On the Road Again
Driving with Low Vision

Jackelyn Meyer, O.D.

Low Vision Resident

University of Incarnate World

Rosenberg School of Optometry

Overview

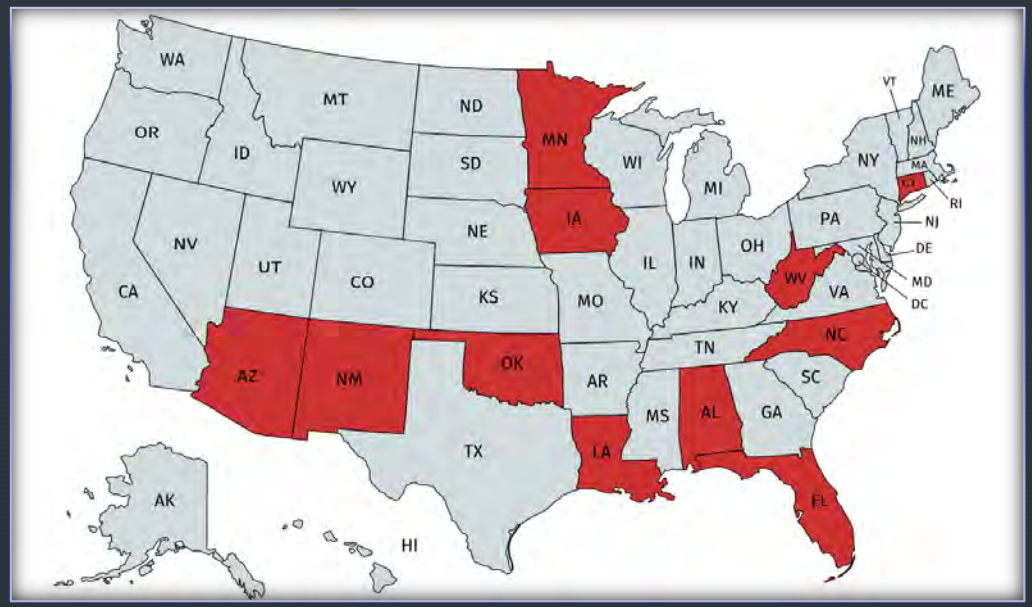
- Driving Requirements
- Tests to perform on driving patients
- Current and future visual accommodations for driving
- Identifying Low Vision driving patients in your practice

Driving Requirements

- Determined by STATE laws, not federally required
- International Counsel of Ophthalmology, published *Vision Requirements for Driving Safety* recommend unrestricted driving be;
  - visual acuity of 20/40
  - horizontal field of 120*
  - vertical field of 40*
- Assistive Technology is allowed in a state by state manner
  - Texas ALLOWS bioptics

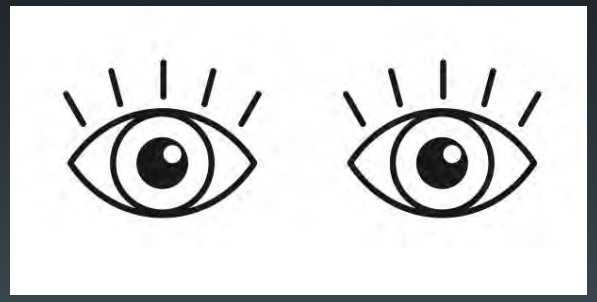
Driving Requirements

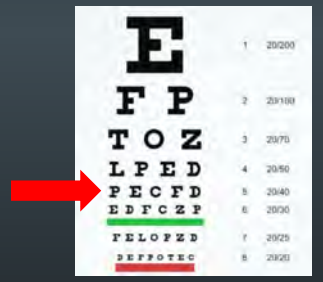
- Assistive technology by states
  - States that do NOT allow bioptics
  - Alabama, Arizona, Connecticut, Florida, Iowa, Louisiana, Minnesota, New Mexico, North Carolina, Oklahoma, West Virginia
- Can patients drive with bioptics in these states?
  - As long as requirements of license are being met, it is legal to drive with a bioptic or other accommodative device



https://mapchart.net/usa.html

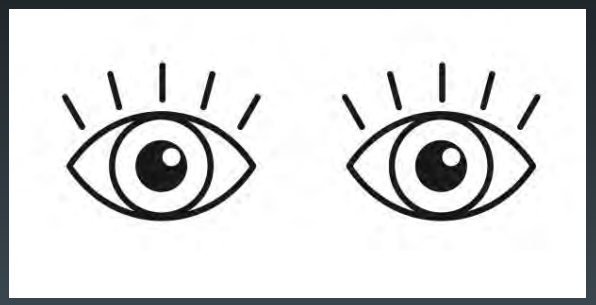
Texas Requirements

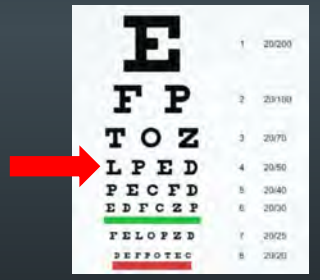




Unrestricted

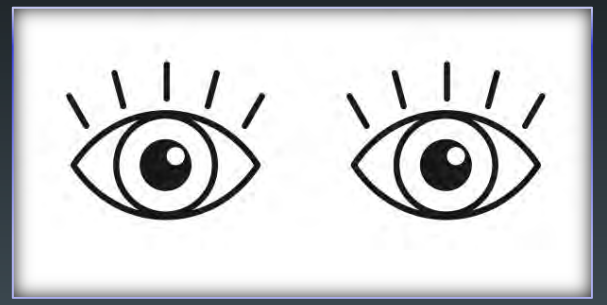
Better eye better than 20/40





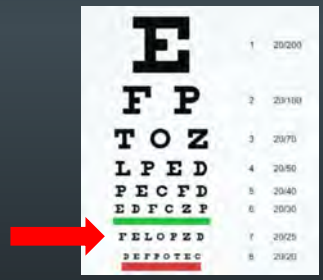
Unrestricted

Better eye is 20/50



Restricted

Better eye is 20/60 or 20/70

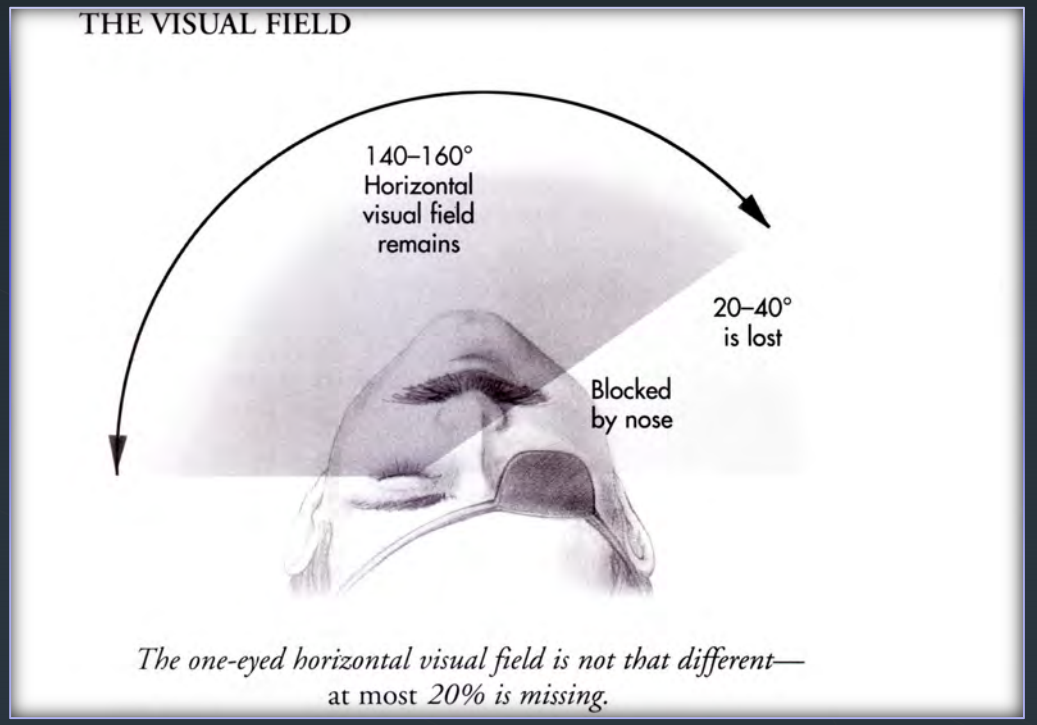


Unrestricted

Monocularly 20/25

Texas Requirements

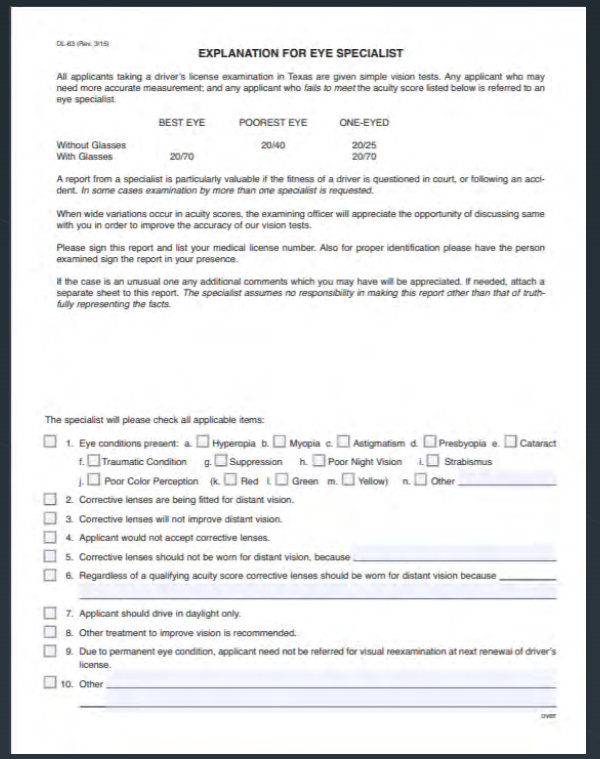
- Visual Field Requirement
  - Not Required
  - 140* horizontally
  - No vertical recommendations



https://eyeternus.wordpress.com/tag/visual-field/

Texas Requirements as an Optometrist

- Do not have a duty to report
- Duty to inform
- Texas Vision Form
- Visual Acuity testing
- Field of Vision Tests



DL-63 (Rev. 3/15)

EXPLANATION FOR EYE SPECIALIST

All applicants taking a driver's license examination in Texas are given simple vision tests. Any applicant who may need more accurate measurement; and any applicant who *fails to meet* the acuity score listed below is referred to an eye specialist.

	BEST EYE	POOREST EYE	ONE-EYED
Without Glasses		20/40	20/25
With Glasses	20/70		20/70

A report from a specialist is particularly valuable if the fitness of a driver is questioned in court, or following an accident. *In some cases examination by more than one specialist is requested.*

When wide variations occur in acuity scores, the examining officer will appreciate the opportunity of discussing same with you in order to improve the accuracy of our vision tests.

Please sign this report and list your medical license number. Also for proper identification please have the person examined sign the report in your presence.

If the case is an unusual one any additional comments which you may have will be appreciated. If needed, attach a separate sheet to this report. *The specialist assumes no responsibility in making this report other than that of truthfully representing the facts.*

The specialist will please check all applicable items:

☐ 1. Eye conditions present: a. ☐ Hyperopia b. ☐ Myopia c. ☐ Astigmatism d. ☐ Presbyopia e. ☐ Cataract f. ☐ Traumatic Condition g. ☐ Suppression h. ☐ Poor Night Vision i. ☐ Strabismus j. ☐ Poor Color Perception (k. ☐ Red l. ☐ Green m. ☐ Yellow) n. ☐ Other _____

☐ 2. Corrective lenses are being fitted for distant vision.

☐ 3. Corrective lenses will not improve distant vision.

☐ 4. Applicant would not accept corrective lenses.

☐ 5. Corrective lenses should not be worn for distant vision, because _____

☐ 6. Regardless of a qualifying acuity score corrective lenses should be worn for distant vision because _____

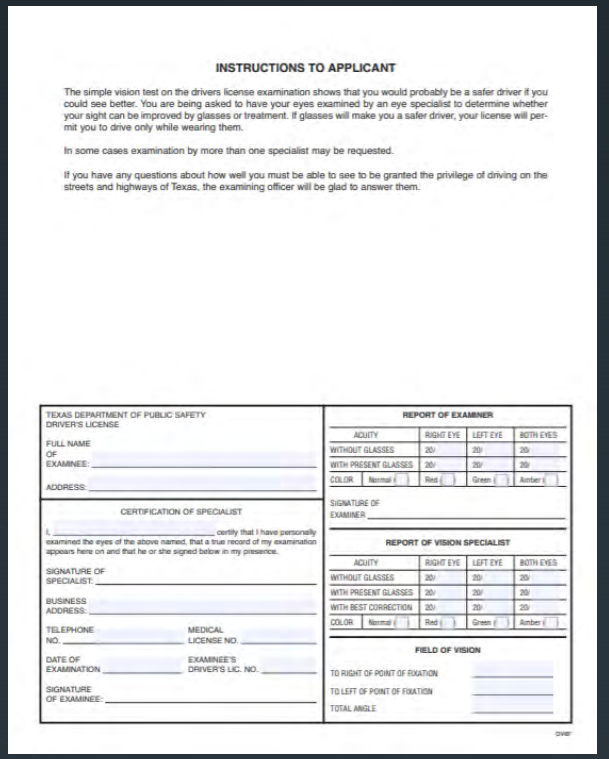
☐ 7. Applicant should drive in daylight only.

☐ 8. Other treatment to improve vision is recommended.

☐ 9. Due to permanent eye condition, applicant need not be referred for visual reexamination at next renewal of driver's license.

☐ 10. Other _____

over



INSTRUCTIONS TO APPLICANT

The simple vision test on the drivers license examination shows that you would probably be a safer driver if you could see better. You are being asked to have your eyes examined by an eye specialist to determine whether your sight can be improved by glasses or treatment. If glasses will make you a safer driver, your license will permit you to drive only while wearing them.

In some cases examination by more than one specialist may be requested.

If you have any questions about how well you must be able to see to be granted the privilege of driving on the streets and highways of Texas, the examining officer will be glad to answer them.

TEXAS DEPARTMENT OF PUBLIC SAFETY
DRIVER'S LICENSE

FULL NAME OF EXAMINEE: _____

ADDRESS: _____

CERTIFICATION OF SPECIALIST

I, _____ certify that I have personally examined the eyes of the above named, that a true record of my examination appears here on and that he or she signed below in my presence.

SIGNATURE OF SPECIALIST: _____

BUSINESS ADDRESS: _____

TELEPHONE NO. _____ MEDICAL LICENSE NO. _____

DATE OF EXAMINATION _____ EXAMINEE'S DRIVER'S LIC. NO. _____

SIGNATURE OF EXAMINEE: _____

REPORT OF EXAMINER

ACUITY	RIGHT EYE	LEFT EYE	BOTH EYES
WITHOUT GLASSES	20/	20/	20/
WITH PRESENT GLASSES	20/	20/	20/
COLOR Normal ( )	Red ( )	Green ( )	Amber ( )

SIGNATURE OF EXAMINER _____

REPORT OF VISION SPECIALIST

ACUITY	RIGHT EYE	LEFT EYE	BOTH EYES
WITHOUT GLASSES	20/	20/	20/
WITH PRESENT GLASSES	20/	20/	20/
WITH BEST CORRECTION	20/	20/	20/
COLOR Normal ( )	Red ( )	Green ( )	Amber ( )

FIELD OF VISION

TO RIGHT OF POINT OF FIXATION _____

TO LEFT OF POINT OF FIXATION _____

TOTAL ANGLE _____

over

A Clinician's Approach

Does the patient meet;

1. Vision Requirements
2. Motor capabilities to handle driving the car
3. Cognition to make decisions, navigate a route, pay attention to obstacles

Optometric Testing

- Visual Acuity*
- Visual Fields*
- Contrast Sensitivity
- Visual Processing Skills

*Required

Optometric Testing-
Visual Acuity

Visual Acuity

- High contrast targets
- Visual acuity has a correlation of <1% of motor vehicle accidents
- **Functional acuity** measures lower

Optometric Testing- Visual Acuity

- **Functional acuity**
  - Acuity that is possible during normal daily tasks
  - Functional visual acuity of normally 20/20 patient decreases to 20/40 when driving at night-time, going >55MPH, with high beams on

https://www.consumerreports.org/car-repair-maintenance/old-headlights-can-be-dangerously-dim/

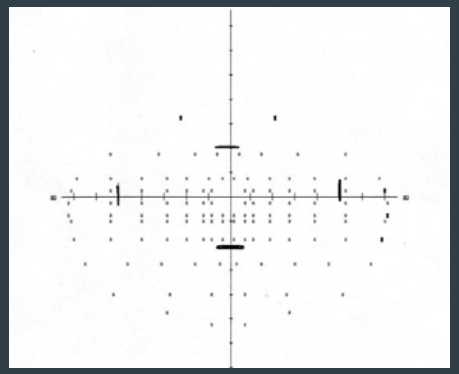
Optometric Testing

- Visual Acuity*
- Visual Fields*
- Contrast Sensitivity
- Visual Processing Skills

*Required

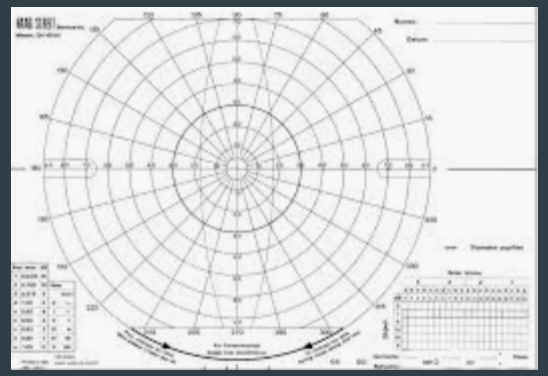
Optometric Testing
Functional Visual Field Assessment

Binocular Esterman



https://synapse.koreamed.org/search.php?where=aview&id=10.3341/jkos.2013.54.10.1567&code=0035JKOS&vmode=PUBREADER

Goldman Perimeter



https://www.west-op.com/perimeterpaper.html

Arc Perimetry

vision2020lvrc.org.hk

Optometric Testing

- Visual Acuity*
- Visual Fields*
- Contrast Sensitivity
- Visual Processing Skills

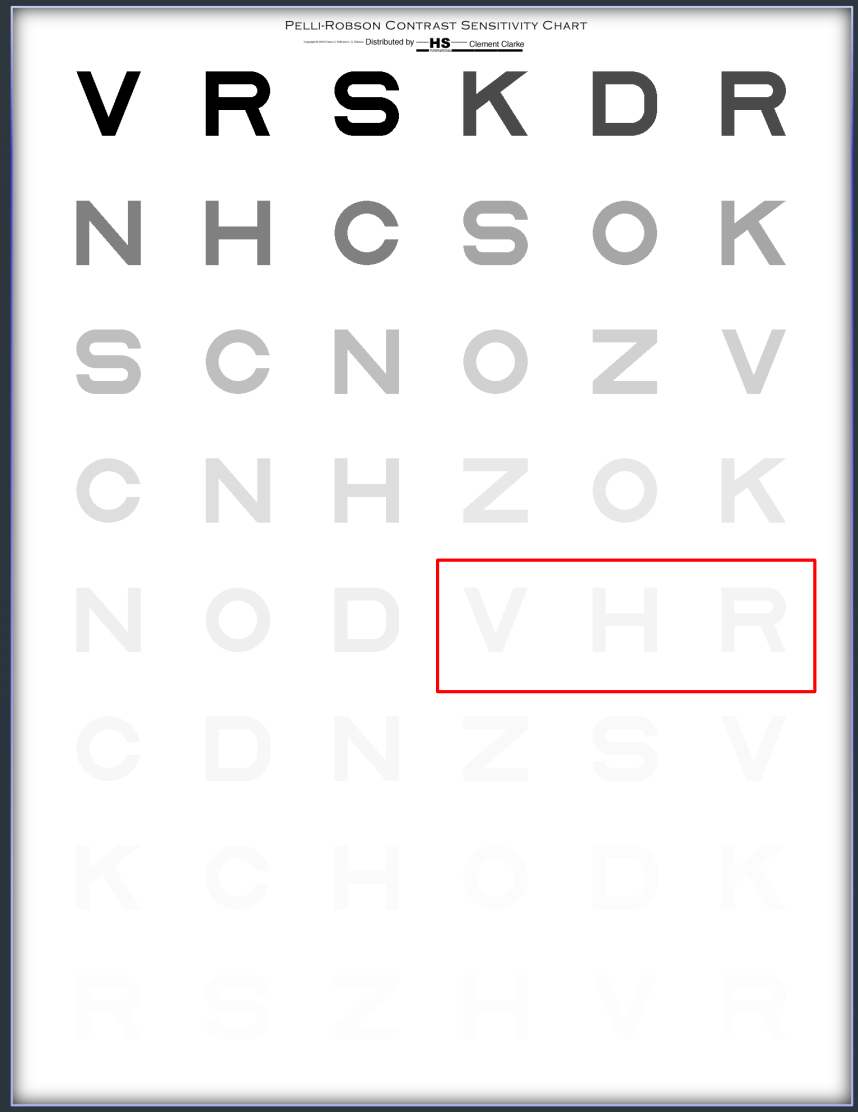
*Required

Tests that optometrists should consider

Hold a truer correlation between good results and safer more alert driving

Optometric Testing Contrast Sensitivity

- More predicative of patients having a difficulty time driving
  - Greater than VA
  - Greater than field loss
- Even if just one eye is affected
- Contrast sensitivity of less than 1.25 log units (moderate contrast impairment) were 8x more likely to have been involved in a car accident



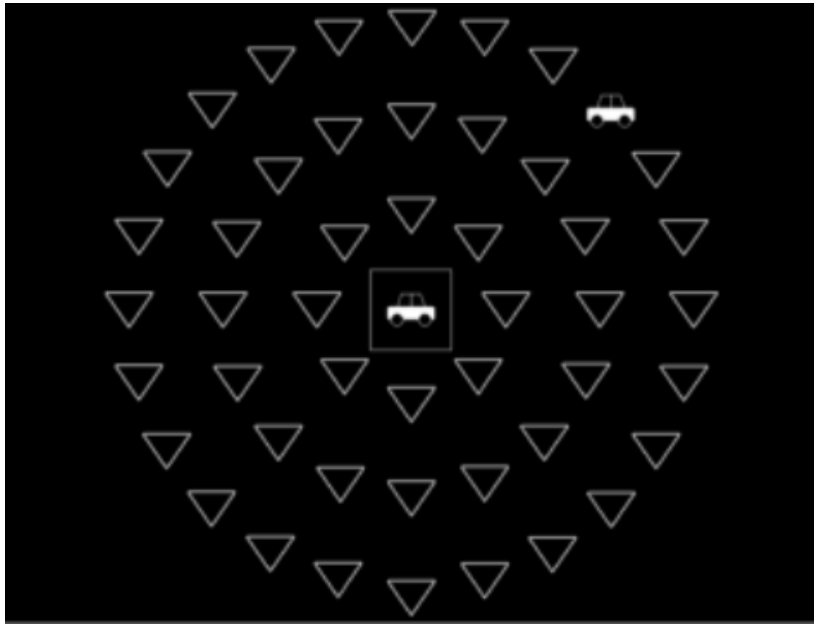
https://www.google.com/search?q=pelli+robson&dz=1C1GCEU_enUS856US856&sxsrf=ACYBGNSM6iC1A27uYB0oJDlf:-JaGXjK3w:1575569981999&tbm=isch&source=iu&ictx=1&fir=Rbaw44zmPDFEgM%253A%252CdxTWGIb9vC2K1M%252C_&vet=1&usg=AI4_-kR-mrpqZaBJxVg95upo4ds7RtRow&sa=X&ved=2ahUKEwig4eHI5_mAhVCPq0KHeEWCA0Q9QEwAHoECAgQFA#imgrc=Rbaw44zmPDFEgM:

