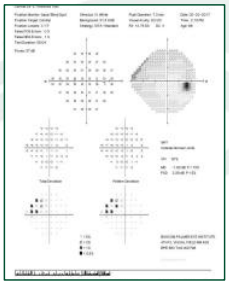
Assessment
1) NTG suspect based on **disc heme LE Oct 2020**
Seen 9/25/23: New disc heme LE
OCT RNFL and GCC done: Is stable vs. 2022 and 2021 scans
Has corresponding Inf RNFL thinning and slight CD asymmetry L>R
Good IOP on Latanoprost LE only
TA Better IOP LE on Latanoprost (9/8)
VF: RE stable, non specific, LE central depression stable
Does not fit with OCT
Never elevated IOP.
Could consider following without Meds but will not

Plan
1) Ed and reassure
2) Continue with latanoprost qhs LE
Refill provided
3) RTC 6 mo: dilate and VF at next visit t

85

Visual Field

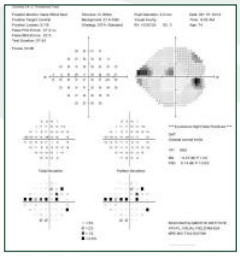
- Various testing methods
- Standard automated perimetry
  - SAP or White on White most commonly used
- It is a difficult test to perform
- It relies on the patient being able to provide subjective input on what they see
  - Many patients have extreme difficulties



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Some Things to Keep in Mind

- GL visual field loss shows more variability than normal fields
- There tends to be **high variability and reductions in sensitivity preceding definite field loss**
- **Local depressions** of sensitivity frequently **come and go** before finally resolving into stable repeatable VF defects

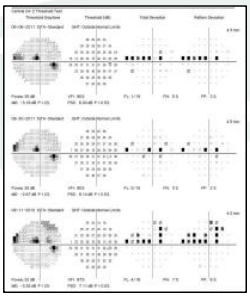


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Visual Fields and Glaucoma

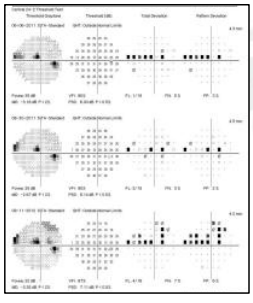
- Visual fields can be **difficult** to perform
- Visual fields can be **variable**
  - Some days better and some days worse
- Determining progression can be very difficult
  - Because of long term fluctuations

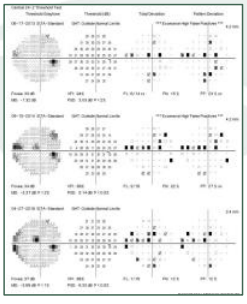
Are they progressing?



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Are they progressing?

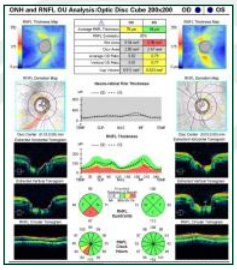




89

OCT: The missing piece of the puzzle?





90

The OCT can show glaucomatous change
BEFORE it is seen on visual fields

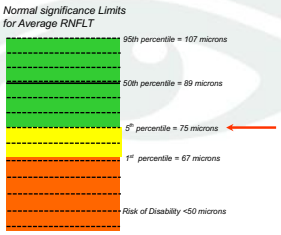
91

There is a Large "Range" of Normal

- *Just like perimetry, the average patient can lose a third of his/her RNFL or neuro-retinal rim and still be inside the normal range.*

Average RNFL Thickness
75 microns – tipping point

Floor Affect in Advanced Glaucoma
40-50 microns



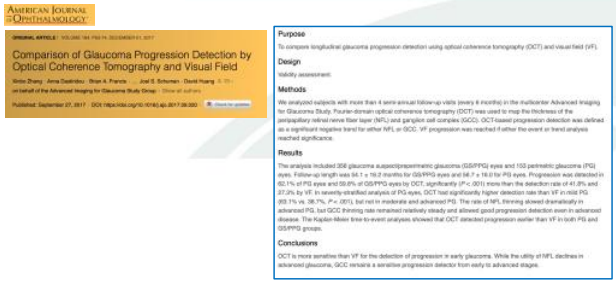
92

Estimating the Lead Time Gained by Optical Coherence Tomography in Detecting Glaucoma before Development of Visual Field Defects

