Office-Based Electrophysiology for Early Detection and Management

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THREE RIVERS CASINO
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Financial Disclosures:

• Consultant for Diopsys®.

• I am solely responsible for course content

• Consultant for Bausch and Lomb Pharmaceutical, Valeant®

• Previous Consultant for Johnson and Johnson Vision Care®

• Past AOA President
What do you think of when you think of electrophysiology?
PREVIOUS LIMITATIONS

- Test time was approximately 45 minutes
- Required highly trained operators
- Limited to large research institutions
- Interpretation was exceedingly complex requiring trained neurophysiologists
CURRENT CONDITIONS

• Actual test time is considerably shorter
• Simplified staff training
• Easy to use, intuitive software
• Comfortable for the patient, convenient for doctor and staff
Innovations: New Technologies

- What technologies do you have in your practice?
- Visual Field?
- Pachymeter?
- Fundus Digital Imaging including Optomap?
- OCT?
- Slit lamp Imaging?
- B-Scan?
- VEP/ERG Instrumentation?
Visual Electrophysiology: Visual Evoked Potential (VEP) and Electroretinography (ERG)

- Electrophysiology objectively measures strength and speed of the visual signal to the brain (VEP) or retina (ERG).
Dueling Dichotomies

- Structure vs. Function
- Subjective vs. Objective
Structure vs. Function

**STRUCTURE**
- Fundus Photo

**FUNCTION**
- Visual Field
- OCT
- ERG/VEP

**SUBJECTIVE**

**OBJECTIVE**
Early Detection

Asymptomatic

Healthy

Non structural damage documented

OHT

PERG/VEP

Symptomatic

OCT

VF

Glaucoma

Documented structural damage

Technical Standards

• International Society of Electrophysiology for Vision (ISCEV)

Standards, Recommendations and Guidelines for VISUAL ELECTRODIAGNOSTICS
Clinical Applications of Electrophysiology in Ophthalmology

ISCEV Indications

• Inherited retinal dystrophies
• Vascular diseases including diabetes
• Opaque media or trauma
• Retro bulbar neuritis
• Unexplained visual loss
• Infant with questionable vision
• Toxic and nutritional eye disease
• Glaucoma
• Suspected intracranial lesion
ISCEV Standards: VEP

• “Visual evoked potentials (VEPs) can provide important diagnostic information regarding the functional integrity of the visual system.”
ISCEV Standards: Pattern ERG

• “Since the PERG (in contrast to the flash ERG) is a local response from the area covered by the retinal stimulus image, it can be used as a sensitive indicator of dysfunction within the macular region and it reflects the integrity of the optics, photoreceptors, bipolar cells and retinal ganglion cells.”
ISCEV Standards: Full Field (Flash) ERG

• “The full-field electroretinogram (ERG) is a widely used electrophysiologic test of retinal function.”

• Especially important for patients w/opaque media
Clinical Application

• Both ERG and VEP are based on varying
  1. Check or line size,
  2. Contrast, and
  3. Speed of reversal pattern

• ERG – Retinal function
• VEP – integrity of the visual pathway
Pattern vs. Flash ERG

• Electrical signals that are a measure of the electrophysiological activity at the retina.

• Pattern ERG (PERG)
  ◦ Pattern stimulation
  ◦ Measures function of ganglion cells

• Full Field ERG (ffERG) – also known as Flash ERG
  ◦ Flash stimulation
  ◦ Measures function of photoreceptors
PERG Waveform (Steady State)

“At higher temporal frequencies, that is, above 10 rps (5 Hz), the successive waveforms overlap and a ““steady-state”’ PERG is evoked.”

• Time (latency) is measured in milliseconds (ms) along the horizontal (x) axis

• Amplitude is measured in microvolts (uV) along the vertical (y) axis

• A healthy response should present as equally spaced sinusoidal-like peaks
PERG Applications

• Detection and management of early disease states:
  ◦ Glaucoma
  ◦ AMD
  ◦ Plaquenil
  ◦ DME
  ◦ DR
ffERG Applications

- Evaluation of retinal function in patients with media opacities
- Treatment tracking and disease management
- Manage patient expectations for IOL procedures
Electrophysiology Of Vision

ERG
Electroretinogram

pERG
Inner retinal layers

fERG
Outer retinal layers
Repeatability of Flash Electroretinogram and Steady-State Pattern Electroretinogram using a novel office-based testing platform in normal subjects.

