Making a Case for ERG

BOBBY "CHIP" WOOD, JR. OD
Medical Director, Wood Vision Source, San Antonio, TX
Medical Director, Coyote Optical, Uvalde, TX

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Disclosures

Dr. Wood:

- LKC Technologies – Clinical Advisory Board
- Alcon – Contact Lens KOL/Speaker
- Bausch & Lomb – Contact Lens Expert/Speaker
- Essilor Instruments – LLLT/IPL Speaker
- Euclid Vision Group – Speaker/Consultant
- Orasis Pharmaceuticals – Speaker/Consultant
- Pure & Clean – Research/Speaker
- Vision Source Administrator – San Antonio
- Vision Source Vendor Relations Consultant – Equipment/Contact Lens

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The journey to standard of care for functional testing

1. The American Academy of Ophthalmology added ERG to their latest Preferred Practice Pattern guidelines for diabetic retinopathy for BOTH diagnosis and disease management.
2. A research study published in Ophthalmology Science identified the RETeval DR Score as the strongest predictor of DR progression within 1 year.
3. The RETeval is included in two Mary Tyler Moore Vision Initiative-sponsored clinical trials being conducted by the Diabetic Retinopathy Clinical Research Network (DRCR). The device was selected for its potential to measure retinal function as the DRCR seeks to augment the current guidelines for detection and staging of diabetic retinopathy.

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ERG 101
The Fundamentals of Functional Testing

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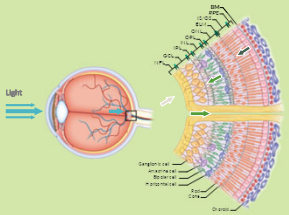
Electrophysiology 101



ERG measures the electrical responses of various cell types in the retina, including the photoreceptors (rods and cones), inner retinal cells (bipolar and amacrine cells), and the ganglion cells in response to a stimulus.

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Types of ERG

Full-field ERG (ffERG)	• Electrodes record the summed electrical response of the retinal cells • Shows the status of the retina as a whole
Pattern ERG (PERG)	• Evokes electrical responses from the ganglion cells composing the inner retina • Used as a test for disorders affecting ganglion cells and neurodegenerative disorders
Multifocal ERG (mfERG)	• Best for measuring dysfunction of the central retina area • Not sensitive to abnormalities in the ganglion axon

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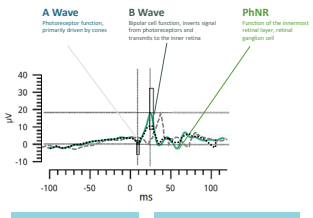
The ERG Waveform

- **Amplitudes** are how far the baseline electric potential of the eye dips in the a-wave and climbs in the b-wave.
- **Implicit times** are how much time elapses after the light flash until the trough of the a-wave or the peak of the b-wave.
- The **PhNR** originates from the activity of the retinal ganglion cells, the innermost cells of the retina that transmit signals to the brain via the optic nerve.



A delay in **implicit times** indicates cellular stress / abnormal metabolism

Reduced **amplitude** indicates cells are dying; number of cells is decreasing

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Common Clinical Applications

Diabetic retinopathy	Glaucomatous optic atrophy	Changes in retinal vascular appearance	Central serous chorioretinopathy	Disorders of the optic nerve & visual pathway	Drusen of optic disc
Epiretinal membrane/ puckering of the macula	Hypertensive retinopathy	Multiple defects of the retina without detachment	Nonexudative age-related macular degeneration	Nystagmus	Central retinal vein occlusion (CRVO)
Optic neuritis	Other specified retinal disorders	Other visual disturbance	Papilledema	Peripheral retinal degeneration	Retinal detachment with retinal break
Retinal hemorrhage	Retinal micro-aneurysms	Unspecified night blindness	Unspecified visual disturbance	Venous engorgement	Exudative age-related macular degeneration

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GLP-1 Agonists
The Role of Advanced Testing

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Initial Visit

February 2020

- 46 y/o African-American male "JH" presents for annual exam
- Only complaint is some dry eye symptoms with his current contact lenses
- Ocular history: high myopia, lattice degeneration OU
- Systemic history: unremarkable
- Meds: vitamin C, vitamin D, garlic capsules

