


OCT & OCTA RETINAL IMAGING: HOW TO PREVENT "RAGING" GLAUCOMA!

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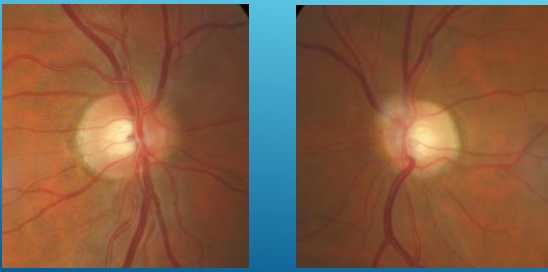
THE ORIGINAL "RAGING" GLAUCOMA

- ▶ 47-year-old Black male presenting for a "routine" eye examination
- ▶ Intraocular pressures in 2010
 - ▶ Right eye -- 14mm Hg
 - ▶ Left Eye -- 17mm Hg
- ▶ 20/20 visual acuity in each eye with low power prescription to treat myopia
- ▶ No other risk factors for glaucoma or abnormal clinical signs to suggest the presence of glaucoma
- ▶ Previous eye examination with me one year earlier – all results normal*



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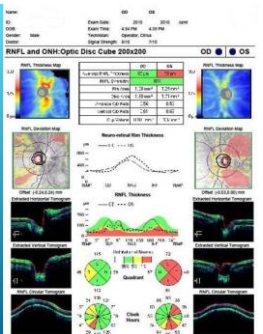
OPTIC NERVE HEAD EXAMINATION



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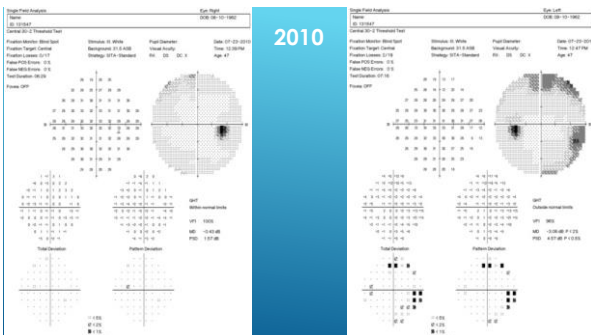
OCT RETINAL IMAGING

- ▶ Wedge-shaped defects of the retinal nerve fiber layer in the left eye
- ▶ The TSNIT Curve Profile Analysis superior and inferior retinal nerve fiber layer humps are flattened in the left eye
- ▶ Because glaucomatous damage to the retinal nerve fiber layer has a predilection for the inferotemporal and superotemporal regions of the optic disc, focal nerve fiber layer defects in these areas are strongly suggestive of glaucoma



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2010



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PRIMARY OPEN-ANGLE GLAUCOMA

- ▶ Glaucoma is a multifactorial optic neuropathy characterized by structural changes to the optic nerve head and peripapillary retina that are associated with characteristic functional deficits
- ▶ There is clear evidence that glaucoma is a neurodegenerative disease that affects the brain as well as the eye
- ▶ Glaucoma is associated with the following clinical features
 - ▶ Aqueous outflow restrictions
 - ▶ Unphysiologic intraocular pressure
 - ▶ Abnormal ocular perfusion
 - ▶ Abnormal rate of apoptosis
 - ▶ Progressive ganglion cell loss
 - ▶ Characteristic changes in optic nerve anatomy

Punjab G, Lin S, Stamper R. Advances in mapping the glaucomatous visual field from confrontation to multifocal visual evoked potentials. *The Internet Journal of Ophthalmology and Visual Science*. 2004;4(1).