Tammy M. Kuang, MD,[1,2,3] Chaowei Zhang, MD,[1,4] Linda M. Zangwill, PhD,[1] Robert N. Weinreb, MD,[1] Felipe A. Medeiros, MD, PhD[1]

- At 95% specificity, up to **35% of eyes had abnormal average RNFL thickness** 4 years before development of visual field loss and **19% of eyes had abnormal results 8 years before field loss**.
- **Conclusions:** Assessment of RNFL thickness with OCT was able to detect glaucomatous damage before the appearance of VF defects on SAP. In many subjects, significantly large lead times were seen when applying OCT as an ancillary diagnostic tool.

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94

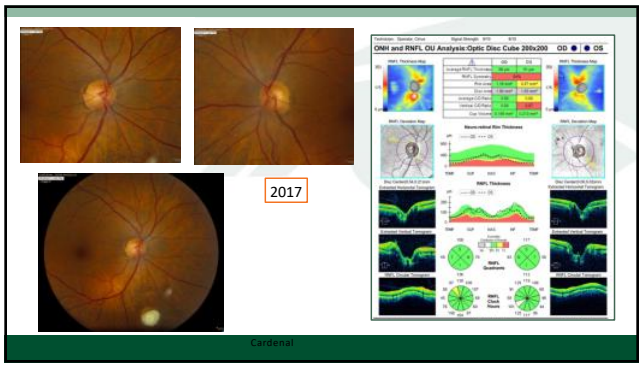
When is it glaucoma?

95

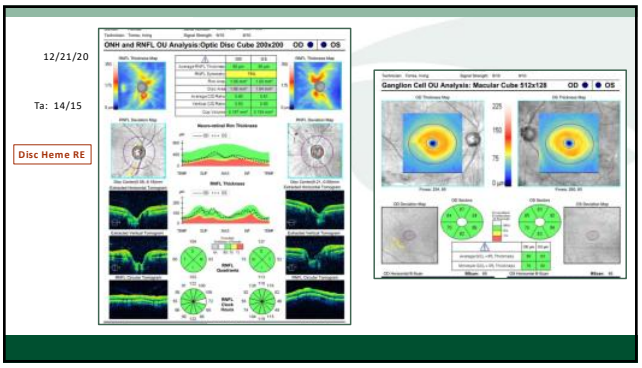
63 yo Hispanic Female

- UM Employee 1st presented 2017 for glasses and followed annually for glasses
- On the initial visit noted to be a glaucoma suspect based on CD: inferior sloping
  - Granulomatous retinal lesion RE
- TA. Always ~ 15
- 2020: noted to have a disc heme

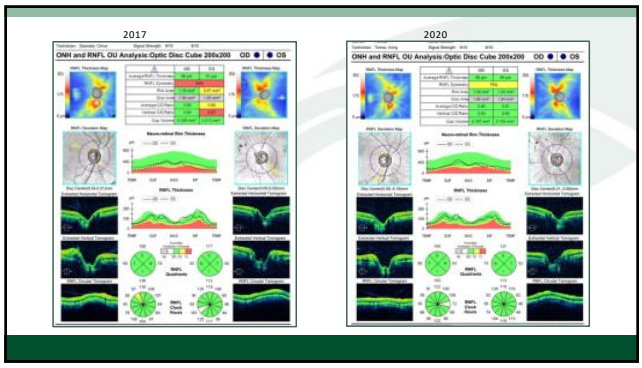
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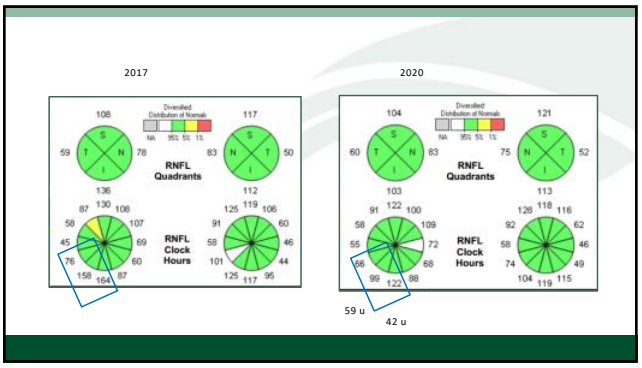
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98



