

HVF Hoopla

Pearls and Pitfalls of Visual Field Testing

Humphrey Visual Field (HVF)

- Basics
- When is a field reliable?
- Common Errors
- Pearls



Zeiss HVF Analyser

What are we testing?

- Ability of a patient to see a white(red) light the size of 0.5 degrees(stimulus III) and 2 degrees (stimulus V) of increasing intensity / contrast against a white background in an algorithm arranged sequence to estimate an area of the patient's entire field.
 - Patients responses are compared to database of normal controls for that stimulus and intensity to give a representation of their field. (Automated perimetry)
- The first number indicates the degrees from fixation of the field for the eye and the second number is the testing protocol the machine performs. It's a function of how close the stimulus presents to the horizontal and vertical meridian.
 - Ex: 24-2 tests 24 degrees of the patients field from fixation. and the 2 means the stimulus is presented no closer than 3 degrees of the assumed horizontal and vertical meridians
 - Ex: 30-1 tests 30 degrees to either side of fixation and the 1 means it is testing within 1 degree(directly on) the assumed horizontal and vertical meridians
 - The -1 fields are not used as it does create some issues with easily distinguishing horizontal and vertical meridians for both the patient and the interpreter / print out.

Stimulus Arrangement

- Standard(SAP)/SITA /SITA Fast (Swedish Interactive Threshold Algorithm)
 - Different algorithms used to test the patients field of view in a particular sequence.
 - As we move to the right we test fewer points with some assumptions made between the untested areas(decreased accuracy) but the test duration also decrease for patient attention span(meaningful field).
 - ~10 minutes for a Full field and ~3 minutes for SITA fast to be completed.
 - First few lights test 4 areas within the perimeter edge of the macula.
 - Then a randomized arrangement with the entire field(including the blind spot)
 - Arranged in such a pattern and with sub-threshold stimuli that a patient is predicted to miss 50% of the total lights shined during the test duration.
 - Very helpful to explain to your Field techs and patients to reassure them about their experience.

Basics

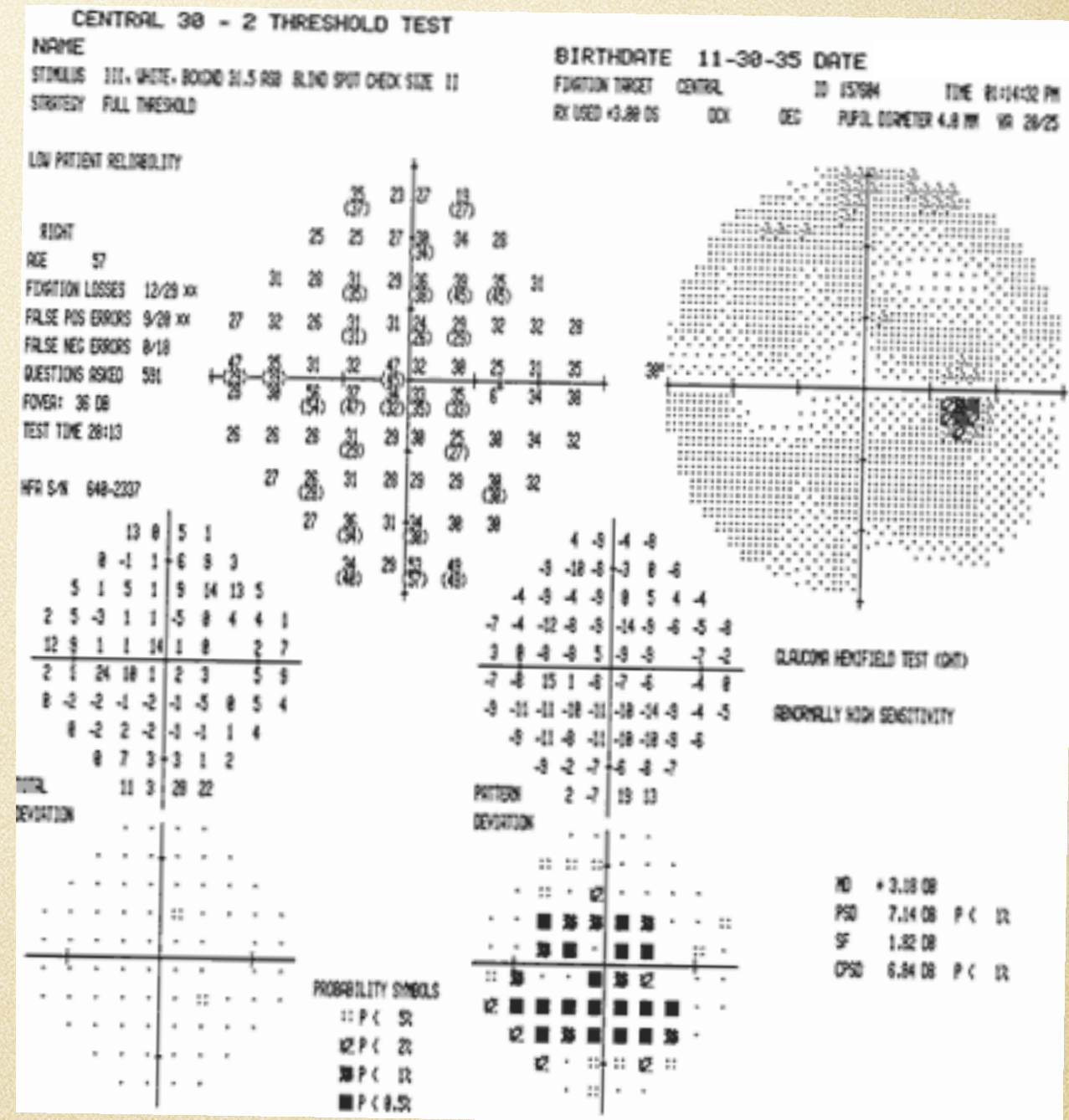
- Name and Age
 - Fields are compared to patients of same age(20-80) and NOT a range like OCT.
 - Extremes out of this range must be extrapolated.
- Field Test Numbers(30-2)
- Eye Side
 - Wrong eye in field(Monocular OS pt)
- Pupil Size(Recommend Undilated)
 - $<2.5\text{mm}$ or $>5.5\text{mm}$ pupils will effect field. Important to compare pupil sizes between series of tests.
- Refractive Error
 - Must enter the refractive error of patient into machine and appropriate ADD power every time!
 - Changes $>1\text{ D}$ will cause $\sim 1.26\text{dB}$ drop in peripheral defects and generalized depression with stimuli.
 - Patients with high refractive errors should wear their contacts when possible.
- Stimulus Size
 - Important to compare fields with same stimulus size based on degrees measured.
 - Stim III(4mm^2 or 0.5 degree), Stim V(64mm^2 or $\sim 2\text{ degrees}$)
 - Use Stim V or 10-2 for those with low vision or difficult test takers!

When is a Field Reliable?

- False Positives
- False Negative
- Fixation Losses
- Mean Deviation
- Visual Field Index
- Pattern Standard Deviation
- Total Deviation

False Positives

- Patient responds to light when it is below normal threshold.
- Nervous Patients / Click Happy
- Produces White Scotomas in field / Gray Scale
- Useless test
- Repeat with assurance they should see bright and dim lights and miss 50% of the lights during the test.