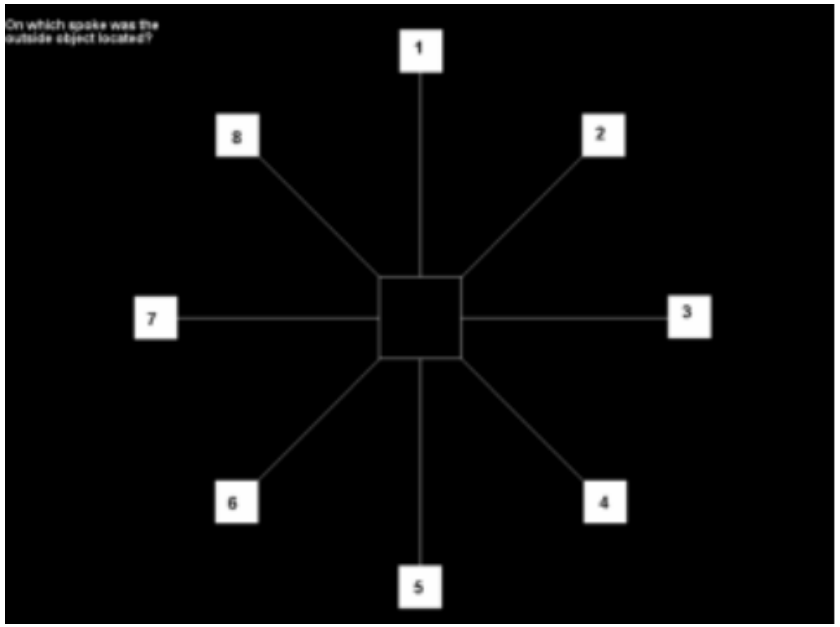
Optometric Testing
Visually Processing Skills

- Impaired Visual Processing speed was strong predictor of driving performance
- Predict driving safety patients with systemic conditions
    - **Stroke, Parkinson's, and Dementia**

Optometric Testing
Visual Processing Skills

- Useful Field of View (UFOV)
  - Measures “functional field of view”
  - Higher order visually possessing skills
    1. Quickly detect and localize targets
    2. Divide visual attention in both central and peripheral visual field
    3. Detect relevant targets amongst “visual clutter”
    - Stronger predictor of driving ability, safety, and crash risk than JUST visual acuity and fields



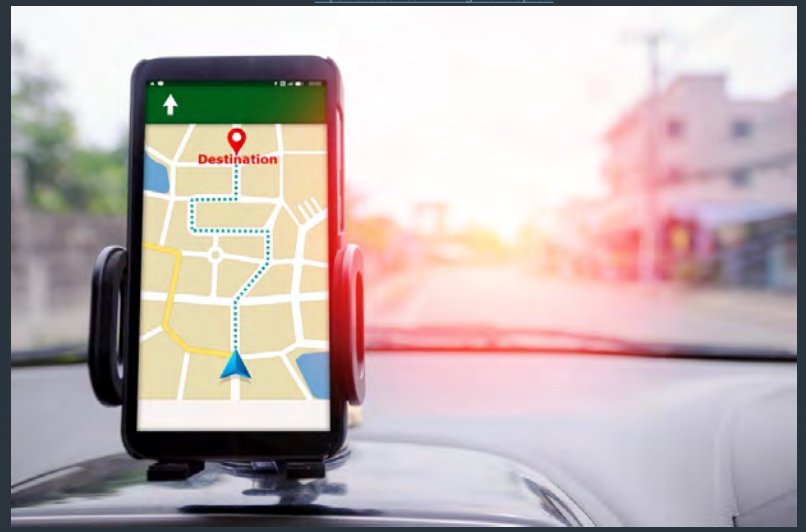


http://www.biopticdrivingusa.com/ufov-usefull-field-of-vision/

Visual Accommodations

- Present

https://ocutech.com/driving-with-bioptics/

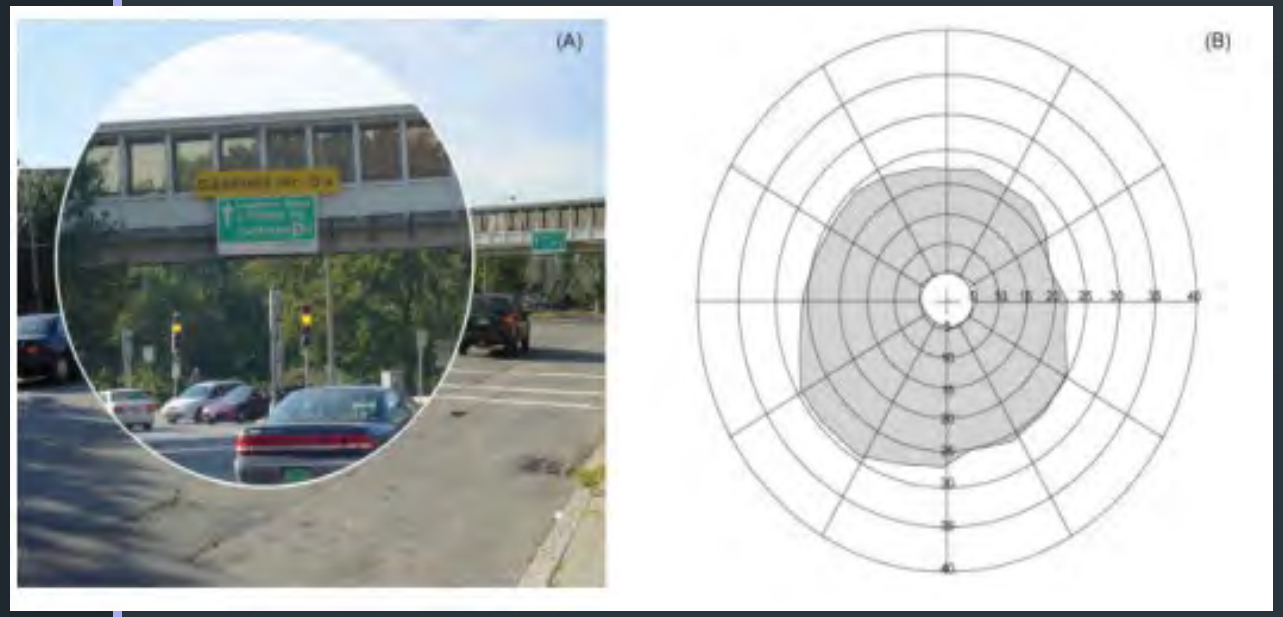


https://www.scienceabc.com/innovation/how-gps-global-positioning-system-works-satellite-smartphone.html

- Future
  - Self-driving cars

https://www.aarp.org/auto/trends-lifestyle/info-2018/self-driving-cars.html

Bioptic Driving



https://www.spiedigitallibrary.org/journals/Journal-of-Biomedical-Optics/volume-15/issue-1/016011/DLPsupTMsup-based-dichoptic-vision-test-system/10.1117/1.3292015.full?SSO=1

- Bioptic is mounted over “good” eye
- Maximum visual acuity of 20/200
  - Maximum bioptic telescope is 4x
- Still need to maintain appropriate 140* of uninterrupted horizontal field of vision
  - Create an additional ring scotoma when being used
- Bioptic is used less than <1% of time

A Driver’s Approach to Autonomous Driving

https://www.prescouter.com/2013/01/intelligent-steering-wheel-tells-you-to-go-left-or-right/

Stage 1	Visual stimuli is registered
Stage 2	Stimuli needs to be localized and recognized
Stage 3	Driver decides action
Stage 4	Driver executes motor response to complete decision

Bioptic Training

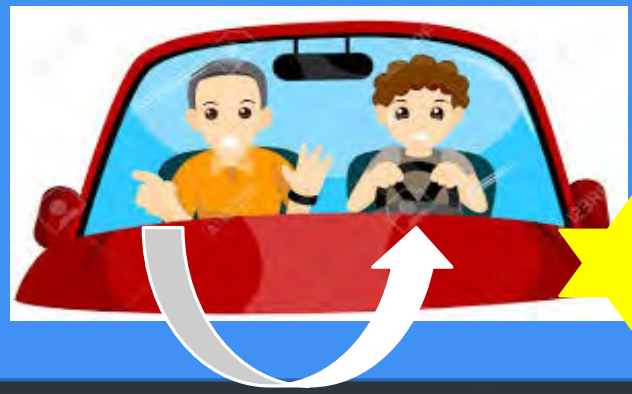
Hand Held Telescope Skills

-Localizing
-Focusing
-Spotting
-Tracking
-Tracing

Real Life Bioptic Skills

-Nearness illusion
-Reduced Field
-Movement of objects

Passenger Skills ➡ Driving Skills



- Receive and remember directions
- Detect and react to obstacles
- Intersections
- Glare/light reactions

Driving with a Bioptic-Perspectives

- Safety study looked at motor collision rates with bioptic drivers
- A Self assessment of the safety of bioptic drivers
  - Not overconfident
  - Maintain safe driving skill

Identifying Low Vision Drivers in your practice

New drivers with stable conditions and permanent vision loss

https://thenewswheel.com/new-study-names-the-best-and-worst-states-for-teen-drivers/

Experienced drivers with age related and likely progressive visual impairments and/or vision loss

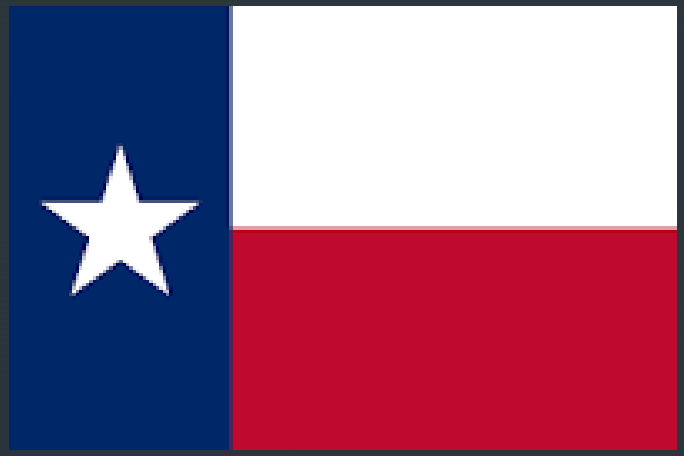
https://thenewswheel.com/new-study-names-the-best-and-worst-states-for-teen-drivers/

Aging Population and the Implications of driving

- Loss of independence
- Non-Visual disorders that affect driving
  - Neurological issues
  - Stroke/Cerebrovascular Event
- Texas Medical Advisory board these patients need comprehensive driving tests before being allowed back on the road
  - In a survey of 290 stroke survivors
    - 30% resumed driving
    - 48% received NO ADVICE about returning to driving
    - 87% reported that NO driving evaluation was done on them before they started driving

Texas Resources

- State Agencies
  - Texas School for the Blind Visually Impaired (Austin)
  - Texas Workforce Agency
- Federal Agencies
  - Veterans Affairs Blind Rehab Centers
- Non-Profits
  - Criss Cole Center (Austin)
  - OWL radio
- Private resources
  - Hospitals with Rehabilitation
  - Private Occupational Therapists
  - Private Low Vision Clinics



References

Chun, Robert, et al. “Current Perspectives of Bioptic Driving in Low Vision.” *Neuro-Ophthalmology*, vol. 40, no. 2, 2016, pp. 53–58., doi:10.3109/01658107.2015.1134585.

Dougherty, Bradley E. “Previous Driving Experience, but Not Vision, Is Associated With Motor Vehicle Collision Rate in Bioptic Drivers.” *Investigative Opthalmology & Visual Science*, vol. 56, no. 11, May 2015, p. 6326., doi:10.1167/iovs.15-16882.

Guide for Determining Driver Limitation . 2013, *Guide for Determining Driver Limitation* .

Owsley, Cynthia. “Driving and Age-Relaged Macular Degeneration.” *Journal of Visual Impairment and Blindness*, vol. 102, no. 10, 1 Oct. 2008, pp. 621–635.

Owsley, Cynthia, et al. “Visually Impaired Drivers Who Use Bioptic Telescopes: Self-Assessed Driving Skills and Agreement With On-Road Driving Evaluation.” *Investigative Opthalmology & Visual Science*, vol. 55, no. 1, 2014, p. 330., doi:10.1167/iovs.13-13520.

Peli, Eli. “American Academy of Optometry.” American Academy of Optometry. Orlando.

“Vision Requirements for Driving Safety with Emphasis on Individual Assessment.” *International Council of Ophthalmology*, Feb. 2006.

Wilkinson, Mark. “American Academy of Optometry.” American Academy of Optometry. Orlando.

Wood, Joanne M., and Cynthia Owsley. “Useful Field of View Test.” *Gerontology*, vol. 60, no. 4, 2014, pp. 315–318., doi:10.1159/000356753.

Questions?


Sight Gags by Scott Lee, O.D.
© 2008 Scott Lee, O.D.
"I'm sure he's well-trained, but seeing-eye dogs just aren't allowed to drive."

Non Organic Vision Loss

Doctor Bailey Peterson

Nothing to Disclose

Objectives

To learn what non-organic vision loss means to patients and providers
To categorize non-organic vision loss to a specific cause to ensure proper pt care
To learn what exam elements can be used to test for NOVL
To effectively and efficiently treat patients with NOVL
To become more comfortable with a NOVL patient

What is Non Organic Vision Loss?

Disturbance of vision not supported by an organic etiology upon examination

Commonly associated with the following:

- Stress
- Pediatric Population

Important to remember: not a diagnosis of exclusion

Malingering or Simulation

Intentionally counterfeiting a disease with the intent to benefit either monetarily or non-monetarily

Reasoning: Escape work, reduction of court sentence, collect social security, attract sympathy

Positive Simulation: Simulating an ophthalmic disease

Negative Simulation: Denial of an ophthalmic disease

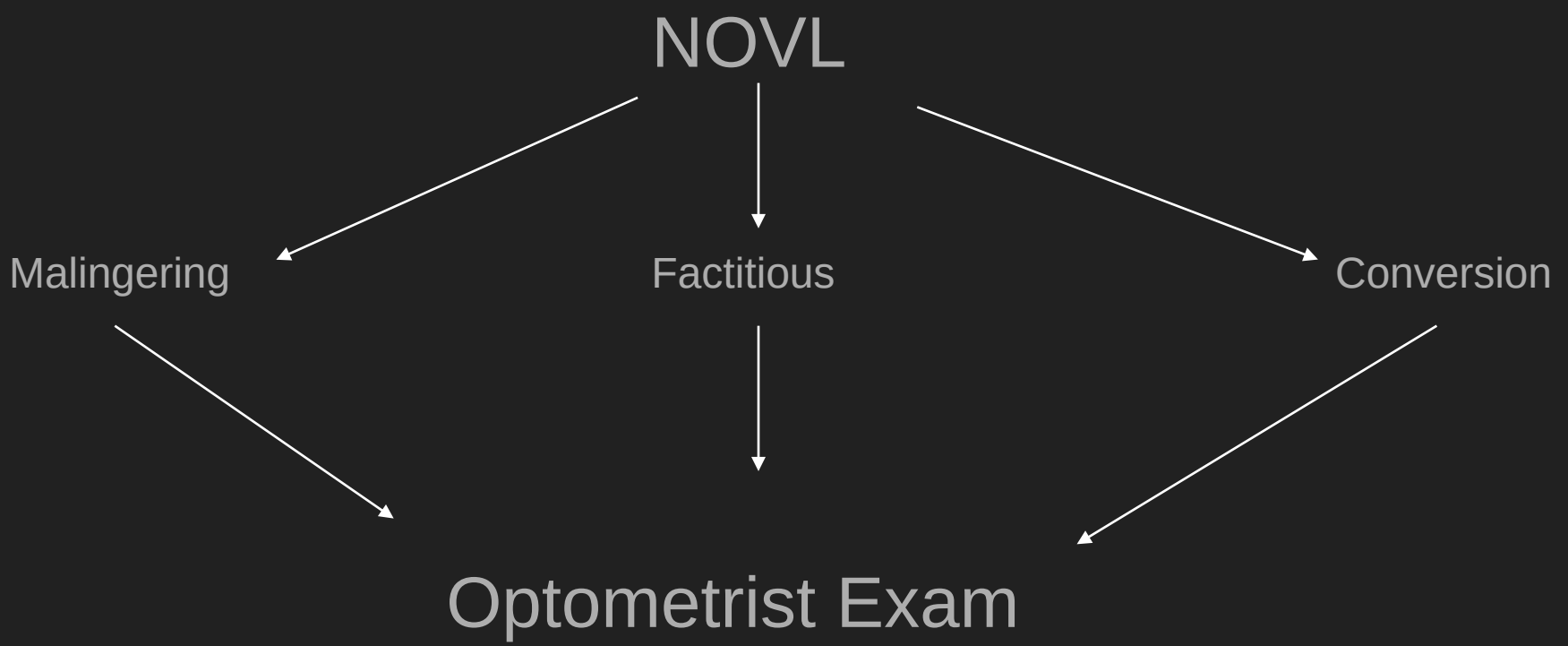
Factitious Disorder

Mental disorder in which someone deceives others by appearing sick by purposely getting sick or by self injury

Mild to severe (munchausen)

Somatoform Disorders

- Conversion Disorder
- Neurological symptoms specifically
    - Weakness/paralysis
    - Abnormal Movements (tremor)
    - Blindness
    - Hearing Loss
    - Numbness


NOVL
Malingering
Factitious
Conversion
Optometrist Exam

What Does the Patient Look Like?

	Malingering	Factitious	Conversion
Pt Background	Financial benefit: transferred from court, local military draft office, health insurance or other gov org Child	Extensive health knowledge, eager to have testing, many doctors, don't talk to family	Anxiety, trauma, grief, depression,stress, guilt, or anger Presence of other neurologic complaints
Chief Complaints/symptoms	Vague: vision loss, field loss, decreased vision; monocular or binocular	Vague: vision loss, field loss, decreased vision; monocular or binocular	Double vision, blindness, field loss
Symptoms	Highly suggestible or exaggerated	Get worse without apparent reason	Vary year to year and are rarely ever absent
Ocular health	Unremarkable	Unremarkable	Unremarkable

How to Test for Non Organic Vision Loss

- Visual Acuity
  - Monocular vs Binocular
- Visual Field Loss
- Electrodiagnostics

Table 15.3. Examination strategies for alleged blindness or loss of vision

Bilateral blindness	Monocular blindness or visual impairment	Bilateral visual impairment
1. Testing of reflexes • Observation of behavior • Blink reflex • Prisms: fixation movements • OKN • Mirror-induced pursuit movements • Fixation star of direct ophthalmoscope • Pupillary light reactions 2. Deception • Tasks of coordination that require no visual function • Saccades on command combined with index finger movements 3. Objective testing methods • VEP, ERG	1. Testing of reflexes • Pupillary reactions: relative afferent pupillary defect • Convergence test • Refixation movement when covering the healthy eye 2. Binocular Tests • Prisms • Stereoacuity • Confusion test (polarized tests, red–green glasses, etc.) 3. Testing central visual functions by other methods • Central thresholds at the perimeter • Preferential looking acuity • Fixation • Laser interferometry	1. Deception regarding the sizes of optotypes • Use of constant angular sizes of optotypes at varying distances • Testing with single optotypes, allowing no comparisons to other characters • Near acuities with optical magnification 2. Tests of central vision by other methods • Central threshold sensitivity at the perimeter • Preferential-looking acuity • Fixation • Laser interferometry • Probability of seeing 3. Objective methods • Acuity VEP • Multifocal ERG • OKN (quantitative) • Psychogalvanic reflexes

Visual Acuity

Fog lens

Mirror Test

Colored Lenses

OKN

Prism Test

Proprioception

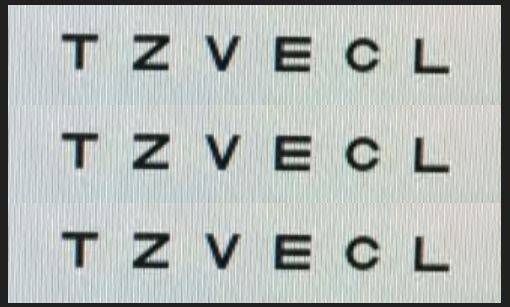
Stereo

PAM

Menance test

Others

Fog Lens



Asymmetric vision loss

Easiest with a trial frame

Good eye:Place +6 and -6 cyl lenses both axis 180 to effectively make plano lens
Bad eye: plano or similar set up; Dr's preference

Have the pt read a chart full of BCVA of good eye and while they are reading move the axis of one lens so it blurs the good eye and the pt is reading the chart with the bad eye

Second version:
Check near acuity of good eye with high plus lenses, then suddenly switch to distance chart and have pt read chart with "bad eye"

VA: Mirror test

Test for gross vision

Move a mirror in front of a patient’s face and their eyes will have a horizontal movement (pursuits)

VA: OKN

Gross vision corresponds to at least 20/400

Works on the same principle as the mirror test

VA: Prism Test

4 BO over the weak eye (typically)

Vertical 4 BU

Half way over pupil of the good eye; bad eye covered; monocular diplopia

Ask if clarity of two lines is the same

Uncover bad eye and move prism down and completely cover good eye

Pt will say they still see double if they have good vision

Duane Test: 10 BU while reading paragraph text over bad eye; look for hesitation

VA: Proprioception

When a patient reports blindness

- Finger to nose
- Index fingers end to end

VA: Menace, Provocative test, Signature

Menace: reflex testing

Provocative: make someone read something funny, inappropriate, or shocking and watch for response

