IN-OFFICE ELECTRODIAGNOSTICS
FOR THE NON-GLAUCOMA
PATIENT: DM, AMD, ETC

Nate Lighthizer, O.D., F.A.A.O
Associate Professor, NSUOCO
Assistant Dean for Clinical Care Services
Director of CE
Chief of Specialty Care Clinics

Course Outline/Objective
- What is electrodiagnostics testing?
- Visual Pathway – Basic Understanding
- VEP
- pERG
- HERG
- mfERG
- Clinical Cases

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” above inion

VEP Electrodes

Why VEP?
- Many optic nerve diseases are asymptomatic because central vision is not affected until late in the disease
- Diagnosis and management of optic nerve disorders are often based on structural or subjective visual field tests
- VEP is an objective, functional test that can help discriminate between healthy and glaucomatous eyes

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

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

Why VEP?

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

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

Why VEP?

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

VEP is an objective, functional test that can help discriminate between healthy and glaucomatous eyes.
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 NEUROVISUAL FUNCTION

PARAMETERS

<table>
<thead>
<tr>
<th>Parameters</th>
<th>OD</th>
<th>OS</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity Low Contrast</td>
<td>5.5</td>
<td>6.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Sensitivity High Contrast</td>
<td>9.8</td>
<td>10.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Latency Low Contrast</td>
<td>124.4</td>
<td>117.2</td>
<td>7.2</td>
</tr>
<tr>
<td>Latency High Contrast</td>
<td>109.4</td>
<td>104.6</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Remarks

Operator: 

Counselor: 

Signature: 

VEP - Normal

VEP - Abnormal
VEP is an objective, functional test that can help discriminate between healthy and diseased eyes.

Indications:
- Glaucoma
- MS/Optic neuritis
- Optic neuropathies
- Unexplained vision loss
- Transient vision loss
- Visual field defects
- Amblyopia/Strabismus
- Traumatic brain injury

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).

**VEP - Summary**

**Pattern ERG (pERG)**

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

1. 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
2. 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)

---

### Detection of Glaucoma - Timeline

Healthy Cells

<table>
<thead>
<tr>
<th>% of cell loss</th>
<th>Sick but Viable</th>
<th>You Are Missing a Big Valuable Piece of the Puzzle!</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>VTG</td>
<td>pERG</td>
</tr>
<tr>
<td>100%</td>
<td>OCT VF</td>
<td>Disease</td>
</tr>
</tbody>
</table>

- ERG shown to detect glaucoma while cells are alive
- OCT shown before the disease
- pERG may be able to detect glaucoma slightly earlier
- OCT shown to detect cells before the disease
- VEP shown to detect 30% (5% to 57%) range
dead cell death to register peripheral vision loss
- OCT detects glaucoma approximately 2 to 3 years before VF with about 15% RNFL loss

---

### 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)."

DOI:10.1167/iovs.12-11026

---

### 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)."

DOI:10.1167/iovs.12-11026
pERG Indications

- Glaucoma
- Optic Neuropathies
- Maculopathies
  - AMD
  - Diabetic retinopathy
  - Diabetic macular edema
  - Macular toxicity

Review Article

Role of Electrophysiology in the Early Diagnosis and Follow-Up of Diabetic Retinopathy

Nicola Procopiulă,1 Andrea Barbuta,2 Alexia Stefanescu,2 and Giuseppe Ruoppolo2

1Department of Ophthalmology, University of Sassari, Sassari, Italy
2Department of Ophthalmology, University of Sassari, Sassari, Italy

Correspondence should be addressed to Andrea Barbuta; andreabarbuta@gmail.com

Received 19 December 2016; Accepted 1 April 2017

Academic Editor: Isacch F. Reis

Copyright © 2017 Nicola Procopiulă et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Diabetic retinopathy is a common and serious complication of diabetes, representing a leading cause of blindness among working-age people in developed countries. It is estimated that the number of people with diabetes worldwide will rise from 1.6 million in 2010 to 4.4 million by 2030. The pathology varies from mild non-proliferative diabetic retinopathy to severe proliferative diabetic retinopathy. The efficacy of early intervention is crucial to prevent visual loss and blindness.

RESEARCH

Beneficial effects of the nutritional supplements on the development of diabetic retinopathy

M. A. H. Manzur1,2, Q. Zhao,3 J. Liu,2 and D. L. Gau2

1Division of Ophthalmology, Department of Surgery, University of California, San Francisco, CA, USA
2Division of Ophthalmology, Department of Surgery, University of California, San Francisco, CA, USA
3Department of Ophthalmology, University of California, San Francisco, CA, USA

Open Access

Abstract

Purpose: Previous studies have reported beneficial effects of nutritional supplements on the development of diabetic retinopathy. In this study, we aimed to investigate the potential of antioxidant-enriched nutritional supplements (BeeCalm®) in preventing diabetic retinopathy.

Methods: In a randomized, controlled trial, 60 patients with type 2 diabetes were randomly assigned to either the intervention group (BeeCalm®) or the control group (placebo). Blood samples were collected at baseline and at 6 months to assess the levels of oxidized LDL, lipid peroxidation, and inflammatory markers.

Results: The intervention group showed a significant decrease in the levels of oxidized LDL and lipid peroxidation compared to the control group. Additionally, there was a reduction in the levels of inflammatory markers in the intervention group.

Conclusion: The results of this study suggest that BeeCalm®, an antioxidant-enriched nutritional supplement, may have a beneficial effect on the prevention of diabetic retinopathy.

