

The “Potential” for Electrodiagnosis in Glaucoma Diagnosis and Management

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- Disclosures
 - None
- Acknowledgement
 - Carolyn Majcher, OD made major contributions to the development of this course

Commercially available systems for office-based electrophysiologic evaluation

DIOPSYS NOVA-VEP
Office Based Visual Evoked Potential Testing

EvokeQ X
Visual Function Diagnostics

The Big Picture

Why perform electrophysiologic testing on glaucoma patients?

- Delivers objective functional data not offered by any other technology
- Clinically relevant information that can improve patient care
- Minimal disruption to normal patient flow
- Small investment in space and training
- Billable procedure

Electrophysiology

DIOPSYS NOVA-VEP/LX
Office Based Visual Evoked Potential Testing

OBJECTIVE STRUCTURE

OBJECTIVE & FUNCTIONAL

Visual Evoked Potential

An objective measure of visual function that assesses the electrical activity of the cerebral cortex while the subject views standardized visual stimuli

Types of VEP

- Pattern VEP ("conventional" VEP)
 - Checkerboards and gratings
 - Steady state vs transient
 - Transient: Pattern reversal rate < 3 Hz (slow)
- Flash VEP
 - Limited clinical use (low vision)
- Multifocal VEP (mfVEP)
 - Localized regions of the VF are tested & analyzed
- Short-duration transient VEP (SD-tVEP)

SD-tVEP

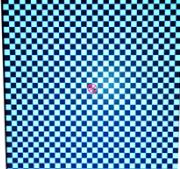
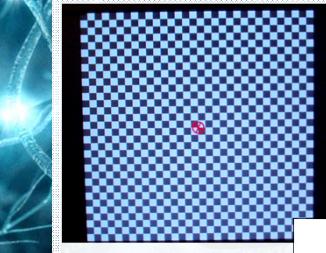
Short Duration, Transient VEP

- Short duration = Rapid test administration (~1 min)
- Modifications to shorten the exam time
 - More efficient signal acquisition technique
 - Automated signal processing (eg. VEP-Extractor™)

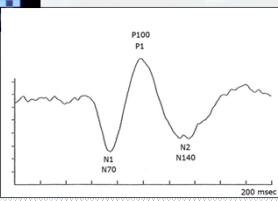


Diopsys NOVA-LX Fixed Protocol SD-tVEP

- Stimulus
 - 32x32 checkerboard pattern
 - 1 Hz (reversal every 0.5s)
 - Low Contrast (15%), High Contrast (85%)
- Fixed Protocol
 - "Warm-up" (8s)
 - Low Contrast (15s)
 - High Contrast (15s)
 - Repeat for fellow eye

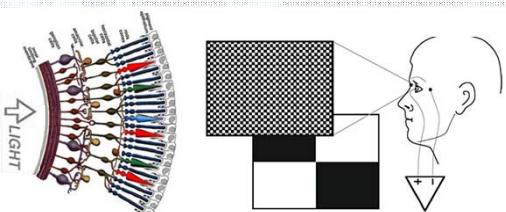



Diopsys NOVA-LX pattern VEP stimulus. Slow pattern reversal generates a transient VEP



Electroretinogram

- A non-invasive, **objective** measure of the **retinal electrical activity** in response to standardized visual stimuli



Types of ERG

- Pattern ERG (pERG)
 - Transient
 - Steady state
- Full-field flash ERG
- Multifocal ERG (mfERG)
- Photopic negative response (phNR)

Pattern ERG

- Assess ganglion cell function in the macula
- Contrast reversal checkerboard or grating
- Tests macular region
- Stimulus size 15°

Pattern ERG

Transient vs steady state pERG depends on the temporal frequency

| Reversal rate | pERG |
|---------------|------|
| 2/sec | |
| 4/sec | |
| 7/sec | |
| 10/sec | |
| 14/sec | |

Increasing stimulus frequency

Transient pERG

Steady State pERG

Pattern ERG

- Steady state pERG (SS-pERG)
 - Rapid stimulus reversal
 - Generates a **sinusoidal-like waveform**
 - Direct, objective measure of RGC function
 - Ideal for glaucoma assessment**

Diopsys® NOVA pERG

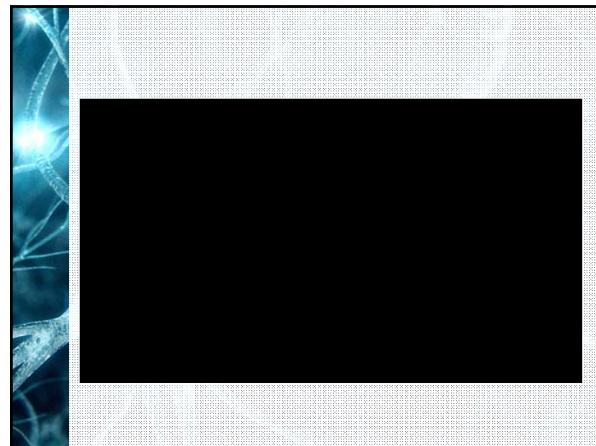
- Fixed protocol
 - Concentric Fields, **Contrast Sensitivity**
 - Steady state pERG
 - All test parameters are standardized
 - Normative database
 - Manual