Signature: blind pts can still write their signatures; not scribbles

Visual Fields

Confrontations

Goldmann

Tangent

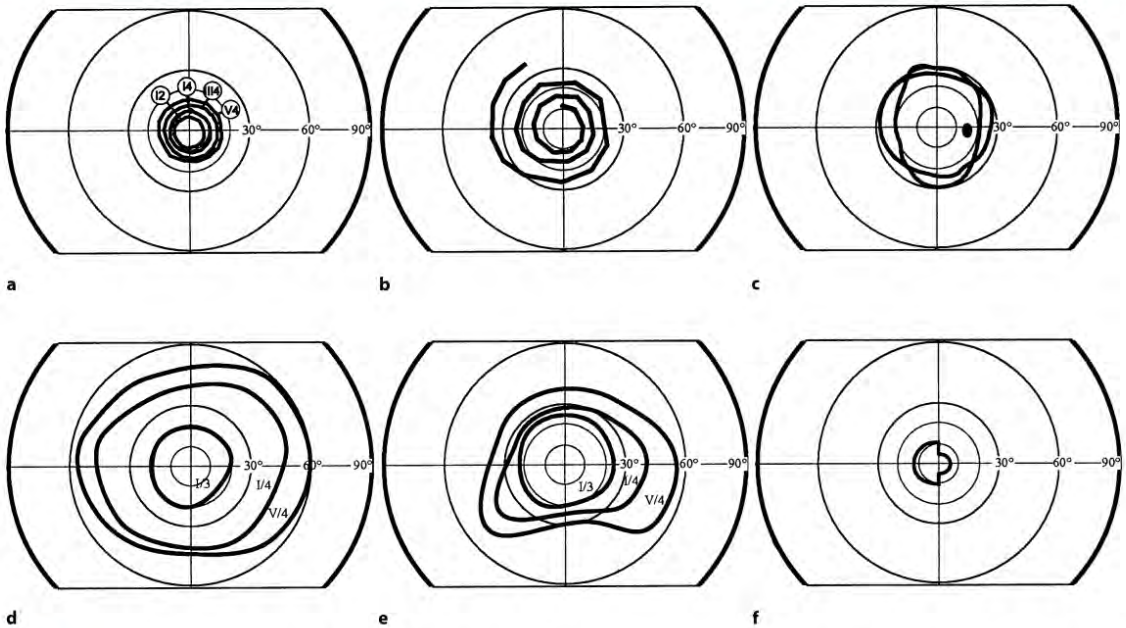
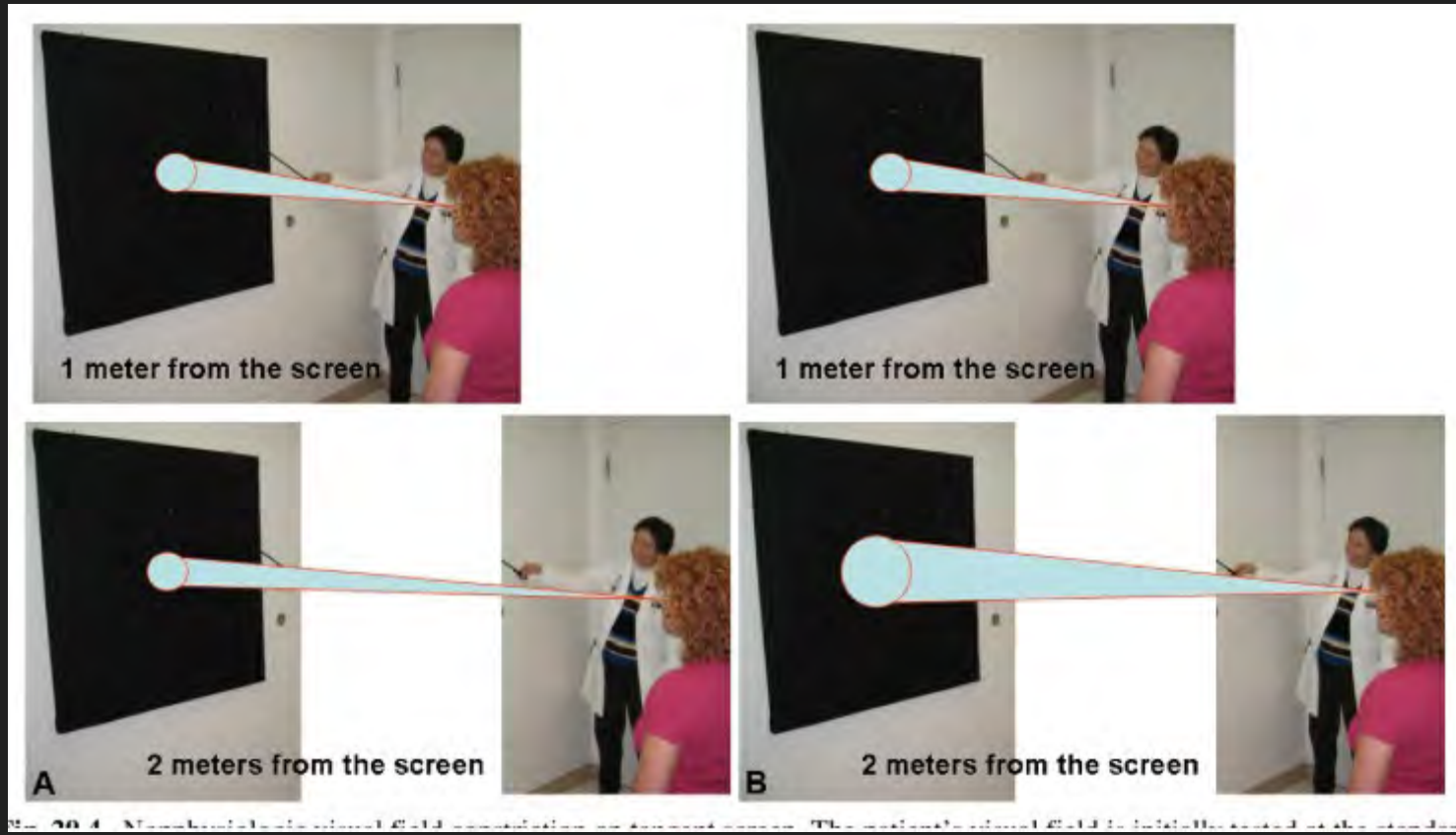


Fig. 15.3. The differential diagnosis of concentric constriction of the visual field. *Top* Typical configurations of the visual field in feigned loss of peripheral vision. **a** Symmetrical constriction of the more peripheral isopters (tunneling of the visual field). **b** Spiraling of isopters. **c** Crossing of adjacent isopters. *Bottom* Constriction of the visual field in cases of organic disease. **d** Symmetrical narrowing predominantly of the central isopters, caused by loss of media clarity. **e** Asymmetric constriction of the peripheral isopters in heredofamilial retinal degenerations. **f** Sharp discontinuities of isopters at the vertical midline and macular sparing in visual field loss caused by bilateral occipital lobe disease


1 meter from the screen
1 meter from the screen
2 meters from the screen
A
2 meters from the screen
B

Electrodiagnostics/Psychophysical testing

VEP

ERG

Dark Adaptometry

Neuro-imaging consult

CT

MRI

Psychology/Psychiatrist Consult

Patient dependent

Treatment

Reassurance

Therapy

Patient Cases

1. 48 WM

Hx of TBI and complex PTSD
- 2006 NBR LOC <10 mins
- 2009 NBR -LOC

Chief complaint blur dist and near; glare; headaches from focusing near; dryness;
UIW (4/19) checked him for glaucoma
Lasik 2004

Entrance Testing

DVA sc	NVA sc
OD 20/30	OD 20/60
OS 20/30	OS 20/80
OU 20/25	OU 20/60

Entrance Testing

CT Distance: ortho
Near: XP

Maddox Rod sc
Vertical: Rhyper
Horizontal: eso

EOMS: FROM OD,OS; erratice saccadic movements; had to keep reminding pt to look at the target

CVF
OD: inf nasal sup nasal defect
OS: inf nasal sup nasal defect

Midline shift: pt reports double vision; mild misalignment to pt’s right

Pupils normal

Refraction

Refraction

OD: plano+0.50x005 20/20

OS:plano+0.50x020 20/20

Add:+1.25

Damp

OD: plano+0.75x015 20/20

OS:plano+0.75x020 20/20

Initial horizontal diplopia when both eyes opened and pt wouldn’t accept any prism to make it single

Worth 4 fused

BV

Von grafe

Dist V: 1 BD OS

Dist H: ortho

Von grafe: pt reports near diplopia fused with 9 BI

Near V: ortho

Near H: 10 exo

Stereo: 100 arc seconds

BI: x/6/4

BO:x/4/2

BI: unable

BO: unable

Ocular Health

IOP: 17 mmHG OD/OS

Anterior Seg: unremarkable

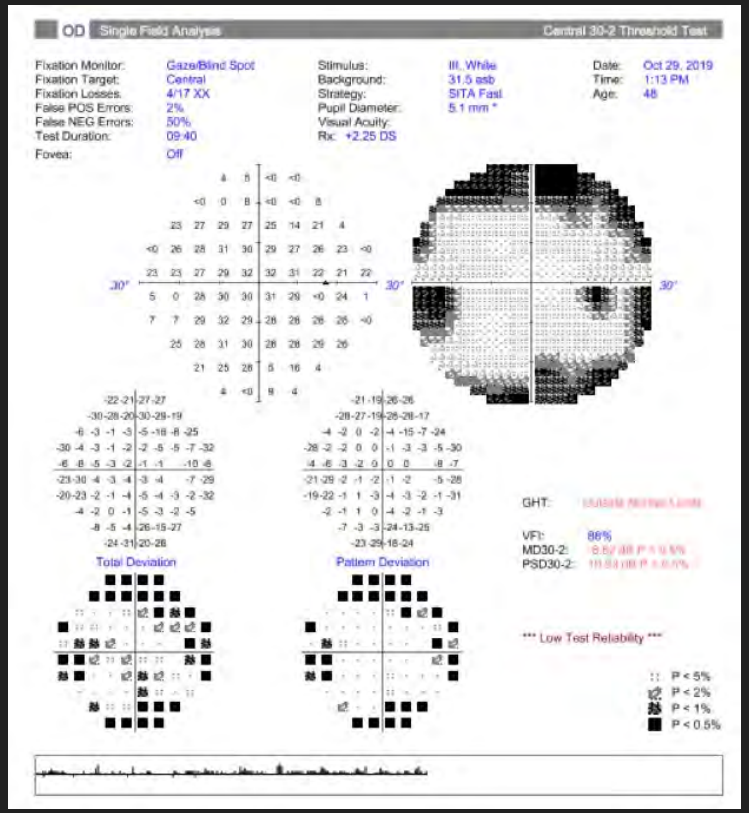
Posterior Seg:

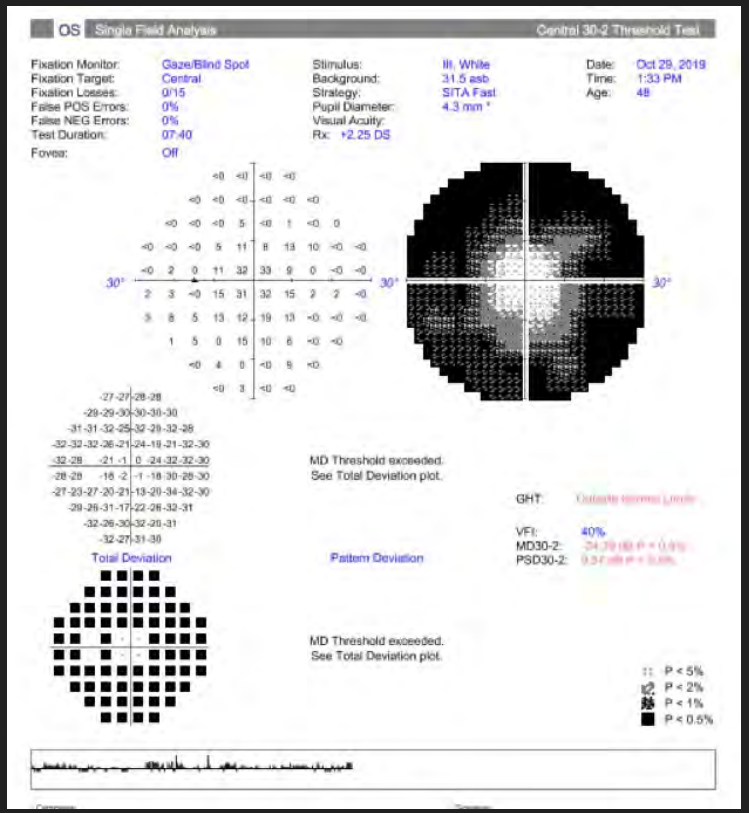
- .60 nerves OD/OS; healthy rim tissue
- +FLR
- Pavingstone inf temp OU

Assessment/Plan

1. Hx of TBI: 2006 NBR (+)LOC <10 min; 2009 NBR (-) LOC
    a. (+) inconsistent finding: EOMS,midline, CVF, diplopia reporting; repeat BV 2 months after glasses adapt
    b. (+) accommodative dysfunction: presbyopia
    c. (+) Ocular path: glc suspect (low risk) and possible binasal hemi vf defect
2. Refractive error
3. Photosensitivity
    a. Send for tint eval
4. Headaches
    a. Could be from uncorrected ametropia vs diplopia
5. Glc suspect secondary to large C/D; doubt glc at this time
    a. Large C/D
    b. ONH ok for iop
    c. Monitor
6. Possible binasal hemianopsia
    a. Abnormal confrontations
    b. Pt asymptomatic
    c. 1 month VF

1 month VF 10/31/19





Patient 2

57HM

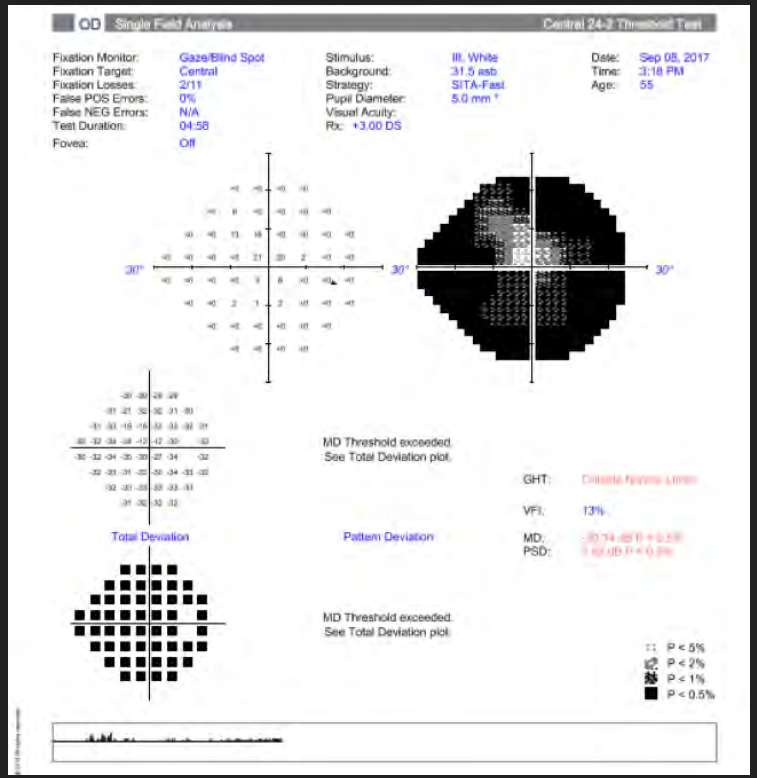
Seen at DPC since 2009 corrected 20/20- and 20/25

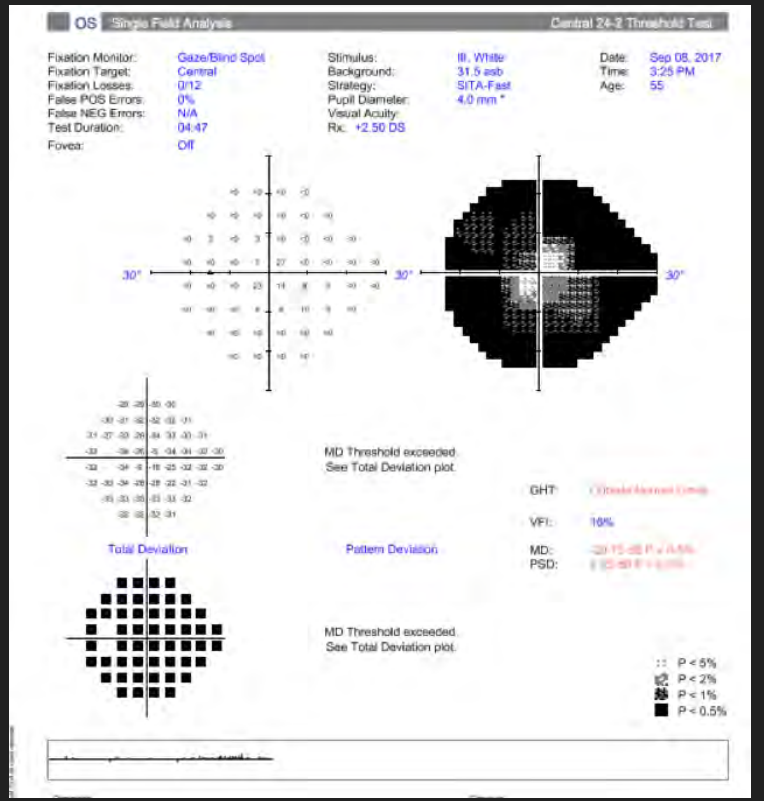
Glc Suspect secondary to .5/.55 nerves and HVF

Always been observing annually

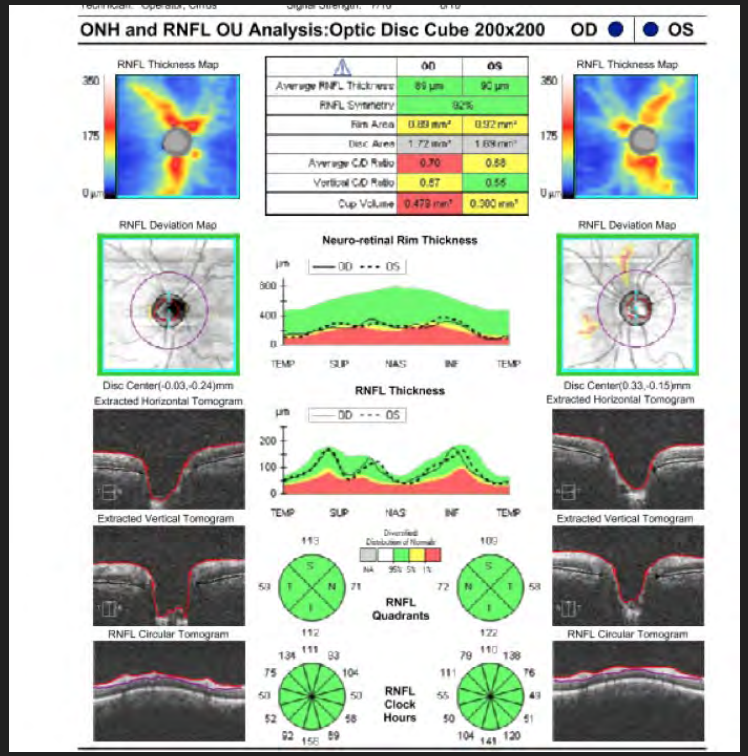
Seen 3/2019 for TBI exam and subsequently sent to UIW for tangent screen visual fields

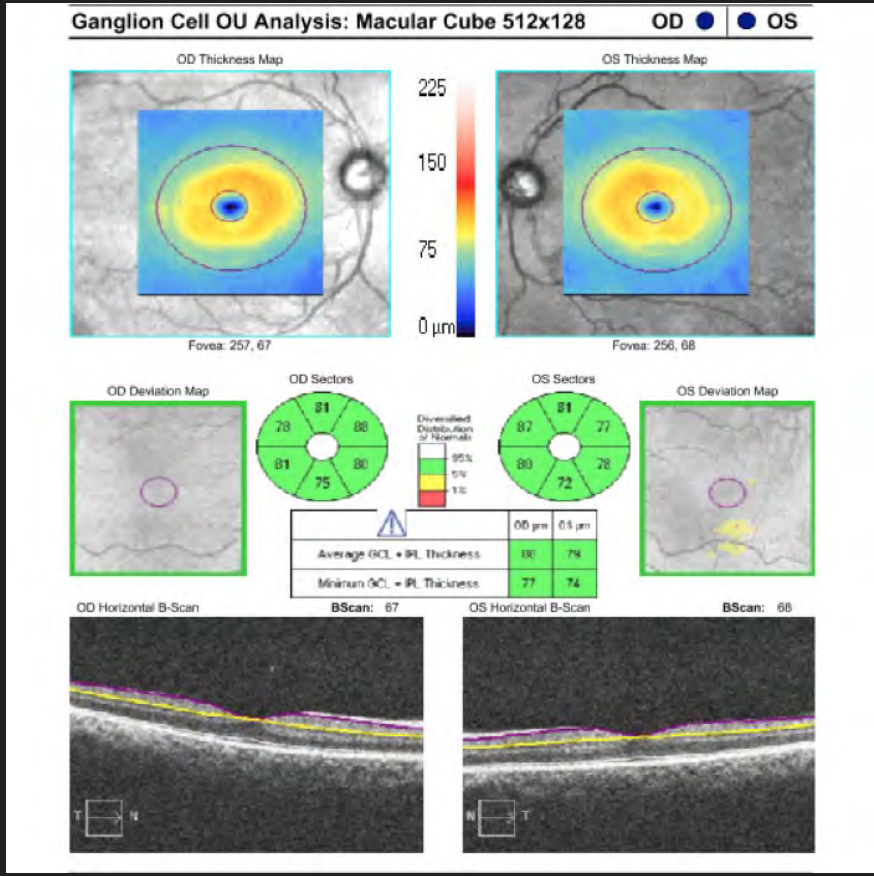
Visual Fields 2017



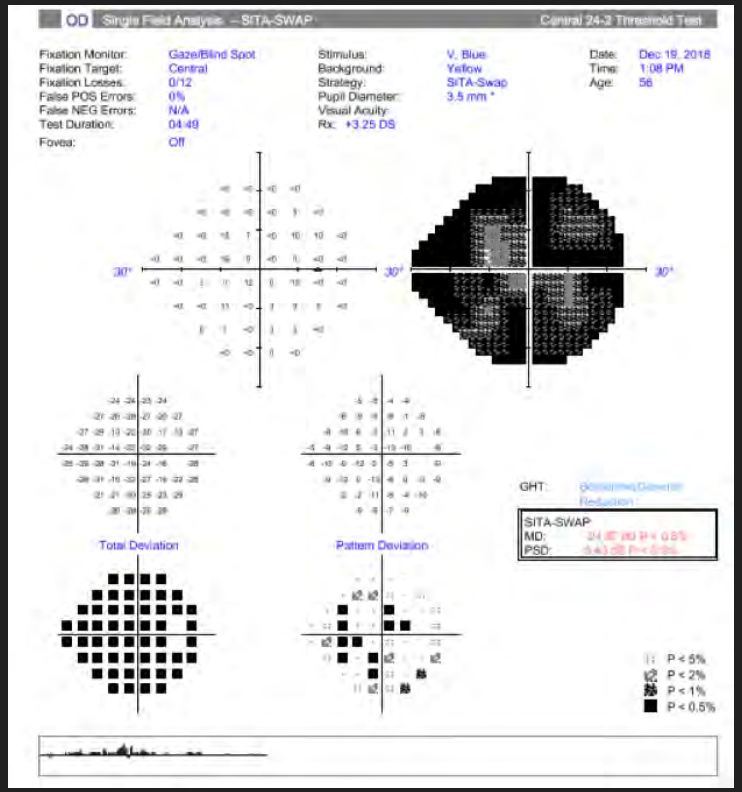


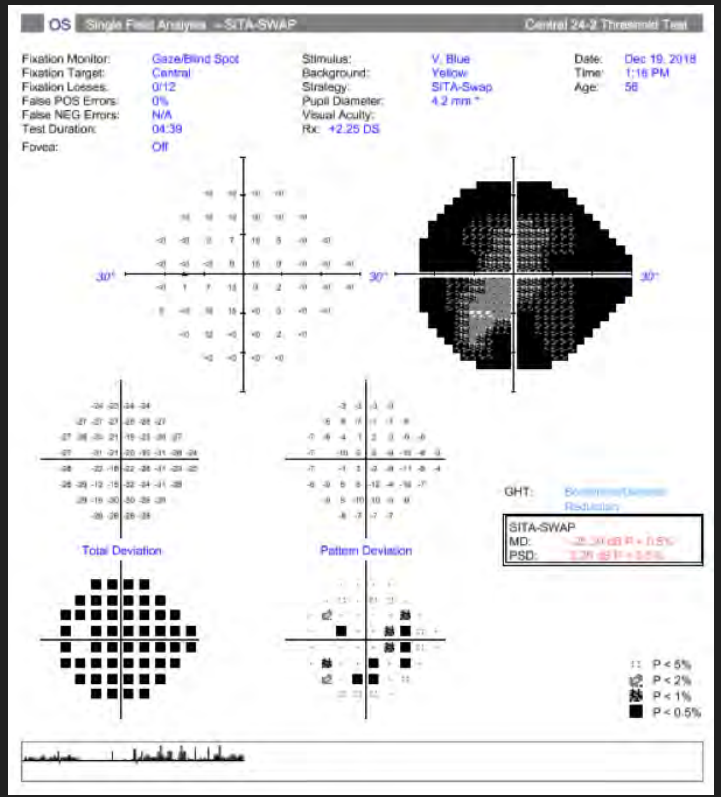
2018 OCT

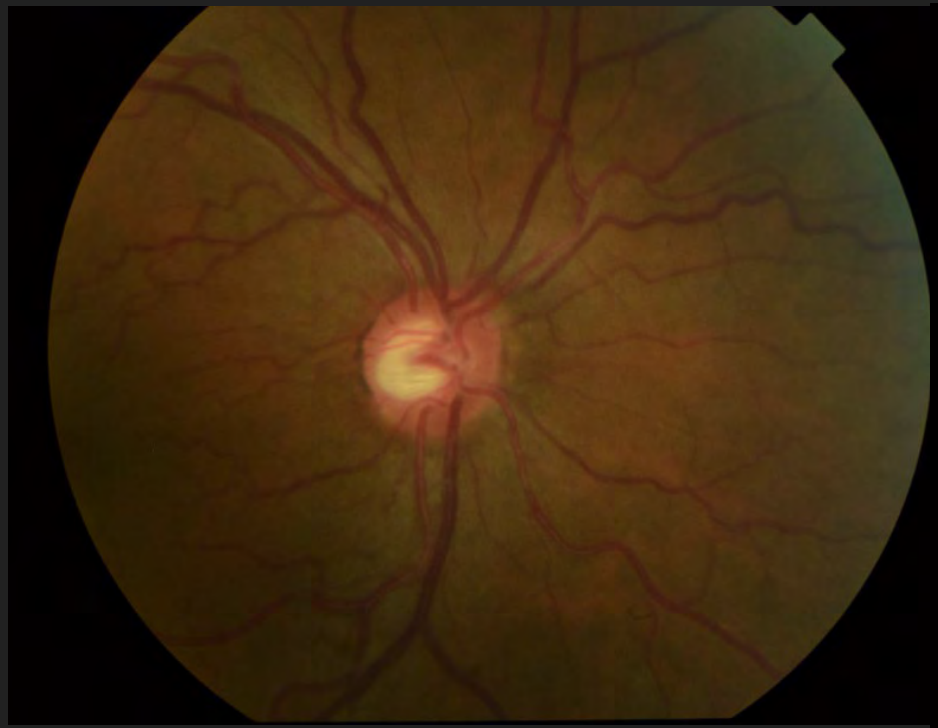

ONH and RNFL OU Analysis:Optic Disc Cube 200x200
OD
OS
RNFL Thickness Map
RNFL Deviation Map
Neuro-retinal Rim Thickness
RNFL Thickness
Disc Center(-0.03,-0.24)mm
Disc Center(0.33,-0.15)mm
Extracted Horizontal Tomogram
Extracted Vertical Tomogram
RNFL Circular Tomogram
RNFL Quadrants
RNFL Clock Hours
TEMP
SUP
NAS
INF

