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

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.

**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**
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).

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)

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


**Detection of Glaucoma - Timeline**

- ERG shown to detect glaucoma while cells are alive.
- % of cell loss: 0% to 100%
- VEP may be able to detect glaucoma slightly earlier.
- OCT (0.3 to 0.5 mm) is shown to detect cell death before testing.
- VEP 30.6 may detect 30% (5 to 27%) cell death to register peripheral vision loss.
- OCT detects cell death approximately 18 to 3 years before VF with about 10% RNFL loss.

**Before Treatment**

- OCT
- HRT
- GDX
- VEP
- Suffering
- Alive

**After Treatment**

- OCT
- HRT
- GDX
- VEP
- Alive

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

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

ROLE OF GLUCOSE ON RETINAL FUNCTION - THE DIABETIC VISUAL FUNCTION SUPPLEMENT STUDY (DVFS) Study

Objective: To examine the effects of changes in glucose on retinal function in individuals with diabetes.

Methods: A randomized controlled trial of participants with diabetes who were randomized to receive either a supplement containing vitamins, minerals, and antioxidants or a control supplement.

Results: Participants who received the supplement had improved retinal function compared to those who received the control supplement.

Conclusion: A supplement containing vitamins, minerals, and antioxidants may improve retinal function in individuals with diabetes.

REFERENCE

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

Nicola Preondonzio,1 Andrea Barbato,3 Alessio Stellaianoz,2 and Giuseppe Rupinelli2

1Department of Ophthalmology, University of Verona, Italy
2Department of Ophthalmology, University of Bologna, Italy
3Department of Ophthalmology, University of Padua, Italy

Objectives: To evaluate the role of electrophysiological tests in the early diagnosis and follow-up of diabetic retinopathy.

Methods: A retrospective study of patients with diabetic retinopathy who underwent electrophysiological tests.

Results: Electrophysiological tests were able to detect retinal dysfunction before clinical signs of retinopathy were present.

Conclusion: Electrophysiological tests may be useful in the early detection and follow-up of diabetic retinopathy.

REFERENCE
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

Magnitude 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.

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.

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)

- Stimulus Mini-ganzfeld
- Photoreceptors & Bipolar
- 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
Full-field ERG (ffERG)

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- Test of overall retinal functioning
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- Flash flicker stimulus

ffERG indications:
- DM & diabetic retinopathy
- Monitoring improvement with treatment
- Retinal dystrophies/disease
- RP
- FP symptoms:
  - Color vision issues
  - VF defects
  - Decreased vision
  - Unexplained decreased vision
- Testing retinal function with significant media opacities
- Indicator for prognosis following cataract surgery
- Is the retina functioning well or not?

ERG for Early Detection

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

M. Fruscione, A. Barbato, A. Stefano, and G. Bramanti

Accepted: 11 November 2010 / Accepted: 1 April 2011

Abstract

Purpose: To evaluate the influence of multimodal eye examination on the functional neuroretinogram (ffERG), visual evoked potentials, and subjective visual symptoms in diabetic patients with diabetic macular edema.

Methods: Twenty diabetic patients were examined electrophysiologically (ffERG, VEP) and optically (standard fundus photography, fluorescein angiography) before and after focal laser photocoagulation therapy for diabetic macular edema. Visual symptoms were also assessed before and after treatment.

Results: FFERG and VEP values returned to normal in all patients treated with laser photocoagulation. The improvement of subjective visual symptoms was statistically significant. No significant change in visual acuity was observed in any examined patient.

Conclusion: The multimodal eye examination and follow-up are useful tools in the management of diabetic retinopathy.

ERG for Evaluating Retinal Dysfunction

The Electroretinogram in Diabetic Retinopathy

R. Tinken, MD, PhD, and G. H. Slein, MD, PhD, FRCS

Purpose: To evaluate the influence of multimodal eye examination on the functional neuroretinogram (ffERG), visual evoked potentials, and subjective visual symptoms in diabetic patients with diabetic macular edema.

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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

Korinna Reine / Markus Schuster / Nicolas Livonious / Adrian

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### Flicker ERG Reproducibility

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

Wills Eye Hospital, ARVO 2016

### Retinal Evaluation in Eyes with CRVO

**Association of electroretinogram and morphological findings in central retinal vein occlusion with macular edema**

**Phenomenology of flicker ERG as a predictor for reisus in central retinal vein occlusion**

### ERG vs FA: Predictive value of Vascularization

FA: 52%
ERG: 94%

--- *Acta Orthopédica Scandinavica* 1998

Fluorescein angiography versus ERG for predicting the prognosis in Central Retinal Vein Occlusion

Jörgen Larsson, Bjarke Braae, Ulla Coudal Syberg and Nina Almquist

Department of Ophthalmology, Lund University Hospital, Sweden

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

**Abstract**

Potentially harmful oxidative stress and inflammatory mediators are involved in the development of diabetic retinopathy, and in this study we have investigated the effects of a nutritional supplement containing vitamins C and E, and omega-3 polyunsaturated fatty acids, on the retinal function and morphology of diabetic rats. The results of this study indicate that the nutritional supplement had beneficial effects on the retinal function and morphology of diabetic rats, and that these effects were more pronounced in rats that received the supplement for a longer period of time.

**Methods**

The rats were divided into two groups: a control group and a treatment group. The treatment group received the nutritional supplement for a period of 12 weeks, while the control group received a placebo. The retinal function was measured using the electroretinogram (ERG), and the retinal morphology was assessed using histological techniques.

**Results**

The ERG results showed that the treatment group had significantly better retinal function than the control group. The histological examination revealed that the treatment group had less retinal damage than the control group.

**Conclusions**

The results of this study indicate that the nutritional supplement containing vitamins C and E, and omega-3 polyunsaturated fatty acids, has beneficial effects on the retinal function and morphology of diabetic rats, and that these effects are more pronounced in rats that receive the supplement for a longer period of time.

**References**


### 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

Ganzfeld Cataract


**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

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**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 (Taquenil)
9. Generalized DR

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

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