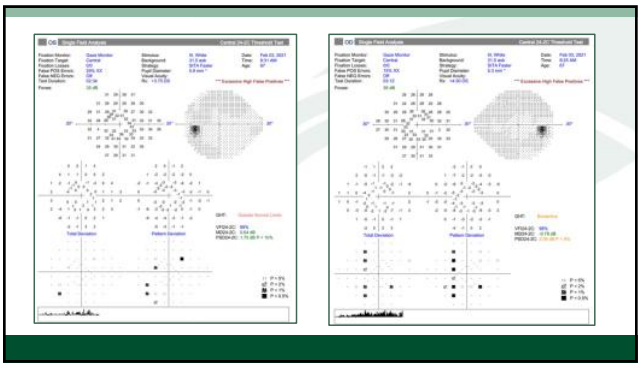
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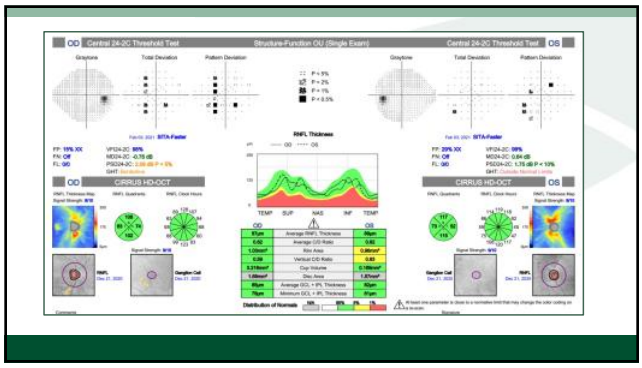
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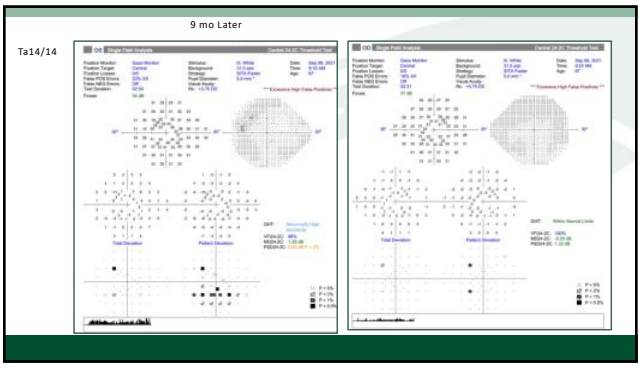
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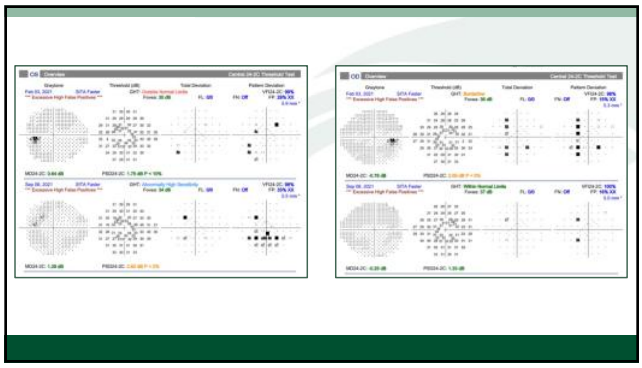
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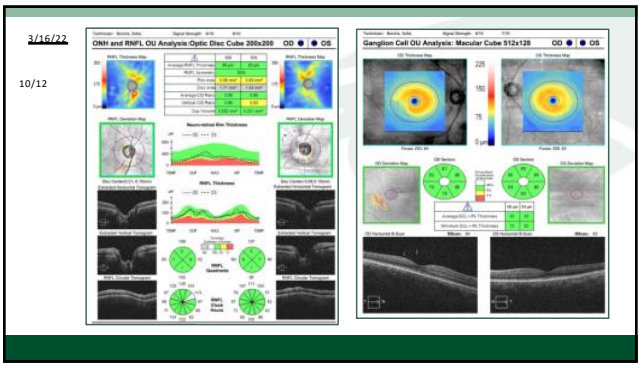
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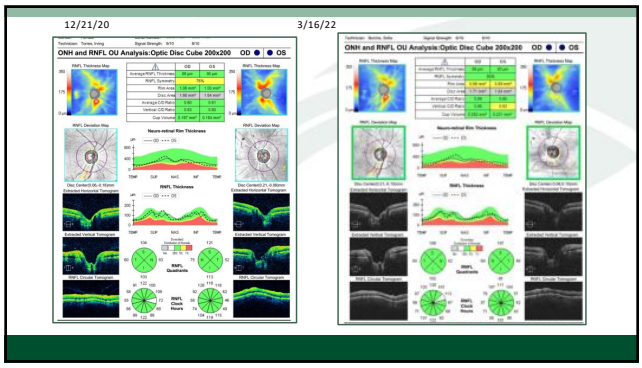
104