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Ocular History

Entrance Testing

- Unremarkable

Manifest Refraction

- OD -8.50 -1.25 X 015, 20/20
- OS -8.50 – 1.50 X 170, 20/20

Slit Lamp Exam

- Eyelids: clear OU
- Conjunctiva: clear OU
- Cornea: clear OU
- A/C: deep and quiet OU
- Iris: clear OU
- Lens: clear OU

IOP

- 17 mmHg OD, 16 mmHg OS

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Optomap Scan

OD

OS

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Dilated Fundus Exam

- Vitreous: clear OU
- ONH: large optic nerve head OU, healthy rim tissue OU
- C/d ratio .45/.45 OD, .55/.55 OS
- Macula: clear OU
- Posterior pole: cotton wool spot OD, intraretinal hemorrhage OD
- Periphery: lattice degeneration OU

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Impression + Plan

Impression

- Lattice degeneration OU
- Retinopathy OD- unknown etiology
  - Blood pressure measured in office 132/82 RAS

Plan

- Refer to PCP for physical and blood work-up
- RTC 4 month dilated fundus exam to monitor retinopathy

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Follow-up 1

- Did not want to come into the office due to the COVID pandemic
- Patient returns on February 4, 2022 (2 years after last exam)
- Had been diagnosed with Type 2 DM
  - Taking Metformin
  - Last A1C was 6.5
- Denied any new ocular or visual complaints
- Slit lamp exam unchanged OU
- Fundus exam: cotton wool spots OD, intraretinal hemorrhages OU

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Optomap Scan

OD

OS

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Impression + Plan

Impression

- Type 2 diabetes mellitus with mild non-proliferative retinopathy OU
  - Worsened since previous visit

Plan

- Reinforced need for tight control of blood glucose
- RTC 6 months for dilated fundus exam

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Follow-up 2

- Patient presents August 28, 2023 (1 ½ years after last visit)
- Patient is very happy with blood glucose levels as he has lost weight and has had great A1C results since starting Ozempic injections several months earlier
  - A1C had went from 12.0 to 6.0 during the past year

Patient Stated…

"The only reason I came in today is because I bet my wife that my diabetic bleeding has all gone away after starting Ozempic and I want you to tell her that I'm right."

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Follow-up 2

- Entrance testing was unremarkable
- Visual acuity 20/20 OD, OS
- Slit lamp exam was unremarkable OU
- IOP 17 mmHg OD, 16 mmHg OS
- Fundus exam: dot and blot hemes in all quadrants OU, increased cotton wool spots OU in all quadrants, hard exudates near macula OD

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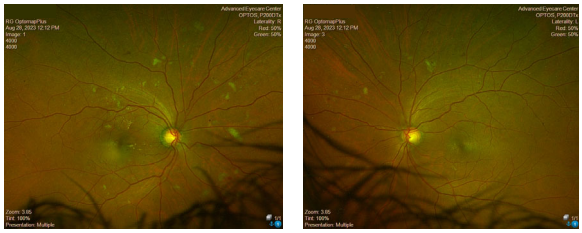
Optomap Scan



OD **OS**

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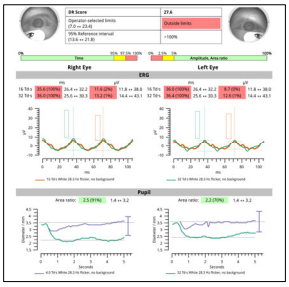
ERG

- ERG testing ordered to help quantify retinopathy by measuring retinal function
- Severely delayed implicit time OU
- Severely reduced amplitude OU
- DR score of 27.6
  - Significantly outside normal limits of 7.0 to 23.4



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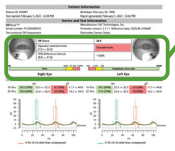
How to Interpret the DR Score

PATIENT TEST CONDITIONS
Test is always done un-dilated. Patient is diabetic with suspected retinopathy or diabetic with existing retinopathy.

PROTOCOL
DR Assessment

RESULTS
If the Operator-selected limit is marked red with text Outside limits, the patient is at risk to develop vision threatening DR within the coming 36 months.