ARVO 2016
Arthur F. Resende, MD; Michael Waisbourd, MD; Alberto Gonzalez, PhD; Lisa A. Hark, PhD, Anand V. Mantravadi, MD; L. Jay Katz, MD

**Purpose:** The purpose of this study was to investigate the test-retest repeatability of two novel office-based electrophysiology platforms: flash electroretinogram (fERG) and steady-state pattern electroretinogram (ssPERG) in normal subjects.

**Conclusion:** Test-retest repeatability of ssPERG (P-ERG) and fERG (flicker and white flash) using a novel office-based testing platform ranged between good to excellent for all tested parameters.
Flash ERG

Flash Stimulation
Macular Function Evaluation in Eyes With 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)

[Link: iscev.org/standards/proceduresguide.html]
Healthy

Dysfunction

**Full Field Electroretinography**

**Fixed Luminance Flicker**

**First Name:**

**Last Name:**

**DOB:**

**Age:**

**Gender:**

**Exam Date:**

**Exam Time:**

**OD:**

**OS:**

**Signal Quality:**

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<td>Artifacts (%)</td>
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**Comments:**

**Signature:**

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**First Name:**

**Last Name:**

**DOB:**

**Age:**

**Gender:**

**Exam Date:**

**Exam Time:**

**OD:**

**OS:**

**Signal Quality:**

<table>
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**Comments:**

**Signature:**
Where Medical Necessity and Coverage Meet

VEP CPT 95930

• For subclinical optic nerve concerns (beneath the surface of clinical detection)
  • H47.23 (glaucomatous optic atrophy)
  • Other H47 including optic nerve drusen
  • H53 amblyopias
• Systemic or Traumatic manifestations that affect vision
  • H53 (visual disturbances) or other signs and symptoms or concerns from
    • Neurological, TBI, Infectious, Infiltrative, Degenerative causing diplopia and visual field defects
  • S06 codes involving concussion and brain injuries

Utilize when only when medically necessary and with Interpretation and Report
Where Medical Necessity and Coverage Meet

ERG CPT 92275
• For subclinical retinal concerns (beneath the surface of clinical detection)
  • H40.00-H40.069 Glaucoma suspects
  • H47 (optic nerve/pathway disorders)
  • H40.10X0-H40.9 Confirmed glaucoma (mild to moderate stage)
  • H30-H36 Retina (Diabetic Retinopathy), Maculopathy (AMD) and toxicity concerns

Utilize when only when medically necessary and with Interpretation and Report
Can Both VEP and ERG be performed on the same day?

• Both tests seen used to locate dysfunction – is it retinal (ERG) or retrobulbar (VEP) - optic nerve to visual cortex?

• Always requires documentation of medical necessity and impact on care

• May be performed same day as other tests, NO Correct Coding Initiatives

• Select the most appropriate ICD for the chief reason for the test(s)
VEP Basics

• **Visual Evoked Potential (VEP)**
  ◦ **Visual** – patient observes a visual stimulus
  ◦ **Evoked** – generates electrical energy at the retina
  ◦ **Potential** – measure the electrical activity in the visual cortex.

• Objectively measure the function of the entire vision system; no verbal response or “button pushing” required
VEP: Amplitude

• Measured in microvolts (μV)

• Delta measurement from N75 to P100 (NOT FROM ZERO)

• Typical conditions that may cause a decreased amplitude
  ◦ AMD,
  ◦ cataracts,
  ◦ corneal opacities,
  ◦ refractive error, etc.

Fig. 2 A normal pattern-reversal VEP
VEP: Latency

• Measured in milliseconds

• Shows where the P100 falls in time

• Typical Conditions that may cause a delay in latency
  ◦ Glaucoma,
  ◦ optic neuritis,
  ◦ Traumatic Brain Injuries, etc.

Fig. 2 A normal pattern-reversal VEP
Clinical Application using both VEP and ERG

VEP and ERG for location of dysfunction

• Clinically, PERGs can be used in patients with abnormal pattern VEPs to establish if a central retinal disorder is present to differentiate between retinal and optic nerve dysfunction as a cause for the VEP abnormality.

• P-ERG can be used to detect and monitor dysfunction of retinal ganglion cells caused by conditions such as glaucoma, optic neuropathies.