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Risk Factors for Glaucoma (ICD-10)

- ▶ African-American or Hispanic race
- ▶ Family history in first-degree relative
- ▶ Elevated intraocular pressure
- ▶ Abnormal optic disc appearance
- ▶ A central corneal thickness below 500 microns combined with elevated intraocular pressure

Additional Risk Factors for Glaucoma

- ▶ Diabetes
- ▶ Low blood pressure
- ▶ Sleeping disorders and Breathing disorders
- ▶ Prior trauma to the globe
- ▶ Pseudoexfoliation
- ▶ Pigment dispersion syndrome

OPEN ANGLE BORDERLINE FINDINGS

A "glaucoma suspect" is a person with clinical findings and/or a combination of risk factors that indicate an increased likelihood of developing glaucoma

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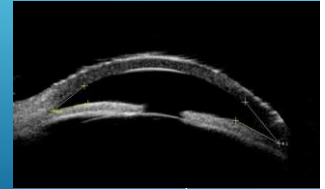
Mechanism of Primary Glaucoma

- ▶ Determine the mechanism of elevated intraocular pressure by showing the relationship between the peripheral iris and the trabecular meshwork

Determine the Occludability of the Anterior Chamber Angle

- ▶ Use ultrasound biomicroscopy (UBM) to determine the exact degree of angle closure and assess whether the patient is predisposed to angle closure
 - ▶ Document abnormal signs with biomicroscopy and/or gonioscopy
 - ▶ Narrow angles
 - ▶ Forward bow of iris
 - ▶ Anterior synechiae

AQUEOUS OUTFLOW RESTRICTIONS



UBM images iris, scleral spur and ciliary body

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UNPHYSIOLOGIC INTRAOCULAR PRESSURE

- ▶ IOP above 22 mmHg as measured by applanation tonometry
- ▶ Measurements above 24 mmHg are clinically significant
- ▶ 99.85% of the population have IOPs below 24 mmHg
- ▶ Increase in intraocular pressure over time
- ▶ Asymmetry in intraocular pressure > 5 mmHg
- ▶ Diurnal variation greater than 6 mmHg

Corneal Hysteresis and its Relevance to Glaucoma*

- ▶ Corneal hysteresis is a biomechanical corneal behavior and not a static physical property like corneal thickness
- ▶ Low corneal hysteresis is associated with optic nerve and visual field damage in glaucoma and the risk of progressive glaucomatous damage to the visual system

Deel M, Taylor D, Radcliffe N. Corneal hysteresis and its relevance to glaucoma. *Curr Opin Ophthalmol*. 2018;Mar;24(2):96-102. doi: 10.1097/CUO.0000000000000130

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ABNORMAL OCULAR PERFUSION

Ocular Perfusion Impairment

- ▶ Decreased optic disc and peripapillary perfusion can be found in eyes with glaucoma
- ▶ Ocular perfusion impairment can be visualized with OCT angiography (OCTA) by measuring retinal vessel density in different regions around the optic disc and the macula
- ▶ Vessel density can be increased by treating glaucoma and the reversal of peripapillary vessel density is associated with higher pre-treatment intraocular pressure and greater post-treatment intraocular pressure reduction
- ▶ In some patients with early glaucoma, reduced macular and peripapillary retinal vessel density can be detected with OCTA prior to measurable visual field loss

Yamashiro M, A, Zangwill LM, Manotas PC, et al. Peripapillary and macular vessel density in patients with primary angle-closure glaucoma and unilateral field loss. *Ophthalmology*. 2018;125:78-87.

Jung H, Lee SY, Cho SH, Hong YJ. Peripapillary Vessel Density Reversal after Trabeculectomy in Glaucoma. *J Ophthalmol*. 2018; 2018:890974. doi: 10.1155/2018/890974

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- ▶ The retinal nerve fiber layer (RNFL) contains all the ganglion cells

- ▶ The structure has a striated appearance traversing across the major blood vessels and can be seen with ophthalmoscopy

- ▶ Loss of vision from glaucoma is the result of axonal damage at the level of the optic disc

- ▶ Directly below the papillomacular bundle, the striae appear altered, as if they were peeled away

- ▶ This defect in the RNFL indicates a loss of retinal ganglion cells

- ▶ This is a localized, wedge-shaped defect with its apex at the optic disc

PROGRESSIVE GANGLION CELL LOSS



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CHANGES IN OPTIC NERVE ANATOMY