DIOPSYS NOVA-ERG
OFFICE BASED PATTERN ELECTRORETINOGRAPHY TESTING

Diopsys NOVA-pERG Fixed Protocol Contrast Sensitivity

- Stimulus
 - 64 horizontal bar pattern
 - Reversing at 15 rps
 - High contrast (85%), low contrast (15%)
- Fixed Protocol
 - High contrast (85%) - 25s
 - Low contrast(15%) - 25s
 - Repeat for fellow eye



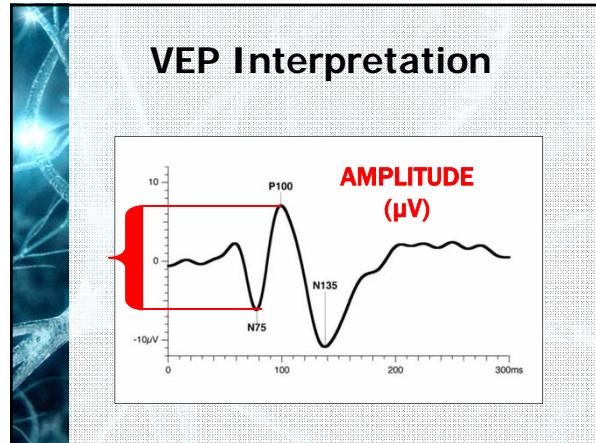
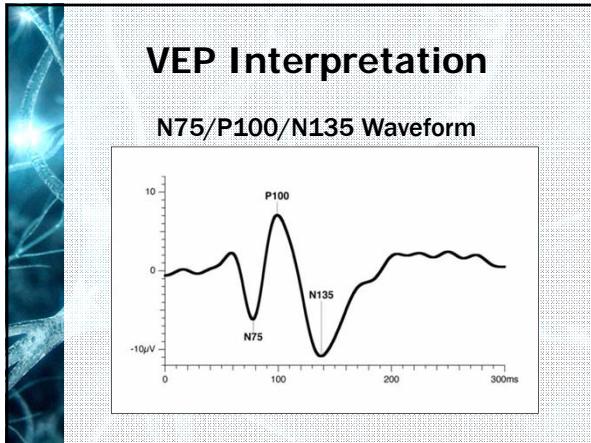