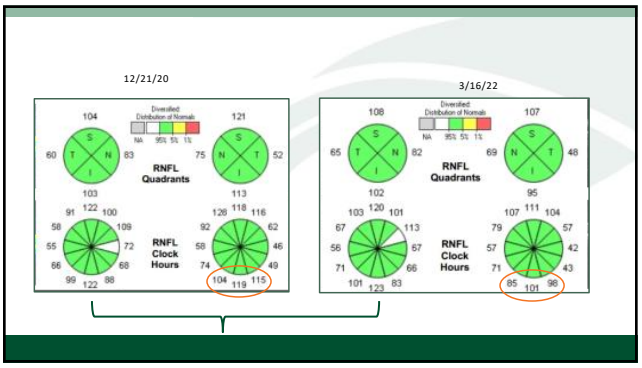
105



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3/16/2022
The Lennar Foundation Medical Center Bascom Palmer Eye Institute

Dunbar, Mark T., OD
Optometry

OAG (open angle glaucoma) suspect, high risk, right +1 more
Dx

Referred by Dunbar, Mark T., OD
Reason for Visit

Progress Notes — Dunbar, Mark T., OD (Optometrist) • Optometry

Assessment

1) GL suspect based on disc heme in RE - noted 2020
"Normal" OCT RNFL **BUT - clear and significant thinning inf vs. 2017**. - Stable RNFL vs. 2020
GCC - starting to show wedge defect - small
TA 10-12: Few episodes of IOP 22 but always low teens

2) KCS OU -> Doing much better with Restasis

Plan

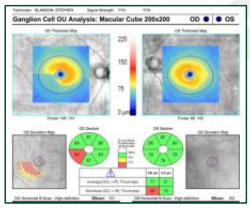
1) Ed and reassure
2) Continue with Restasis bid
3) RTC 6 mo for IOP check and VF

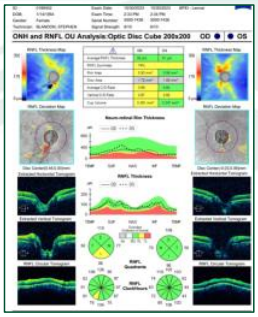
109

10/30/23 1 ½ years later

Tonometry (Applanation, 2:06 PM)