Changes in Coloration of the Optic Nerve

- ▶ Localized pallor is more diagnostic of glaucomatous optic atrophy

Changes in Position of the Optic Cup

- ▶ Temporal or inferior decentration of the cup is highly suspicious for glaucoma

Changes in Optic Cup Size

- ▶ Focal enlargement is a positive indicator for glaucomatous optic atrophy
- ▶ Loss of tissue appears as a wedge-like bite taken out of the margin called a "notch"

Changes in the Margins of the Optic Cup

- ▶ The margin of the cup is typically smooth and slightly rounded
- ▶ Very sharp or heavily-sloped cup margins are suspicious for glaucoma

Changes in Optic Cup Depth

- ▶ Normal eyes can have deep cups
- ▶ Deep cups that are also wide are more suspicious for glaucoma

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CASE REPORT #1

- ▶ 50-year-old White male presents for a "routine" eye examination in 2015
- ▶ Intraocular pressures
 - ▶ Right eye -- 24 mm Hg
 - ▶ Left eye -- 25 mm Hg
- ▶ Order OCT retinal imaging and threshold visual field examination
- ▶ Diagnosed with ocular hypertension – scheduled to RTC in one year
- ▶ Patient returns to the office for another "routine" eye examination in 2018
- ▶ Intraocular pressures
 - ▶ Right eye -- 34 mm Hg
 - ▶ Left eye -- 25 mm Hg
- ▶ Order OCT retinal imaging (RNFL, ganglion cell, angiography)
- ▶ Order threshold visual field exam, extended color vision exam, electroretinography, visual evoked potential testing, corneal pachymetry, corneal hysteresis and gonioscopy

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Glaucomatous Visual Field Defects

Widespread loss of retinal sensitivity in characteristic patterns/locations

Nasal step
Arcuate scotoma
Paracentral scotoma

The loss of sensitivity should be considered highly diagnostic of glaucoma when it is asymmetric and correlates with asymmetric changes in intraocular pressure or optic disc appearance

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VISUAL FIELD EXAMINATION

- ▶ 24-2 and 30-2 automated threshold testing patterns
 - ▶ 54 points and 74 points, respectively, each six degrees apart
 - ▶ 12 points tested within the central ten degrees
 - ▶ 4 points tested within the macular region (central eight degrees)
 - ▶ 30% of the total retinal ganglion cells
 - ▶ 60% of visual cortex area
- ▶ In progressive glaucoma, a relationship exists optic disc cupping and changes in the visual field
 - ▶ In the majority of patients with glaucoma, there is a functional latency period where structural change occurs early in the natural history of the disease without functional vision loss
- ▶ A minority of patients develop visual field defects before structural defects can be visualized or imaged

Thomas C. The Structure-Function Relationship. Review of Ophthalmology, Jul 2017; 54-59.
Libert A, Fisher B, Shurman A, Cordes S, Carter S, Perkins T. 10-2 Visual Field Testing: A Tool for All Glaucoma Stages. Review of Ophthalmology, Jul 2015; 62-67.

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OCT RETINAL IMAGING

- ▶ Circumpapillary retinal nerve fiber layer thickness
- ▶ Neuroretinal rim width
- ▶ Ganglion cell inner plexiform layer thickness

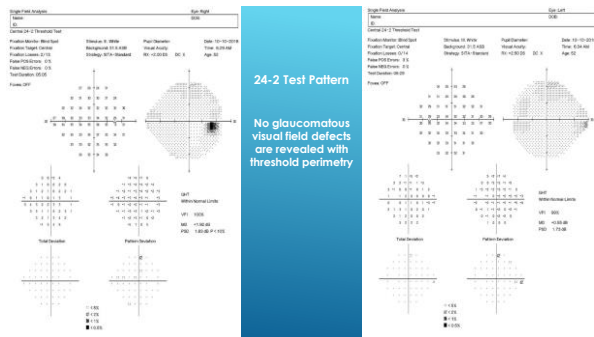
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FUNDUS EXAMINATION