False Negatives

- Patient has loss interest, fell asleep, malingering
- Classic is clover leaf defect
 - Due to starting with 4 foveal border points
- Correct this with observation or Stim V

Eye: Right

DOB: 01-02-1954

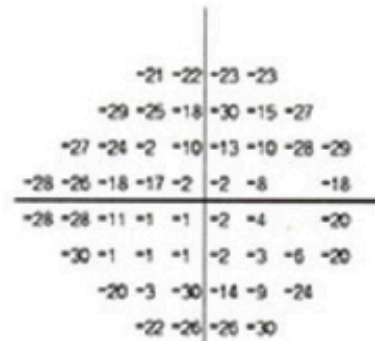
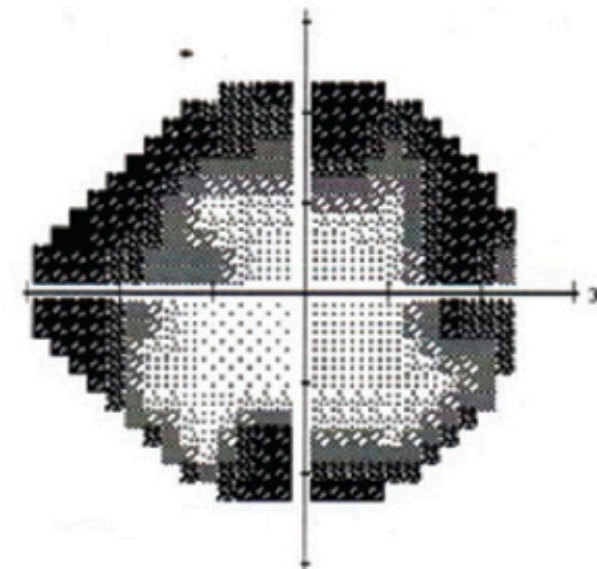
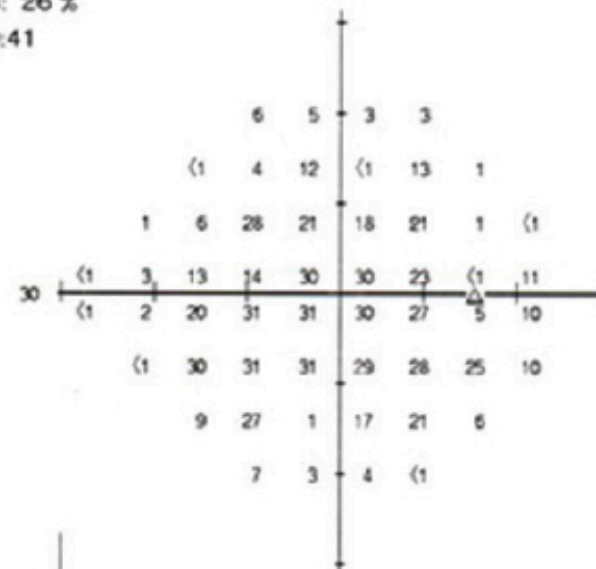
Central 24-2 Threshold Test

Date: 19-09-2015

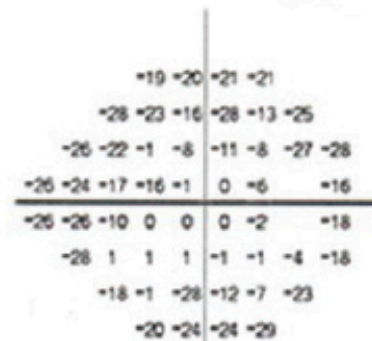
Time: 11:21 AM

5 Age: 61

Fovea: 34 dB



Total Deviation



Pattern Deviation

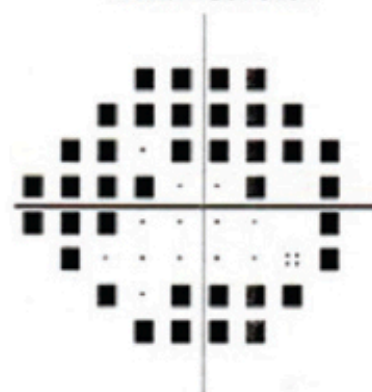
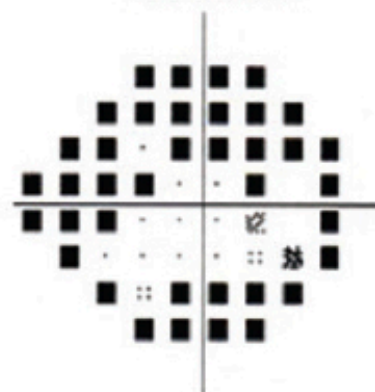
GHT

Outside Normal Limits

VFI 62%

MD -14,38 dB P < 0.5%

PSD 11.43 dB P < 0.5%



:: < 5%
 ■ < 2%
 ■ < 1%
 ■ < 0.5%

Fixation Losses

- Blind Spot is ~15 degrees temporal to fixation
 - Calculated using Heijl-Kracku Technique
 - Maps Blind spot early, then will shift for fixation.
- If all else is good may consider a field good with high fixation losses still.
- Confirm with the Gaze tracker
 - Up ticks are fixation losses, Down ticks are blinks
- Correct this by reassuring they should miss 50% of lights

Name	Age	Gender	Occupation	Education	Marital Status	Religion	Political Affiliation	Income	Assets	Liabilities	Net Worth
John Doe	35	Male	Software Engineer	Master's Degree	Married	Christian	Democrat	\$80,000	\$150,000	\$50,000	\$100,000
Jane Smith	42	Female	Marketing Manager	Bachelor's Degree	Single	Jewish	Republican	\$60,000	\$100,000	\$30,000	\$70,000
Michael Johnson	28	Male	Investment Banker	PhD	Married	Muslim	Democrat	\$120,000	\$200,000	\$80,000	\$120,000
Sarah Williams	55	Female	Retired Teacher	Bachelor's Degree	Widowed	Protestant	Democrat	\$40,000	\$50,000	\$20,000	\$30,000
David Brown	60	Male	Business Owner	High School Graduate	Married	Catholic	Republican	\$90,000	\$180,000	\$60,000	\$120,000
Emily Davis	30	Female	Consultant	Master's Degree	Single	Buddhist	Democrat	\$70,000	\$120,000	\$40,000	\$80,000
Robert Miller	45	Male	Lawyer	JD	Married	Hindu	Democrat	\$110,000	\$190,000	\$70,000	\$120,000
Lisa Wilson	50	Female	Healthcare Administrator	Master's Degree	Married	Orthodox Jewish	Democrat	\$85,000	\$160,000	\$55,000	\$105,000
James Taylor	38	Male	Entrepreneur	Bachelor's Degree	Single	Sikh	Republican	\$100,000	\$220,000	\$90,000	\$130,000
Amanda White	48	Female	Project Manager	Master's Degree	Married	Anglican	Democrat	\$75,000	\$140,000	\$45,000	\$95,000
Christopher Lee	58	Male	Financial Analyst	PhD	Married	Evangelical Protestant	Republican	\$95,000	\$170,000	\$65,000	\$105,000
Michelle Garcia	33	Female	Product Designer	Bachelor's Degree	Single	Secular Humanist	Democrat	\$65,000	\$110,000	\$35,000	\$75,000
Kevin Martinez	40	Male	Operations Manager	Master's Degree	Married	Unitarian Universalist	Democrat	\$80,000	\$150,000	\$50,000	\$100,000
Nicole Anderson	52	Female	Public Health Specialist	PhD	Married	Interfaith	Democrat	\$70,000	\$130,000	\$40,000	\$90,000
Brandon Clark	37	Male	Systems Administrator	Bachelor's Degree	Single	Atheist	Democrat	\$60,000	\$100,000	\$30,000	\$70,000
Stephanie Hall	44	Female	Human Resources Manager	Master's Degree	Married	Quaker	Democrat	\$75,000	\$140,000	\$45,000	\$95,000
Gregory King	56	Male	Retired Engineer	Bachelor's Degree	Widowed	Methodist	Democrat	\$45,000	\$60,000	\$25,000	\$35,000
Victoria Scott	31	Female	UX Researcher	Master's Degree	Single	Wiccan	Democrat	\$65,000	\$110,000	\$35,000	\$75,000
Timothy Green	41	Male	Business Development	Bachelor's Degree	Married	Presbyterian	Republican	\$85,000	\$160,000	\$55,000	\$105,000
Angela Adams	49	Female	Operations Director	PhD	Married	Secular Jew	Democrat	\$90,000	\$180,000	\$60,000	\$120,000
Jonathan Baker	36	Male	Software Developer	Master's Degree	Single	Scientist	Democrat	\$70,000	\$120,000	\$40,000	\$80,000
Christina Nelson	54	Female	Project Coordinator	Bachelor's Degree	Married	Anglican	Democrat	\$75,000	\$140,000	\$45,000	\$95,000
Benjamin Hill	62	Male	Retired Executive	High School Graduate	Widowed	Protestant	Republican	\$50,000	\$70,000	\$30,000	\$40,000
Rebecca Young	34	Female	Marketing Specialist	Master's Degree	Single	Secular Buddhist	Democrat	\$65,000	\$110,000	\$35,000	\$75,000
Eric Roberts	43	Male	Business Analyst	Bachelor's Degree	Married	Unitarian	Democrat	\$80,000	\$150,000	\$50,000	\$100,000
Kimberly Lewis	51	Female	Healthcare Manager	PhD	Married	Interfaith	Democrat	\$70,000	\$130,000	\$40,000	\$90,000
Matthew Walker	39	Male	Systems Engineer	Master's Degree	Single	Atheist	Democrat	\$60,000	\$100,000	\$30,000	\$70,000
Heather Allen	46	Female	Operations Manager	Bachelor's Degree	Married	Quaker	Democrat	\$75,000	\$140,000	\$45,000	\$95,000
Christopher Evans	57	Male	Retired Scientist	Bachelor's Degree	Widowed	Methodist	Democrat	\$45,000	\$60,000	\$25,000	\$35,000
Olivia King	32	Female	Product Manager	Master's Degree	Single	Wiccan	Democrat	\$65,000	\$110,000	\$35,000	\$75,000
William Wright	42	Male	Business Development	Bachelor's Degree	Married	Presbyterian	Republican	\$85,000	\$160,000	\$55,000	\$105,000
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Christopher Green	35	Male	Software Developer	Master's Degree	Single	Scientist	Democrat	\$70,000	\$120,000	\$40,000	\$80,000