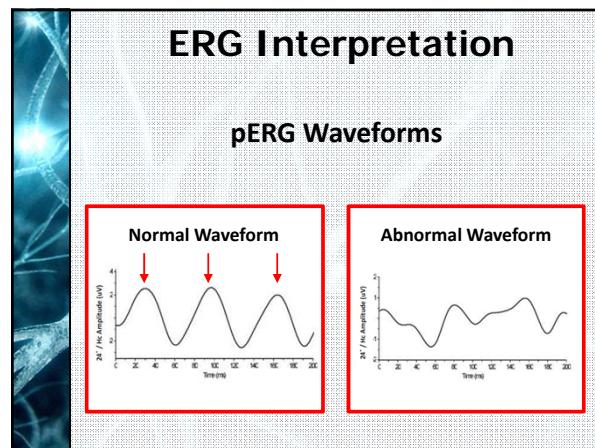
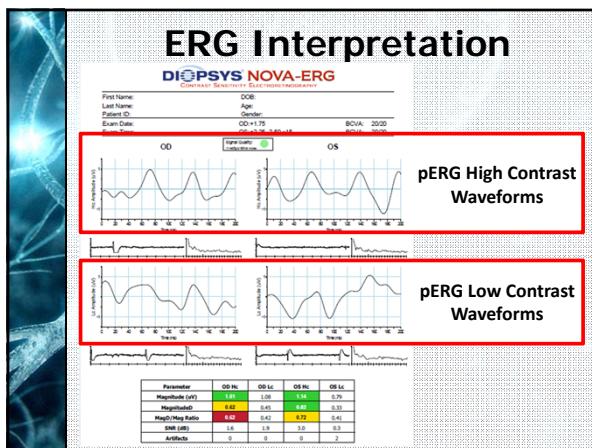
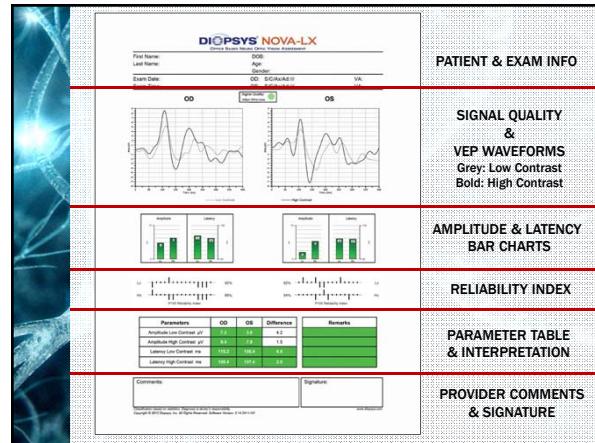
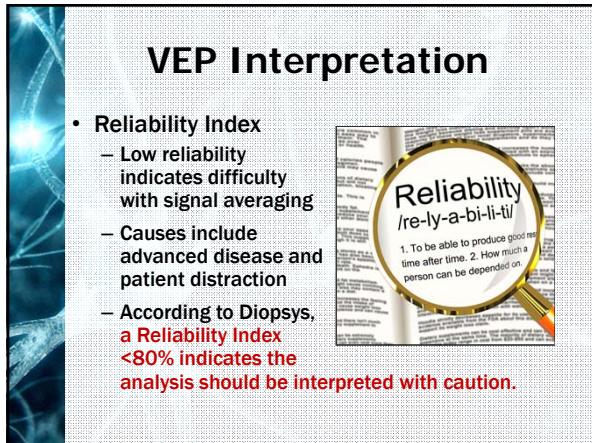
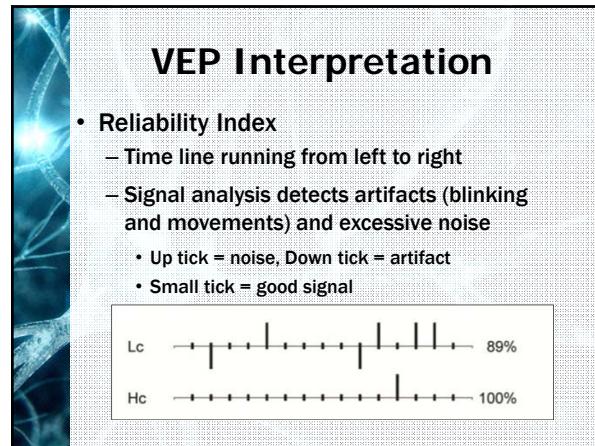
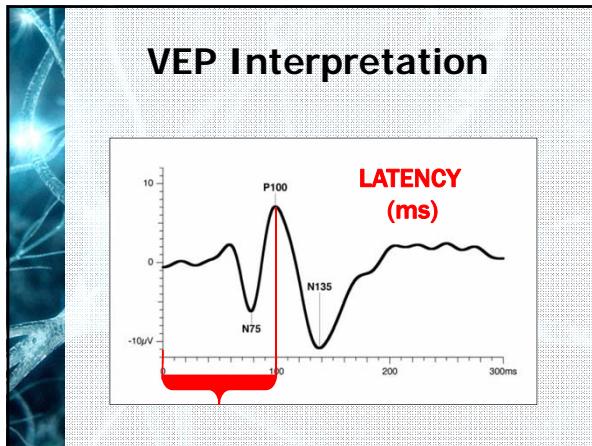
Diopsys NOVA Vision Testing System