Predicting DR progression

DR Score	6-Month Progression Risk	1-Year Progression Risk
19.9 or less	0%	0%
20.0 – 23.4	9%	48%
23.5 – 26.8	35%	60%
26.9 or greater	49%	79%

Davis, C. Quentin et al. Predicting Progression to Vision-Threatening Complications in Diabetic Retinopathy. Ophthalmology Science, online June 17, 2025, 100859

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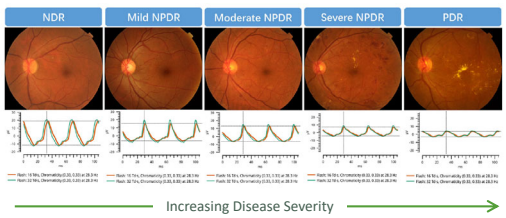
Correlate Structure and Function

First published in 1987, results replicated in North & South America, Europe, and Asia



Zeng et al. (2019) "Screening for Diabetic Retinopathy in Diabetic Patients with a Mydriasis-Free, Full-Field Flicker Electroretinogram Recording Device". Documenta Ophthalmologica.

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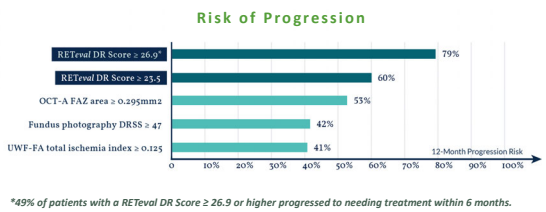
DR Score Predicts Who Will Need Tx



*49% of patients with a RETeval DR Score ≥ 26.9 or higher progressed to needing treatment within 6 months.

Davis, C. Quentin et al. Predicting Progression to Vision-Threatening Complications in Diabetic Retinopathy. Ophthalmology Science, online June 17, 2025, 100859
Data found in Supplemental Figure 1, available online.

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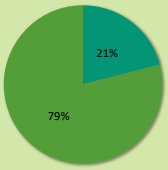
Slide 21

GS1 I’m getting the eye images photoshopped since the placement of the sensor strips isn’t ideal.
Gail Schwartz, 2025-02-24T18:51:55.051

DR Score Predicts Who Will Progress PDR/DME



Patients with a DR Score of 26.9 or higher had a 79% chance of progressing to needing treatment in less than 1 year.

- Longitudinal prospective study published in *Ophthalmology Science*, the journal of the American Academy of Ophthalmology
- 48 weeks (~11 months)
- 74 patients with moderate to severe NPDR tested with ERG
- Evaluated 56 parameters at multiple US sites from 4 testing modalities:
  - RE*teval* DR Assessment (ERG + pupillometry)
  - Color fundus photography (FP)
  - OCT angiography (OCT-A)
  - Ultra-widefield fluorescein angiography (UWF-FA)

Davis, C. Quentin et al. Predicting Progression to Vision-Threatening Complications in Diabetic Retinopathy. Ophthalmology Science, online June 17, 2025, 100859

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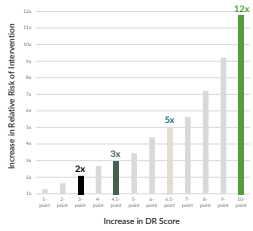
Structure: Assess Risk

Each 1-point change in the DR Score increases the probability of ocular intervention over 3 years by 28%

Higher DR Score & change over time dramatically increases risk:

- Risk of intervention **doubles** with a 3-point increase in DR Score (e.g. 20 to 23)
- Risk of intervention **triples** with a 4.5-point increase in DR Score (e.g. 20 to 24.5)
- Risk of intervention **increases 5x** with a 6.5-point increase in DR Score (e.g. 20 to 26.5)
- Risk of intervention **increases 12x** with a 10-point increase in DR Score (e.g. 16 to 26)



Cox proportional hazards analysis (CI = 1.17 – 1.40, p < 0.0001)

Source: Brigell MG, Chiang B, Maa AY, Davis CQ. Enhancing Risk Assessment in Patients with Diabetic Retinopathy by Combining Measures of Retinal Function and Structure. Trans Vis Sci Tech. 2020;9(9):40-40

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Impression + Plan

Impression

- Severe non-proliferative diabetic retinopathy with possible macular edema OD

Plan

- DR Score helped convince patient of the level of functional stress and damage and the need to refer.
- Prompt evaluation with retinal specialist as patient is now at significant risk for developing macular edema and proliferative diabetic retinopathy.