DOB: 16-11-1945

ID: 1

Central 24-2 Threshold Test

Fixation Monitor: Gaze/Blind Spot

Stimulus: III, White

Pupil Diameter: 3.0 mm

Date: 27-02-2016

Fixation Target: Central

Background: 31.5 ASB

Visual Acuity:

Time: 10:19 AM

Fixation Losses: 0/16

Strategy: SITA-Standard

RX: +1.75 DS DC X

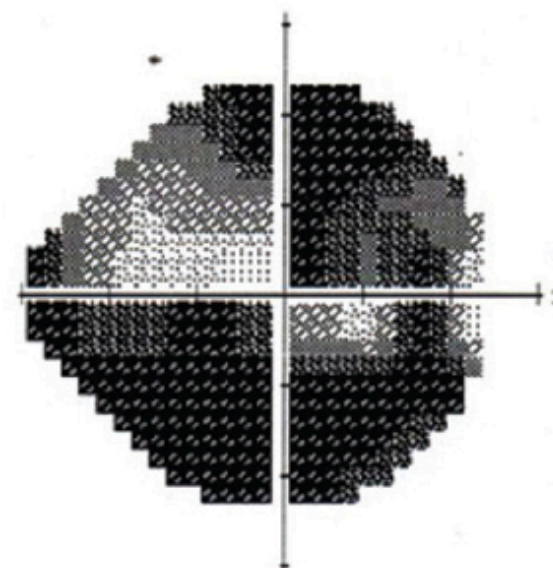
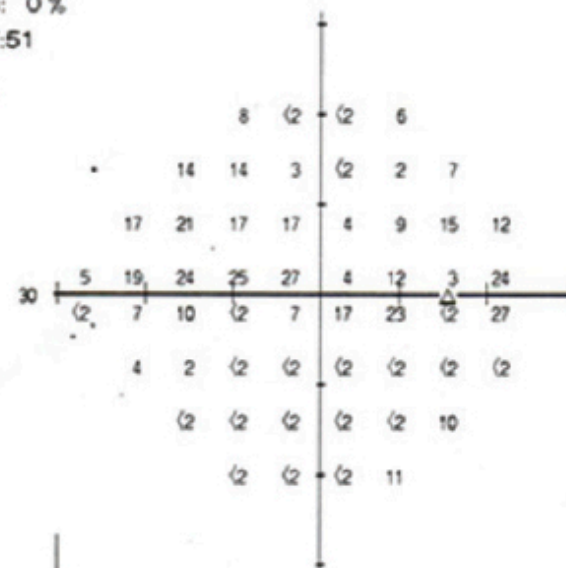
Age: 70

False POS Errors: 2 %

False NEG Errors: 0 %

Test Duration: 07:51

Fovea: 32 dB ::



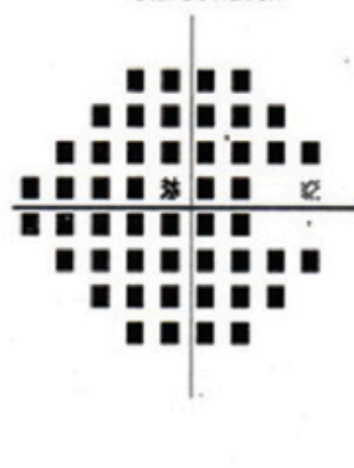
Pattern Deviation not shown for severely depressed fields. Refer to Total Deviation.

GHT
Outside Normal Limits

VFI 31%

MD -21.11 dB P > 0.5%

PSD 9.65 dB P < 0.5%



Pattern Deviation

Pattern Deviation not shown for severely depressed fields. Refer to Total Deviation.

:: < 5%
 〇 < 2%
 〇 < 1%
 ■ < 0.5%

Mean Deviation

- Index used to determine the average difference in visual field response in (dB) from person of same age. (0 to -2dB is WNL)
- Also used to monitor progression over time esp in moderate stage disease (-6 to -12dB)
- Past -12dB MD is not useful for progression monitoring (Severe disease)

Visual Field Index

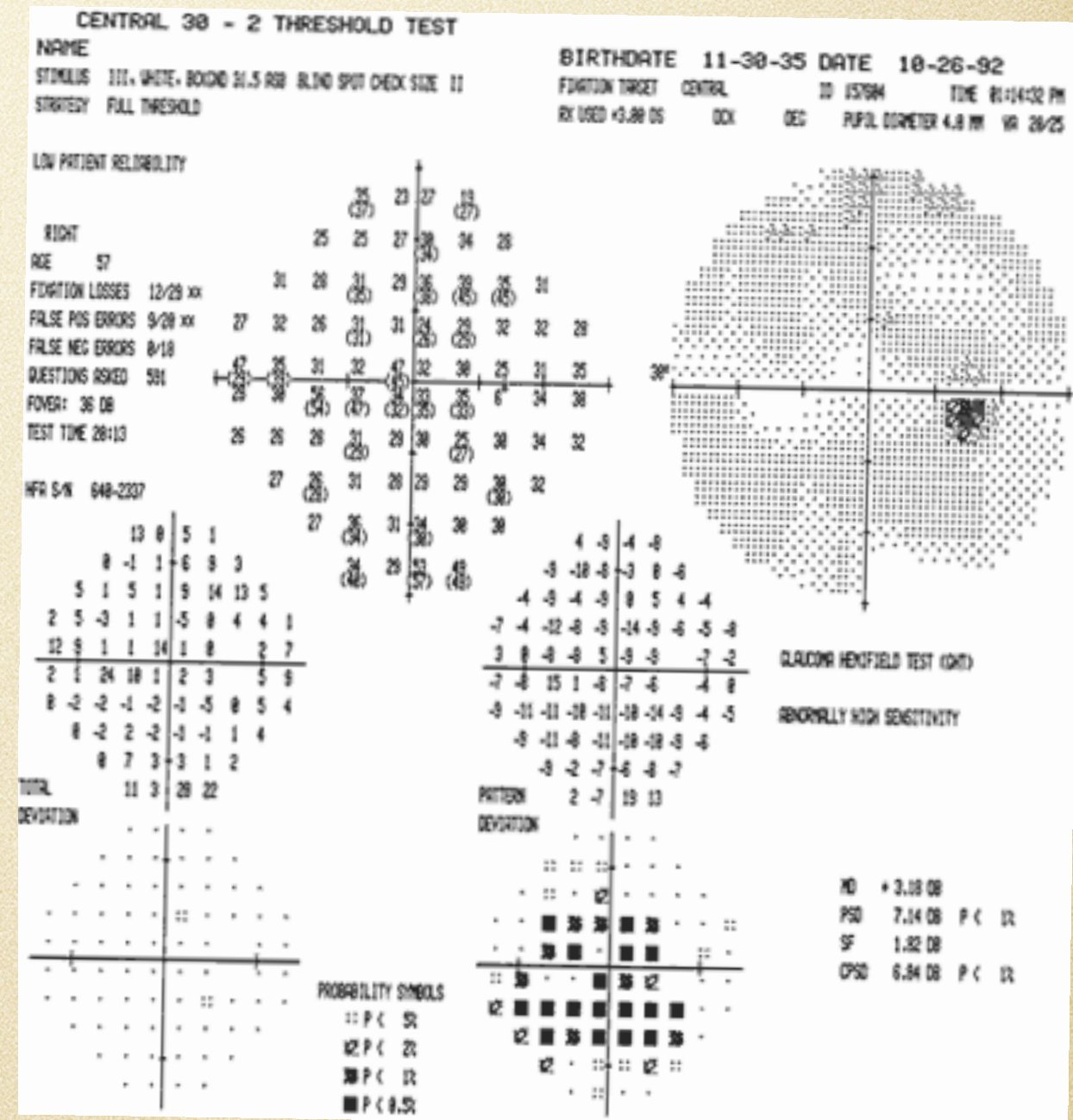
- Percentage estimation of field remaining
- Has good correlation with Mean Deviation
- Useful for monitoring progression or giving patients an idea of severity of condition.

