

In office electrodiagnostics: what can it do for you

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Chief of Specialty Care Clinics
Chief of Electrodiagnostics Clinic

Course Outline/Objective

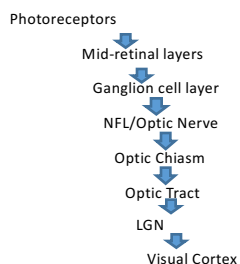
- What is electrodiagnostics testing?
- Visual Pathway – Basic Understanding
- VEP
- ERG
 - Full field flash
 - Pattern
 - mfERG
- EOG
- Clinical Cases

Visual Pathway

- Upstream



- Downstream



The Visual Evoked Potential (VEP) OBJECTIVELY measures the functionality of which structure?

- A. Photoreceptors
- B. RPE layer
- C. Ganglion cell layer
- D. Nerve fiber layer & optic nerve
- E. Entire visual pathway

Which of the following is an indication to perform a VEP?

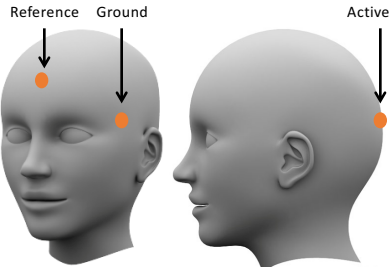
- A. Glaucoma
- B. Traumatic brain injury
- C. Optic neuritis
- D. Amblyopia
- E. Unexplained vision loss
- F. VF defect
- G. All of the above

Visually Evoked Potential (VEP)

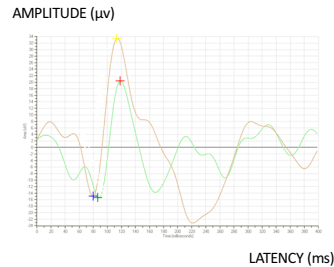
- AKA Visually Evoked Response (VER)
 - Flash vs. Pattern
- Measures the entire visual pathway
 - From cornea to occipital lobe
- 3 electrodes
 - Ground
 - Reference
 - Measuring -> occipital lobe
 - 1" aboveinion



VEP Electrodes



VEP



- Amplitude usually translates to the amount of axons conducting along the visual pathway
- Latency usually translates to the myelin status of the visual pathway

Why VEP?

- Many optic nerve diseases are asymptomatic because central vision is not affected until late in the disease¹
- Diagnosis and management of optic nerve disorders are often based on structural or subjective visual field tests²

VEP is an objective, functional test that can help discriminate between healthy and glaucomatous eyes²

1 Glaucoma. American Optometric Association. www.aoa.org
2 Prata, Tiago MD, G. De Moraes MD, J. Liebmann MD, R. R. R. R. C. Tello MD. (2009). Diagnostic Ability of Fast Transient Visual Evoked Potential for Glaucoma Assessment [Poster & Abstract] American Academy of Ophthalmology. 128

VEP and Glaucoma: Well Defined Science

The Visual Evoked Potential in Glaucoma and Ocular Hypertension: Effects of Check Size, Field Size, and Stimulation Rate

Invest Ophthalmol Vis Sci 24:175-183, 1983

The Visual Evoked Potential in Glaucoma and Ocular Hypertension: Effects of Check Size, Field Size, and Stimulation Rate

Version 1.0, 1983. © Anne M. Swadlow, Samuel S. Z. and Bernard Schwartz

In order to determine the optimal stimulation rate for the detection of glaucoma, the effects of check size, field size, and stimulation rate on the visual evoked potential (VEP) were studied. The VEP was recorded from 20 glaucoma patients, 20 ocular hypertensive patients, and 20 age-matched normal subjects. The check size was 1.5, 3, and 6 arc minutes (1.5, 3, and 6 arc minutes). The field size was 10, 20, and 30 degrees (10, 20, and 30 degrees). The stimulation rate was 1, 2, and 3 Hz (1, 2, and 3 Hz). The results showed that the VEP amplitude was significantly higher in the glaucoma patients than in the normal subjects for all check sizes, field sizes, and stimulation rates. The VEP amplitude was also significantly higher in the ocular hypertensive patients than in the normal subjects for all check sizes, field sizes, and stimulation rates.