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ANTERIOR CHAMBER EXAMINATION

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24-2 Test Pattern

No glaucomatous visual field defects are revealed with threshold perimetry

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RETINAL NERVE FIBER LAYER EXAMINATION

- Retinal nerve fiber layer (RNFL) is composed of retinal ganglion cells and their axons
- The loss of retinal ganglion cells can be visualized as localized or diffuse thinning of the RNFL

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GANGLION CELL COMPLEX ANALYSIS

- OCT retinal imaging technique that measures the thickness of the inner three retinal layers
- Macular ganglion cell complex pattern parameters include FLV, GLV, and mean, superior, and inferior thickness
- Highest diagnostic accuracy for early glaucoma is with global loss volume (GLV) parameter

Kim N, Lee E, Seong G, Kim J, Ah H, Kim C. Structure-Function Relationship and Diagnostic Value of Macular Ganglion Cell Complex Measurement Using Fourier-Domain OCT. In: Glaucoma. Investigative Ophthalmology & Visual Science. Sep 2010; Vol 51:4646-4651. doi:10.1167/iov.51.9.4646

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COLOR VISION

- Color vision abnormalities are not specific and can occur in a wide variety of neurologic and ophthalmologic diseases
 - Optic nerve disease
 - Loss of foveal function
 - Retinal dystrophies
- Loss of chromatic discrimination in the dyschromatopsia of glaucoma is primarily tritan (blue-yellow) in nature
- Color contrast thresholds are also elevated in some patients with glaucoma

Hwang Y, Muraldi S, Hasko F, Minamitani T. Evaluation of acquired color vision deficiency in glaucoma using the Robin Color Contrast Test. Invest Ophthalmol Vis Sci. 2014 Oct;55:666-670.

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ELECTRORETINOGRAPHY

- Electroretinography (ERG) testing evaluates the integrity of the retina
- Every manufacturer of modern electrodiagnostic testing devices follows ISCEV standards for clinical electroretinography but they also have their own specific testing protocols designed to detect glaucoma-induced functional abnormalities
- ERG testing device measures the photopic negative response (PNR) to evaluate the function of the innermost retinal layers and the ganglion cells
- Abnormal test results can be a diagnostic marker for glaucoma

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Reporting Professional Services

Description	CPT Code	Diagnosis Code	Approved Fees
Eye Examination	92004	H40.013 (ocular hypertension)	\$152.54
Refraction	92015	H40.013 (ocular hypertension)	19.22
OCT Retinal Imaging	92133	H40.013 (ocular hypertension)	43.65
Visual Field Exam	92083	H40.013 (ocular hypertension)	58.97
Color Vision Exam	92283	H53.52 (acquired color vision defect)	43.23
Electroretinography	92273	H47.233 (partial optic atrophy)	134.75
			\$423.87

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SERIAL TONOMETRY

- ▶ This professional service may be used to assess diurnal variations of intraocular pressure when glaucoma is suspected
- ▶ In patients without glaucoma the normal diurnal curve is approximately 4 mm Hg
- ▶ Serial tonometry may be helpful before beginning glaucoma treatment because it enables the optometrist to gain a better understanding of the patient's circadian intraocular pressure measurements
- ▶ Serial tonometry is not indicated in the routine follow-up of glaucoma and it should be an infrequent occurrence for any given patient and in any given office
- ▶ It is inappropriate to bill serial tonometry simply because tonometry is performed more than once during an examination
- ▶ Confirmatory measurement of a particular finding with the same or different tonometers, or with different personnel, does not constitute serial tonometry
- ▶ Documentation requirements are at least three measurements of intraocular pressure over at least a six-hour time period

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Reporting Professional Services