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Summary

- RETeval ERG function testing revealed excellent correlation with fundus exam.
- Ozempic's rapid improvement in glucose control is well known to worsen diabetic retinopathy.
- This is known as "early worsening" because the retinopathy will often get worse before the long-term benefits of better blood glucose control occurs.
- Usually considered temporary
- Skyrocketing usage of Ozempic for weight loss in diabetes patients requires clinicians to monitor retinal structure through usual means as well as consider retinal function through ERG testing to make sure patients are being referred to retina in a timely manner if DR Score is elevated.

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The Value of ERG

- "JH" is being examined every 6 months by the retinal specialist to monitor for clinically significant macular edema and/or proliferative retinopathy.
- The objective DR Score helped convince "JH" of the severity of his retinopathy. He had continuously delayed his own eye care as he did not take the condition as seriously as he should have.
- The RETeval DR Assessment helps provide objective functional data for our diabetic patients to elevate our clinical care by helping guide our decision making.
- We will continue to run the test on as many of our diabetic patients as possible to elevate care provided in our office which helps differentiate our office from other practices.

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Evidence of Ischemic Status
Indicates Whether to Monitor or Refer

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Ocular History

- 50-year-old female
- In for punctal plugs OU
- VA
  - 20/20- OD
  - 20/40 OS
- (+) DM, (+) HTN
  - Last A1C 8.9BP reading today 152/96

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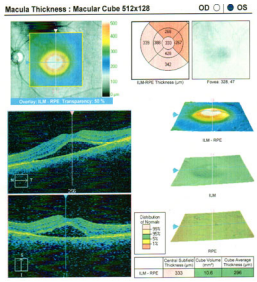
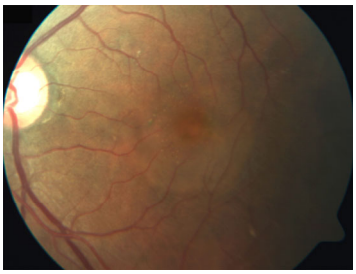
OCT & Fundus





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What's the diagnosis?

- Diabetic macular edema
- Hypertensive retinopathy
- Macular hole
- Central serous

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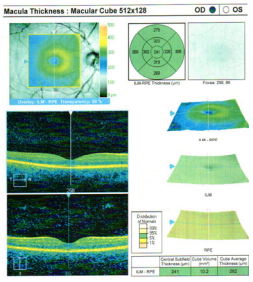
OCT & Fundus



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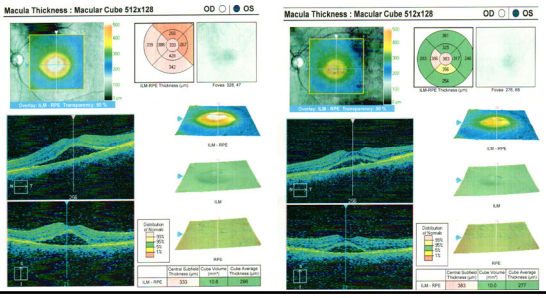
OCT – One Month Later (October 2023)



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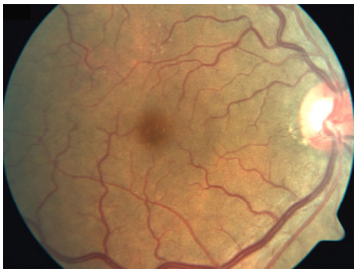
Fundus – One Month Later



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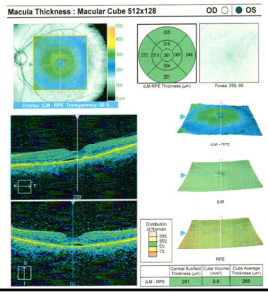
OCT – Two Months Later (November 2023)



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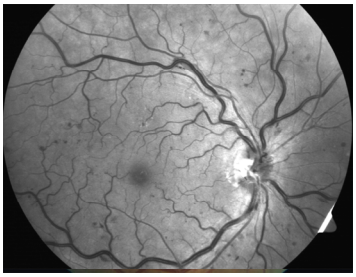
Fundus – Two Months Later



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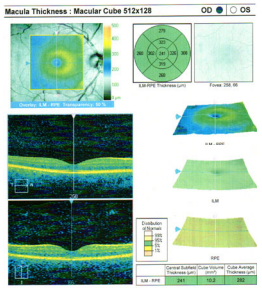
OCT – Two Months Later



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We know we have central serous OS

What's going on OD?