The pattern visual evoked potential (VEP) has been shown to be sensitive to optic nerve lesions caused by demyelination, ischemia, and compression of the optic nerve. The VEP is a functional test that can help discriminate between healthy and glaucomatous eyes. The VEP is a functional test that can help discriminate between healthy and glaucomatous eyes. The VEP is a functional test that can help discriminate between healthy and glaucomatous eyes.

Materials and Methods
All subjects were free from ocular disease, had normal visual acuity of 20/20 or better in each eye, and normal visual fields. The 40 subjects were divided into three groups of 20 subjects each: 20 glaucoma patients, 20 ocular hypertensive patients, and 20 normal subjects. The glaucoma patients had a visual field defect of at least 30 degrees. The ocular hypertensive patients had a systolic blood pressure of at least 160 mm Hg. The normal subjects had no ocular disease and a normal visual field. The VEP was recorded from the occipital lobe of each subject. The VEP was recorded from the occipital lobe of each subject. The VEP was recorded from the occipital lobe of each subject.

“Increased pattern VEP latency was significantly correlated with both the severity and location of visual field defects and the degree of cupping and pallor of the optic disc.” The authors of this paper are world recognized electrophysiology specialist from New England Medical Center and University of Chicago

VEP IN GLAUCOMA AND OCULAR HYPERTENSION / Swadlow et al

Later observation can indicate the degree of glaucoma. The VEP is a functional test that can help discriminate between healthy and glaucomatous eyes. The VEP is a functional test that can help discriminate between healthy and glaucomatous eyes. The VEP is a functional test that can help discriminate between healthy and glaucomatous eyes.

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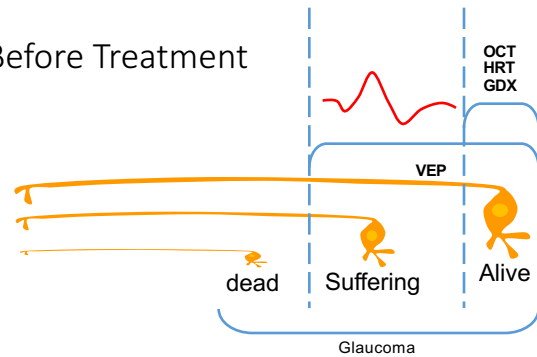
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“The finding that is of clinical importance is the presence of abnormally long VEP latencies in some patients with ocular hypertension. The abnormal prolongation of VEP latency in these eyes may reflect subclinical optic nerve lesions that have not been uncovered with other techniques.”

Additional Clinical Papers

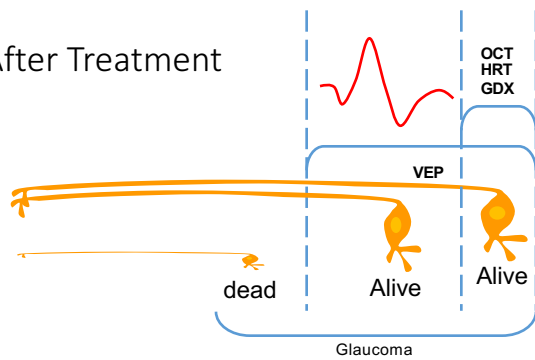
- **Repeatability of short-duration transient visual evoked potentials in normal subjects.** Tello C, De Moraes CG, Prata TS, Derr P, Patel J, Siegfried J, Liebmann JM, Ritch R. *Doc Ophthalmol.* 2010 Jun;120(3):219-28. Epub 2010 Jan 29.
- **Short Duration Transient Visual Evoked Potentials in Glaucomatous Eyes.** Prata TS, Lima VC, De Moraes CG, Trubnik V, Derr P, Liebmann JM, Ritch R, Tello C. *J Glaucoma.* 2011 May 10. [Epub ahead of print]
- **Short-duration transient visual evoked potential for objective measurement of refractive errors.** Anand A, De Moraes CG, Teng CC, Liebmann JM, Ritch R, Tello C. *Doc Ophthalmol.* 2011 Dec;123(3):141-7. Epub 2011 Sep 20.

Before Treatment



Effect of epigallocatechin-gallate on inner retinal function in ocular hypertension and glaucoma: a short-term study by pattern electroretinogram. *Graefes Arch Clin Exp Ophthalmol.* 2009 Sep;47(9):1223-33. Epub 2009 Mar 17.