• Thus, the PERG has clinical value in both neurological and ophthalmic practice.
Current Acceptance in Optometry

• National Board of Examiners in Optometry
  ◦ Visual Pathway section on Gross Electrical Potentials (ERG and VEP)

• American Optometric Association: Clinical Practice Guidelines (CPG):
  ◦ Care of the Patient with Visual Impairment
  ◦ Optometric Care of the Patient with Acquired Brain Injury
  ◦ Care of the Patient with Learning Related Vision Problems
  ◦ Pediatric Eye And Vision Examination
  ◦ Care of the Patient with Amblyopia
Electrophysiological Test Uses

- Results from other tests are borderline for diagnosis.
  - (Do I treat or not?)

- Symptoms are inconsistent with other tests

- Results from other tests contradict each other

- Patient cannot perform standard tests or the results are unreliable

- Monitor disease progression and/or treatment efficacy.
  - (Do I change treatment)
Impact on Care

• **Timing** – Get in front of progressive vision loss
  ◦ (change to follow timing &/or frequency)

• **Consults** – Know what you need to treat or not
  ◦ (confirms ocular condition verses consultation/ co-management)

• **Additional Tests** – Based on findings, yes or no?
  ◦ (e.g. ERG after an abnormal VEP to locate dysfunction)

• **Counseling** – Insight for discussion of risk and treatment compliance

• **Treatment** – Require change?
  ◦ (Validates existing treatment plan or need to change due to disease progression.)
“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
Glaucoma Detection

Short Wavelength Automated Perimetry, Frequency Doubling Technology Perimetry, and Pattern Electroretinography for Prediction of Progressive Glaucomatous Standard Visual Field Defects

Andreas U. Beyer, MD,1,2 Carl Erb, MD3

Pattern ERG as an Early Glaucoma Indicator in Ocular Hypertension: A Long-Term, Prospective Study

Michael Bach,1 Anke S. Unsoeld,1 Hetko Philippin,1 Flemming Staabach,1 Philip Mater,1 Hans S. Walter,2 Thomas G. Bomer,2 and Jens Funk1

Clinical Ability of Pattern Electroretinograms and Visual Evoked Potentials in Detecting Visual Dysfunction in Ocular Hypertension and Glaucoma

Vincenzo Parisi, MD,1 Stefano Miglior, MD,2 Gianluca Manni, MD,1,2 Marco Centofanti, MD,1,2 Massimo G. Bucci, MD3

Head-down Posture Induces PERG Alterations in Early Glaucoma

Lori M. Ventura, MD, Iuri Golubev, MD, William Lee, Izuru Nose, Jean-Marie Parel, PhD, William J. Feuer, MS, and Vittorio Porciatti, DSc

The Relationship between Retinal Ganglion Cell Function and Retinal Nerve Fiber Thickness in Early Glaucoma

Lori M. Ventura, Nancy Sorokac, Roosevelt De Los Santos, William J. Feuer, and Vittorio Porciatti
From the Bascom Palmer Eye Institute, University of Miami Miller School of Medicine, Miami, Florida.

Pattern Electroretinogram in Glaucoma Suspects: New Findings from a Longitudinal Study

Sebastian F. N. Bode,1 Thomas Jeble,2 and Michael Bach1
Ganglion Cell Function Recovery

EFFECTS OF NICERGOLINE ON THE RETINAL AND CORTICAL ELECTROPHYSIOLOGICAL RESPONSES IN GLAUCOMA PATIENTS: A PRELIMINARY OPEN STUDY

VINCENTO PARISI, GASPAR COLACINO, GIOVANNI MILAZZO, ANNA CLAUDIA SCUDERI, and GIANLUCA MANNI


Restoration of Retinal Ganglion Cell Function in Early Glaucoma after Intraocular Pressure Reduction:
A Pilot Study

Lori M. Ventura, MD and Vittorio Porciatti, DSc

DOI 10.1007/s00417-009-1064-z

GLAUCOMA

Effect of epigallocatechin-gallate on inner retinal function in ocular hypertension and glaucoma: A short-term study by pattern electroretinogram

Benedetto Falsini · Dario Marangoni · Tommaso Salgarello · Giovanna Siffano · Lucrezia Montrone · Salvatore Di Landro · Laura Guccione · Emilio Balestrazzi · Alberto Colotto

Electrophysiological assessment of glaucomatous visual dysfunction during treatment with cytidine-5’-diphosphocholine (citicoline): a study of 8 years of follow-up