Pattern Standard Deviation

- Plot of the patients responses(dB) to the field to indicate field depression or loss.
 - Examine size, shape and location
- Most important plot to observe and confirm for glaucomatous defects or early defects.
 - Most useful for tracking mild stage disease progression
- Should closely match total deviation plot with removed generalized field loss
 - If Large PSD defects and no corresponding TD defects = high FP
- Not effected by cataracts

Classic High False Positive

- Very irregular PSD plot
- No corresponding TD
- White Scotoma on Grey Scale
- Trigger Happy PT
- Useless field
- Needs reassurance

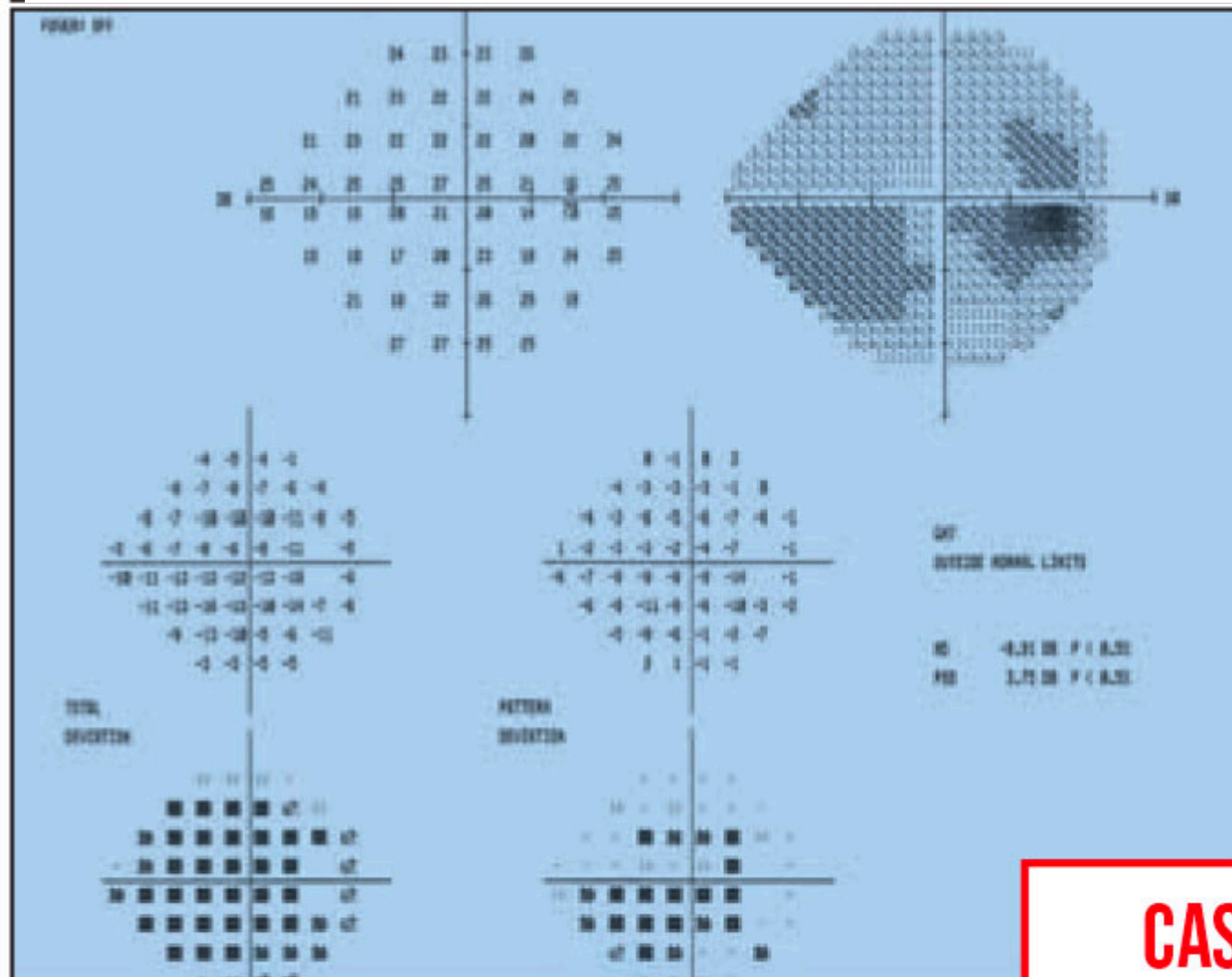


Total Deviation

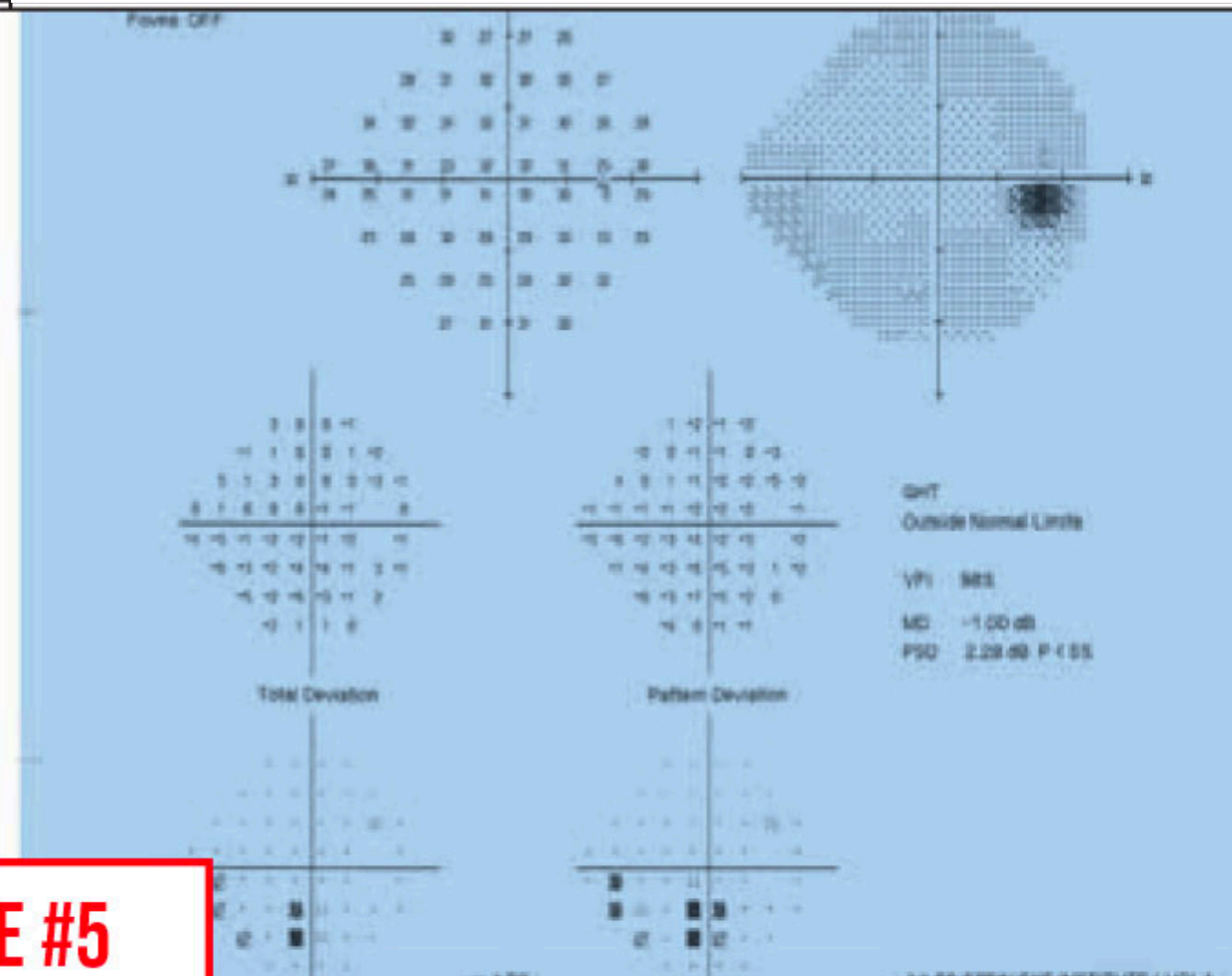
- Plots the patient's VF that are different from normal patient of same age.
- Look at size, shape and location of plot points.
- Can be effected by corneal and lenticular opacity
 - Need to look at PSD instead