After Treatment



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How the LX Protocol works

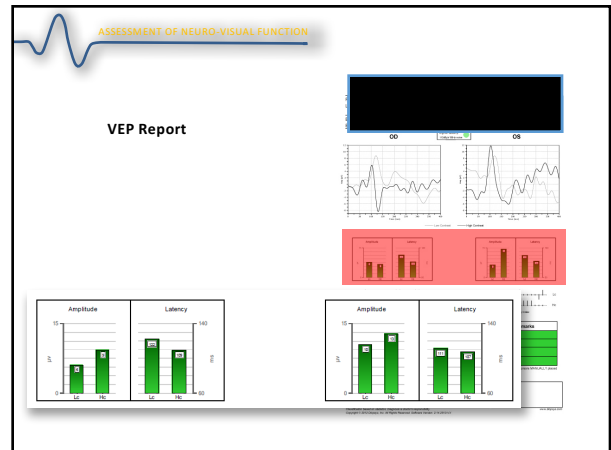
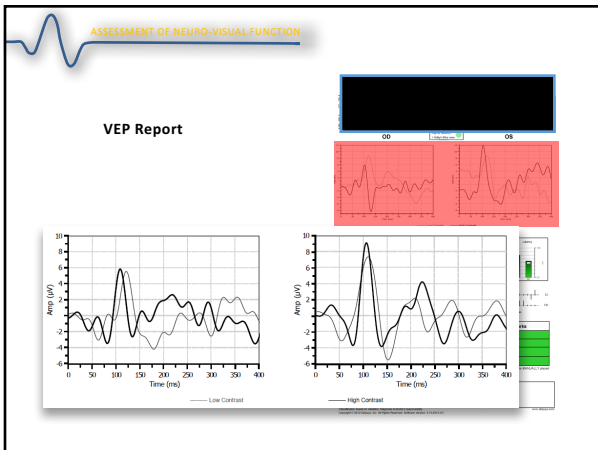
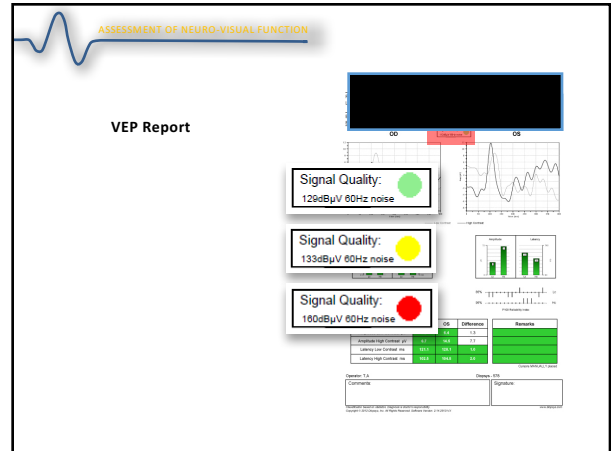
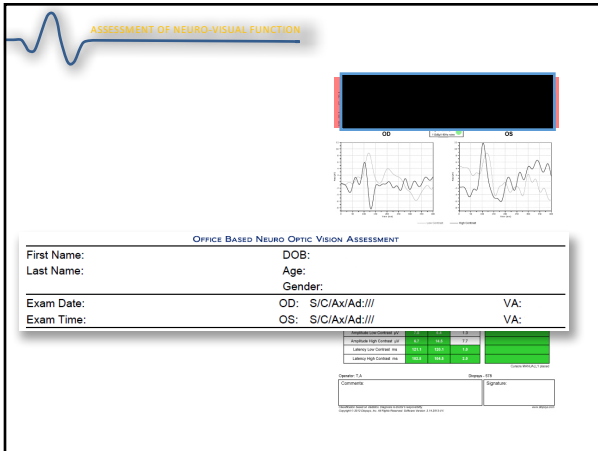
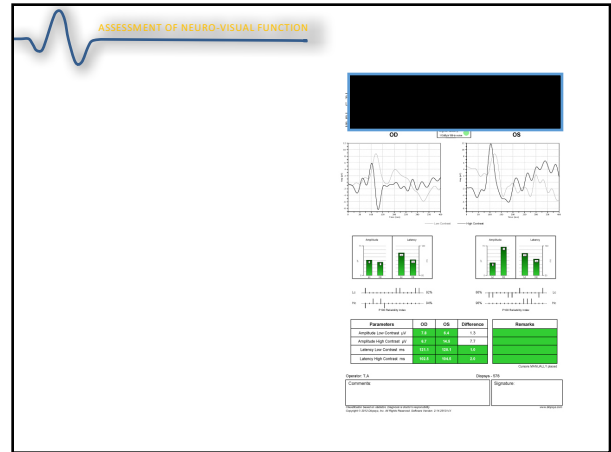
- Low contrast testing demonstrates degradation of magnocellular pathways
 - An early indication of glaucoma
- High contrast testing demonstrates degradation of parvocellular pathways
 - An early indicator of central vision loss and issues caused by problems before signal reaches optic nerve