Vincenzo Parisi

DOI 10.1007/s10633-008-9143-8

CASE REPORT

Reversible dysfunction of retinal ganglion cells in non-secreting pituitary tumors

Lori M. Ventura · Frank X. Venzara III · Vittorio Porciatti

Glaucoma

Progressive Loss of Retinal Ganglion Cell Function Is Hindered with IOP-Lowering Treatment in Early Glaucoma

Lori M. Ventura, William J. Feuer, and Vittorio Porciatti
Macular Function

Pattern Electoretinography in Age-Related Macular Degeneration

Arsham Sheybani, MD; Milam A. Brantley Jr, MD, PhD; Rajendra S. Apte, MD, PhD

The changes of pattern electoretinography at the early stage of photodynamic therapy

Ayse Oner, Serper Karakucuk, Ertugrul Mirza, and Kudret Elibol

Department of Ophthalmology, Erciyes University Medical Faculty, Kayseri, Turkey

Pattern electoretinographic results after photodynamic therapy alone and photodynamic therapy in combination with intravitreal bevacizumab for choroidal neovascularization in age-related macular degeneration

Ayse Oner · Koray Gumus · Hatrice Arda · Yudum Yuce · Serper Karakucuk · Ertugrul Mirza

Pattern electoretinogram changes after intravitreal bevacizumab injection for diabetic macular edema


The PERG in diabetic glaucoma suspects with no evidence of retinopathy

LM Ventura, MD, I Golubev, MD, W Feuer, MS, and Porciatti V, DSc

Bascom Palmer Eye Institute, University of Miami Miller School of Medicine, Miami, Florida
A comparison of pattern and multifocal electoretinography in the evaluation of age-related macular degeneration and its treatment with photodynamic therapy

Magella M. Neveu · Adnan Tufail · Jonathan G. Dowler · Graham E. Holder

Macular Function after PDT in Myopic Maculopathy: Psychophysical and Electrophysiological Evaluation

Monica Varano,1 Vincenzo Parisi,1 Massimiliano Tedeschi,1 Marta Sciamanna,1 Geltrude Gallinaro,1 Nicoletta Capaldo,1 Susanna Catalano,2 and Antonella Pascarella1

Pattern electroretinographic results after photodynamic therapy alone and photodynamic therapy in combination with intravitreal bevacizumab for choroidal neovascularization in age-related macular degeneration

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Abdullah Ozkiriş
Documentation for the Professional Component

• Interpretation and Report
  ◦ Patient Name
  ◦ Reason for Service
  ◦ Test Result
  ◦ Impression and diagnosis
    ◦ Better, worse, stable
  ◦ Impact on Care
  ◦ Signature and Date
Summary of Clinical Value

1. Clinical, Professional and Scientific acceptance
2. Subclinical disorders below level of detection
3. Equivocal diagnoses and patient testing limitations
4. Location to differentiate retinal from other retrobulbar dysfunction for appropriate treatment or referral
5. Progression of diseases that affect visual function for timely intervention; diagnose, stage, treat, monitor efficacy of care plan
Summary of Practice Value

1. Availability for office use
2. Covered for clinical indications seen in eye care
3. User friendly
4. Patient friendly
   A. Easy to take
   B. No dilation
   C. Non-invasive
5. Added reason for practice referrals
6. Affordable - good ROI
Case Reviews
Questions

How and where do you schedule electrophysiology testing in the practice? With other tests? Or on a different day?
Questions

• How long did it take for your staff to become proficient in testing patients?
Conclusions: Clinical

• Electrophysiology using both VEP and ERG can give important clinical data that practitioners can use is both diagnosis and treatment

• There is an increasing large body of evidence based research that supports clinically appropriate use

• This objective, functional office based technology can be easily utilized by practicing ODs

• Staff training and patient education are important considerations in technology adoption as well as manufacturer support
Conclusions: Reimbursement

• Reimbursement is available when medically necessary and with appropriate interpretation and report

• Do not consider electrophysiology in a patient self-pay screening format or in a “convert to third party payer when diagnosis is discovered” type scheme. This is totally inappropriate.

• Utilize the services of instrument manufacturers for support and assistance with reimbursement issues.
Thank you!

• Feel free to email any questions or comments

• drbrooks@advanced2020.com

• Or text me at 201-317-4021