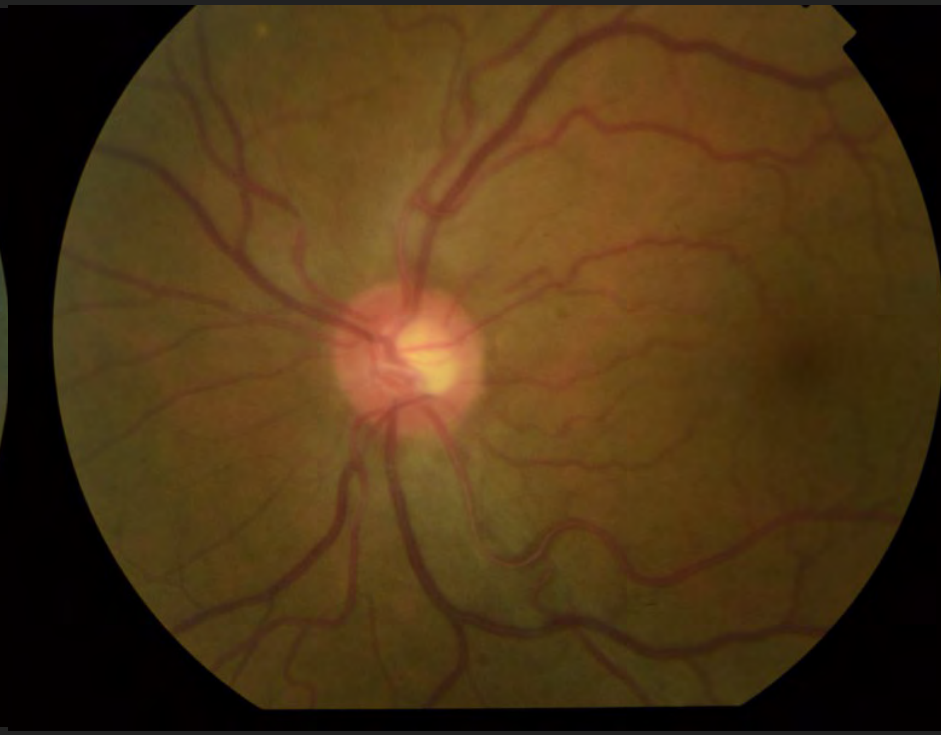

Ganglion Cell OU Analysis: Macular Cube 512x128
OD
OS
OD Thickness Map
OS Thickness Map
225
150
75
0 µm
Fovea: 257, 67
Fovea: 256, 68
OD Deviation Map
OS Deviation Map
OD Sectors
OS Sectors
Average GCL + IPL Thickness
Minimum GCL + IPL Thickness
OD Horizontal B-Scan
OS Horizontal B-Scan
BScan: 67
BScan: 68

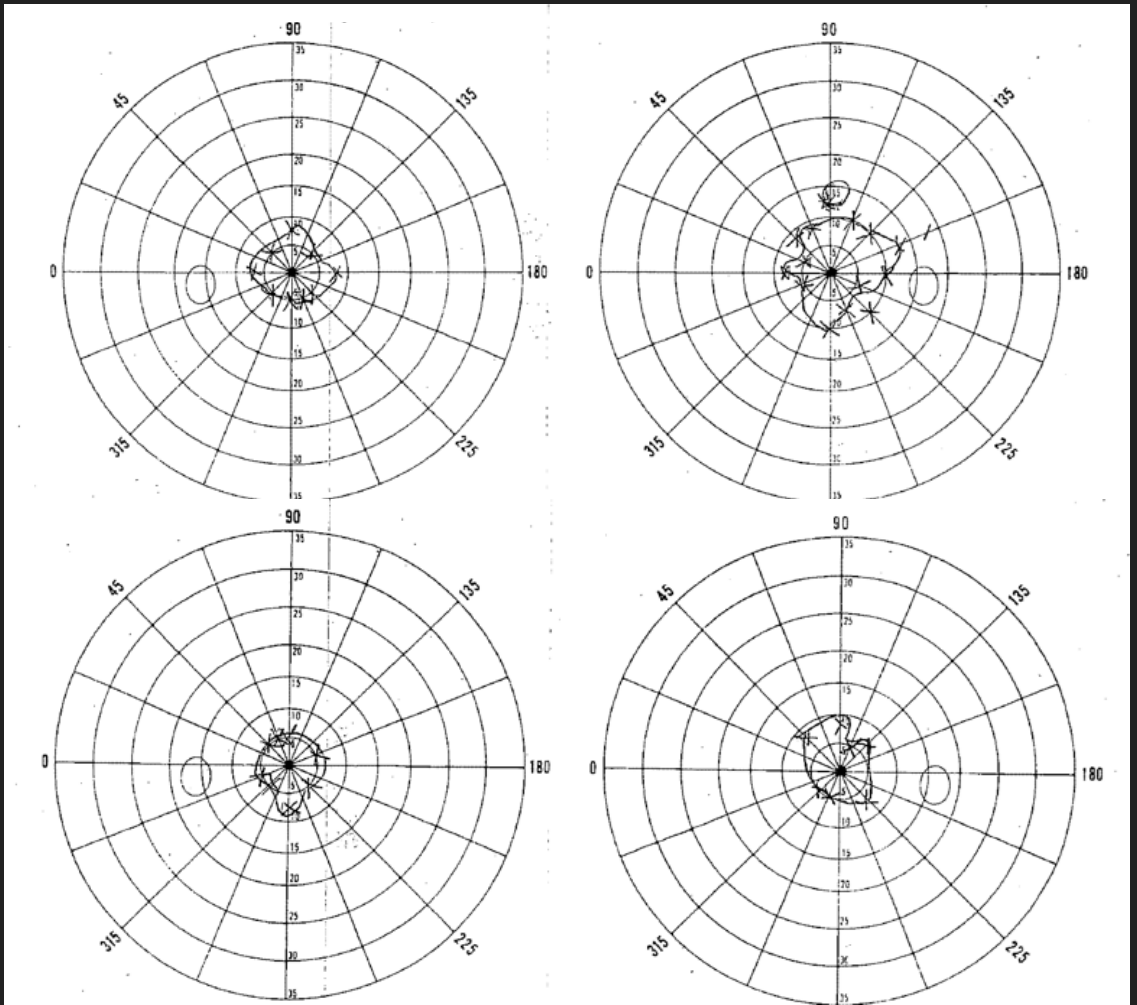
2019 fields


OD
Single Field Analysis – SITA-SWAP
Central 24-2 Threshold Test
Fixation Monitor: Gaze/Blind Spot
Fixation Target: Central
Fixation Losses: 0/12
False POS Errors: 0%
False NEG Errors: N/A
Test Duration: 04:49
Fovea: Off
Stimulus: V, Blue
Background: Yellow
Strategy: SITA-Swap
Pupil Diameter: 3.5 mm *
Visual Acuity:
Rx: +3.25 DS
Date: Dec 19, 2018
Time: 1:08 PM
Age: 56
30°
30°
GHT:
SITA-SWAP
MD:
PSD:
Total Deviation
Pattern Deviation
P < 5%
P < 2%
P < 1%
P < 0.5%


OS
Single Field Analysis – SITA-SWAP
Central 24-2 Threshold Test
Fixation Monitor: Gaze/Blind Spot
Fixation Target: Central
Fixation Losses: 0/12
False POS Errors: 0%
False NEG Errors: N/A
Test Duration: 04:39
Fovea: Off
Stimulus: V, Blue
Background: Yellow
Strategy: SITA-Swap
Pupil Diameter: 4.2 mm *
Visual Acuity:
Rx: +2.25 DS
Date: Dec 19, 2018
Time: 1:16 PM
Age: 56
30°
30°
GHT:
SITA-SWAP
MD:
PSD:
Total Deviation
Pattern Deviation
P < 5%
P < 2%
P < 1%
P < 0.5%






90
45
135
0
180
315
225
90
45
135
0
180
315
225
90
45
135
0
180
315
225
90
45
135
0
180
315
225

UIW Electrodiagnostics 6/5/19

VEP- “normal,robust amplitudes and normal latencies, providing no evidence of central visual pathway dysfunction”

ERG- “photopic negative responses were within normal limits, as were multi luminance flicker ERG and high-luminance flicker ERGs”

But…. “ Measurements had to be repeated (OS only), due to lead and electrode issues but no evidence of retinal or optic nerve dysfunction”

Tangent Screening OU- “pt presents with tubular fields consistent with non-organic psychogenic origin for vision loss”

UIW repeat Testing 10/16/19

Tangent Screen: “tubular response 7 inches @ 1 meter and 9 inches @ 2m”

ERG: “full field flash ERG show largely normal amplitudes and latencies though patient cooperation was limited making several repetitions of ERG recording necessary”

PRESENTING SPECTACLE Rx: (#1)

OD: -0.50DS Add: +1.25 DVA: 20/200 20/200
OS: -0.50DS Add: +1.25 DVA: 20/70 20/70
OU: NVA 12pt@30cm

COLOR DISCRIMINATION: Color vision normal. Testing, Farnsworth D-15.

HIRSCHBERG: eyes grossly aligned

FINAL SPECTACLE Rx:

OD: -0.50 -0.50 x 180 Add: +1.00 DVA: 20/25-
OS: Plano -1.00 x 015 Add: +1.00 DVA: 20/20-2

Assessment/Plan

Possible visual motion sensitivity syndrome- increased peripheral clutter causing him to “shut down”

- Binasal occlusion
- Applied to lenses and pt likes them
- RTC 1 month

VIST- giving him voice output tech because was an avid reader before injury

Neuropsychology consult

Take Aways!

BARTISCH, Georg (1535-1606)
Ophthalmodouleia, Das ist Augendienst. Dresden, 1583.
Foto: Hagströmerbiblioteket, Karolinska Institutet

References:

https://www.aao.org/disease-review/neuro-ophthalmology-non-organic-visual-loss-in-chi

https://pmj.bmj.com/content/75/882/201#xref-ref-23-1

https://www.semanticscholar.org/paper/Functional-and-simulated-visual-loss./70a4a69279fadf4ad8e27e7cbb1b6f1f522f2bc8/figure/5

https://www.aao.org/image/fogging-technique

https://www.aao.org/bcscsnippetdetail.aspx?id=45cef5ac-2f4e-4b67-81ff-85f3fd02878c

https://www.mayoclinic.org/diseases-conditions/factitious-disorder/symptoms-causes/syc-20356028

https://www.webmd.com/mental-health/somatoform-disorders-symptoms-types-treatment#1

https://www.disabled-world.com/disability/types/psychological/psychosomatic.php

http://eknygos.lsmuni.lt/springer/585/203-214.pdf

https://eyewiki.aao.org/Functional_Visual_Loss

https://www.aao.org/disease-review/neuro-ophthalmology-non-organic-visual-loss-in-chi

https://jamanetwork.com/journals/jamaophthalmology/article-abstract/634590

Patient 2

2. 43 AAM

2008 BR (+) LOC 5 min; 2010 NBR (-) LOC

Migraine, TBI,PTSD, anger/irritability

First exam 9/27/18

CC: trouble focusing small print,photophobia

Hx retinal hole repair and glauc; diplopia; words jump on the page

Nerves: .65 and .7 IOP on two meds with IOP’s of 15 OD/OS

Send for field to establish glc care with VA

RX: -0.75 OD 20/20 -1.25 OS 20/20

Pt very upset he was dilated and yelled at the doctors

Second exam 11/1/18

CC: wants dark window tint for his vehicle because sunglasses block his vision; has not received glasses and isn’t sure why he is here

Wearing dark sunglasses and hood; insistent that provider would give him a letter for window tint; when the provider mentioned the tints will help him and became aggravated and was asked to leave

The wife wanted to talk to the provider but the husband would not her talk

** pt was called and talked to later; came to understanding to try tints and then window tint if the sunglasses don’t help

1 year later

Pt did not take visual fields

At my visit 9/23/19

CC: vision worse, depth perception is bad, stopped driving, eyes twitching,

“Hasn’t seen his glc doctor in a while and his PCP changed his glc drops”

VERY DARK TINTS: 20/25; 20/40 PH 20/30 OU 20/25

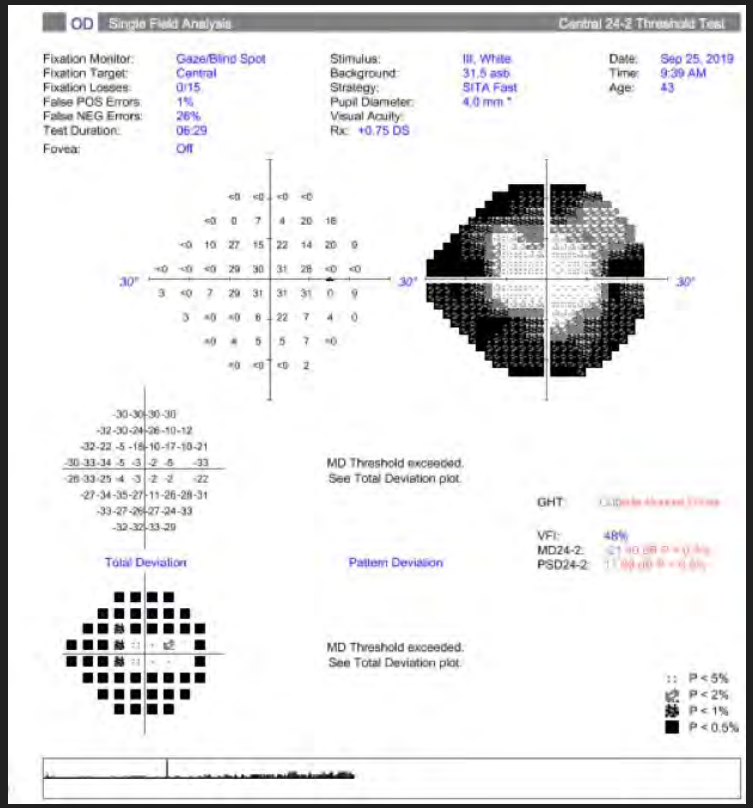
RX -1.00+1.00x180 20/20 and -1.75 20/20 but prefers habitual rx

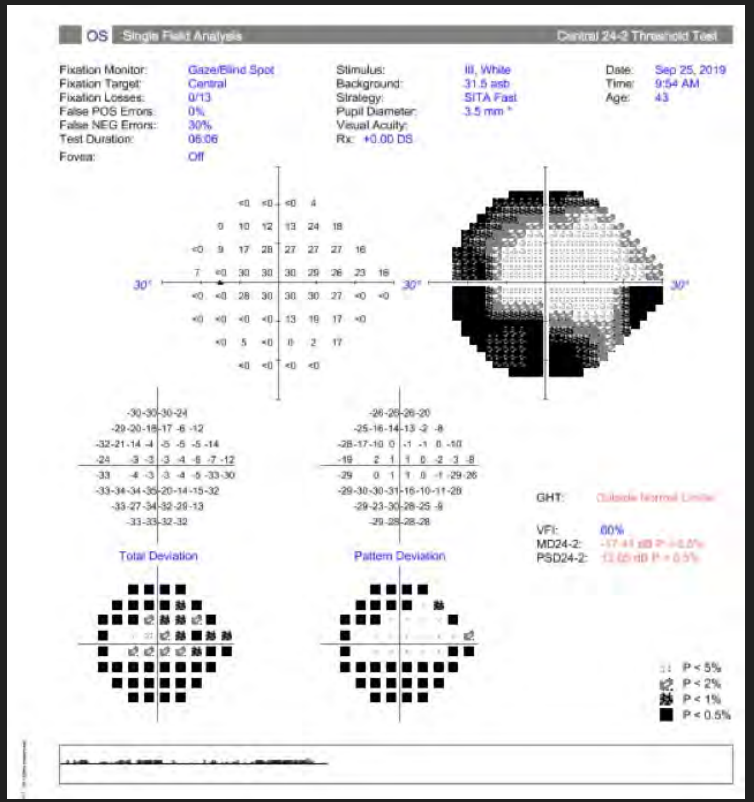
IOP 30/28 and 32/34

Now a .55 and .80 with vessel baring inf rim and excavated

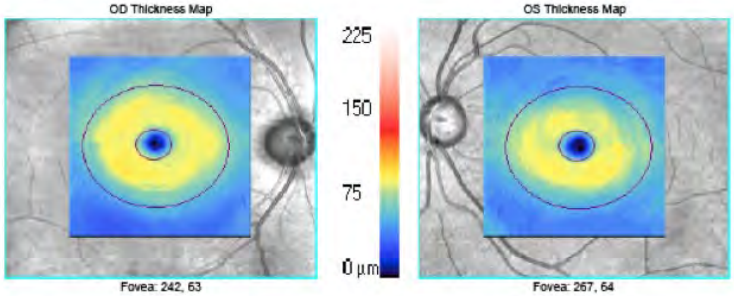
Send to datapoint to lower pressures: refuses to let doctors take his pressures

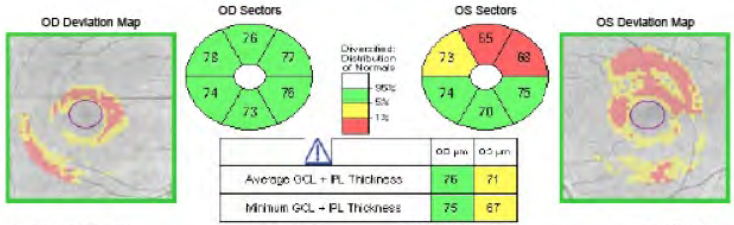
Visual Fields



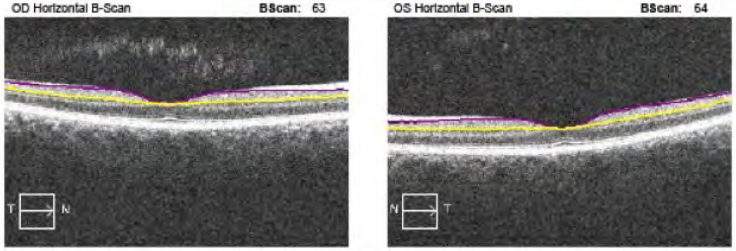


Ganglion Cell OU Analysis: Macular Cube 512x128 OD OS

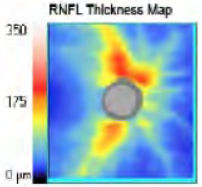




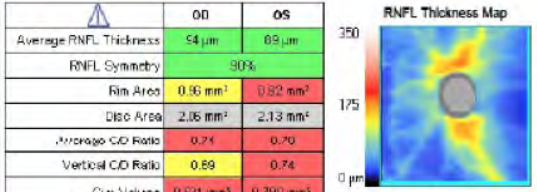
	OD µm	OS µm
Average GCL + IPL Thickness	76	71
Minimum GCL + IPL Thickness	75	67

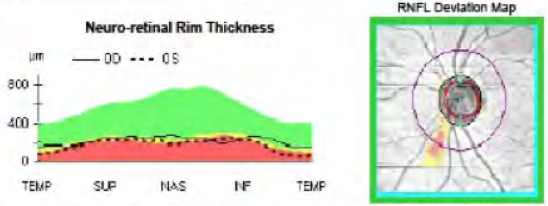


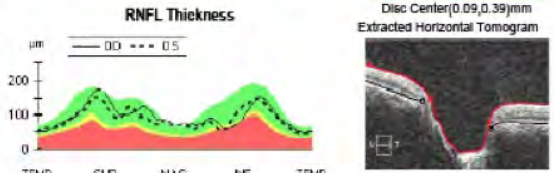
ONH and RNFL OU Analysis:Optic Disc Cube 200x200 OD OS

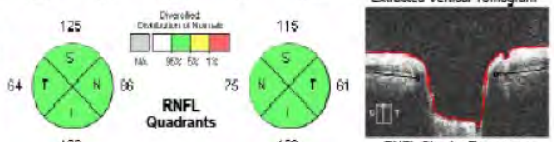


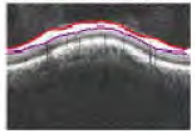
	OD	OS
Average RNFL Thickness	94 µm	89 µm
RNFL Symmetry	90%	
Rim Area	0.96 mm²	0.82 mm²
Disc Area	2.06 mm²	2.13 mm²
Average C/D Ratio	0.71	0.70
Vertical C/D Ratio	0.69	0.74
Cup Volume	0.631 mm³	0.790 mm³

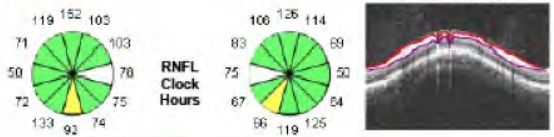












Plan/Assessment

1.TBI; BR (+) LOC <30 min 2008

2. RE- prescribe new tints

3. POAG OU

Currently on unknown hypotensive; send to DPC to establish glc care

DPC glc specialist/co-resident started him on: simbrinza TID and Travatan Z QHS OU

Discontinued- alphagan P and lumigan

New Patient Diagnosis of Low Vision and Fundus Flavimaculatus

ALEX CHRISTENSEN, O.D.