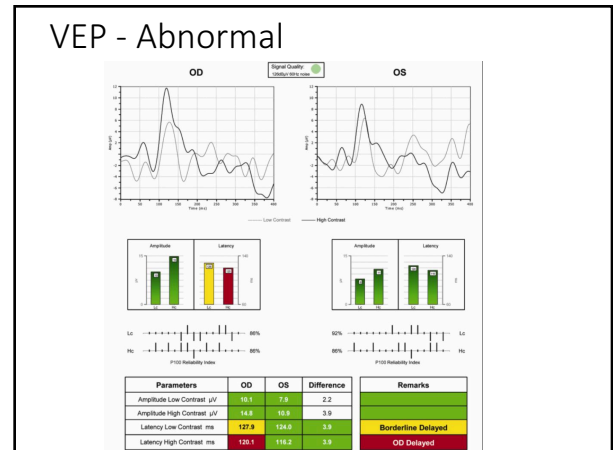
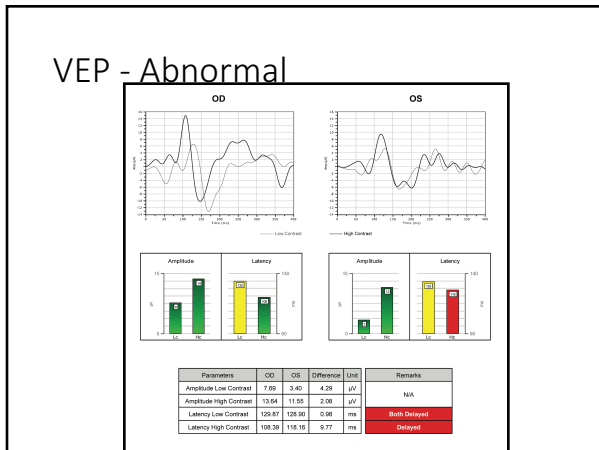
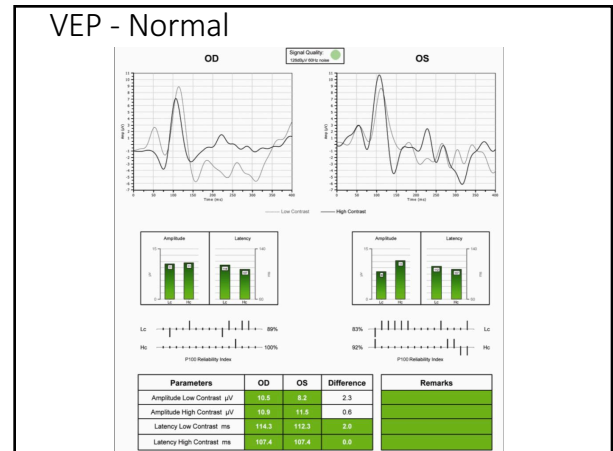
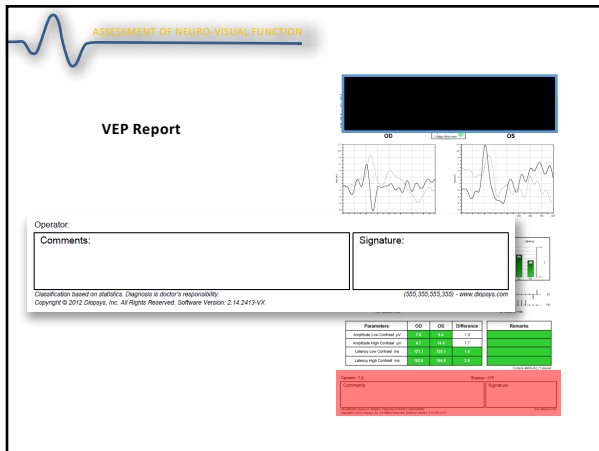
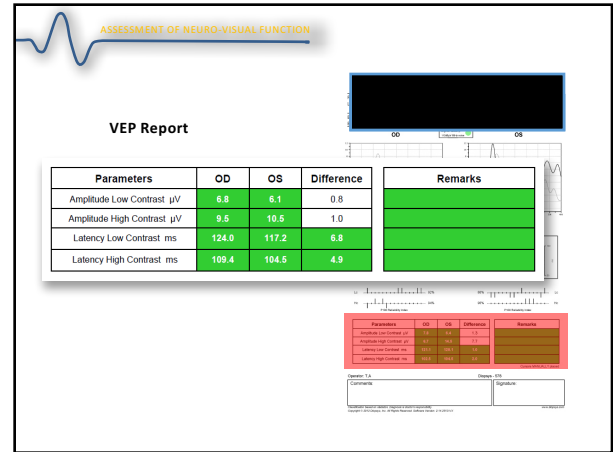
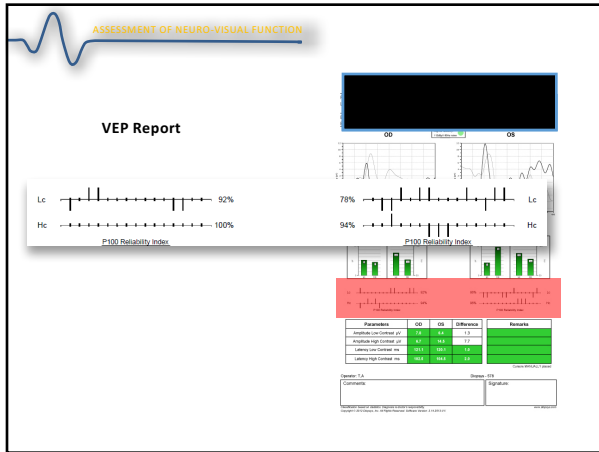
****patient should be tested with best corrected vision****