Media Opacity Effect on TD

Before Surgery



After Surgery



CASE #5

Pearls for HVF

- Confirm the Basics (5R's)
 - 1. Right Test, 2. Reliable, 3. Review PSD / TD, 4. RNFL correlation, 5. Reaffirm Dx. If 1 of 5R's are wrong then REPEAT HVF.
- Look at PSD / TD for mild-mod disease progression
- Look at MD for moderate disease progression
- Fields improve with repetition (>80% of time).
- Don't be afraid to use Stim V and 10-2.
- Explain to patients to press when they see a bright or dim light.
- Reassure patients they should miss 50% of lights during testing.

OCT Mumbo Jumbo

Pearls and Pitfalls of OCT in Glaucoma

Clint Simpson MD

Optical Coherence Tomography(OCT)

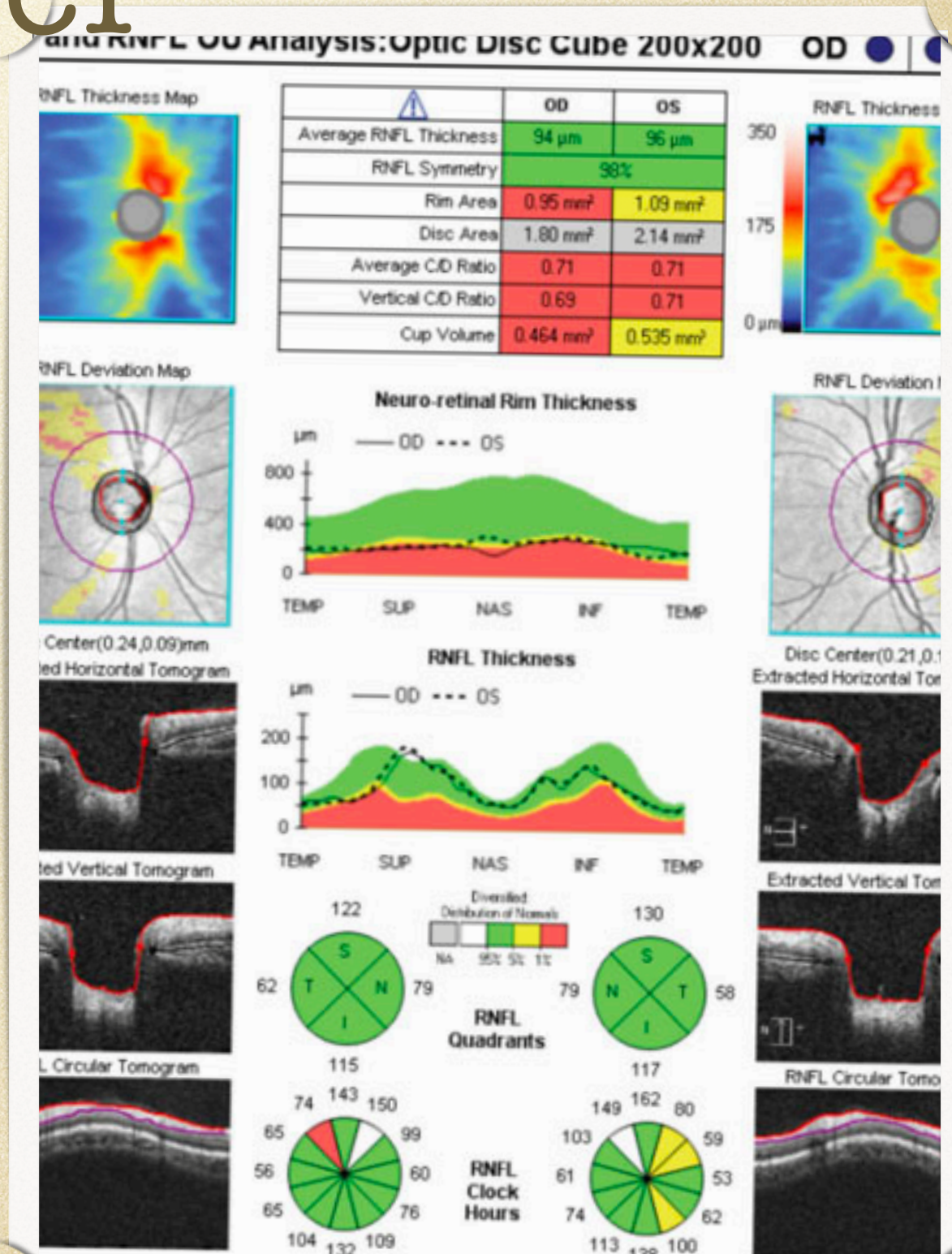
- Non-Contact, Non-invasive imaging device used to exam layers of the retina by looking at the interference patterns of reflected laser light from the individual tissues.
- Glaucoma (Retinal Nerve Fiber Layer, RNFL)

Types of OCT

- Time Domain OCT (TD-OCT)
 - Stratus OCT
- Spectral Domain OCT(SD-OCT)
 - Higher Resolution with faster image capture
 - Cirrus SD-OCT(Zeiss)
 - Spectralis OCT (Heidelberg)
 - RTVue-100 (Optovue)
- Ultrahigh speed swept source, ultrahigh resolution, adaptive optics OCT

Retinal Nerve Fiber Layer

- 3.4mm circle of RNFL is scanned to create a TSNIT map.
- Compares patient thickness to a normative database (284 pts)
- Clocks and Quadrants



Pitfalls with RNFL

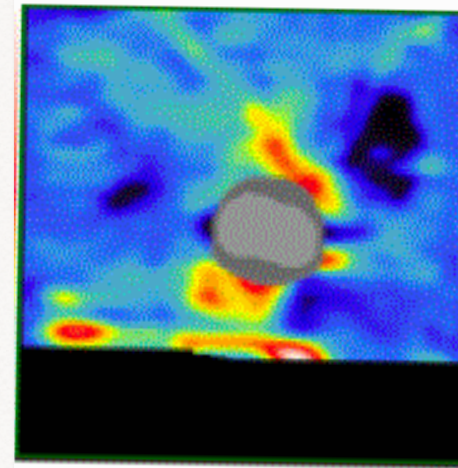
- **Look at Signal Strength (6+/10, Ideal 8+/10)**
 - Poor due to Tech, patient(blink,movement) or media
 - Segmentation Errors
- The High Myope!! Split Inf/Sup NFL Bundle
 - Look for triple hump sign
- Testing Variability with Guided Progression Analysis
 - 3-5 um is considered normal average variability
 - Become suspicious for progression at 8-10um avg total loss(2 S.D./95% CI)
 - Become suspicious for progression at 5-6um in any single quad (Sup/Inf)
 - Pseudophakia (demonstrated to increase RNFL thickness up to 9% post CEIOL!!)
- Natural Progression of RNFL loss
 - 0.5-1um/year avg; 1-1.5um/year sup/inf avg

Signal Strength

- Always exam Signal Str of every scan (8+ ideal and 6+ is mandatory)
- Delete these scans from database esp for progression analysis.
- Look at image collected
 - Blinks miss inf half of RNFL
 - Black=0um measurement!!
 - PVDs block based on location
 - Thin RNFL
 - Cataracts reduce RNFL up to 9%
 - Cortical>PSC>NS
 - Asteroid Hylosis
 - DON'T GET ME STARTED!