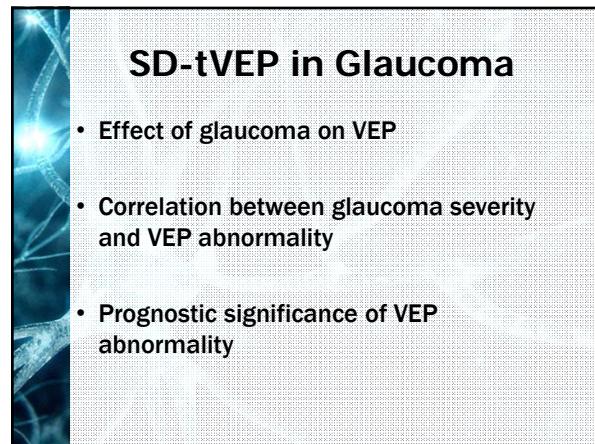
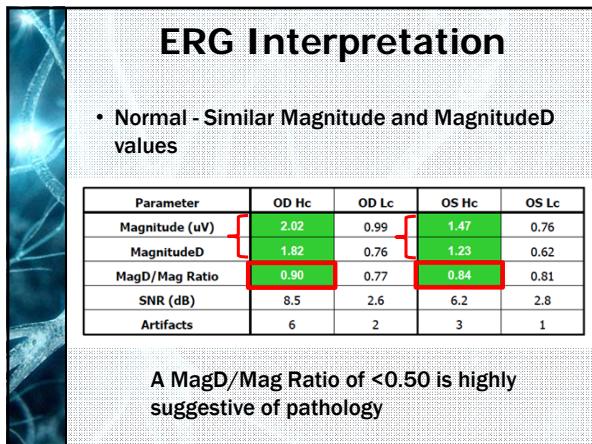
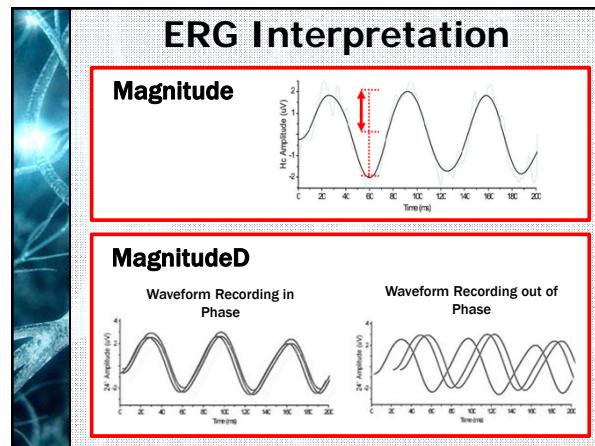
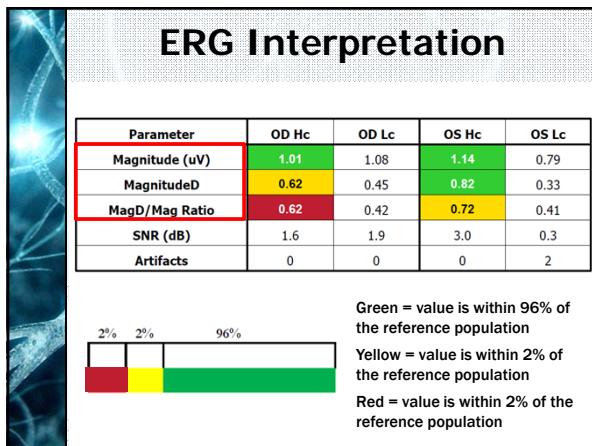
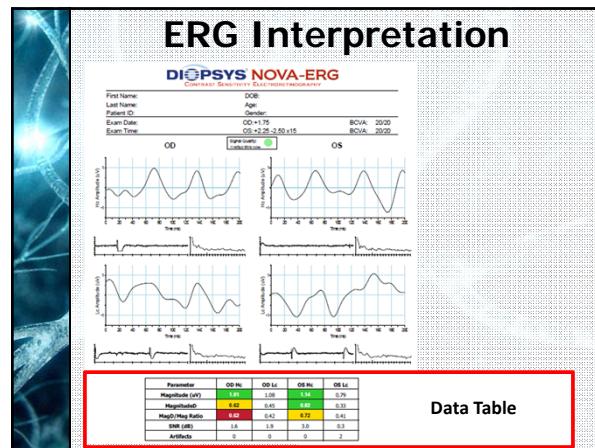
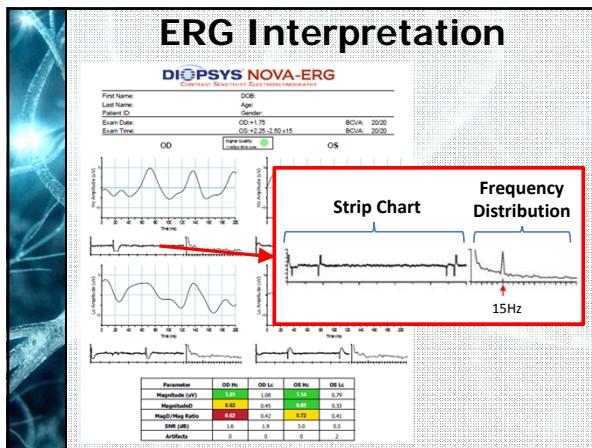
- Contraindication
 - Selze disorders**
 - Flickering stimulus has potential to trigger a seizure

Codes & Reimbursement

- VEP
 - CPT: 95930 (OU, \$130 Medicare allowable)
 - ICD-9: 377.14 – Cupping of the optic disc
 - ICD-10: H47.23X (1,2,3) Glaucomatous optic atrophy
- ERG
 - CPT: 92275 (OU, \$ 148 Medicare allowable)
 - ICD-9: 365 – Glaucoma
 - ICD-10: H40







VEP in Glaucoma

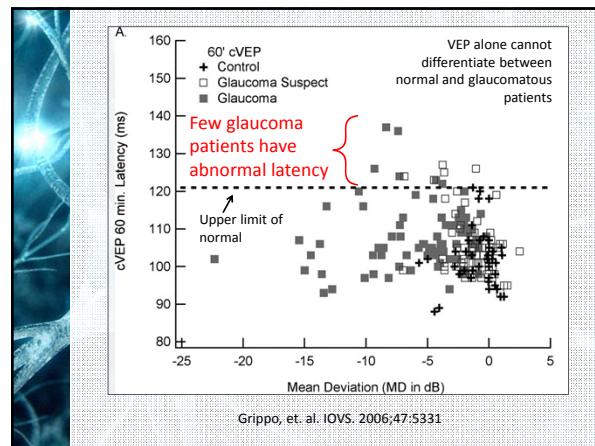
How is VEP latency affected by glaucoma?