Description	CPT Code	Diagnosis Code	Approved Fees
Serial Tonometry	92100	H40.013 (ocular hypertension)	\$95.42
Visual Evoked Potential	95930	H47.233 (partial optic atrophy)	72.35
Corneal Pachymetry	76514	H40.013 (ocular hypertension)	13.22
Total for 4 visits in 5 weeks			\$189.44

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10-2 Test Pattern

No glaucomatous visual field defects are revealed with threshold perimetry

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VISUAL FIELD EXAMINATION

- ▶ 10-2 automated threshold testing pattern
 - ▶ 68 points two degrees apart
 - ▶ 5x as many test points in the central 10 degrees compared with 24-2 and 30-2 test patterns
 - ▶ 60 points tested in the macular region
- ▶ Higher density of points tested in the macular region generally produces greater sensitivity in detecting central and paracentral scotomas that involve only a small area of the visual field at or near fixation
- ▶ Benefits of central 10-2 visual field testing
 - ▶ Diagnose glaucoma earlier
 - ▶ Detect glaucoma progression sooner
 - ▶ More accurate assessment of visual field damage

Liffert A, Fisher B, Sturama A, Cordes L, Carter S, Perkins T. 10-2 Visual Field Testing: A Tool for All Glaucoma Stages. Review of Optometry, Jul 2017; 54:59.

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GONIOSCOPY

Goal of performing gonioscopic examination of the angle

- ▶ Determine the functioning status of the angle
- ▶ Determine the degree of closure of the angle
- ▶ Determine the risk of future closure of the iridocorneal angle

Gonioscopy Exam Results

- ▶ Normal iris configuration, open angles in all quadrants, no evidence of recent angle closure, no synechia, no inflammatory deposits, no cysts, no excessive pigment, no neovascularization, no apparent obstruction of the anterior chamber angle or outflow mechanism

The anatomical configuration of the iris and angle structure is important in the pathogenesis of certain forms of glaucoma

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Reporting Professional Services

Description	CPT Code	Diagnosis Code	Approved Fees
Eye Examination	92012	H40.1131 (glaucoma, mild stage)	\$88.42
Gonioscopy	92020	H40.1131 (glaucoma, mild stage)	20.37
Visual Field Exam	92083	H40.1131 (glaucoma, mild stage)	58.97
Total for 4 visits in 5 weeks			\$423.87

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CASE REPORT #2

15-year-old Black male presents for an eye examination in 2015

- ▶ IOPs OD = 26 mmHg OS = 25 mmHg

Intraocular pressures over the previous six years

2014	OD = 22 mmHg	OS = 26 mmHg
2013	OD = 26 mmHg	OS = 26 mmHg
2012	OD = 19 mmHg	OS = 20 mmHg
2011	OD = 21 mmHg	OS = 20 mmHg
2009	OD = 24 mmHg	OS = 23 mmHg

Family history is positive for glaucoma

- ▶ Grandmother
- ▶ Great-grandmother

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2015
Interior

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OCT + VF 2016

Intraocular pressures

- ▶ OD = 28 mmHg
- ▶ OS = 31 mmHg

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2017

IOPs

OD = 25
OS = 25

Treatment Program Initiated

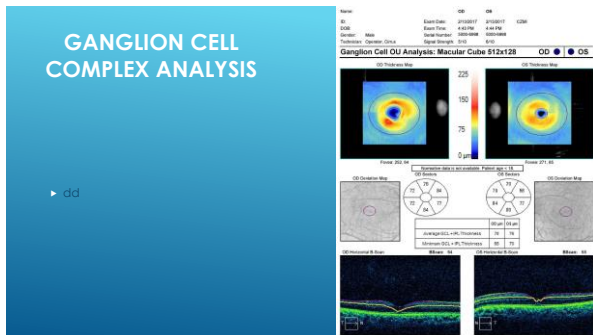
Cosopt BID - OU

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RETINAL NERVE FIBER LAYER EXAMINATION

▶ If

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TREATMENT PROGRAM – 2017/2018