RNFL Thickness Map



RNFL Deviation Map

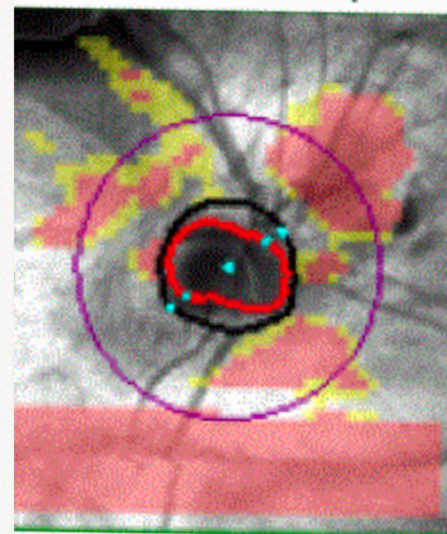
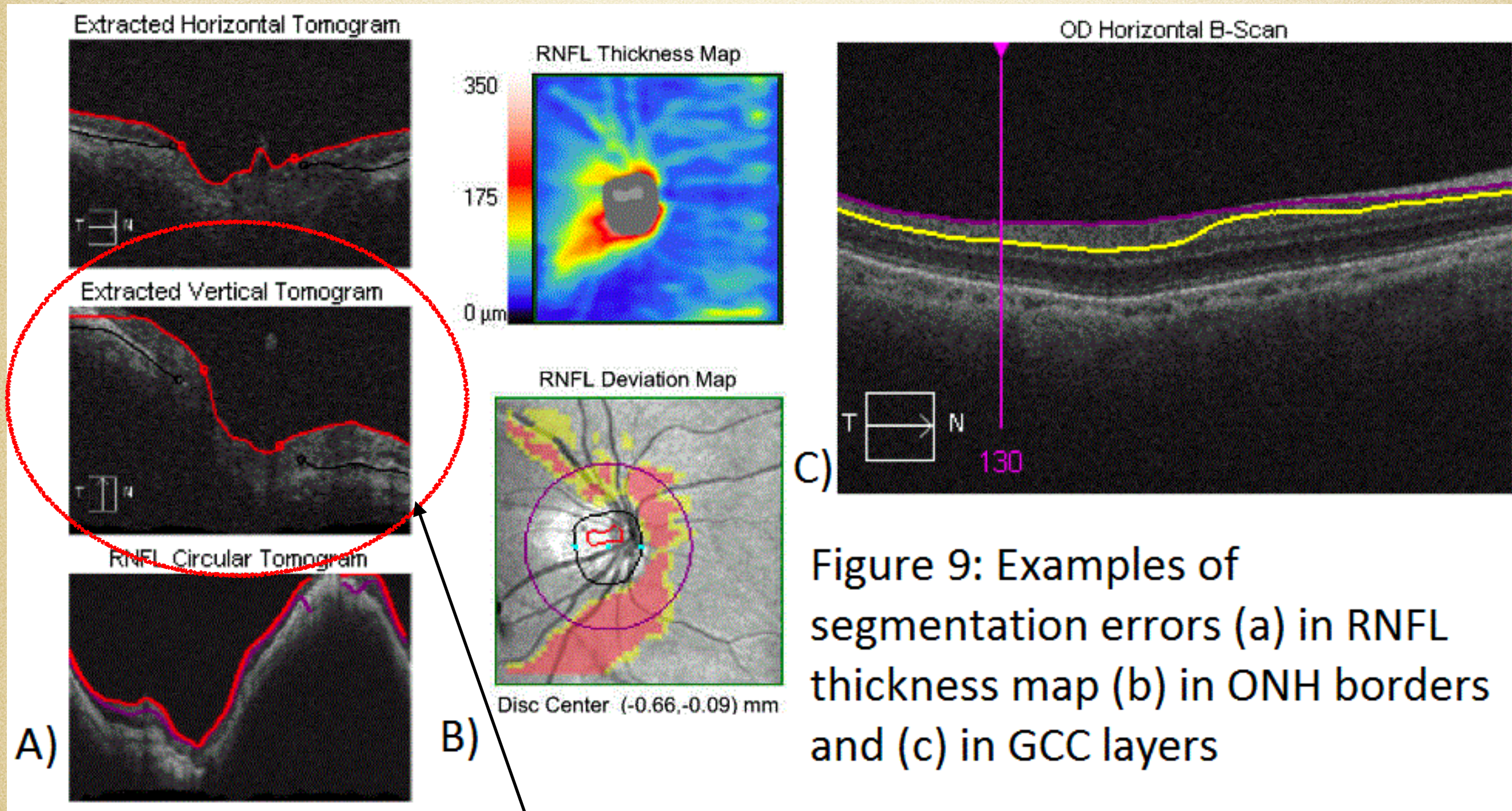


Figure 8:
Example of
error due to
blink with
missing data
represented
black.

Segmentation Errors

- Deviation Map Centration
 - Confirm centration around the disk in 3 dimensions!
- Segmentation Error (Look at Segmentation Lines on tomograms)
 - Confirm scans are not in zero range of tomogram (near top of image range)
 - Occurs in myopes with staphylomas / PPA and Optic Nerve Tilt
- SD-OCT has eye tracking feature which allows for more accurate measurements
 - Uses blood vessels for alignment
 - Make sure its on (Machine)