- Retinal artery occlusion
- Retinal vein occlusion
- Ocular ischemic syndrome
- Diabetic retinopathy

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How would you manage the right eye?

- Patient education and observe
- Refer to retina
- Refer to neuro
- Consult with PCP
- Topical NSAIDs and steroids

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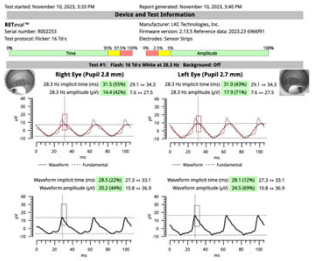
ERG Results

- FA or ERG was needed
- ERG is safe and non-invasive
- ERG determined how the retina was functioning and what degree of ischemia was present
- ERG findings were normal in both eyes with good amplitude and implicit times indicating normal retinal functioning and no retinal ischemia
- Confidence that we could monitor closely!



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Fundus – Two Months Later (January 2024)

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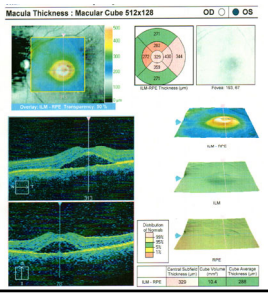
OCT – Two Months Later



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Treatment

- The ERG was right!
  - There was no ischemia
  - This case wasn't likely going to go bad (and it didn't)
- The ERG was a non-invasive test that allowed us to determine retinal function and retinal ischemia
- The retina is functioning well with no ischemia
- This could not have been determined without ERG or FA
- We saved the patient a visit and an injection/FA by having the ERG available

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The Value of ERG

- Do cardiologists believe in EKGs? Would you want a complete cardiac workup without an EKG?
- We as eyecare providers need to believe in ERG
  - ERG provides a more complete picture for our ocular pathology patients
  - We want structure (OCT, fundus photos, etc) and function (ERG) for our patients as well

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ERG Raises Red Flag
Changing Management Trajectory

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History

- 46-year-old
- White
- Male
- No medical history
- No family history or ocular history

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Ocular History

- Hard to see to drive at night
- Acuity: 20/20 right eye; 20/20 left eye

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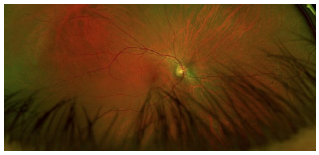
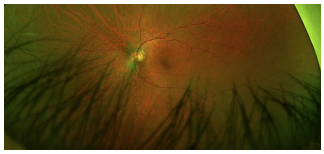
Fundus Exam

- Mild bone spicules in the nasal retina



OD



OS

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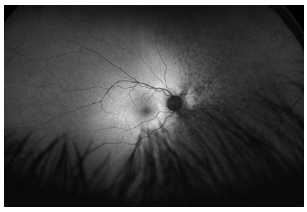
Auto Fluorescence

AF: reveals significant retina loss nasally in both eyes



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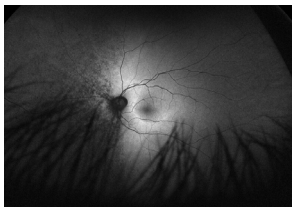

OS

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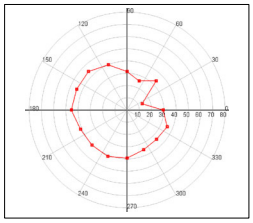
Visual Field

Decreased nasal visual field in both eyes



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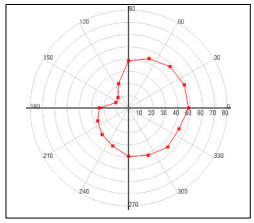

OS

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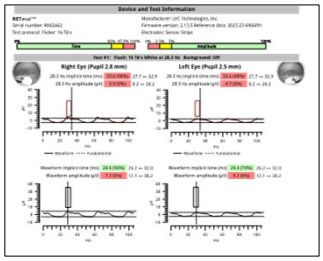
ERG



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ERG

- ERG was ordered to determine overall retinal function.
- Significant decreased in amplitude and implicit time.
- ERG findings would indicate more severe vision loss or decreased function than visual field or acuity represent.