Two visits in February 2017 with patient and mother – initiate glaucoma treatment
 ▶ Patient is in dental and does not want to use eyedrops on a daily basis

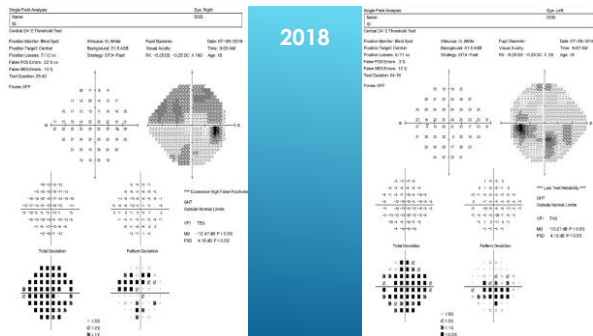
Returns to Dallas from college in July 2017 – patient is noncompliant with the eyedrops
 ▶ IOPs OD = 27 mmHg OS = 18 mmHg

Stress compliance – visit one month later before leaving Dallas for college
 ▶ IOPs OD = 24 mmHg OS = 23 mmHg

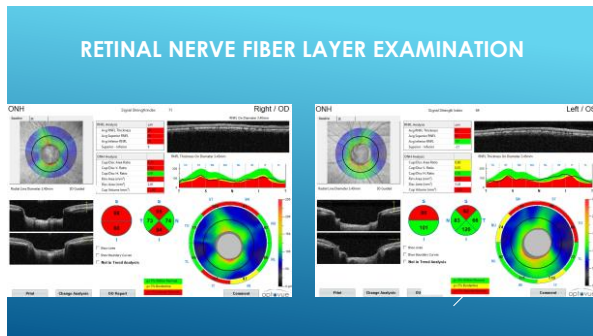
Returns to Dallas from college in December 2017 – patient is noncompliant with the eyedrops -- he says they "burn" too much
 ▶ Change medicine from Cosopt to Cosopt PF – stress compliance with treatment

Returns to Dallas from college in July 2018 – patient is noncompliant
 ▶ IOPs OD = 24 mmHg OS = 25 mmHg
 ▶ Discontinue Cosopt PF and begin Vyzulta

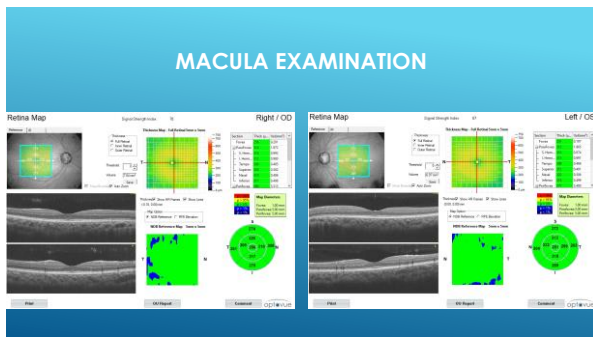
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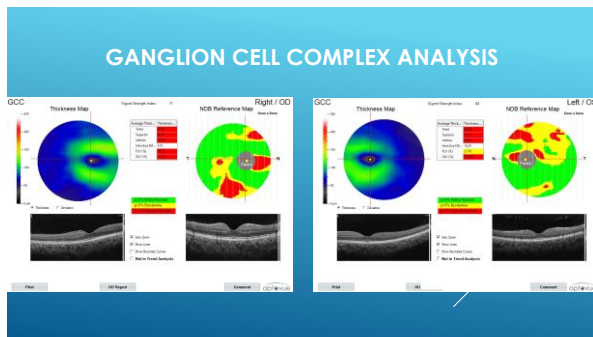
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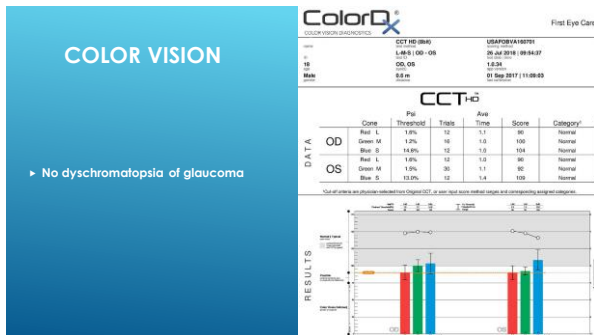
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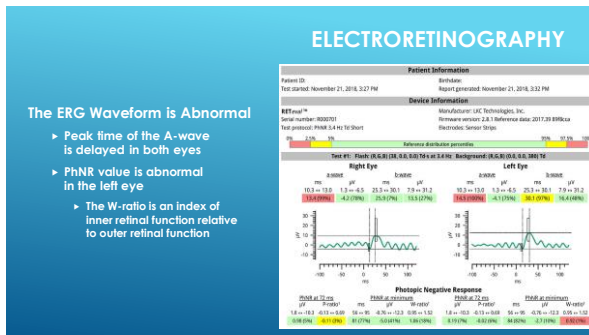