Segmentation Error



Large degree of Temporal Tilt with PPA

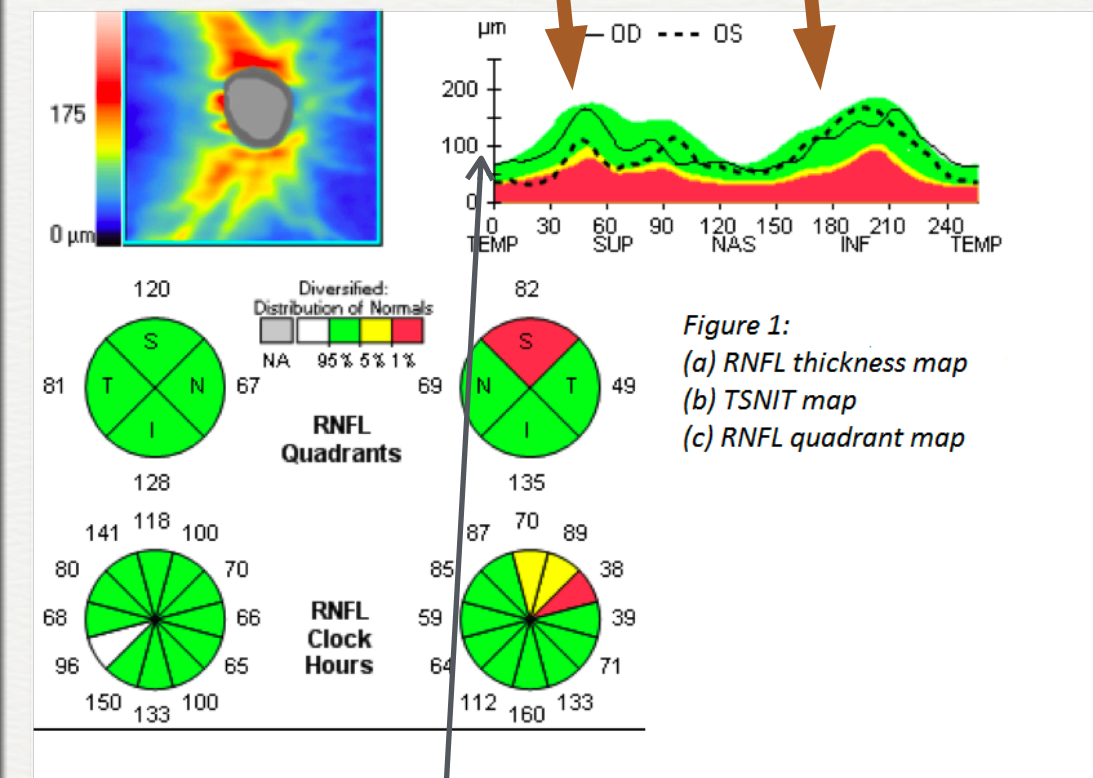
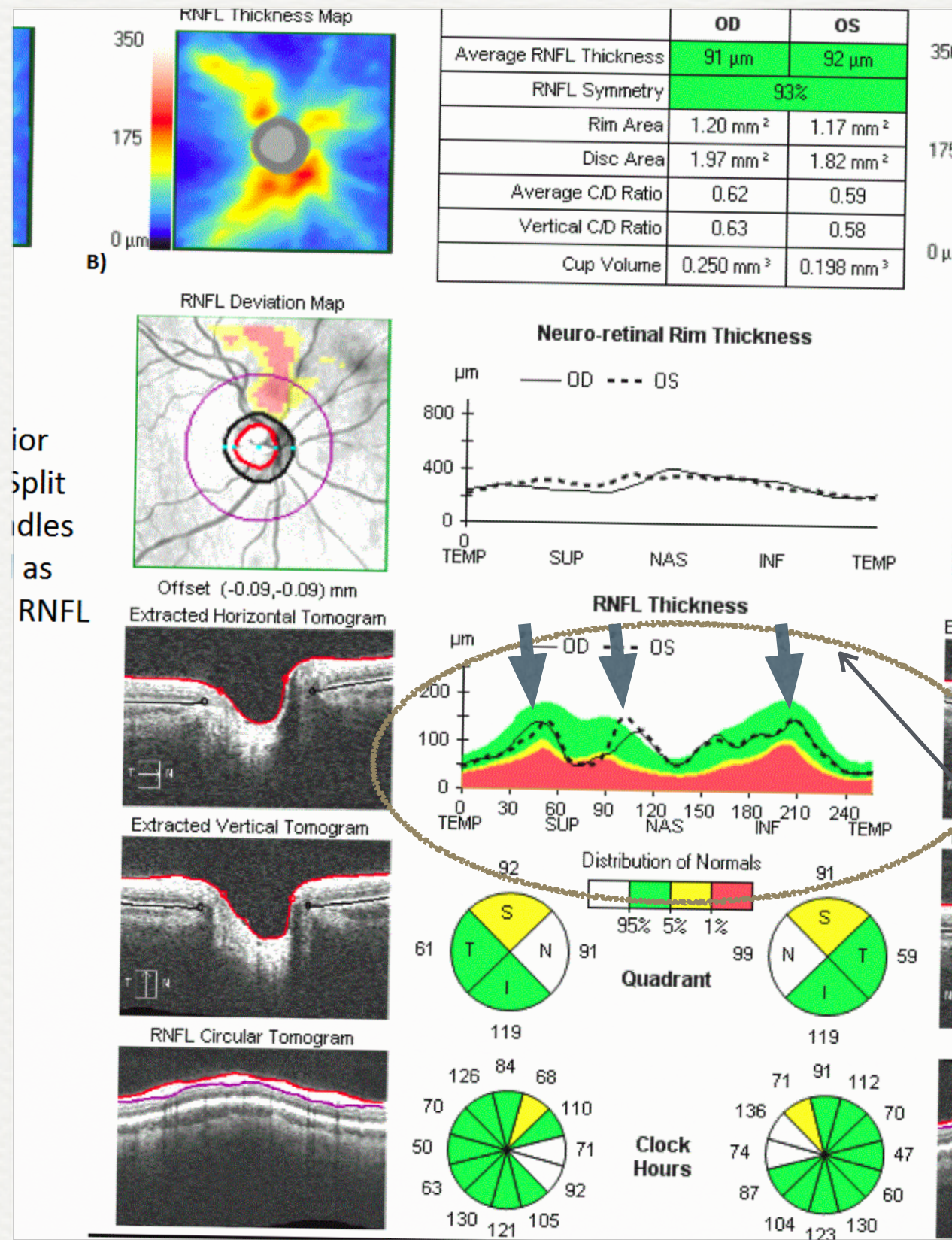
Pitfalls with RNFL

- Look at Signal Strength (6+ / 10, Ideal 8+ / 10)
 - Poor due to Tech, patient(blink,movement) or media
- The Myope!! Split Inf/Sup NFL Bundle
 - Axial length, large C:D, Flooring Effect, Look for triple hump sign
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- Natural Progression of RNFL loss
 - 0.5-1um/year avg; 1-1.5um/year sup/inf avg

The Myope

- The Most Difficult Interpretation
- Normative Nomogram (284 patients)
 - Ranged from -12.0D to +8.0D (Handful of pts were >-6.0D)
 - Best comparison is usually the patient to themselves (serial scans 3+ to start)
- Axial Length Induced Magnification (>25.0mm)
 - Artificial thinning of NFL and poor estimations(shrinking) of neuroretinal rim
 - Larger C:D estimations and severe thinning estimates (Floor Effect)
 - Not currently accounted for on any OCT software/nomograms
 - Not due to refraction unless greater than -20.0D
- Temporal Tilt and Peripapillary Atrophy/Staphaloma (Segmentation Errors)
 - Split RNFL, Large Staphaloma or marked PPA make for reproducibility nightmares
- Best correlated with great 8/10 repeat scans, ignore the nomograms and serial FF and HVFs

High Myope Split Nerve Fiber Layer Bundle



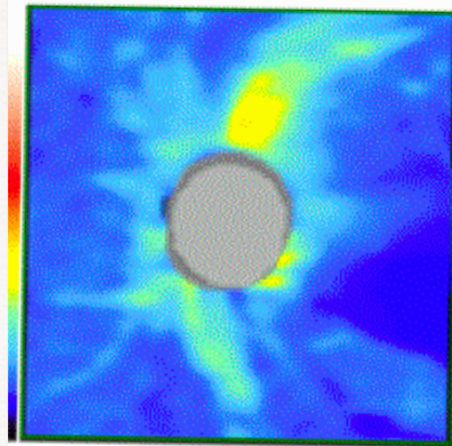
Double Hump with Superior Thinning

Triple Hump with "Sup Thinning"

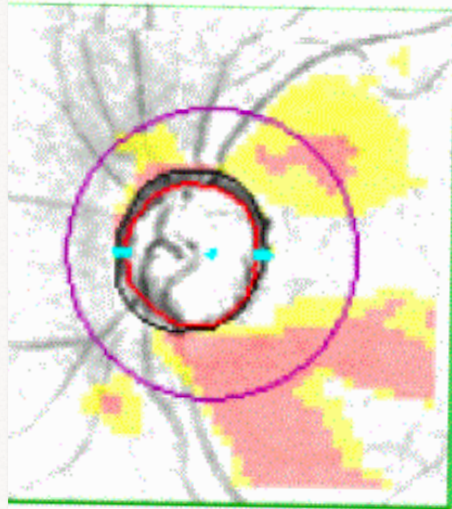
Floor Effect

- Severe Thinning of RNFL
 - Seen in Myopes and Advanced Glaucoma
- Be suspicious for Floor Effect when
 - Scan quality is good(no black)
 - Rim is thin
 - Measurements are $<45\mu\text{m}$
 - Glial cells +BV and connective tissue $=40\mu\text{m}$.
- If scan cannot be improved, must rely on visual fields and fundus photos