Case Report – Exam #1

- 49 y/o AA female
- June 17, 2019
- CC: Blurry vision and that she would like bifocals
- Admitted to the Substance Abuse Treatment Program (SATP)
  - June 13, 2019
- Pt was calm and appropriately oriented
- LEE: 04/10/19 – Shreveport Ophthalmology clinic
  - Pending appointment: 06/21/19 – Retina specialist per pt

Patient History – Exam #1

- Ocular Hx
- Recent ocular trauma of black eyes
- No current medical history
- No known allergies.
- Smoking Hx: current/working to quit

- Medications taken:
  - Amlodipine
  - Aripiprazole
  - Cetirizine
  - Diclofenac
  - Duloxetine
  - Fluticasone
  - Gabapentin
  - Trazodone

Entrance Testing – Exam #1

- VA distance sc:
  - 20/150 OD/OS, PH NI
- VA near sc:
  - 20/200 OU
- Refraction:
  - +0.25 sph OD 20/100
  - -0.25 sph OS 20/80
  - Near OU: +1.75 20/40

- EOM: Smooth, accurate, full and extensive OU
- Confrontational visual fields: Full to counting OD/OS
- Pupils: round, equal, reactive to light, (-) afferent pupillary defect

Examination – Exam #1

Anterior Segment Examination	
Lids and lashes	Clear OU
Conjunctiva	Clear OU
Cornea	Clear OU
Tear break up time	>8 seconds OU
Iris	Flat, no masses, no rubeosis, no synechia OU
Angle	4x4 OD/OS
Anterior chamber	Deep and quiet OU
Lens	Clear OU
Intraocular pressure	15mmHg OD, 14mmHg OS

Examination – Exam #1

Fundoscopic Examination	
Optic nerve head	Pink rims, flat, distinct margins OU
C/D ratio	0.20 OD/OS
Macula	OD: clear OS: Grade 1 epiretinal membrane
Vitreous	OU: Vitreal syneresis
Posterior pole	Unremarkable OU
Vessels	Normal caliber and crossings OU
Periphery	No retinal tears/holes/detachments OU

Assessment/Plan – Exam #1

- Assessment:
  - Refractive Error
    - Subjective compliant not consistent with objective findings
    - Suspicious of malingering
    - Macular OCT showed macular thickness volume loss
    - Recent h/o blunt force trauma/black eyes may be cause of decreased vision or to another yet specified retina disorder
- Plan:
  - RTC 5 weeks for repeat refraction
  - Ordered new glasses with photochromic tint

Exam #2

- July 24, 2019
- RFV: 1 month follow up, full exam with dilation, OCT imaging and retinal photos
- CC: She could not see and everything was blurry
  - Reports near>distance blur with and without correction
  - Slowly worsening over the past 1-2 years
  - Reports vision not being as good as peers when in the Service
- Smoking 1/2 pack per day of cigarettes
- Denies ocular pain

Exam #2

- VA distance cc:
  - 20/400 OD/OS PH NI
- Optokinetic Drum:
  - (+) nystagmus OD/OS
    - 20/400 or better
- Refraction:
  - Plano +0.25 x180 OD 20/400
  - -0.25 +0.75 x180 OS 20/100
  - Near VA: +2.00 20/40
- EOMs, CVF, and Pupils:
  - Within normal limits
- Anterior segment findings: stable to LEE

Examination – Exam #2

Fundoscopic Examination	
Macula	OU: Grade 2 epiretinal membrane
Vitreous	OU: Vitreal syneresis
Posterior pole	OU: Diffuse hypoflourescent flecking throughout posterior pole and periphery
Periphery	OD: CHRPE 3DD size temporal OS: Unremarkable

Assessment/Plan – Exam #2

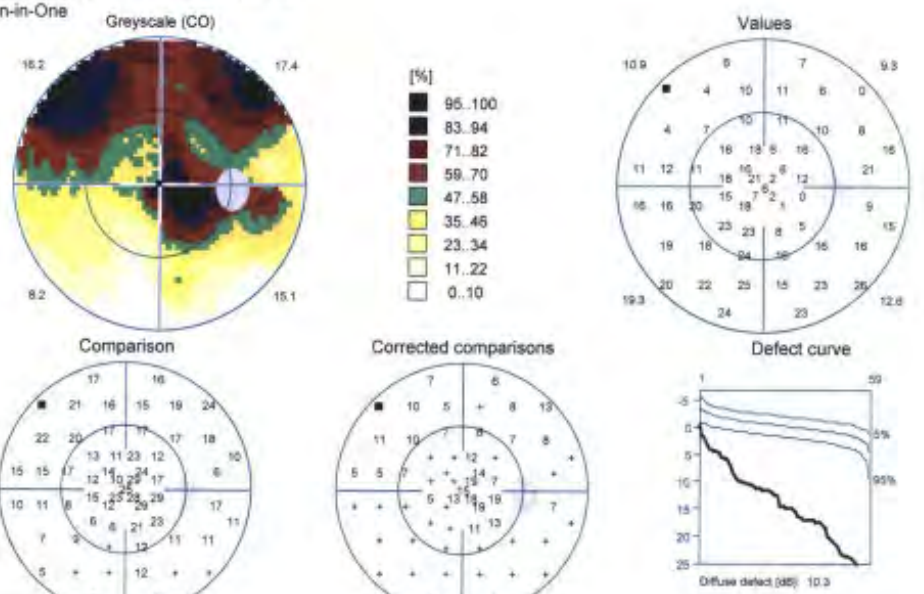
- Assessment:
  - Fundus Flavimaculatus
- Plan:
  - Edu pt fulltime wear of glasses for safety
  - Edu no driving
  - Referred pt to Visual Impairment Service Team (VIST) services
  - Given handout for vision impaired support groups
  - Cosigned Chief of Eye Clinics of CTX, and Temple Low vision specialist for remote second opinion

Follow Up #3

- July 25, 2019
- Reason for visit: Visual field and to fully educate patient on condition

Right eye (OD) / 07/25/2019 / 10:09:27

Seven-in-One



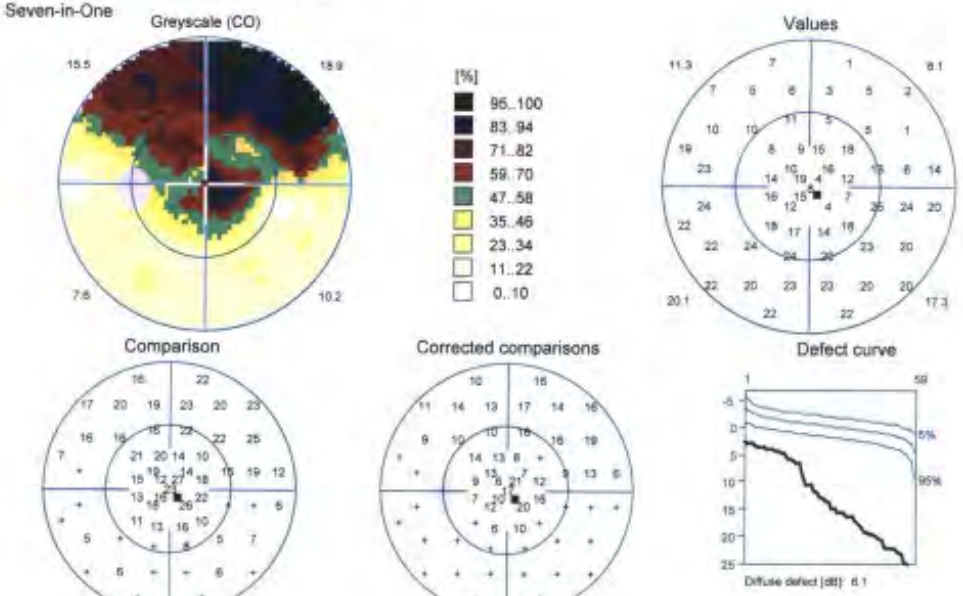
Programs:	G Standard White/White / TOP	**Questions / repetitions:**	69 / 0
Parameters:	31.4 / 4000 asb III 100 ms	**Duration:**	03:06
Catch trials:	1/7 (14%) +, 1/7 (14%) -	**RF:**	14.2
Trial lens S/C/A:	2.0/0.0/0	**VA:**	
Pupil [mm]:	2.85	**IOP [mmHg]:**	
NV:	T12 V2.1		

30°	
MS [dB]:	13.0
MD [< 2.0 dB]:	14.3
sLV [< 2.5 dB]:	7.4

Comment:
Classification:

Left eye (OS) / 07/25/2019 / 10:13:46

Seven-in-One



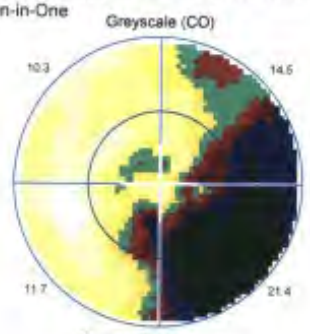
Programs:	G Standard White/White / TOP	**Questions / repetitions:**	81 / 14
Parameters:	31.4 / 4000 asb III 100 ms	**Duration:**	05:41
Catch trials:	1/8 (12%) +, 1/8 (12%) -	**RF:**	12.5
Trial lens S/C/A:	2.0/0.0/0	**VA:**	
Pupil [mm]:	2.34	**IOP [mmHg]:**	
NV:	T12 V2.1		

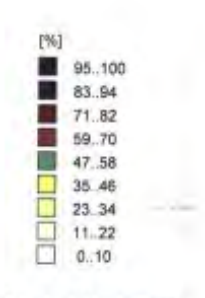
30°	
MS [dB]:	14.1
MD [< 2.0 dB]:	13.2
sLV [< 2.5 dB]:	7.6

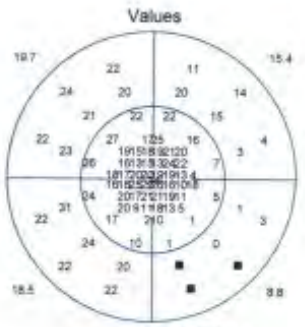
Comment:
Classification:

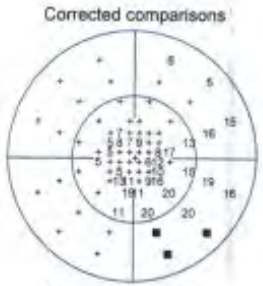
Right eye (OD) / 07/25/2019 / 09:56:20

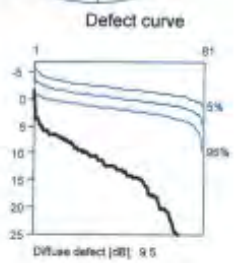
Seven-in-One

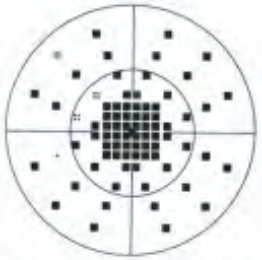


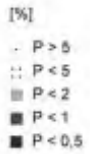












Programs:	M Standard White/White / TOP
Parameters:	31.4 / 4000 asb III 100 ms
Catch trials:	1/8 (12%) +, 1/8 (12%) -
Trial lens S/C/A:	2.0/0.0/0
Pupil [mm]:	2.52
NV:	T12 V2.1

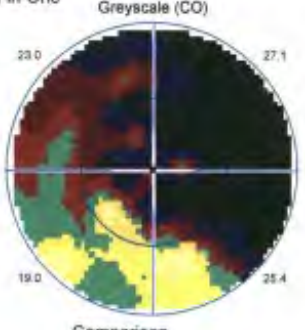
Questions / repetitions:	81 / 0
Duration:	04:23
RF:	12.5
VA:	
IOP [mmHg]:	

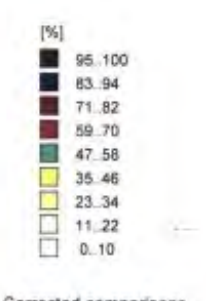
12°	
MS [dB]:	**15.7**
MD [< 2.0 dB]:	**14.4**
sLV [< 2.5 dB]:	**7.6**

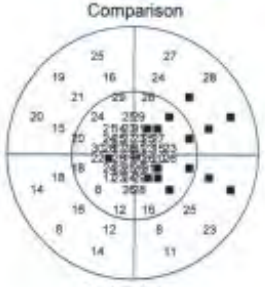
Comment:
Classification:

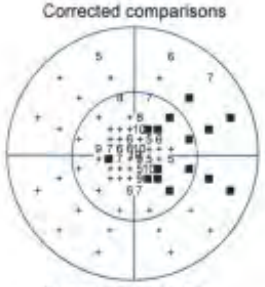
Left eye (OS) / 07/25/2019 / 10:04:19

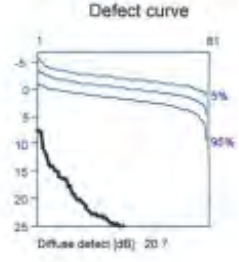
Seven-in-One

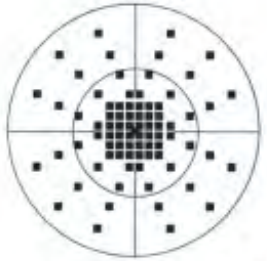


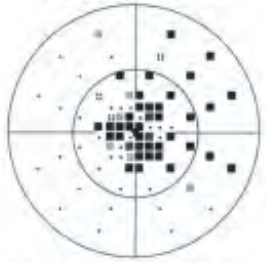


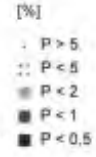










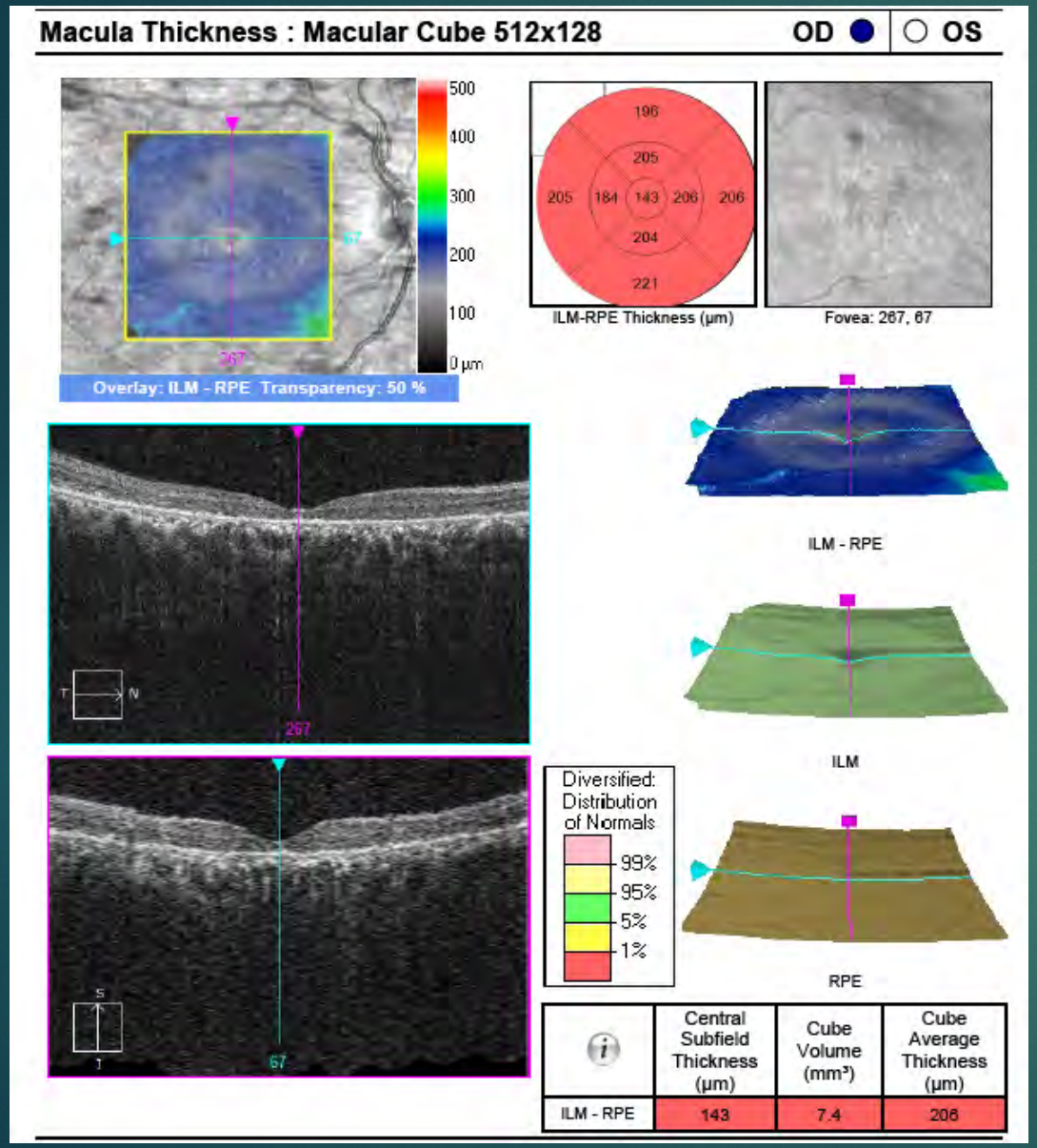


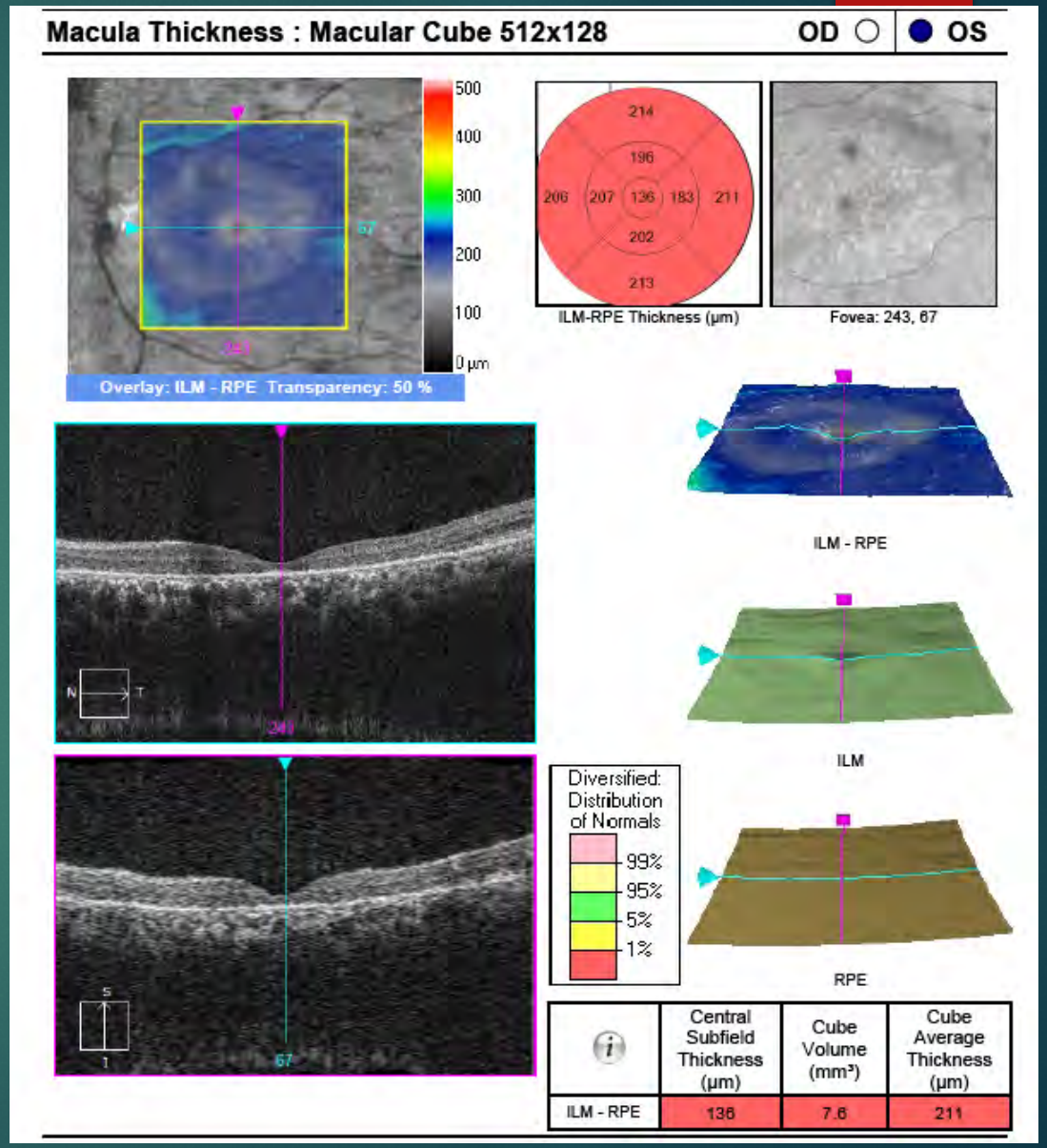
Programs:	M Standard White/White / TOP
Parameters:	31.4 / 4000 asb III 100 ms
Catch trials:	0/8 (0%) +, 5/8 (62%) -
Trial lens S/C/A:	2.0/0.0/0
Pupil [mm]:	
NV:	T12 V2.1

Questions / repetitions:	81 / 0
Duration:	04:07
RF:	31.2
VA:	
IOP [mmHg]:	

12°	
MS [dB]:	**6.4**
MD [< 2.0 dB]:	**23.7**
sLV [< 2.5 dB]:	**6.3**

Comment:
Classification:

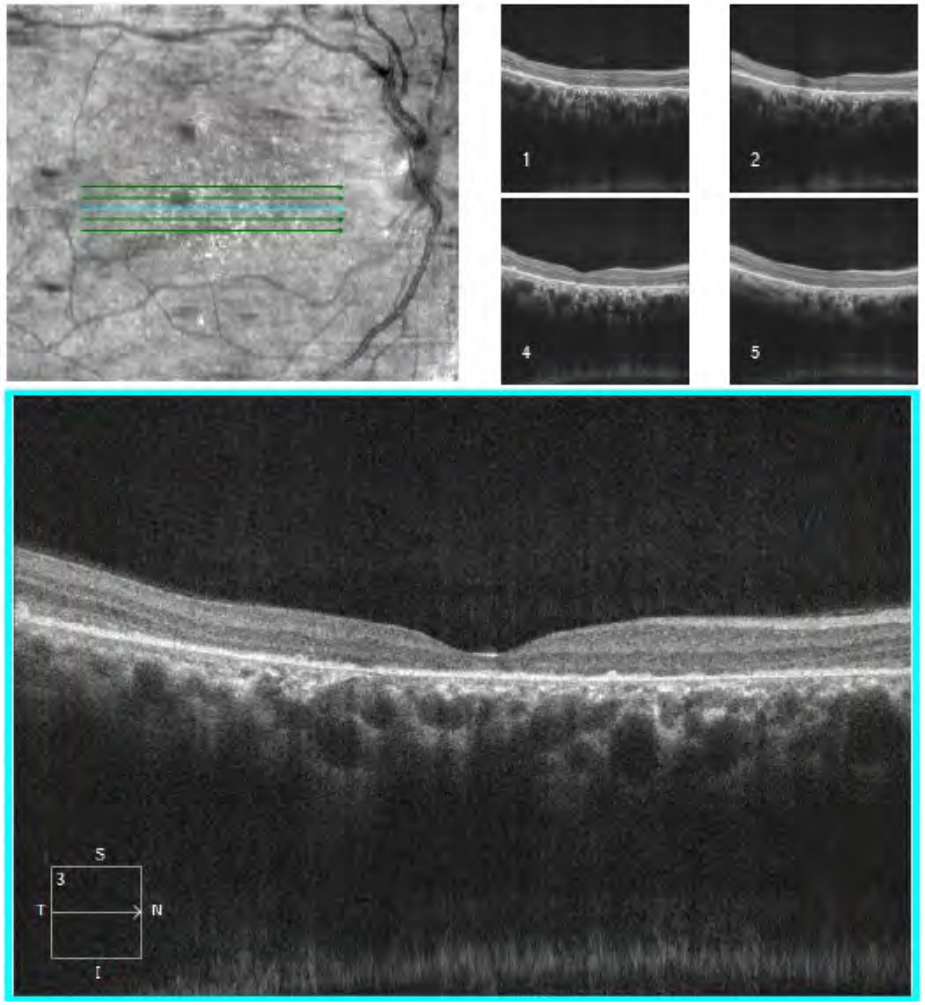

Macula Thickness : Macular Cube 512x128
OD
OS
500
400
300
200
100
0 µm
196
205
205
184
143
206
206
204
221
ILM-RPE Thickness (µm)
Fovea: 267, 67
Overlay: ILM - RPE Transparency: 50 %
ILM - RPE
ILM
RPE
Diversified: Distribution of Normals
99%
95%
5%
1%
Central Subfield Thickness (µm)
Cube Volume (mm³)
Cube Average Thickness (µm)
ILM - RPE
143
7.4
206