A Comparison between Multifocal and Conventional VEP Latency Changes Secondary to Glaucomatous Damage

Tomas M. Grippo,¹ Donald C. Hood,^{2,5} Fabio N. Kanadani,¹ Isaac Ezon,¹ Vivienne C. Greenstein,^{3,4} Jeffrey M. Liebmann,^{4,5} and Robert Ritch^{1,6}

"Contrary to previous reports, prolonged VEP delays were present in a minority of patients with glaucoma."

Grippo, et. al. IOVS. 2006;47:5331



VEP in Glaucoma

Glaucoma

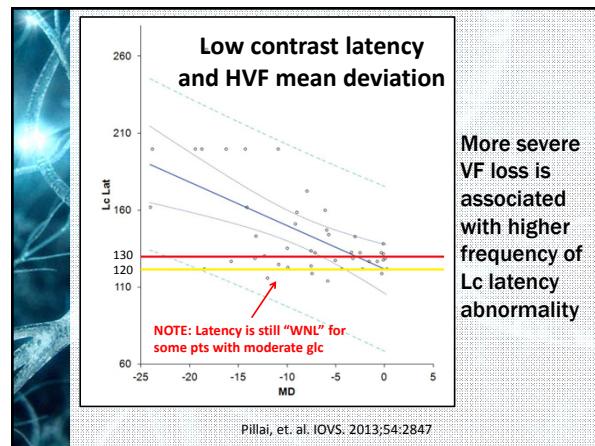
Sensitivity and Specificity of Short-Duration Transient Visual Evoked Potentials (SD-tVEP) in Discriminating Normal From Glaucomatous Eyes

Cinthi Pillai,¹ Robert Ritch,^{1,2} Peter Derr,³ Alberto Gonzalez,³ Laurie Kopko Cox,⁴ John Siegfried,⁵ Jeffrey M. Liebmann,^{1,6} and Celso Tello^{1,2}

"Low contrast latency showed the highest accuracy for discrimination..."
Sensitivity: 91.1%, Specificity: 93.3% PPV: 95.3%, NPV: 87.5%

"The fixed protocol may be beneficial as a singular test in the early detection or diagnosis of [glaucoma]."

Pillai, et. al. IOVS. 2013;54:2847



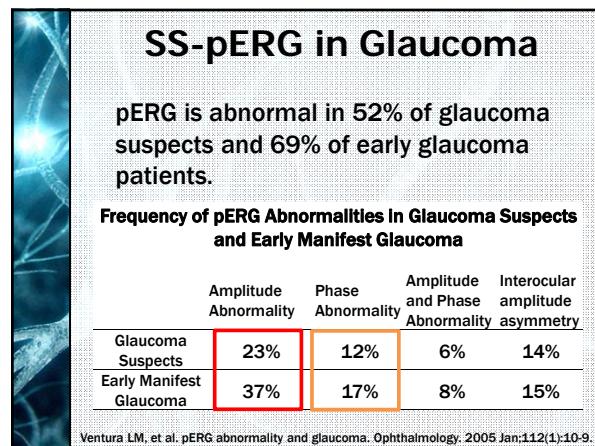
VEP in Glaucoma

Prognostic significance of VEP abnormality

- Does a single-visit VEP latency abnormality identify eyes with glaucoma that are more prone to progression?

| HVF Progression (dB/yr) | Latency Abnormal | Latency Normal |
|-------------------------|------------------|----------------|
| ≥0.7 | 21 (72.5%) | 8 (27.5%) |
| <0.7 | 29 (46.7%) | 33 (53.2%) |
| Mean | -0.87±0.3 | -0.32±0.4 |

Sponsel, et. al. Unpublished Data



pERG Clinical Applications

- 1. Early glaucoma detection and prediction of future VF/OCT NFL loss
- 2. Evaluate treatment efficacy

Earlier Detection of Glaucoma and Prediction of OCT Loss

- Banitt et al. 2013
 - Followed 201 glaucoma suspect eyes for at least 4 years with status OCT and SS-pERG
 - It took ~ 2 years to lose 10% of the initial pERG amplitude, whereas it took ~ 10 years to lose 10% of the initial NFL thickness
 - **The time lag between pERG amplitude and RNFL thickness to lose 10% of their initial values is about 8 years**

Banitt MR, et al. Progressive loss of RGC function precedes structural loss by several years in glaucoma suspects. *Invest Ophthalmol Vis Sci.* 2013 Mar;54(3):2346-52.