RNFL Thickness Map



RNFL Deviation Map



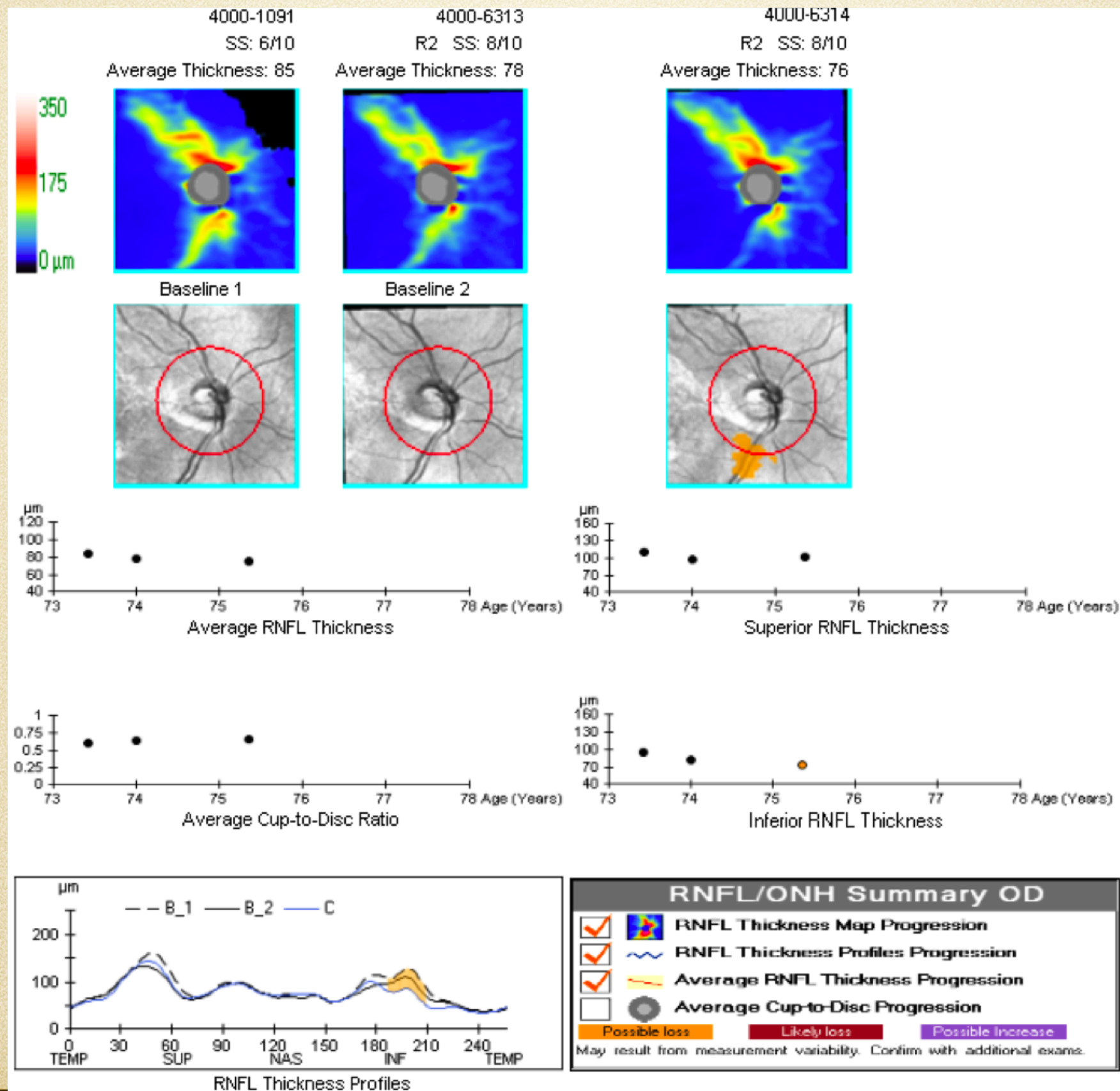
sc Center (0.07,0.03) mm

Figure 6: Exam of diffuse RNFL loss in advanced glaucoma demonstrating floor effect. Since OCT would not be useful at this stage of disease.

Pitfalls with RNFL

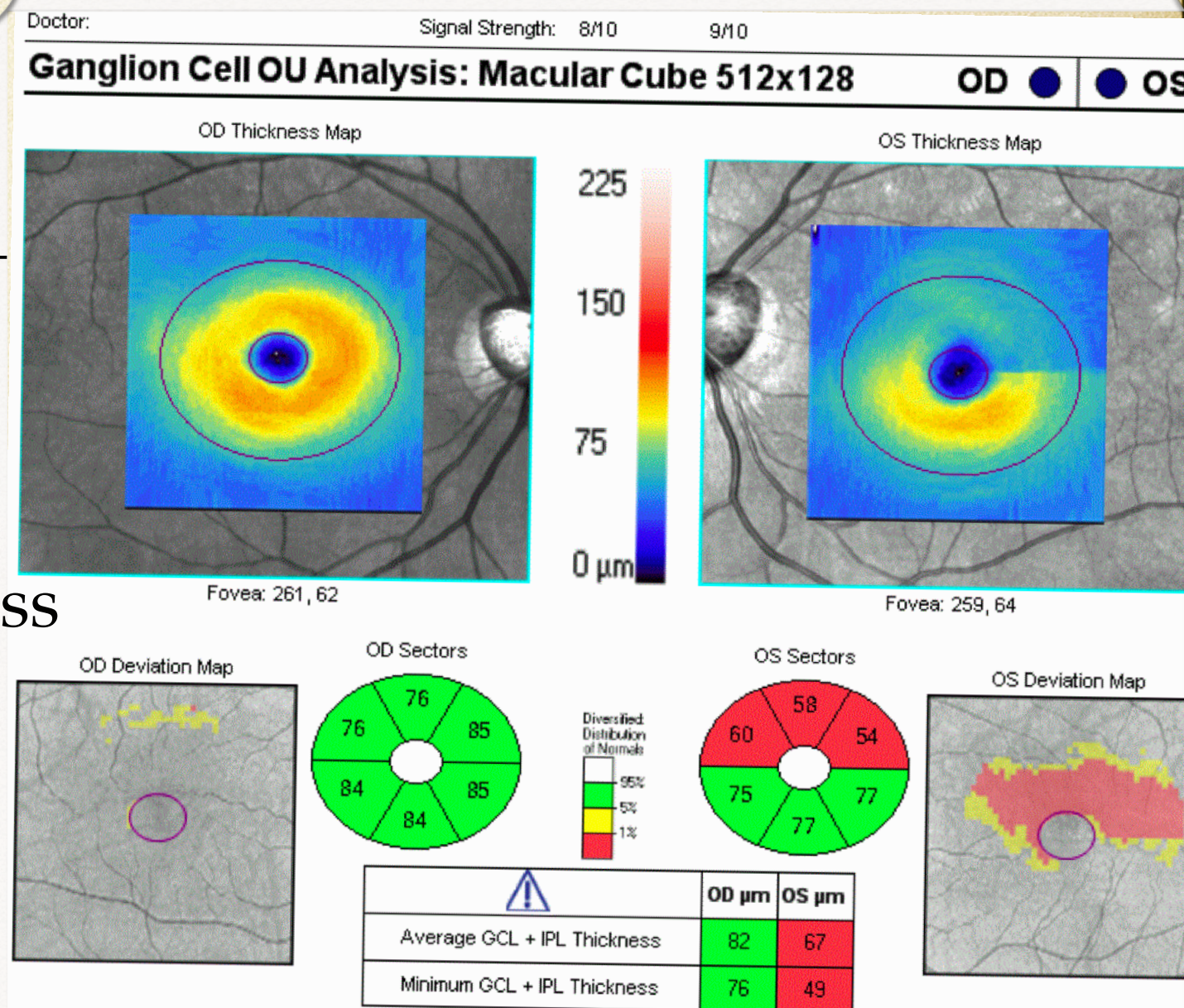
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Guided Progression Analysis



Ganglion Cell Analysis

- Measurement of GCL + IPL of Macula
- Strong correlation with RNFL loss and GCL Loss
- GCL loss may detect earlier glaucoma than RNFL measurements



Pitfalls to GCA

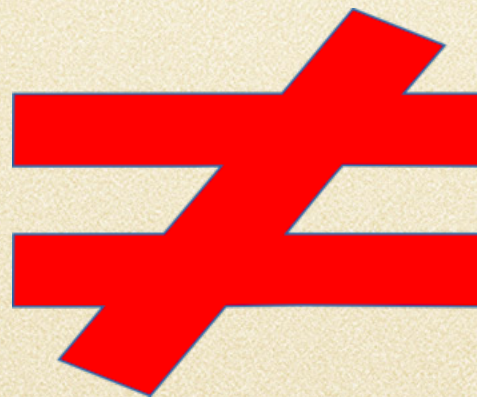
- GCC of macula is about 50% of total RGCs at disc
- Anything that effects the macula will effect GCA accuracy / usability
- ERMs, DME, CME, BRVO, BRAO, CNVM / AMD and Myopic Degen



Conclusion

- OCT in any form is a useful test for monitoring and diagnosing glaucoma
- However it should NEVER be the sole means for diagnosis and monitoring of disease.
- Must be used in conjunction with other modalities and physician judgement/interpretation.

For the Visual Learners



Thank You