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Treatment

- Sector retinitis pigmentosa
- Refer to specialist for bloodwork up
  - Genetic markers
  - Eligibility for RP trials
- Educate on progressive nature of RP
- Discuss night driving

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The Value of ERG

- Implementing ERG into our medical practice allows for detection, monitoring and appropriate referral when necessary.
- Investing in ERG technology has enabled us to monitor the retinal function objectively. Visual fields and visual acuity measure function but can be subjective and vary based on the patient's response.
- Developing protocols for each ocular disease has helped implement ERG technology into the practice flow.

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ERG Provides Clarity
When Fields & OCT are Inconclusive

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Case Report: How ERG Helped Me Initiate Treatment

Patient Info

- 59-year-old Caucasian female
- Glaucoma suspect, mild non-proliferative diabetic retinopathy
- CcIOP 22.0 and 24.7, TMax 24.0 and 26.3
- Pachs 612 AND 613
- Relevant family ocular history: cataracts and glaucoma
- Type 2 diabetes x 11 years, hypertension x 5 years, hypercholesterolemia x 6 years
- Family history of diabetes and hypertension
- Systemic medications:
  - Losartan, metformin, insulin, simvastatin

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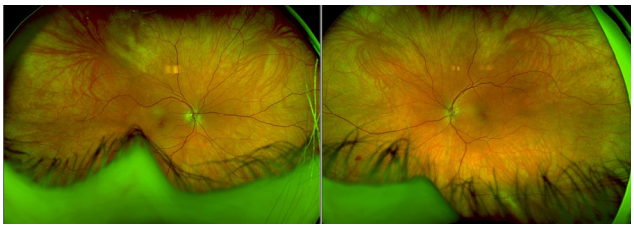
Fundus Exam

- Midperipheral/peripheral dot and blot hemes OD<OS
- Venous beading
- A/V nicking



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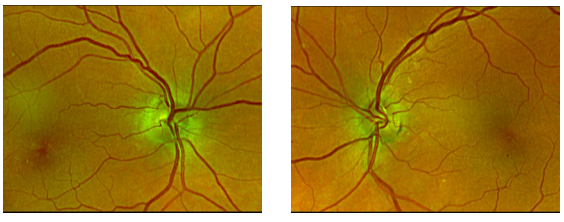
Fundus Exam

Fairly symmetric optic nerves



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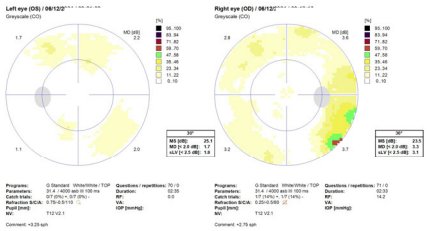
Visual Field

Fields show scattered defects OU with a reduced mean defect OD>OS



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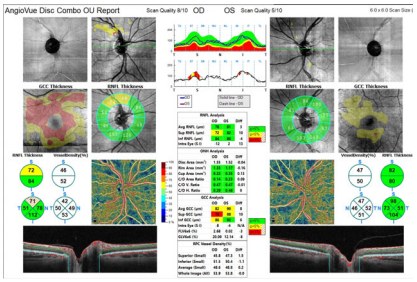
OCT/OCT-A

- Ganglion cell complex thinning OD>OS
- Supratemporal thinning OD on RNFL thickness and TSNIT
- Superior OCT-A vessel density reduction OD



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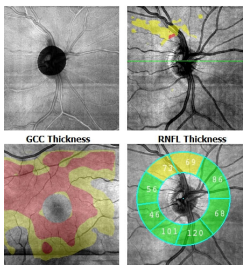
OCT/Visual Field/Polar Analysis

Visual field polar analysis does not show an expected supratemporal reduction. This indicates structural/functional discordance.