Prediction of VF Loss

- Bode et al. 2011
 - Evaluated pERG in 120 ocular OHT eyes followed for a mean of 10.3 years
 - **The pERG amplitude detected glaucoma 4 years before VF defects occurred**

Bode SF, et al. pERG in glaucoma suspects: new findings from a longitudinal study. *Invest Ophthalmol Vis Sci.* 2011 Jun;52(7):4300-6.

Evaluation of Treatment Efficacy

pERG Amplitudes Before and After IOP Reduction in Normal, Mild Glaucoma, and Severe Glaucoma Eyes

| Group | Before (μV) | After (μV) | P-value |
|---------------------------------|-------------|------------|---------|
| Normal Controls | ~1.1 | ~1.1 | |
| Glaucoma No or minor field loss | ~0.55 | ~0.65 | <0.01 |
| Glaucoma Severe field loss | ~0.4 | ~0.45 | |

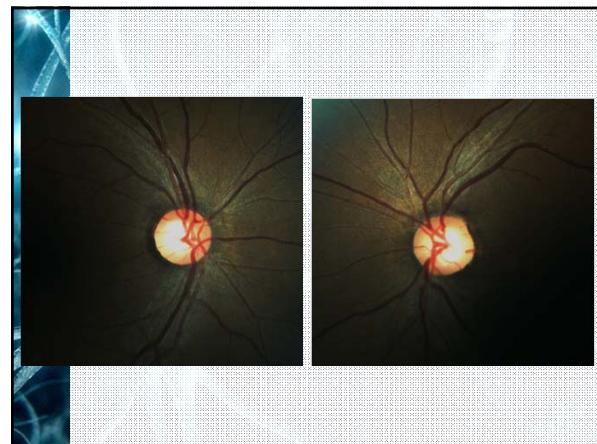
Ventura LM, et al. Restoration of RGC function in early glaucoma after intraocular pressure reduction: a pilot study. *Ophthalmology.* 2005 Jan;112(1):20-7.

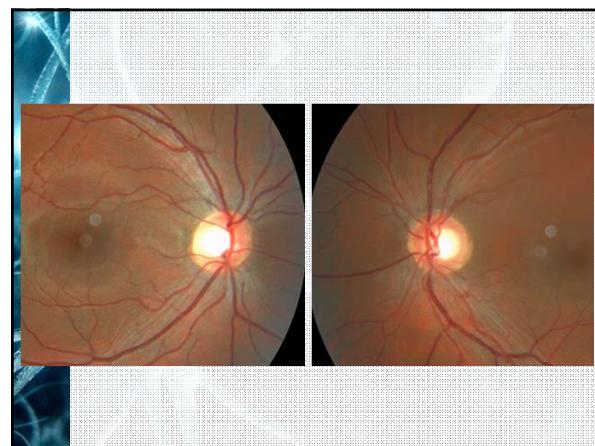
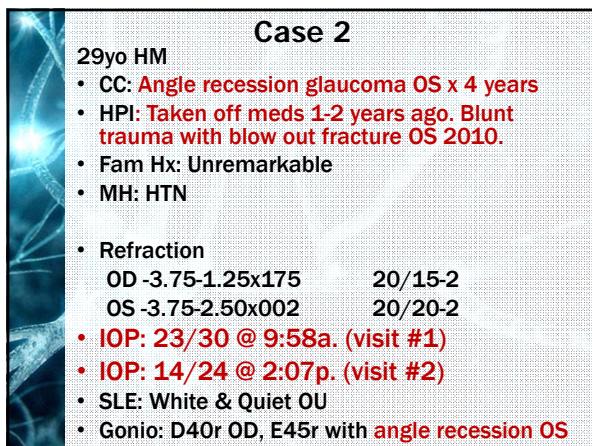
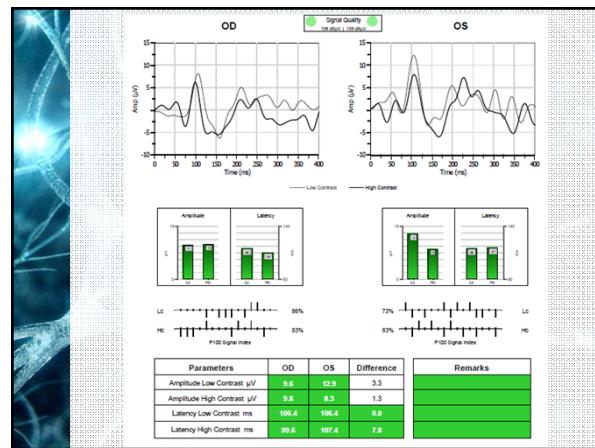
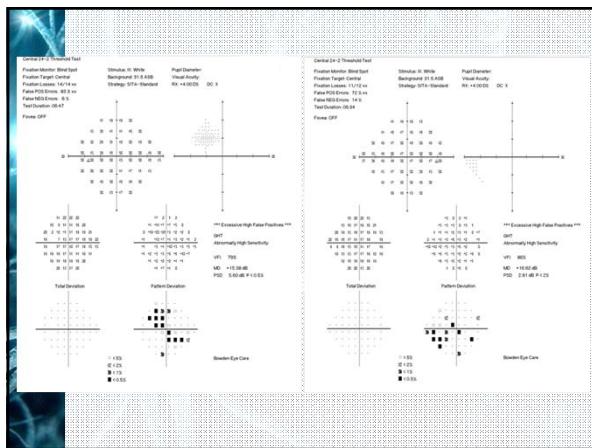
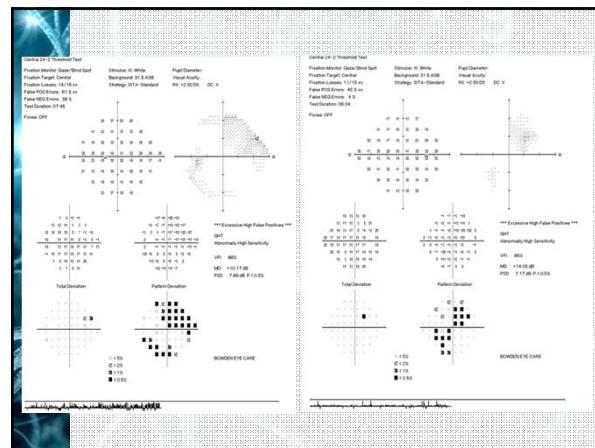
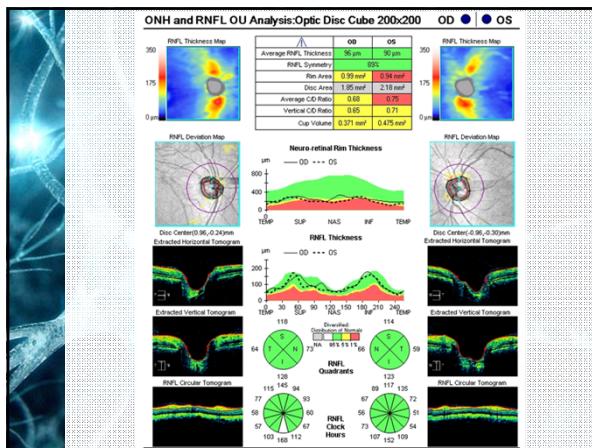
Case 1