ASSESSMENT OF NEURO-VISUAL FUNCTION

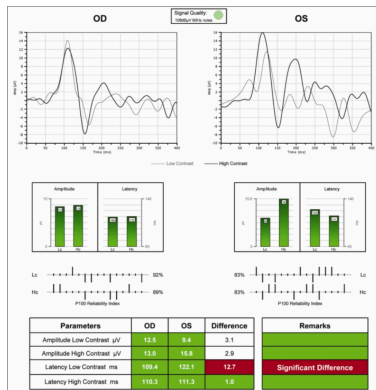
Main Indications

- Glaucoma
 - ***Glaucoma suspects***
- Multiple Sclerosis
- Ischemic Optic Neuropathy
- Traumatic Brain Injury
- Amblyopia
- Other Neuropathies
- Unexplained vision loss
- VF defect
- FDT





VEP abnormal - Asymmetry



Pattern ERG (pERG)

- ERG's are electrical signals that are a measure of the electrophysiological activity at the retina
 - ***Mid-retinal layers, ganglion cell layer, and nerve fiber layer***
- Objectively measures retinal function**
- ERG's can help improve sensitivity and specificity in diagnosing optic neuropathies and maculopathies like glaucoma and macular degeneration when used in conjunction with other tests
- Can also help the clinician differentiate between retinal and optic nerve disorders when used in conjunction with Visual Evoked Potential (VEP).

pERG Advanced Protocols

- Concentric Stimulus Fields
 - Drug toxicity
 - Diabetic macular edema
 - AMD
- Contrast Sensitivity
 - Glaucoma
 - Diabetic retinopathy

pERG

- Concentric Stimulus Fields
 - Stimulus delivered at 15 flips/second
 - BCVA
 - Pt should be properly refracted for 24"
 - 24" testing distance
 - 100% contrast
- Right eye (OD) then Left Eye (OS)
 - 25 seconds at 24 degrees
 - 25 seconds at 16 degrees



pERG

- Contrast Sensitivity
 - Stimulus delivered at 15 flips/second
 - BCVA
 - Pt should be properly refracted for 24"
 - 24" testing distance
 - 85% and 15%
- Right eye (OD) then Left Eye (OS)
 - 25 seconds at High Contrast (Hc)
 - 25 seconds at Low Contrast (Lc)