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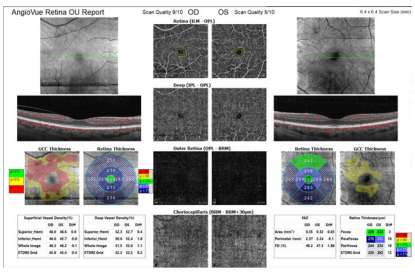
OCT-A

OCT-A showing asymmetry of the foveal avascular zone OD>OS



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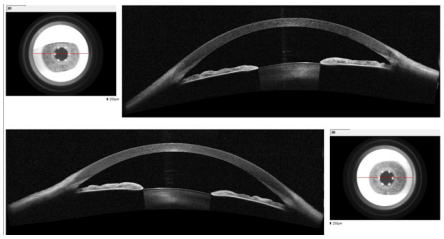
Additional Clinical Testing

OCT angle shows mildly narrow angle with lens vault



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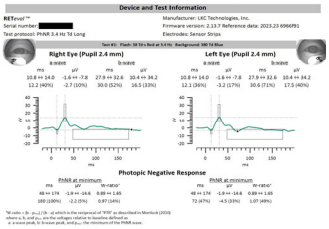
ERG

- I ordered an ERG to explore whether a functional deficit existed and whether it could be localized to the photoreceptor layer or ganglion cell layer.
- The ERG shows a reduced a-wave amplitude OD>OS indicating photoreceptor disruption, most likely secondary to diabetic and hypertensive retinopathy. The ERG also revealed an asymmetric and reduced PhNR implicit time and amplitude OD indicating ganglion cell/optic nerve dysfunction.



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Diagnosis/Treatment

- Hypertensive retinopathy
- Moderate non-proliferative diabetic retinopathy
- Primary open angle glaucoma OD, ocular hypertension OS
- Send for bilateral SLT
- I suspected glaucoma OD, but the structure/function discordance of OCT/visual field made this case a bit more challenging than if there was agreement of structure/function.
- The patient is awaiting SLT

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The Value of ERG

- I probably would have monitored this patient for 6 months to a year before seeing OCT structural progression and/or OCT/field concordance.
- The ERG helped me make the diagnosis earlier.
- Early diagnosis and early treatment leads to better patient outcomes.

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Key Takeaways

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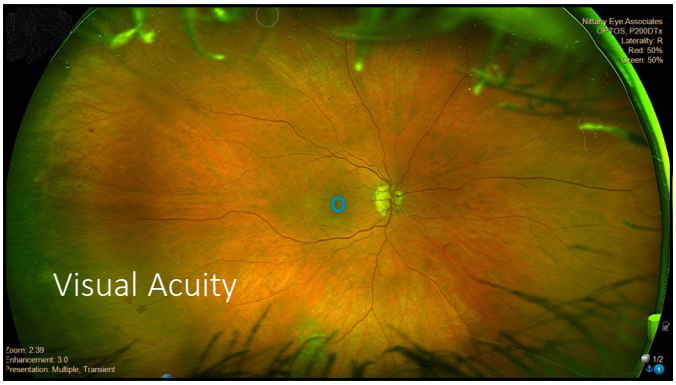

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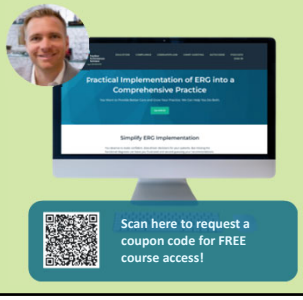
Take an ERG course by Dr. Chris Wolfe for FREE!

Learn (from an ERG user!) how to:

- Confidently implement ERG into your workflow
- Understand when and why to order ERG
- Bill correctly using CPT 92273 and applicable ICD-10 codes
- Estimate revenue potential and ROI
- Train your team
- Educate your patients

Request your coupon code at ***lkc.com/course-coupon***
Course available from Practice Performance Partners & EyeCode Education



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THANK YOU!

Questions?

Bobby "Chip" Wood, Jr., O.D.
bwood@visionsource.com

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