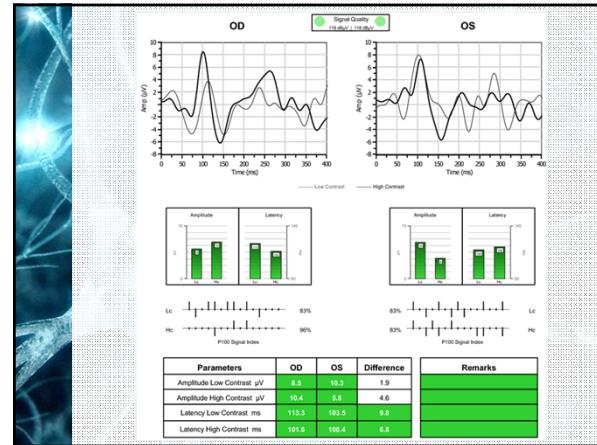
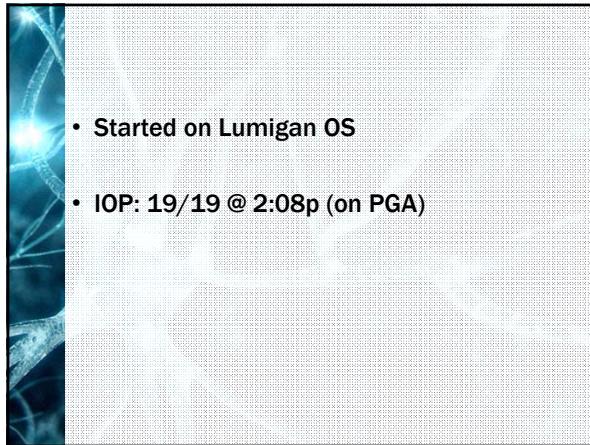
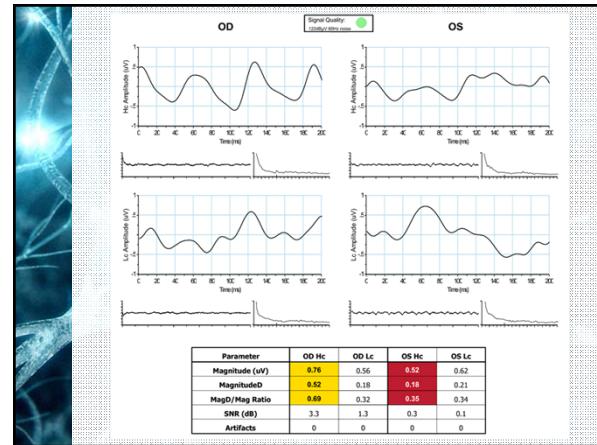
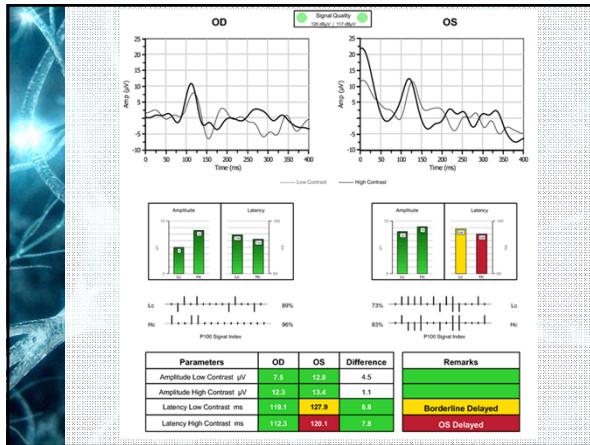
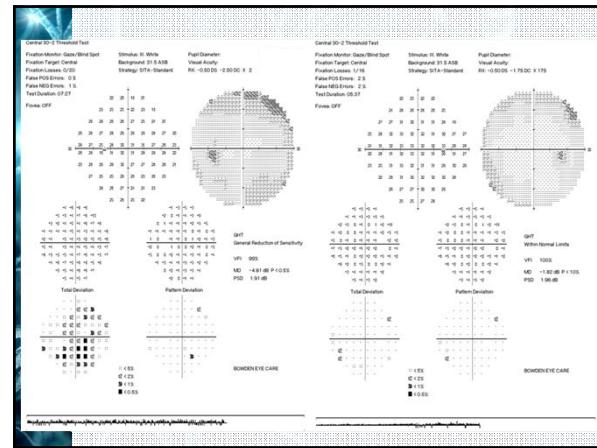
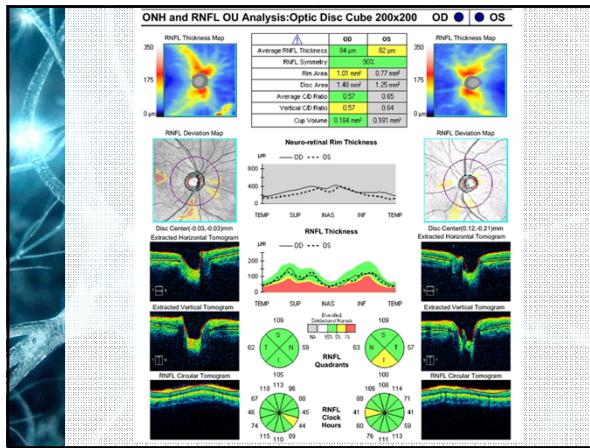
47yo HF