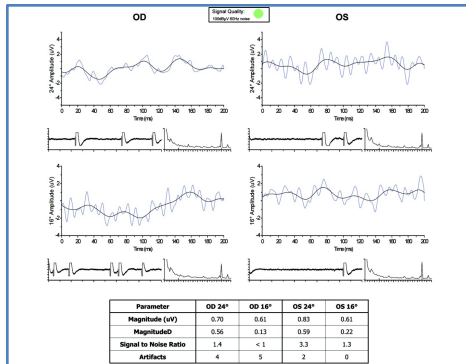
Per NIH and Bascom-Palmer:

"In patients who are glaucoma suspects, pERG signal anticipates an equivalent loss of OCT signal by several years (as many as 8 years).

Invest Ophthalmol Vis Sci. 2013;54:2346-2352
DOI:10.1167/iov.12-11026



Pattern ERG (pERG)



Normal PERG Response

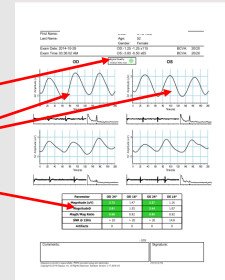
3 Quick Steps To Report Interpretation

Signal Quality – Look for a green signal

Sinusoidal Peaks – Look for 3 humps

Magnitude, MagnitudeD and MagD/Mag Ratio are colorized.

Green indicates within normal limits
Yellow indicates values are borderline
Red indicates outside normal limits



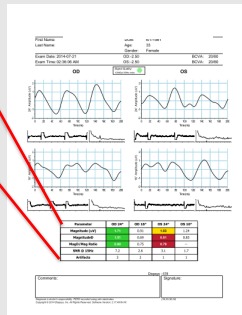
PERG Report – Data Table

Parameter	OD 24°	OD 16°	OS 24°	OS 16°
Magnitude (uV)	1.71	0.91	1.83	1.24
MagnitudeD	1.51	0.69	0.81	0.83
MagD/Mag Ratio	0.88	0.75	0.79	—
SNR @ 15Hz	7.2	2.6	3.1	1.7
Artifacts	3	2	1	1

Magnitude (uV) is defined as the strength of the patient's response at a reversal rate of 15 reversals per second.

Larger magnitudes are typically generated from normal eyes. Smaller magnitudes typically indicate pathology.

As the contrast level drops or the stimulus size decreases, the magnitude will typically decrease.



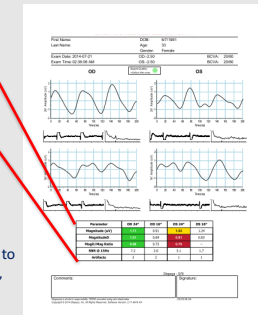
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MagnitudeD averages the signal within the 25 second test time and takes into account the magnitude strength and the phase variability throughout the test.

In a healthy patient, the phase response tends to be consistent throughout the test. In this case, MagD is close in value to Mag.

In a patient with disease, the phase response tends to be inconsistent throughout the test - MagD will be significantly reduced in comparison with Mag.

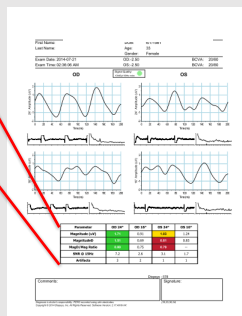


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Artifacts	3	2	1	1

MagD/Mag Ratio is the most repeatable measurement test-over-test. The closer the ratio is to 1.0, the lower the phase variability throughout the test, and the healthier the patient's response. Variability in phase may indicate pathology.

MagD/Mag ratio can be used to monitor patients over time.

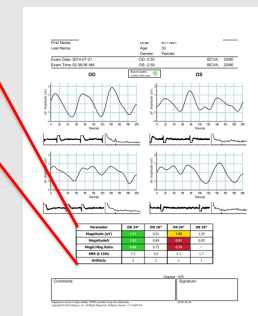


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SNR - Signal to Noise Ratio shows how strong the signal is at 15Hz compared to noise at 15Hz. Larger numbers indicate stronger PERG signals compared to the noise.