Macula Thickness : Macular Cube 512x128
OD
OS
500
400
300
200
100
0 µm
214
196
206
207
136
183
211
202
213
ILM-RPE Thickness (µm)
Fovea: 243, 67
Overlay: ILM - RPE Transparency: 50 %
ILM - RPE
ILM
RPE
Diversified: Distribution of Normals
99%
95%
5%
1%
Central Subfield Thickness (µm)
Cube Volume (mm³)
Cube Average Thickness (µm)
ILM - RPE
136
7.6
211

High Definition Images: HD 5 Line Raster

OD ● ○ OS

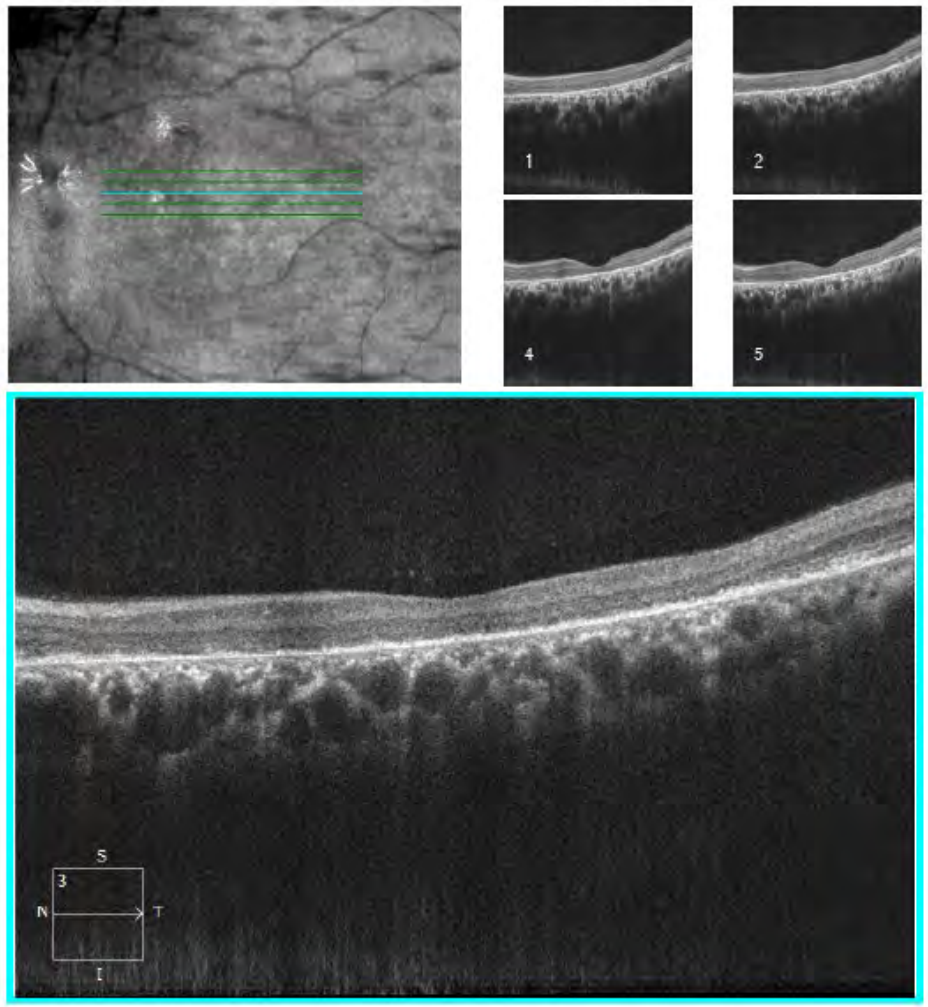
Scan Angle: 0° Spacing: 0.25 mm Length: 6 mm

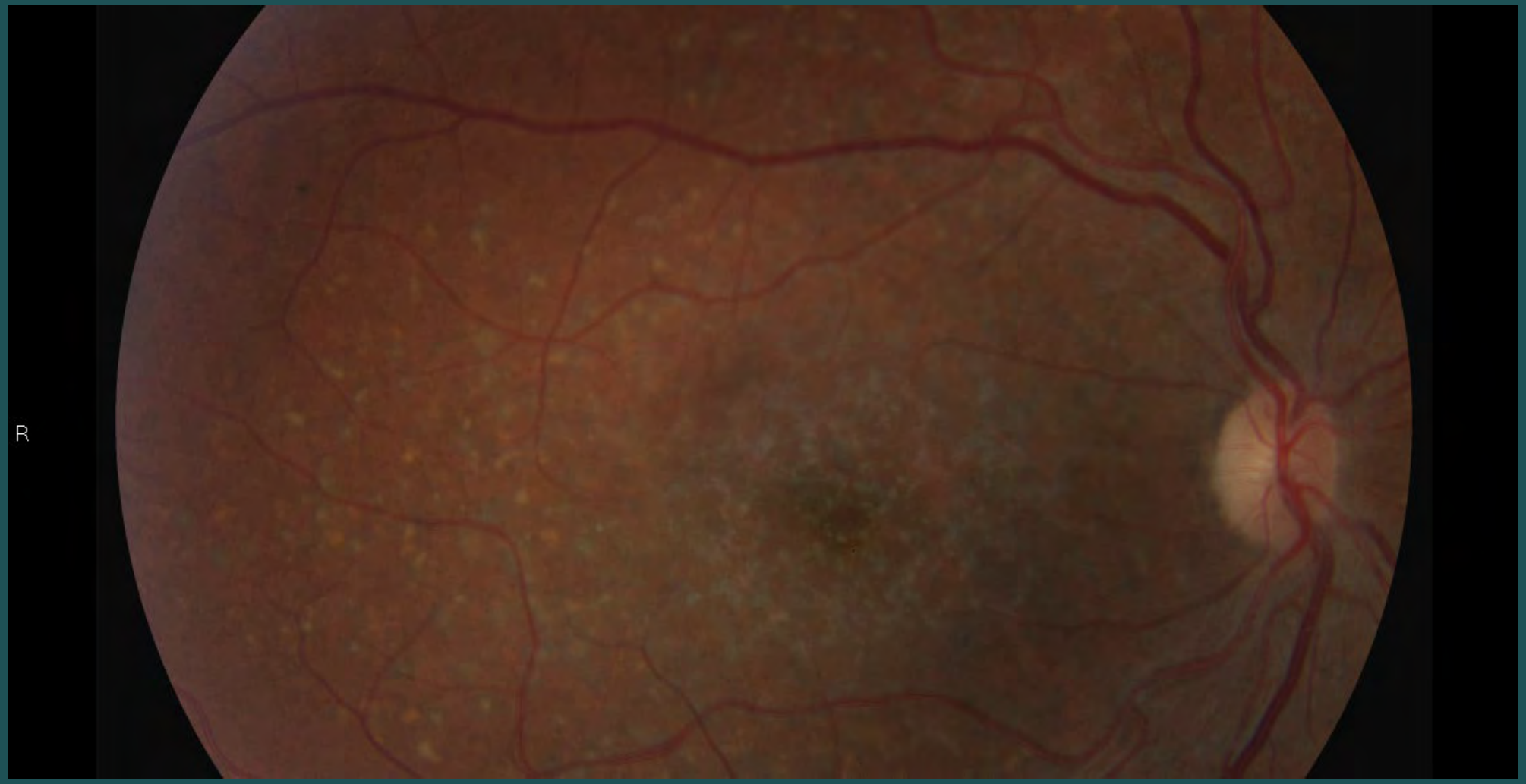


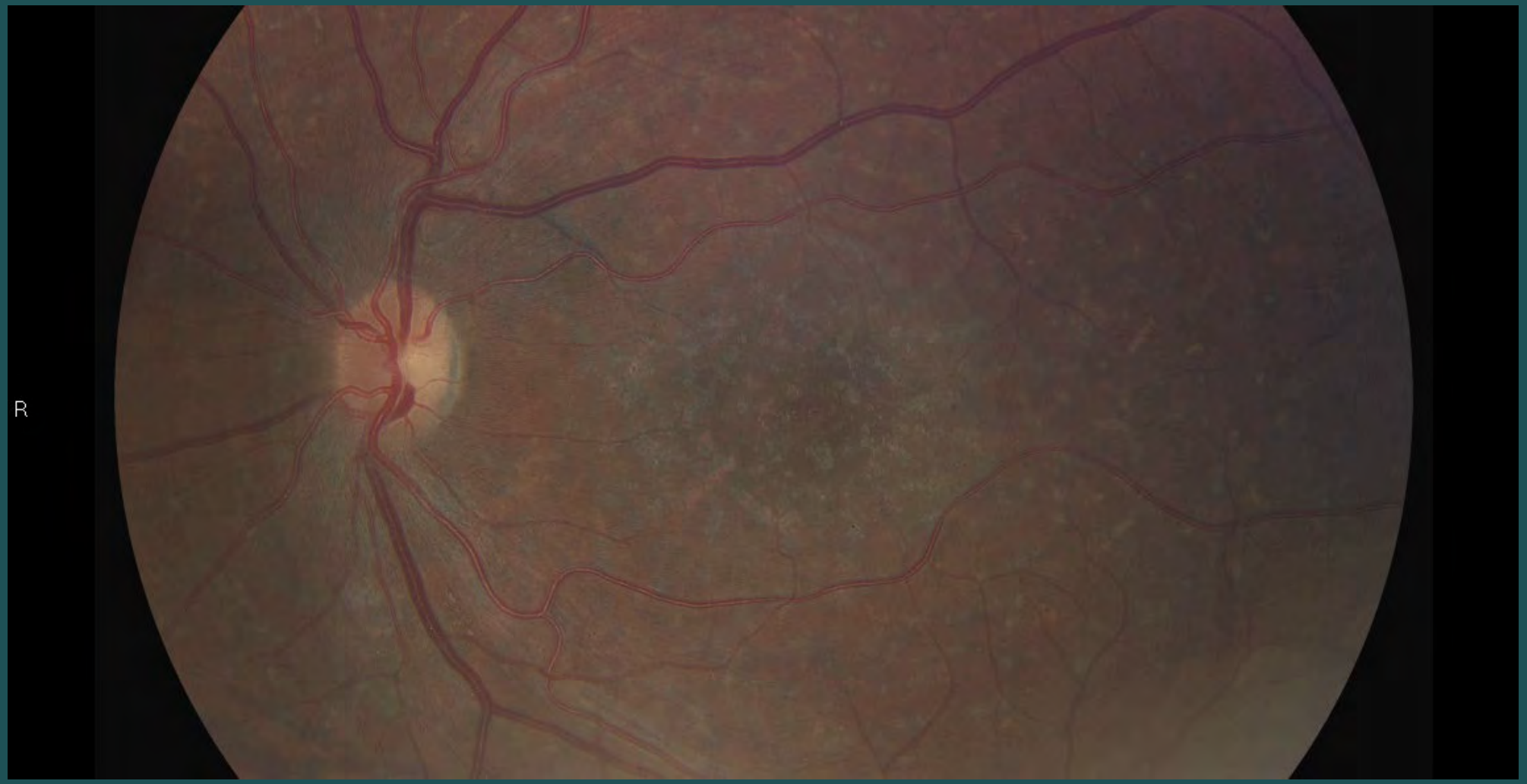
High Definition Images: HD 5 Line Raster

OD ○ ● OS

Scan Angle: 0° Spacing: 0.25 mm Length: 6 mm




R


R

Assessment/Plan #3

- Edu pt on condition
- Reaffirmed importance to set up appointment with the Shreveport VA eye clinic when she gets discharged
- Counseled to avoid smoking
- Seek opinion of eye care provider prior to starting certain medications such as retinoids, plaquenil, tamoxifen, etc
- Tell children the diagnosis of fundus flavimaculatus and to ask them to get eye exams soon.

Differential Diagnoses

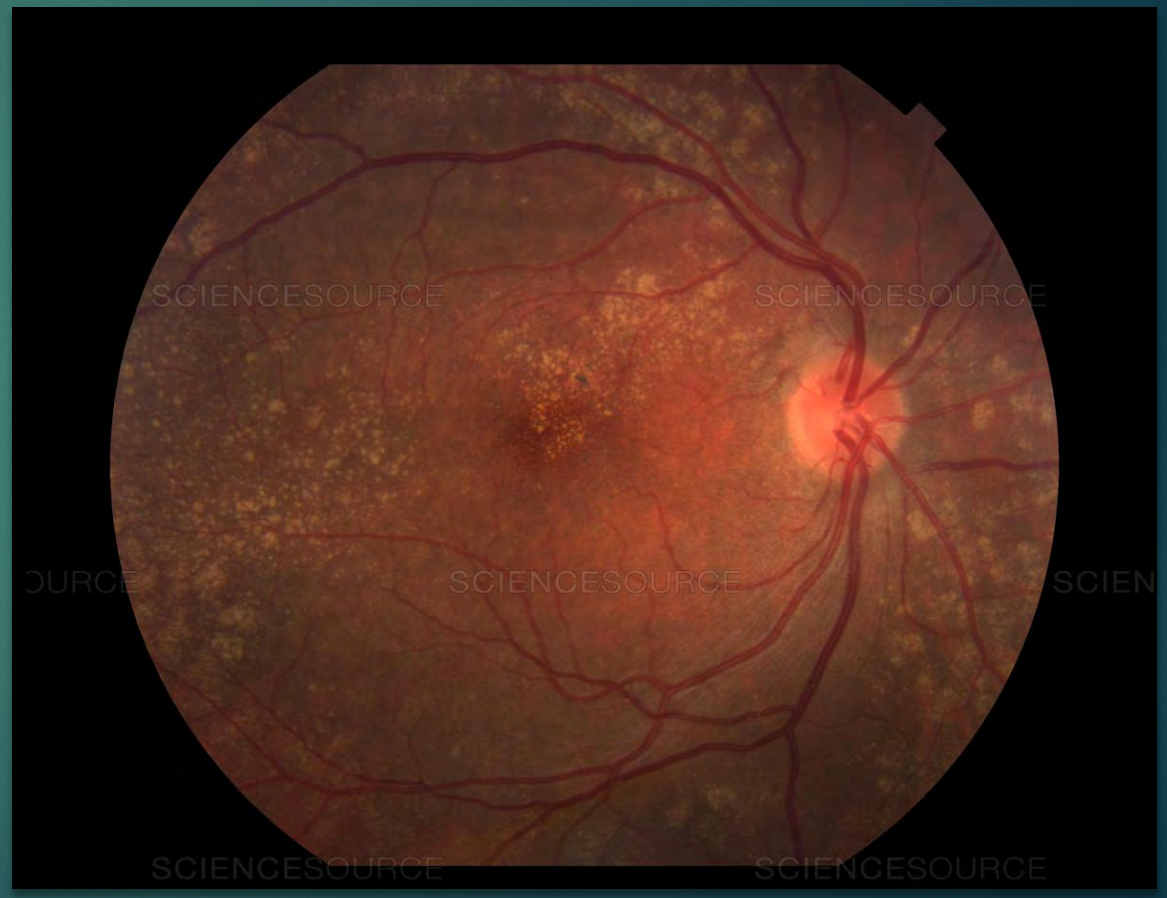
- Retinitis Punctata Albescens
- Familial Drusen
- Stargardt Disease
- Fundus Flavimaculatus

Differential Diagnoses

- Retinitis Punctata Albescens
  - Childhood onset night blindness
  - White retinal deposits
  - Decreased vision of around 20/40
  - Peripheral retinal atrophy

Differential Diagnoses

- Familial Drusen
  - Confluent soft drusen near the macula
  - Drusen temporal to the optic nerve heard that are arranged in radial lines that converge towards the fovea
  - Large drusen nasal to the optic nerve head



Fundus Flavimaculatus vs Stargardt Disease

- Genetically the same
- Autosomal recessive
- Difference between the two
  - Fundus Flavimaculatus tends to have a later disease onset
  - Slower visual deterioration
- Fundus Flavimaculatus can be seen as a subset of Stargardt disease

Fundus Flavimaculatus

- Early stages:
  - Asymptomatic
  - Visual loss without clinical signs
  - Malingering
  - Misdiagnosed as amblyopia

Fundus Flavimaculatus

- Symptoms:
  - Central vision loss
  - Photophobia
  - Abnormal color vision
  - Slow dark adaptations
- Fundus:
  - Yellow-whitish “fishlike” (pisciform) shaped flecks
- Later stages:
  - Macular atrophy showing a “beaten bronze” appearance
- Rare complication:
  - Choroidal neovascular membranes (CNVM) or subretinal bleeds

Molecular Biology

- Mutation of the ABCA4 gene
- ABCA4 gene encodes for a photoreceptor rim protein, ABCR
- When ABCR is defected, it causes the accumulation of protonated N-retinyledine-PE in the rod outer segment
- N-retinylidene-N-retinylethanolamine (A2E), a byproduct of N-retinyledine-PE then accumulates in the RPE and is toxic
- Photoreceptors then die due to the loss of RPE support function

Specialty Testing

- Visual fields
  - Early stage: normal
  - Later stage: relative central scotoma -> absolute central scotoma
- Fundus Autofluorescence
  - Hyperfluorescence at lipofuscin deposits (flecks)
  - Hypofluroescence at sites of atrophy

Specialty Testing

- Fluorescein Angiography
  - “Dark-choroid” due to the lipofuscin accumulation in RPE
  - Hyperfluorescent flecks
  - Hypofuorescence at fovea depending on level of atrophy
- Electrophysiology Testing
  - EOG: subnormal
  - ERG: normal

Treatment

- Prognosis
  - The earlier the onset of the disease, the more likely it is that both eyes will eventually have vision of 20/200 or worse
- No current treatment
  - Refrain from having a Vitamin A rich diet
  - Avoid direct sunlight exposure
  - Use ultraviolet blocking sunglasses and brimmed hats
- Experimental Treatment
  - Isotretinoin

Low Vision

- Optical devices
  - Magnifiers for near vision
  - Telescopes for distance vision
- Non-optical devices
  - Tints
- Educating patients on eccentric viewing

Clinical Pearls

- Perform a visual field, fundus autofluorescence, fluorescein angiography, and electrophysiologic testing as needed to make a diagnosis
- Do genetic testing on the ABCA4 gene to help find the exact etiology
- Educate the patient on low vision services and aids such as magnifying devices

Conclusion

- FFM can be easily misdiagnosed
- Remember what diagnostic examinations are available, fundus autofluorescence, fundus angiography, electrophysiologic testing, and genetic testing
- Educate the patient on the realistic prognosis but have empathy for how it will change the patient's life
- Low vision services can be very impactful to help the patient have a functional life

References

- Yevseyenkov, V. (2017, March). Glendale.
- Silva, N., Tsakiris, K., & Shah, V. (2014, December 6). Stargardt disease/Fundus flavimaculatus. Retrieved from https://eyewiki.aao.org/Stargardt_disease/Fundus_flavimaculatus.
- Arepalli, S., Traboulsi, E. I., & Ehlers, J. P. (2018). ELLIPSOID ZONE MAPPING AND OUTER RETINAL ASSESSMENT IN STARGARDT DISEASE. *Retina (Philadelphia, Pa.)*, *38*(7), 1427–1431. doi:10.1097/IAE.0000000000001716
- Solberg, Y., Dysli, C., Escher, P., Berger, L., Wolf, S., & Zinkernagel, M. S. (2019). RETINAL FLECKS IN STARGARDT DISEASE REVEAL CHARACTERISTIC FLUORESCENCE LIFETIME TRANSITION OVER TIME. *Retina (Philadelphia, Pa.)*, *39*(5), 879–888. doi:10.1097/IAE.0000000000002519
- The Epidemiology of Stargardt Disease in the United Kingdom. Spiteri Cornish, Kurt et al. Ophthalmology Retina , Volume 1, Issue 6, 508 - 513
- Chen, Y., Roorda, A., & Duncan, J. L. (2010). Advances in imaging of Stargardt disease. *Advances in experimental medicine and biology*, *664*, 333–340. doi:10.1007/978-1-4419-1399-9_38
- Shienbaum, R. (2010, September 2). Wills Eye Resident Case Series. Retrieved from https://www.reviewofophthalmology.com/article/wills-eye-resident-case-series.
- Yang, S., Borirakchanyavat, S., Chan-Kai, B. T., Stout, J. T., & Fu, A. D. (2009). Diagnostic and therapeutic challenges. *Retina (Philadelphia, Pa.)*, *29*(5), 708–714. doi:10.1097/IAE.0b013e3181a0bde9
- Torres Soriano, M., & Torres Lopez, M. (2017). Stargardt's Disease. *Ophthalmology: Current and Future Developments*, 203–208. doi: 10.2174/9781681084138117020017
- Cornish, K. S., Ho, J., Downes, S., Scott, N. W., Bainbridge, J., & Lois, N. (2017). The Epidemiology of Stargardt Disease in the United Kingdom. *Ophthalmology Retina*, *1*(6), 508–513. doi: 10.1016/j.oret.2017.03.001

- Bowling, B., & Kanski, J. J. (2016). *Kanskis clinical ophthalmology: a systematic approach*. Edinburgh: Elsevier.
- Banda, H. K., Shah, G. K., & Blinder, K. J. (2019). Applications of fundus autofluorescence and widefield angiography in clinical practice. *Canadian Journal of Ophthalmology*, *54*(1), 11–19. doi: 10.1016/j.jcjo.2018.10.003
- Maharana, P. K., Sharma, N., & Kumar, A. (2017). *Ophthalmology clinics for postgraduates*. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.
- Grezda, A., Simaku, E., & Boci, B. (2015). Stargardt's Disease (Fundus Flavimaculatus). *Anglisticum Journal*, *4*(10), 77–80. doi: http://dx.doi.org/10.0001/(aj).v4i10.1181.g1572
- Bax, N. M., Lambertus, S., Cremers, F. P. M., Klevering, B. J., & Hoyng, C. B. (2019). The absence of fundus abnormalities in Stargardt disease. *Graefes Archive for Clinical and Experimental Ophthalmology*, *257*(6), 1147–1157. doi: 10.1007/s00417-019-04280-8
- Sohn, E. H., Wang, K., Thompson, S., Riker, M. J., Hoffmann, J. M., Stone, E. M., & Mullins, R. F. (2015). Comparison of drusen and modifying genes in autosomal dominant radial drusen and age-related macular degeneration. *Retina (Philadelphia, Pa.)*, *35*(1), 48–57. doi:10.1097/IAE.0000000000000263
- Abeshi, A., Coppola, P., Beccari, T., Dundar, M., D'Esposito, F., & Bertelli, M. (2017). Genetic testing for retinitis punctata albescens/fundus albipunctatus. *The EuroBiotech Journal*, *1*(s1), 96–98. doi: 10.24190/issn2564-615x/2017/s1.30
- Browning, D. J. (n.d.). What You Should Know About Stargardt Disease and Fundus Flavimaculatus . Retrieved from http://www.retinareference.com/diseases/54bc6d7d003e44a8/documents/abe457313b/document.pdf.
- Dhungel, P. (2015). Low Vision Management in a Case of Stargardts Disease. *Advances in Ophthalmology & Visual System*, *2*(1). doi: 10.15406/aovs.2015.02.00029
- Deutman, A. F. (2003, January). Stargardt disease. Retrieved from https://www.orpha.net/data/patho/GB/uk-Stargardt.pdf.
- Fishman, G.A., Roberts, M.F., Derlacki, D.J., Grimsby, J.L., Yamamoto, H., Sharon, D., Nishiguchi, K.M., & Dryja, T.P. (2004). Novel mutations in the cellular retinaldehyde-binding protein gene (RLBP1) associated with retinitis punctata albescens: evidence of interfamilial genetic heterogeneity and fundus changes in heterozygotes. *Archives of ophthalmology, 122 1*, 70-5 .
- Dominant Drusen. (n.d.). Retrieved November 11, 2019, from https://www.sciencesource.com/archive/Dominant-Drusen-SS2570653.html#/SearchResult&ITEMID=SS2570653.
- Porzokoviak, T. (2017, September). Glendale.