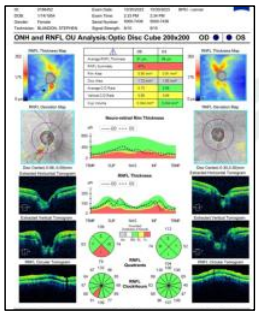
	Right	Left
Pressure	14	13



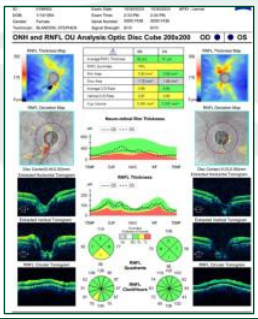


110

Scan 1

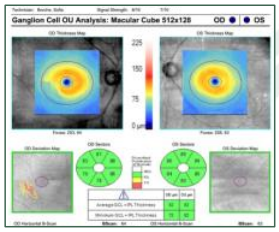


Scan 2

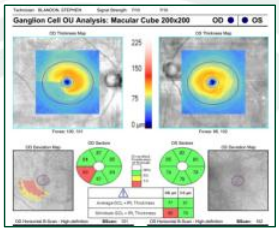


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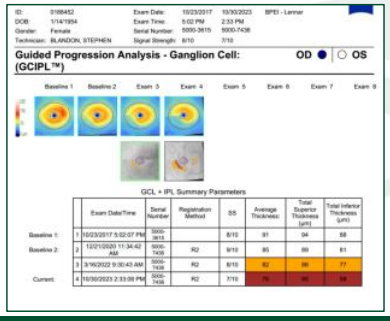
3/22



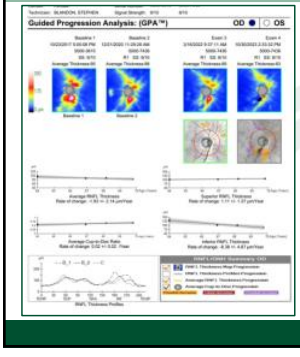
10/23



112



113





114

10/30/23

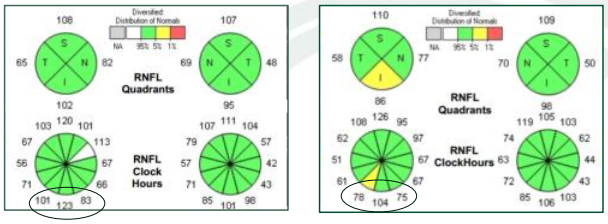
Assessment
1) NTG RE with worsening of OCT/GCC over the last 18 mo
   Hx of disc heme RE
   Evidence of clear progression RE since 2020
2) Horse shoe retinal tear RE - seen by Yanuzzi today
2) KCS OU -> Doing much better with Restasis

Plan
1) Ed and reassure
2) Refill Restasis bid
3) Add Latanoprost qhs OU
4) Seen with Yanuzzi today

Dunbar 1 mo for VF and disc photo

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3/22 10/31/23



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Recent Tonometry

Date	Right	Left	Method
10/30/2023	14	13	Applanation
03/16/2022	10	12	Applanation
10/13/2021	13	14	Tonopen
09/08/2021	14	14	Tonopen
02/03/2021	13	15	Applanation
12/21/2020	14	15	Tonopen
02/12/2019	17	15	Tonopen
04/11/2018	12	13	Tonopen
10/23/2017	16	16	Applanation



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Clear progression – started in the normal range?





Started Latanoprost qhs OU

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It Takes a Village to Manage Glaucoma Patients



- All the data that is gathered is critical!
  - IOP measurement
  - Optic nerve evaluation
  - Visual fields
  - OCT
- The data needs to be accurate and reliable
- Even though the patient comes to see **"their doctor"** for glaucoma
- Everybody who sees these patients along the way plays a critical role in the care of a glaucoma patient

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