SNR values like 5, 15, >20 show strong PERG response. Numbers less than 2 are typical of a weak response.

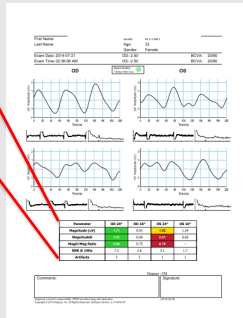


Data Table

Parameter	OD 24"	OD 16"	OS 24"	OS 16"
Magnitude (uV)	1.71	0.91	1.03	1.24
MagnitudeD	1.51	0.69	0.81	0.83
MagD/Mag Ratio	0.88	0.75	0.79	0.67
SNR @ 13Hz	7.2	2.6	3.1	1.7
Artifacts	3	2	1	1

Artifacts are caused by blinking or patient movement. They are detected and counted. A high number of artifacts will effect the amount of data that can be analyzed.

The goal is to have a low number of artifacts. We want the patient to be comfortable and blink when necessary, but not excessively. The goal is less than 10. If test results show Artifacts greater than 10, the test should be repeated.

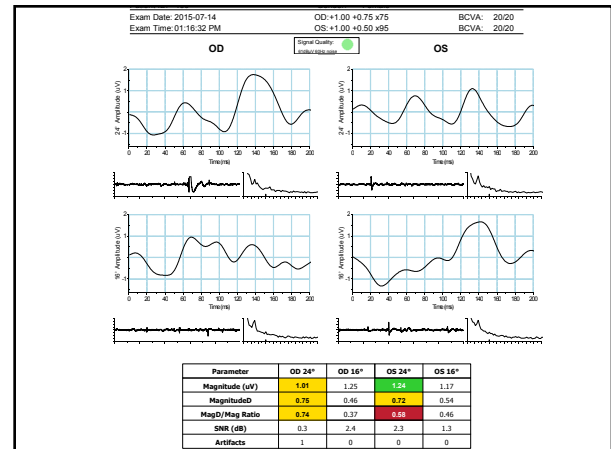
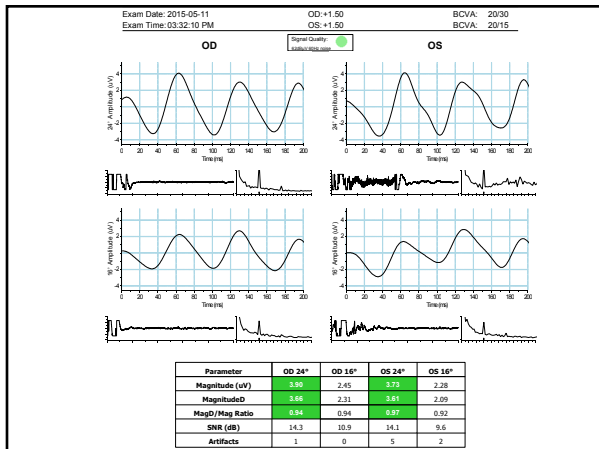
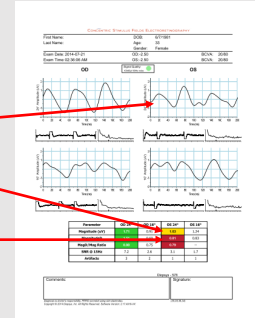


Abnormal PERG

Missing 3 humps

Yellow indicates values compared to normal are borderline

Red indicates values are outside normal limits



Applying to Your Practice

VEP

1. Glaucoma & glaucoma suspects
2. Unexplained vision loss
3. Transient vision loss
4. Unexplained VF defects
5. Unreliable VF
6. Optic neuropathies
7. Optic neuritis/MS
8. Amblyopia
9. TBI

PERG

1. Glaucoma & glaucoma suspects
2. Unexplained VF defects
3. Unreliable VF
4. Optic neuropathies
5. Maculopathies
 1. AMD
 2. Diabetic macular edema
 3. High risk med use (Plaquenil)
 4. Generalized DR

Flash ERG

1. RP & its variants
2. Cone dystrophies & Rod monochromat
3. Symptoms:
 - "Night blindness"
 - Restricted peripheral fields
 - Color vision deficits