Questions?

INCORPORATING ELECTRODIAGNOSTIC TESTING IN THE MODERN OPTOMETRIST'S PRACTICE

SAOUL MANCHA, OD

ROSENBERG SCHOOL OF OPTOMETRY PRIMARY CARE RESIDENT

DISCLOSURES

- No conflicts of interest or financial disclosures to report.

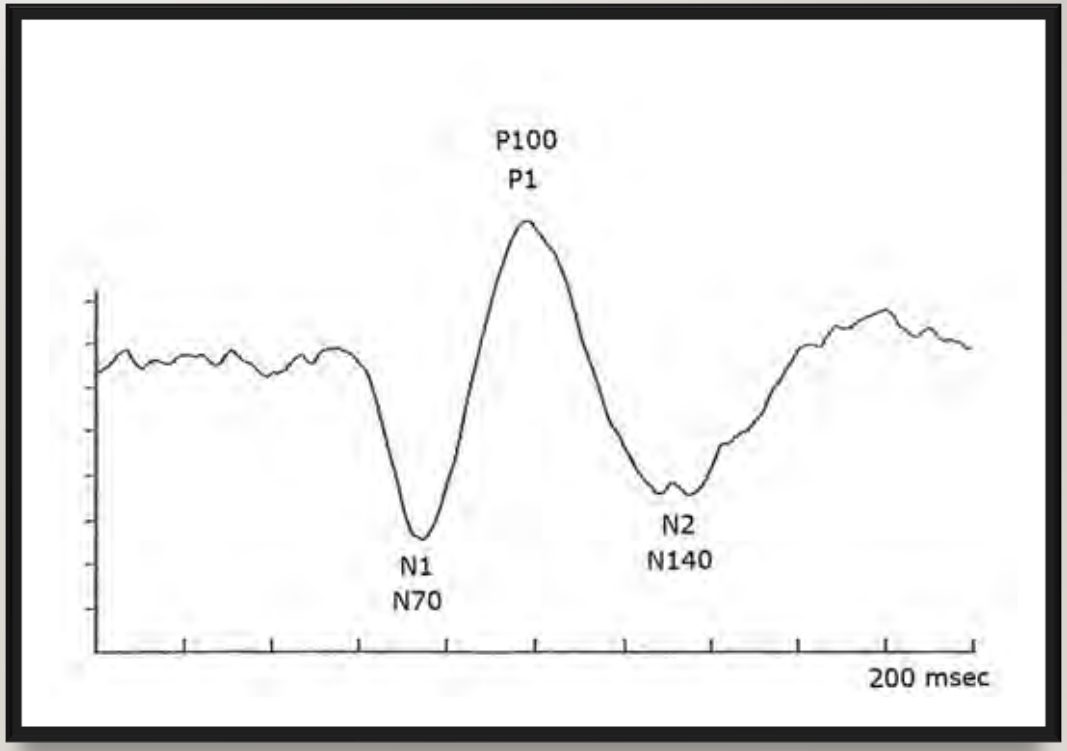
VISUAL EVOKED POTENTIAL (VEP)

- 1st mentioned description of VEP was in the year
- "The VEP is an evaluation of the entire visual system from the retina through the primary visual cortex. It measures the conduction time of neuronal activity from the retina to the occipital cortex and is used clinically as a measure of the functional integrity of the visual system."
- Historically VEPs have been used to study the function of the afferent visual pathway objectively.

VEP REFRESHER

- Types of VEP
  - Flash VEP
  - Pattern VEP
  - Multifocal VEP

- VEP wave components:
  - N1 (N70)- Visual cortex
  - P1 (P100)- Dorsal extrastriate cortex

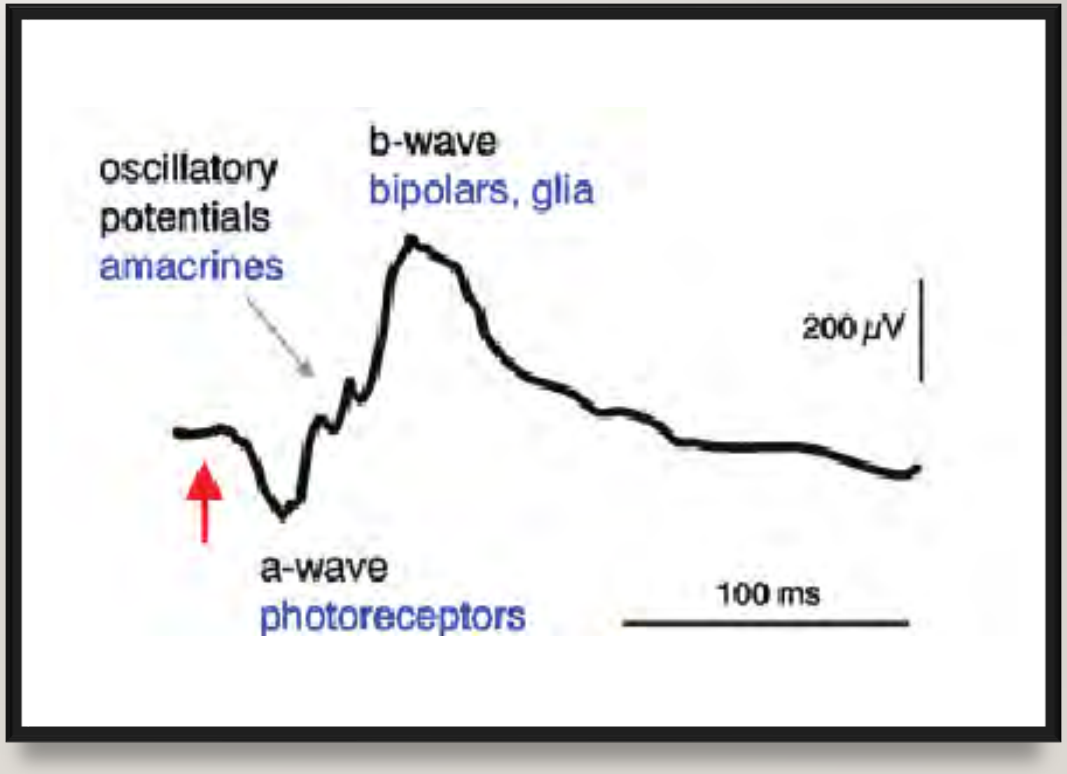


ELECTRORETINOGRAM (ERG)

- 1st recorded electroretinogram (ERG) in humans was performed in the year
- ERG works by recoding retinae responses to a light stimulus of known luminance.
- Historically ERGs have been used to monitor/study retinal function objectively.
  - A wave- photoreceptor response
  - B-wave bipolar/muller cells response

ERG REFRESHER

- Full Field ERG
  - Measures a global retinal response.
  - May mask smaller retinal lesions.
- Multifocal ERG
  - Measures multiple local macular responses.
  - Capable of revealing localized macular dysfunction.



ERG

- Pattern ERG
  - Measures ganglion cell function and correlates to optic nerve integrity (Mohsen)
  - P50 may be used to check macular function.
  - N95 used for ganglion function.

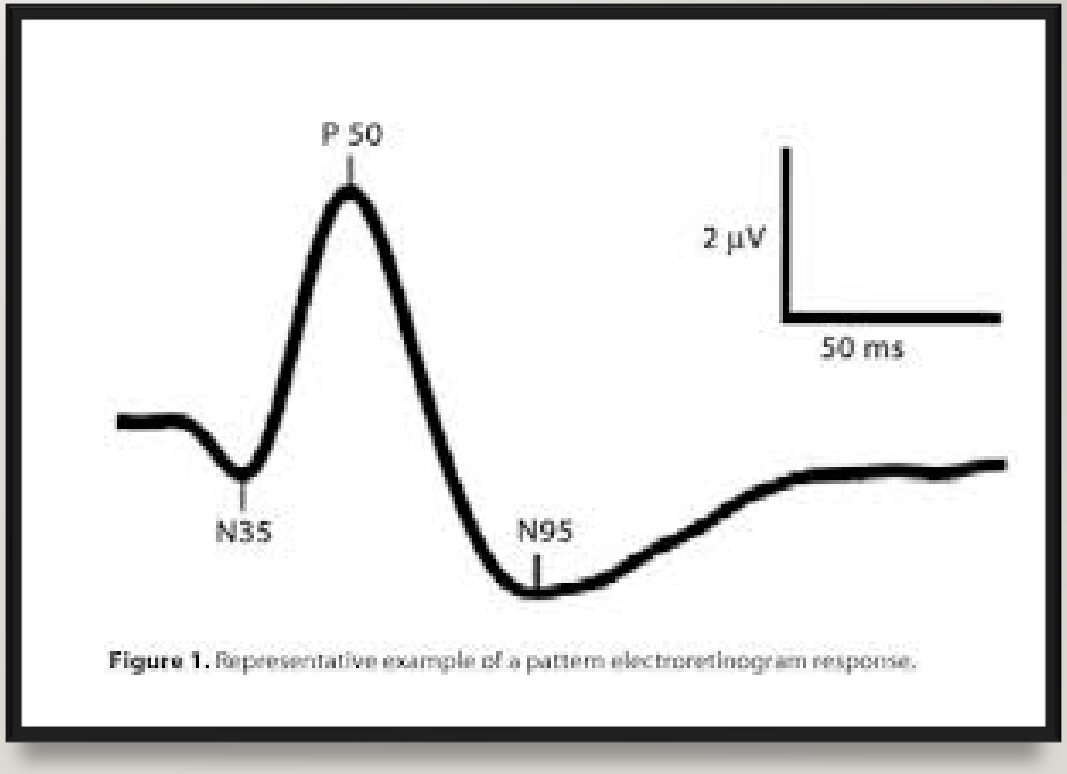


Figure 1. Representative example of a pattern electroretinogram response.

DIABETES AND VEP

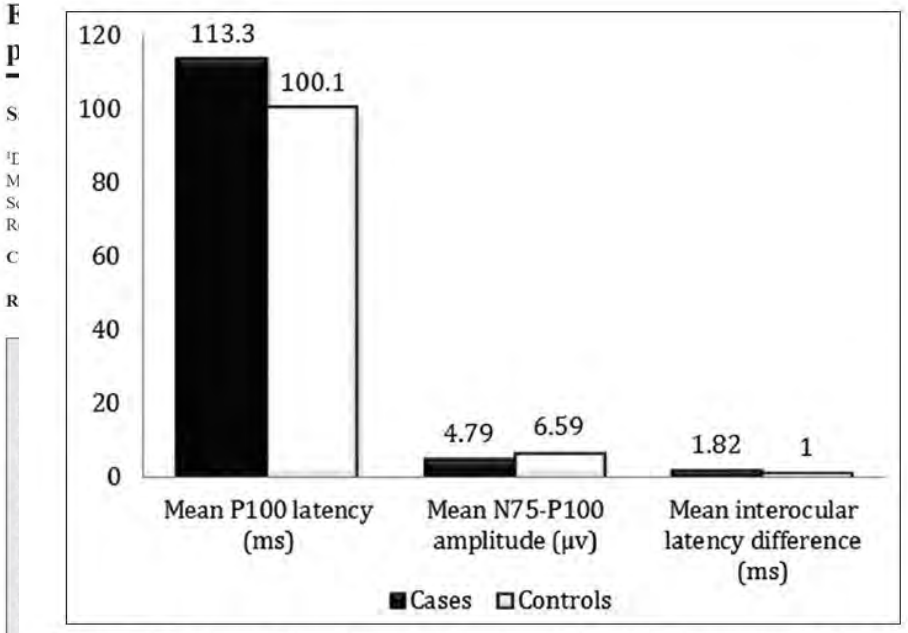
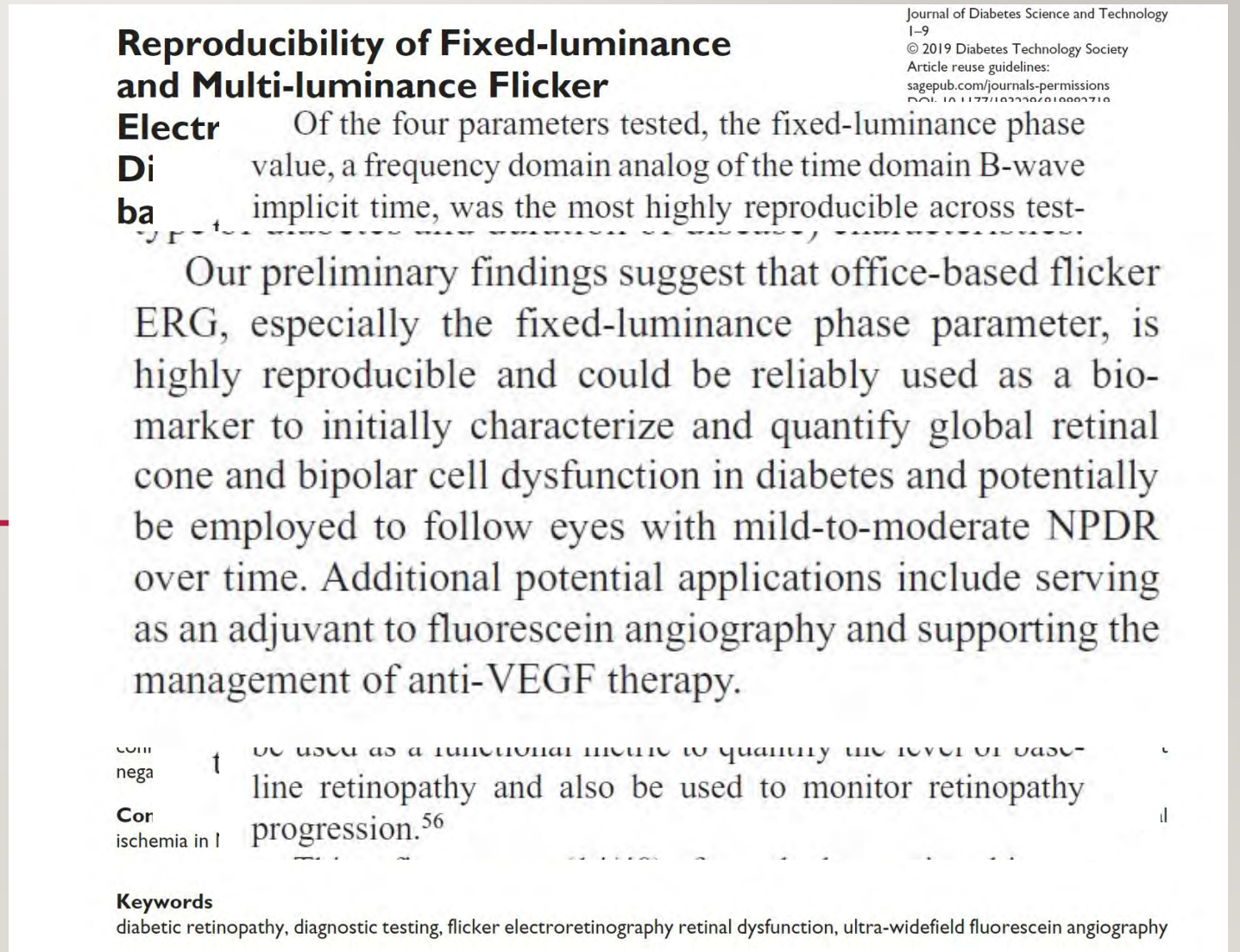


Figure 2: Mean visual evoked potential P100 latency, N75-P100 amplitude and interocular latency difference (mean of both the eyes) compared in cases and controls

DIABETES AND ERG



Reproducibility of Fixed-luminance and Multi-luminance Flicker Electr Di ba

Journal of Diabetes Science and Technology
1–9

DOI: 10.1177/1932296819892718

Of the four parameters tested, the fixed-luminance phase value, a frequency domain analog of the time domain B-wave implicit time, was the most highly reproducible across test-

Our preliminary findings suggest that office-based flicker ERG, especially the fixed-luminance phase parameter, is highly reproducible and could be reliably used as a biomarker to initially characterize and quantify global retinal cone and bipolar cell dysfunction in diabetes and potentially be employed to follow eyes with mild-to-moderate NPDR over time. Additional potential applications include serving as an adjuvant to fluorescein angiography and supporting the management of anti-VEGF therapy.

nega t

Cor
ischemia in l

be used as a functional metric to quantify the level of baseline retinopathy and also be used to monitor retinopathy progression.[56]

Keywords
diabetic retinopathy, diagnostic testing, flicker electroretinography retinal dysfunction, ultra-widefield fluorescein angiography

FIXED LUMINENCE ERG

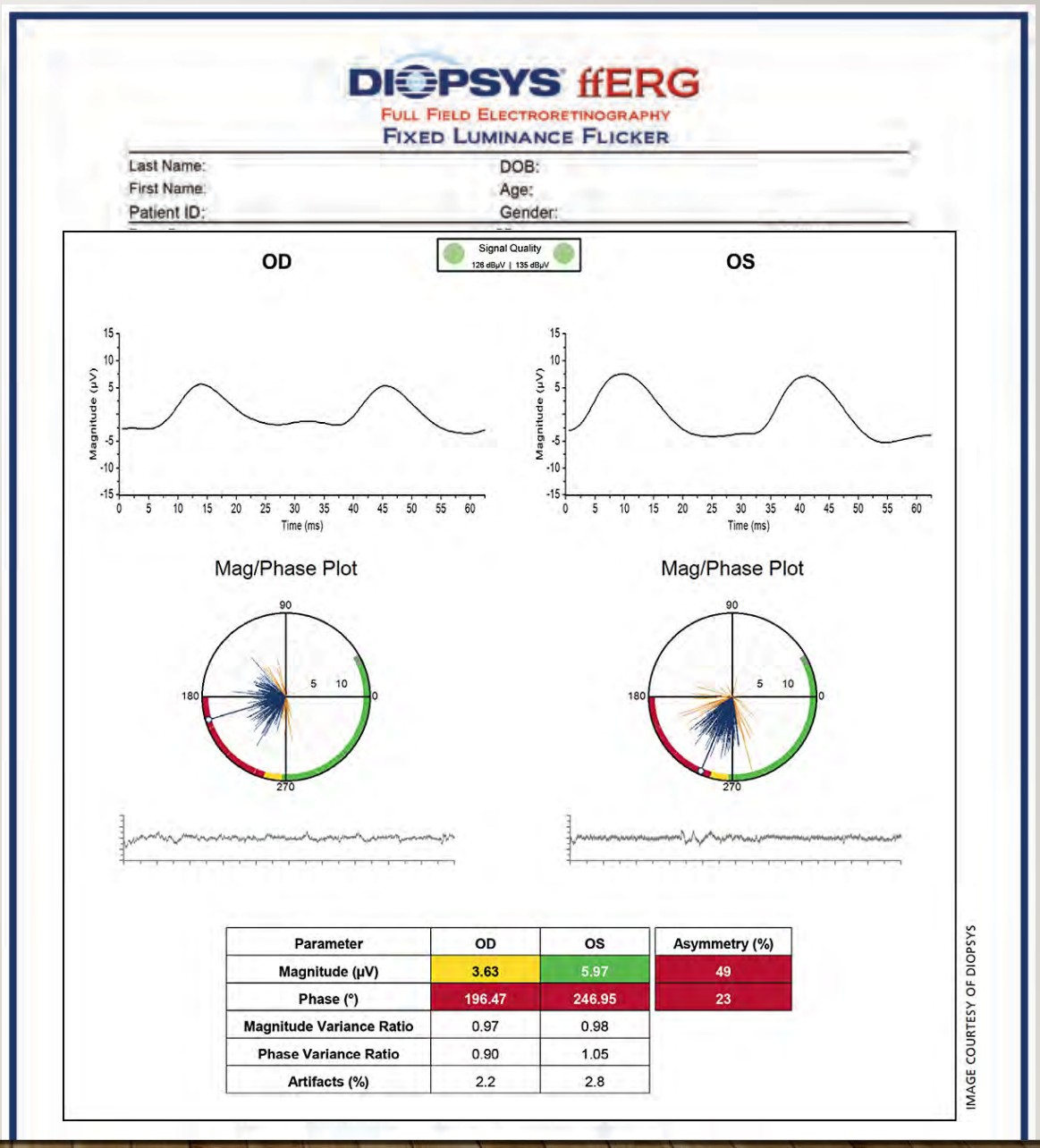


IMAGE COURTESY OF DIOPSYS

MACULAR DEGENERATION AND MF-ERG

Br J Ophthalmol 2001;85:287–290

Reduced amplitude and delayed latency in foveal response of multifocal electroretinogram in early age related macular degeneration

Methods

In this study, early AMD changes were defined

the P1 amplitude as well as a significant delay in the N1 latency of foveal responses from pre-AMD or early AMD eyes and their asymptomatic fellow eyes when compared with normal control eyes. These findings suggest that both foveal P1 amplitude and foveal N1 latency in MERG measurements may be sensitive means to detect early foveal AMD changes.