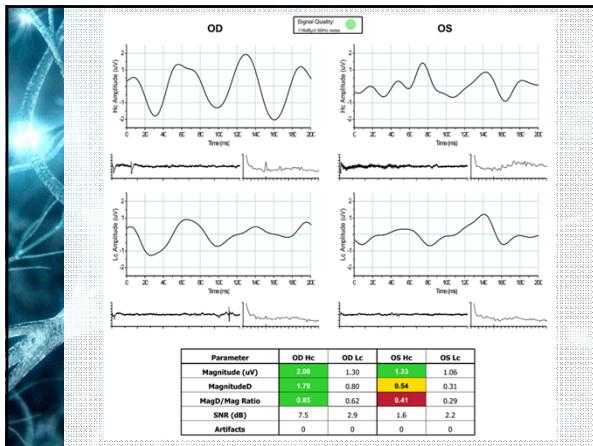
- CC: Referred to glaucoma clinic because of **large optic cups OU**
- Oc Hx: Unremarkable.
- Fam Hx: Non-contributory
- Med Hx: Good health
- Refraction:

| | |
|---------------|---------|
| – OD +0.50 DS | 20/20-1 |
| – OS Plano | 20/20-1 |
- **IOP: 16/16 @ 4:53p. (visit #1)**
- **IOP: 20/18 @ 4:50p (visit #2)**
- SLE: White & Quiet OU
- Gonio: D40r, 1+ pigment OU









"Potential" for Electrodiagnosis in Glaucoma Diagnosis and Management

- PRO
 - Objective measure of visual function
 - Potential prognostic value
 - Evaluate treatment efficacy
 - Rapid, simplified test administration
 - Comparison to healthy subject reference range
- CON
 - More research is needed to fully establish its role in glaucoma diagnosis and management