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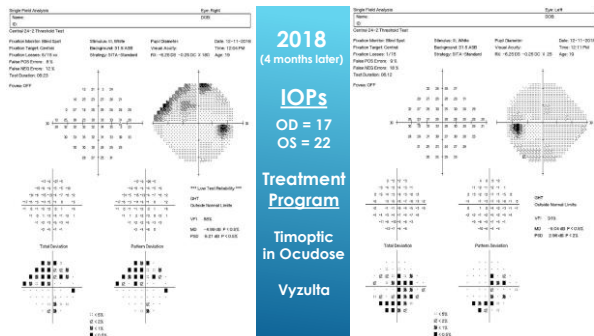


▶ No dyschromatopsia of glaucoma

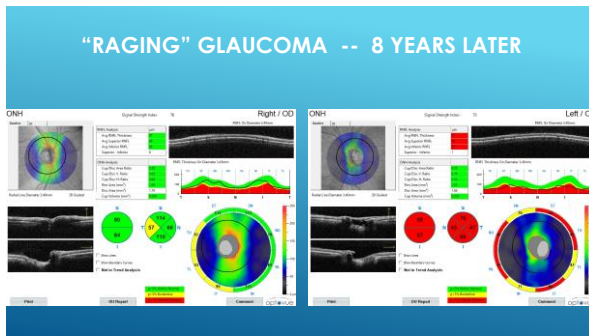
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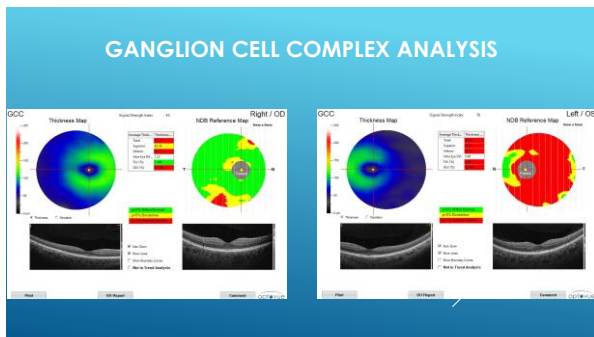
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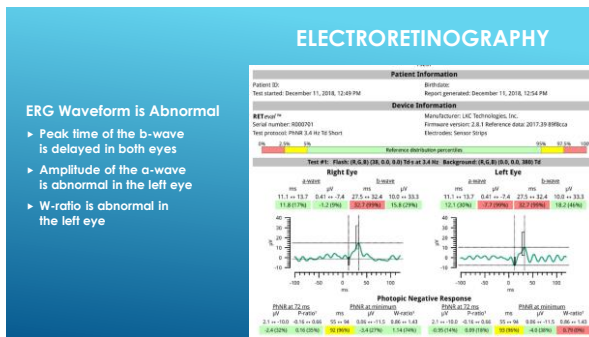
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