Keywords: BeeCalm®, antioxidant-enriched nutritional supplement, diabetes, retinopathy
Magnitude D

Value as a Prognostic Indication of Progression of OHT to Glaucoma

Visual Field and FDT: 25-50% sensitivity

OCT: approximately 70%

PERG: 77%
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

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.

PERG Report – Data Table

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.

Data Table

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

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

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 tests 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

Flicker Electroretinogram (Flicker ERG)

- Retinal signal recorded at the lower lid in response to flash stimuli of high frequency

Full-field ERG (ffERG)

- Tests the outer retina
  - Photoreceptors (rod & cones)
  - Bipolar cells
- Test of overall retinal functioning
  - May not pick up small retinal issues
- Flash flicker stimulus
**Flicker ERG (ffERG)**

- Tests the outer retina
  - Photoreceptors (rod & cones)
  - Bipolar cells
- Test of overall retinal functioning
  - May not pick up small retinal issues
- Flash flicker stimulus

**ERG for Early Detection**

*Role of Electrophysiology in the Early Diagnosis and Follow-up of Diabetic Retinopathy*

Marta Procedilè,1 Andrea Barabas,1 Alicea Ferrante,2 and Giuseppe Brignacchi2

1Department of Ophthalmology, Sapienza University of Rome, Italy
2Department of Ophthalmology, University of Pisa, Italy

**ERG for Evaluating Retinal Dysfunction**

The Electroretinogram in Diabetic Retinopathy

R. Tintore, MD, PhD,1 and G. B. Aronson, MD, PhD, FRCS2

1Retina Foundation of the Southwest, Dallas, Texas, USA, and 2Center for Applied Vision Research, Department of Ophthalmology and Visual Sciences, Eye Institute, Johns Hopkins University, Baltimore, MD, USA

**Flicker ERG for Treatment Evaluation**

Peripheral retinal function assessed with 30-Hz flicker seems to improve after treatment with Lucentis in patients with diabetic macular oedema

Kristina Behn1, Markus Schwoerer2, and Michael Livschitz3

1Department of Ophthalmology, Saarland University Hospital, Homburg, Germany, 2Department of Ophthalmology, Max Planck Institute for Human Development, Berlin, Germany, and 3Department of Ophthalmology, Saarland University Hospital, Homburg, Germany

**ERG for Early Detection**

Review Article

Role of Electrophysiology in the Early Diagnosis and Follow-up of Diabetic Retinopathy

Marta Procedilè,1 Andrea Barabas,1 Alicea Ferrante,2 and Giuseppe Brignacchi2

1Department of Ophthalmology, Sapienza University of Rome, Italy
2Department of Ophthalmology, University of Pisa, Italy

**ERG for Evaluating Retinal Dysfunction**

The Electroretinogram in Diabetic Retinopathy

R. Tintore, MD, PhD,1 and G. B. Aronson, MD, PhD, FRCS2

1Retina Foundation of the Southwest, Dallas, Texas, USA, and 2Center for Applied Vision Research, Department of Ophthalmology and Visual Sciences, Eye Institute, Johns Hopkins University, Baltimore, MD, USA

**Flicker ERG for Treatment Evaluation**

Peripheral retinal function assessed with 30-Hz flicker seems to improve after treatment with Lucentis in patients with diabetic macular oedema

Kristina Behn1, Markus Schwoerer2, and Michael Livschitz3

1Department of Ophthalmology, Saarland University Hospital, Homburg, Germany, 2Department of Ophthalmology, Max Planck Institute for Human Development, Berlin, Germany, and 3Department of Ophthalmology, Saarland University Hospital, Homburg, Germany
Flicker ERG Reproducibility

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ICC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude</td>
<td>0.93</td>
</tr>
<tr>
<td>Phase</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Wills Eye Hospital, ARVO 2016

ERG vs FA: Predictive value of Vascularization

FA: 52%
ERG: 94%

Flicker ERG Reproducibility

Flicker ERG is a good predictor of ischemia
Flicker ERG can be used to evaluate DR
Flicker ERG can be used to monitor patients and evaluate referrals
ffERG Testing

Flicker ERG Report

Magnitude is the cone/bipolar signal strength
Phase is the timing of the cone/bipolar response
Magnitude and Phase Variance represent the consistency of the strength and speed of the signal respectively

Flicker ERG Report

Magnitude area is the cone/bipolar combined signal strength of the 6 luminance levels
Phase area is the cone/bipolar combined signal timing of the 6 luminance levels

Macular Function Evaluation in Eyes Without Cataracts

Macular Function Evaluation in Eyes With Cataracts


ISCEV* Recommend using ERG for the evaluation of retinal function in patients with media opacities.

*International Society of Clinical Electrophysiology of Vision

iscev.org/standards/proceduresguide.html

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
6. AMD
7. Diabetic macular edema
8. High risk med use (Plaquenil)
9. Generalized DR

**FFERG**
1. DM & retinopathy
2. RP & its variants
3. Cone dystrophies & Rod monochromat
4. Symptoms:
   - "Night blindness"
   - Restrict peripheral fields
   - Unexplained VF defects
   - Unexplained decreased vision
5. To get an idea of retinal functioning in a pt with media opacity

IN-OFFICE ELECTRODIAGNOSTICS FOR THE NON-GLAUCOMA PATIENT: DM, AMD, ETC

Nate Lighthizer, O.D., F.A.A.O
Associate Professor, NSUCO
Assistant Dean for Clinical Care Services
Director of CE
Chief of Specialty Care Clinics