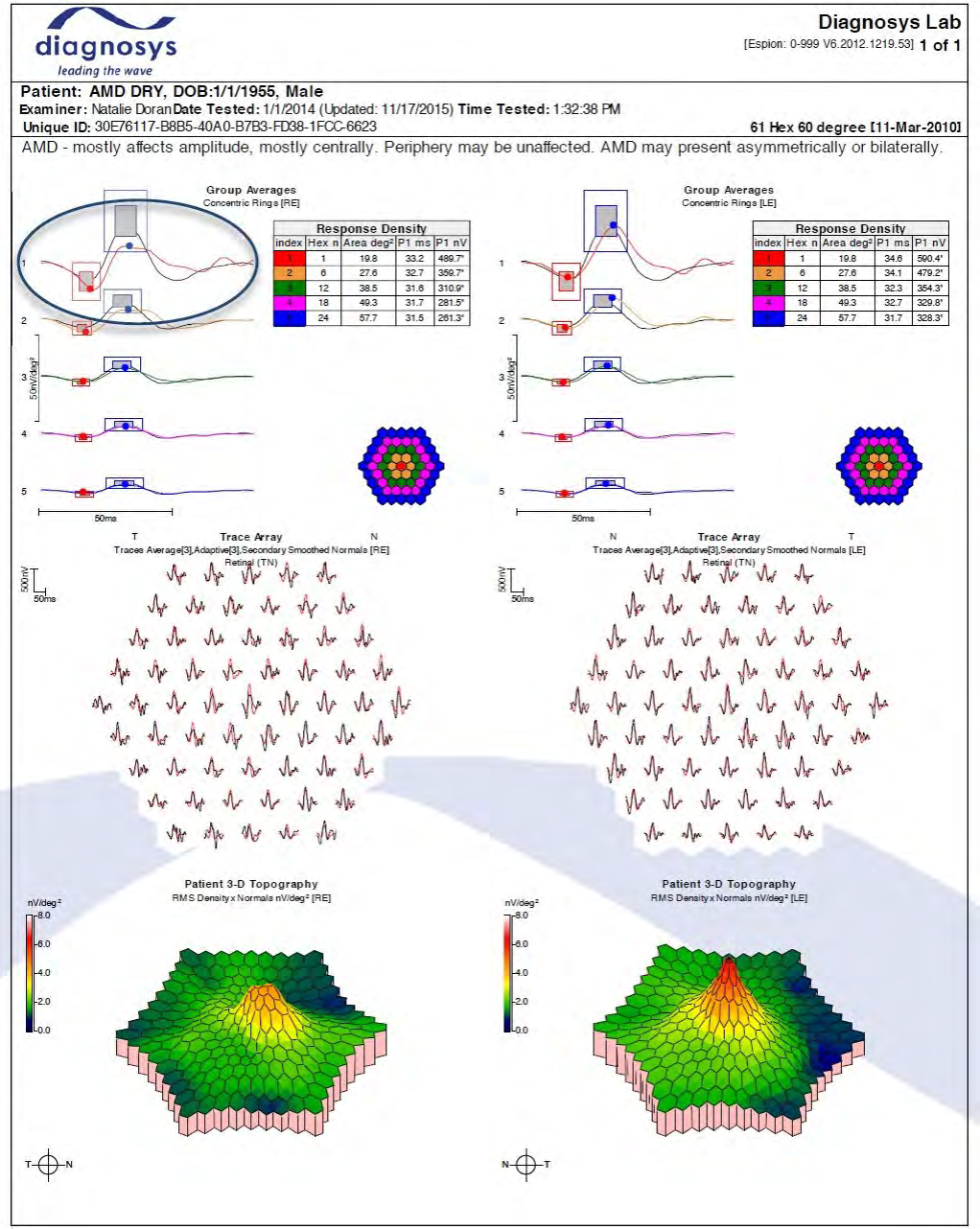
(Hong Kong) in 1997. Preliminary screening

Table 4 Summary of P1 amplitudes and N1 latencies with configuration C

	R1		R2		R3		R4		R5		R6	
Group	Amplitude (nV/deg^2)	Latency (ms)	Amplitude (nV/deg^2)	Latency (ms)	Amplitude (nV/deg^2)	Latency (ms)	Amplitude (nV/deg^2)	Latency (ms)	Amplitude (nV/deg^2)	Latency (ms)	Amplitude (nV/deg^2)	Latency (ms)
Normal (n=20)	60.1 (15.5)	14.2 (1.3)	32.5 (5.7)	14.6 (1.0)	21.5 (3.2)	14.5 (0.6)	16.2 (2.6)	14.5 (0.8)	13.7 (2.5)	14.8 (0.7)	12.2 (2.4)	15.1 (0.8)
AMD (n=15)	44.5 (13.7)	17.1 (1.0)	25.6 (7.1)	15.6 (1.5)	19.7 (4.9)	14.4 (1.0)	15.1 (3.6)	15.2 (1.0)	12.8 (3.7)	15.8 (1.0)	11.4 (3.6)	16.0 (0.7)
Fellow eye (n=15)	49.2 (13.4)	15.8 (1.1)	27.2 (6.8)	15.0 (1.0)	20.0 (5.0)	14.7 (1.2)	15.0 (3.9)	14.8 (0.9)	12.8 (3.9)	15.5 (0.9)	11.4 (3.7)	16.0 (0.8)

six concentric rings centred on the fovea.

AMD AND MF-ERG



diagnosys
leading the wave

Diagnosys Lab
[Espion: 0-999 V6.2012.1219.53] 1 of 1

Patient: AMD DRY, DOB:1/1/1955, Male
Examiner: Natalie Doran **Date Tested:** 1/1/2014 (Updated: 11/17/2015) **Time Tested:** 1:32:38 PM
Unique ID: 30E76117-B8B5-40A0-B7B3-FD38-1FCC-6623
61 Hex 60 degree [11-Mar-2010]

AMD - mostly affects amplitude, mostly centrally. Periphery may be unaffected. AMD may present asymmetrically or bilaterally.

Group Averages
Concentric Rings [RE]

Response Density

index	Hex n	Area deg²	P1 ms	P1 nV
1	1	19.8	33.2	489.7°
2	6	27.6	32.7	359.7°
3	12	38.5	31.6	310.9°
4	18	49.3	31.7	281.5°
	24	57.7	31.5	261.3°

Group Averages
Concentric Rings [LE]

Response Density

index	Hex n	Area deg²	P1 ms	P1 nV
1	1	19.8	34.6	590.4°
2	6	27.6	34.1	479.2°
3	12	38.5	32.3	354.3°
4	18	49.3	32.7	329.8°
	24	57.7	31.7	328.3°

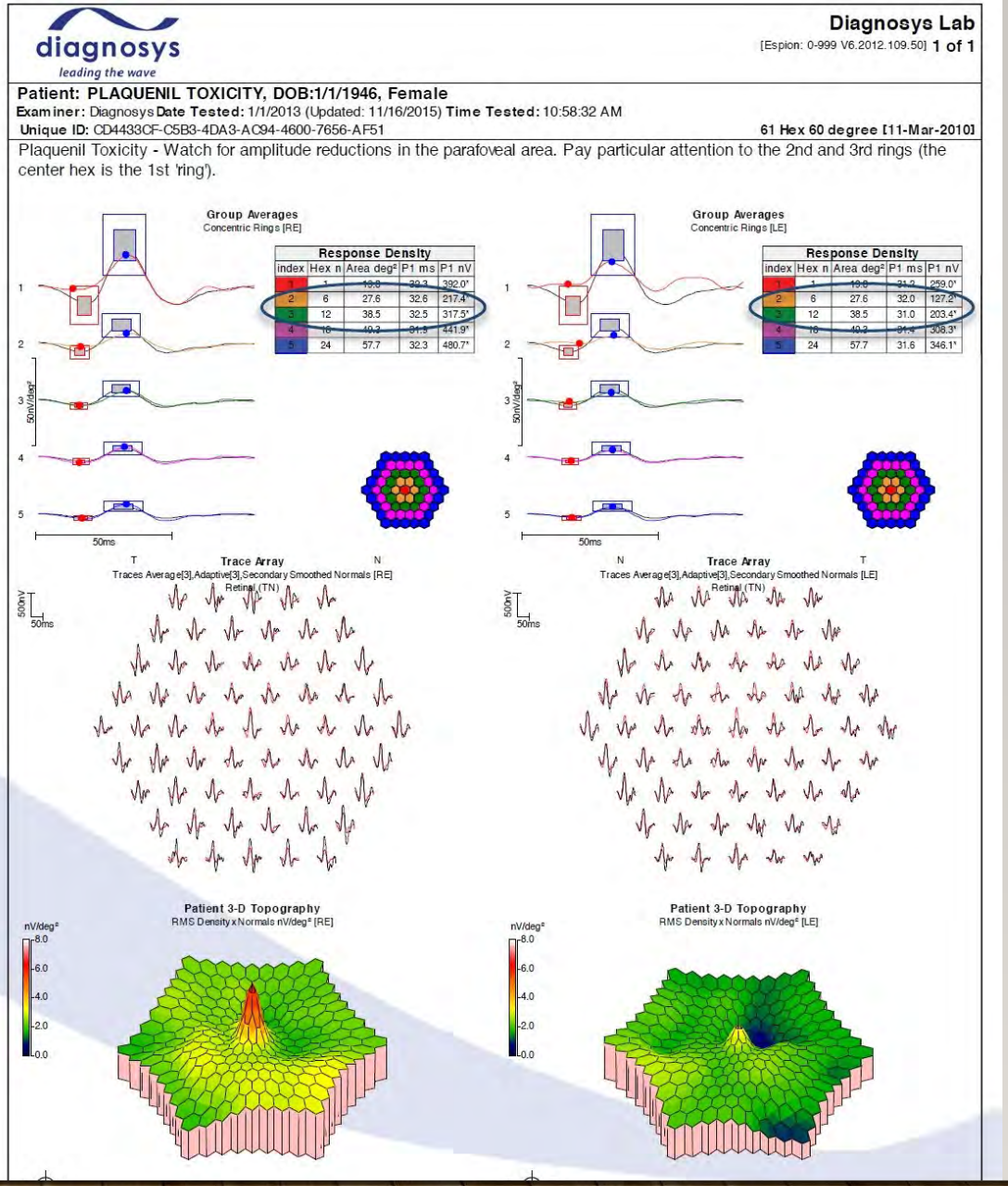
Trace Array
Traces Average[3],Adaptive[3],Secondary Smoothed Normals [RE]
Retinal (TN)

Trace Array
Traces Average[3],Adaptive[3],Secondary Smoothed Normals [LE]
Retinal (TN)

Patient 3-D Topography
RMS Density x Normals nV/deg² [RE]

Patient 3-D Topography
RMS Density x Normals nV/deg² [LE]

PLAQUENIL AND MF-ERG



GLAUCOMA

Steady-state pattern electroretinogram and short-duration transient visual evoked potentials in glaucomatous and healthy eyes

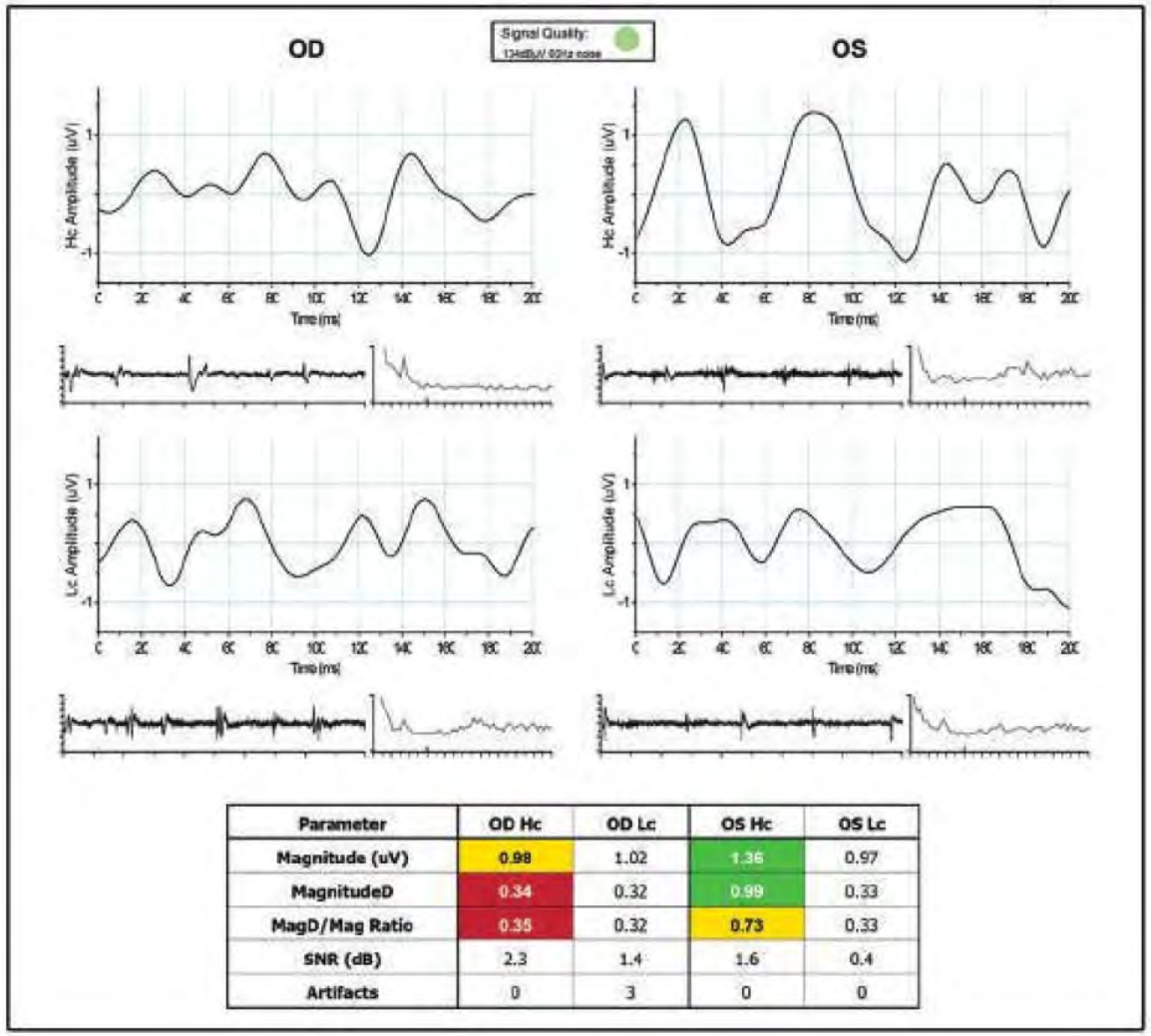
			Glaucoma	Control	*P*-value
ss-PERG	Lc		*n* = 72	*n* = 79	
Step 1 (64 bar size)		MagnitudeD ([μV] mean, [95% CI])	0.32 (0.25, 0.39)	0.48 (0.42, 0.55)	0.001
		MagnitudeD/Magnitude ratio (mean, [95% CI])	0.45 (0.39, 0.51)	0.51 (0.45, 0.57)	0.148
		SNR (mean, [95% CI])	2.29 (1.9, 2.8)	2.75 (2.29, 3.32)	0.178
	Hc		*n* = 72	*n* = 80	
		MagnitudeD ([μV] mean [95% CI])	0.43 (0.32, 0.54)	0.77 (0.67, 0.88)	<0.001
		MagnitudeD/Magnitude ratio (mean [95% CI])	0.50 (0.44, 0.56)	0.65 (0.59, 0.71)	<0.001
					0.010
SD-tVEP					0.462
32 × 32 spatial freque					0.179
					0.351
					0.577

Unreliable test resu … ation tran-
sient visual evoked po …

eyes.
contra …
compa …
param …
high-c …
measu …
tential …

MagnitudeD was the most accurate ss-PERG parameter for discerning glaucomatous dysfunction across all stimuli. MagnitudeD represents the amplitude of the ss-PERG signal as well but is also heavily influenced by the phase consistency of the signal. This phase is calculated by averaging measurements taken during each testing sequence. Phase consistency describes the SD of these measurements. A low phase consistency indicates a failure of the RGCs to adapt to the large energy demand of an ss-PERG stimulus, leading to different phases as testing time goes on.[14] This difference in phase consistency is demonstrated in Figures 1c,d. A low ss-PERG phase consistency and decreased amplitude have been previously seen in patients with glaucoma.[30] Accordingly, we found MagnitudeD to be significantly

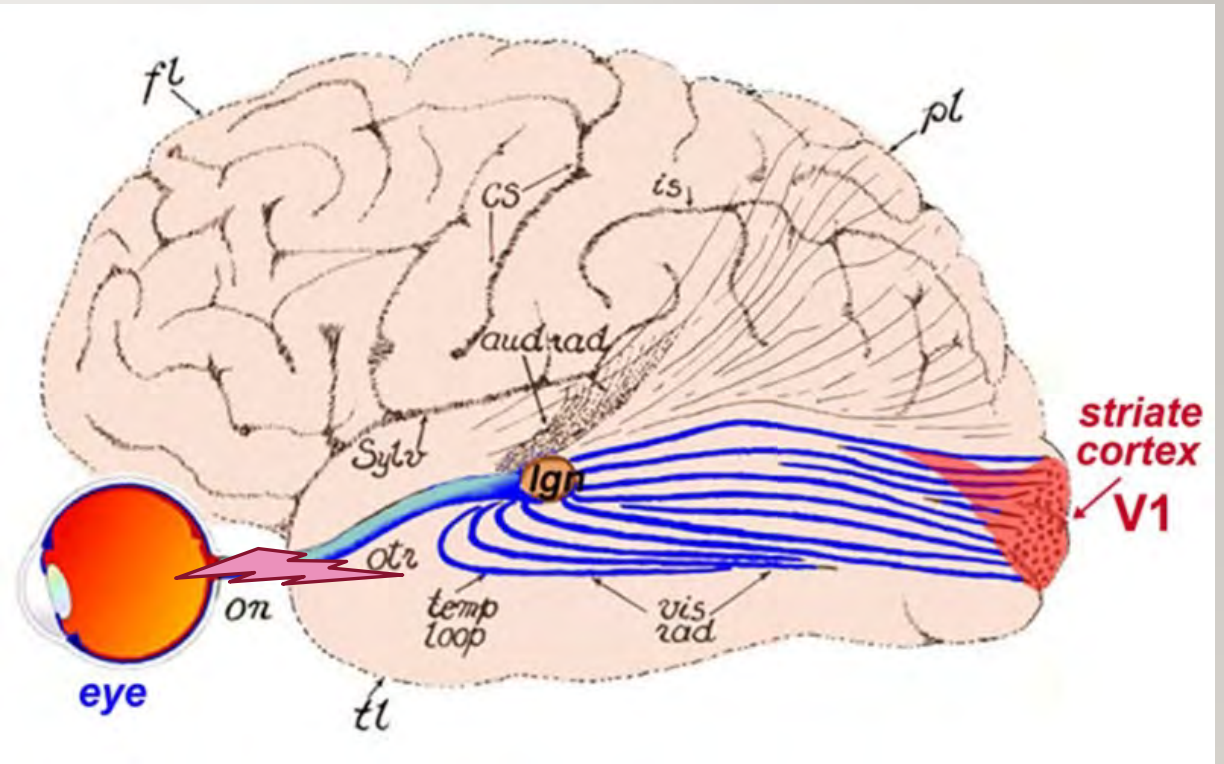
GLAUCOMA AND PERG

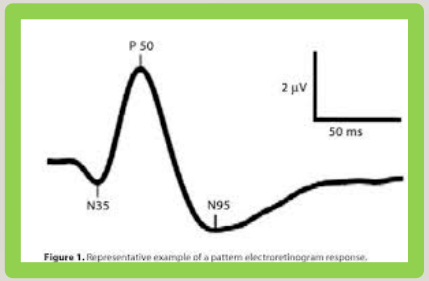


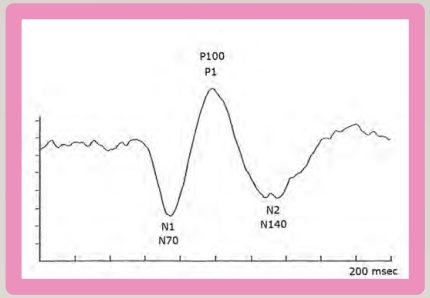
Parameter	OD Hc	OD Lc	OS Hc	OS Lc
Magnitude (uV)	0.98	1.02	1.36	0.97
MagnitudeD	0.34	0.32	0.99	0.33
MagD/Mag Ratio	0.35	0.32	0.73	0.33
SNR (dB)	2.3	1.4	1.6	0.4
Artifacts	0	3	0	0

Glaucoma

SUMMARY


fl
pl
cs
ts
aud rad
striate
cortex
V1
Sylv
lgn
otr
on
temp
loop
vis
rad
eye
tl


P 50
2 µV
50 ms
N35
N95
Figure 1. Representative example of a pattern electroretinogram response.


P100
P1
N1
N70
N2
N140
200 msec

SUMMARY

- Electrodiagnostic testing is a clinically relevant tool that is underutilized in the modern everyday optometric practice.
- As the years advance, electrodiagnostic testing will continue to do the same.
- I believe that the with the increasing amount of studies on the clinical use of these electrodiagnostic test it is only a matter of time until they become a part of the standard of care for these common ocular conditions.

REFERENCES

1. Wroblewski JJ, McChancy C, Pickel K, Buterbaugh H, Wieland T, Gonzalez A. Reproducibility of fixed-luminance and multi-luminance flicker electroretinography in patients with diabetic retinopathy using an office-based testing paradigm. *Journal of Diabetes Science and Technology*. 2019:19322968198827-1932296819882719. https://search.proquest.com/docview/2308146789. doi: 10.1177/1932296819882719.

2. Pescosolido N, Barbato A, Stefanucci A, Buomprisco G. Role of electrophysiology in the early diagnosis and follow-up of diabetic retinopathy. *Journal of diabetes research*. 2015;2015:319692-8. https://www.ncbi.nlm.nih.gov/pubmed/26075282. doi: 10.1155/2015/319692.

3. Gupta S, Khan T, Gupta G, Agrawal B, Khan Z. Electrophysiological evaluation in patients with type 2 diabetes mellitus by pattern reversal visual evoked potentials. *National Journal of Physiology, Pharmacy and Pharmacology*. 2017;7(5):527. https://search.proquest.com/docview/1912489789. doi: 10.5455/njppp.2017.7.1235824012017.

4. Li J, Tso MOM, Lam TT. Reduced amplitude and delayed latency in foveal response of multifocal electroretinogram in early age related macular degeneration. *British Journal of Ophthalmology*. 2001;85(3):287-290. http://dx.doi.org/10.1136/bjo.85.3.287. doi: 10.1136/bjo.85.3.287.

5. Skaat A, Solomon A, Moroz I, et al. Increased electroretinogram a-wave amplitude after intravitreal bevacizumab injection for neovascular age-related macular degeneration. *Acta Ophthalmologica*. 2011;89(3):e269-e273. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1755-3768.2010.02005.x. doi: 10.1111/j.1755-3768.2010.02005.x.

6. Pandya HK, Robinson M, Mandal N, Shah VA. Hydroxychloroquine retinopathy: A review of imaging. *Indian journal of ophthalmology*. 2015;63(7):570-574. https://www.ncbi.nlm.nih.gov/pubmed/26458473. doi: 10.4103/0301-4738.167120.

7. J Fraj, A Valero, R Vives, et al. Original article. *Allergy*. 2008;63(1):112. https://search.proquest.com/docview/1969099915. doi: 10.1111/j.1398-9995.2007.01473.x.

8. Pillai C, Ritch R, Derr P, et al. Sensitivity and specificity of short-duration transient visual evoked potentials (SD-tVEP) in discriminating normal from glaucomatous eyes. *Investigative ophthalmology & visual science*. 2013;54(4):2847-2852. https://www.ncbi.nlm.nih.gov/pubmed/23513061. doi: 10.1167/iovs.12-10097.

9. Wilsey L, Fortune B. Electroretinography in glaucoma diagnosis. *Current Opinion in Ophthalmology*. 2016;27(2):118-124. https://www.ncbi.nlm.nih.gov/pubmed/26720775. doi: 10.1097/ICU.0000000000000241.

10. Kirkiewicz M, Lubiński W, Penkala K. Photopic negative response of full-field electroretinography in patients with different stages of glaucomatous optic neuropathy. *Doc Ophthalmol*. 2016;132(1):57-65. https://www.ncbi.nlm.nih.gov/pubmed/26831670. doi: 10.1007/s10633-016-9528-z.

11. Jafarzadehpour E, Radinmehr F, Pakravan M, Mirzajani A, Yazdani S. Pattern electroretinography in glaucoma suspects and early primary open angle glaucoma. *Journal of ophthalmic & vision research*. 2013;8(3):199-206. https://www.ncbi.nlm.nih.gov/pubmed/24349662.

12. Wilsey L, Fortune B. Electroretinography in glaucoma diagnosis. *Current Opinion in Ophthalmology*. 2016;27(2):118-124. https://www.ncbi.nlm.nih.gov/pubmed/26720775. doi: 10.1097/ICU.0000000000000241.