PRIMARY CARE ELECTRODIAGNOSTICS

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DISCLOSURES

• Affiliated with Transitions Optical as a consultant for professional development
• Non-executive board member of Optos, Plc based in Scotland
• Consultant to Diopsys, Inc.
• Administrator for Vision Source in Illinois

BIOGRAPHY

• Principal in 2 practices in Galesburg, and Galva, IL
• Past-President of the American Optometric Association
• Optometric contractor to Illinois Department of Corrections
• ICO Class of 1984
• Fellow, American Academy of Optometry
• Doctor of Science in Optometry – ICO 2009
• Diplomate – American Board of Optometry - 2011
ISCEV

International Society for Clinical Electrophysiology of Vision

http://www.iscev.org/

Mission

To promote and extend the knowledge of clinical electrophysiology of vision.

To promote co-operation and communication among workers in the field of clinical and basic electrophysiology of vision.

http://www.iscev.org/

ISCEV

Standards, Recommendations and Guidelines

VISUAL ELECTRODIAGNOSTICS A Guide To Procedures

Confirmation of Neurological or Ophthalmological Disease
Unexplained Visual Loss
Pediatric Neurology
Opacities in Media
Monitoring Health - Toxicity
Detection of the Disease or Carrier States of Inherited Visual Disorders
Quantitative Assessment of Visual Disease
Assessment of Retinal and Optic Nerve Function Following Trauma
Infants with questionable vision

http://www.iscev.org/standards/proceduresguide.html

http://www.iscev.org/
Electrophysiology

- Electrocardiogram
- Electromyography
- Auditory Evoked Potential
- Electroencephalogram

VISUAL EVOKED POTENTIAL (VEP)

- Electric signal registered at the occipital region in response to a visual stimulus.
- VEP
  - Visual – patient observes a visual stimulus
  - Evoked – generates electrical energy at the retina
  - Potential – measure the electrical activity in the visual cortex
  - Measure the function of the entire vision system; no patient response required – OBJECTIVE TEST

Previous Limitations

- Test time was approximately 45 minutes
- Required highly trained operators
- Required highly trained interpretation (subjective)
- Limited to large research institutions
Advantages of Current Technology

- Test time is approximately 1 minute
- Does not require highly trained operators
- Does not require highly trained interpretation (subjective)
- Currently installed in about 700 offices (one company), 2 or three other companies - limited

VEP Electrodes

- Reference
- Ground
- Active

VEP Stimulus

- Flash
- Pattern
  - Reversal
  - Pattern-onset
  - Transient
  - Steady State
VEP Stimulus

- Pattern
  - Contrast Sensitivity
  - Visual Acuity
  - Color

VEP Components

N75
P100
N135
VEP

**AMPLITUDE**

Microvolts (µv)

1 Volt = 1,000,000 Microvolts

**LATENCY**

Milliseconds (ms)

1 second = 1,000 milliseconds

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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.

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Other Electrophysiological Tests

- Electroretinogram (ERG)
- Multifocal Electroretinogram (mERG)
- Pattern Electroretinogram (pERG)
- Electrooculogram (EOG)
- Multifocal Visual Evoked Potential (mVEP)
OPTIONS FOR CUSTOMIZED VEP TESTING

- User-Defined Protocol
  - LKC
  - Diagnosys
  - Diopsys NOVA-TR
- Customize testing parameters specific to each patient and pathology
  - Pattern Type & Size, Contrast level, Eye
- Testing times are flexible and depend upon the customized settings

EXAMPLE:
2 DIFFERENT SPATIAL FREQUENCIES

16 X 16

64 X 64

RESPONSE TO TREATMENT EXAMPLE

OU with Lens

OU without Lens
MULTIPLE SCLEROSIS EXAMPLE

Expected P100 timing

Actual P100 timing

MS – PATIENT - DG

• Multi-Contrast Stimuli
  • LKC Requires User to Create Fixed
  • Diopsys® NOVA-LX

• Easy to follow fixed protocol guides the technician through the test procedure.

• Testing time takes 38-53 seconds per eye on Diopsys, or about 5 minutes total – about 1/3 of LKC

ABILITY TO USE FIXED PROTOCOLS
"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 specialists from New England Medical Center and University of Chicago.

"Glaucoma has also been reported to affect the VEP by causing both reductions in amplitude and increases in latency."
“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.”

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.

PATIENT D.G. 35 Y.O. MS PATIENT

Parameters | OD | OS | Difference | Remarks
--- | --- | --- | --- | ---
Amplitude/Low Contrast | 11.4 | 8.8 | 2.6 | OD Delayed
Amplitude/High Contrast | 22.8 | 19.3 | 3.5 | OS Delayed
Latenity/Low Contrast | 145.5 | 110.9 | 34.6 | OD Delayed
Latenity/High Contrast | 110.9 | 145.5 | 34.6 | OS Delayed
Main Indications

• Glaucoma
• Multiple Sclerosis
• Ischemic Optic Neuropathy
• Traumatic Brain Injury
• Amblyopia
• Other Neuropathies

HOW WE TEST

• 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*
READING THE RESULTS

- Quickly interpret results to enhance medical decision making and treatment planning
- Easy-to-read reports allow clinician to demonstrate therapeutic results and monitor disease progression
READING RESULTS: NORMAL

READING RESULTS: ABNORMAL

MULTI-FOCAL ERG
THANKS TO:
Nathan Lighthizer, O.D., F.A.A.O
Assistant Professor, NSUOCO
Chief of Specialty Care Clinics
Chief of Electrodiagnostics Clinic
Multifocal ERG (mfERG)

Trace Array

Step 4 from the full-field ERG
**Ring Ratios**

- Normal ring ratios
- Elevated ring ratios

**Very good for:**
- Detecting small areas of damage to the central retina
- **Plaquenil toxicity**
- Detecting areas of functioning retina remaining

**Multifocal ERG (mfERG)**

- **Stimulus (Monitor)**
- **Recording (Sensors)**

*PERG is an accurate and objective indicator of ganglion cell and macular function (ISCEV)*

*PERG can detect retinal dysfunction (OHT) before structural tests (Paris et al.)*
PERG CLINICAL APPLICATIONS

- Developed for Eye Care Specialists to objectively measure retinal function to aid in diagnosis and monitoring of retinal disorders.
- pERG has been recognized as an effective, objective test in helping to diagnose macular pathologies including age-related macular degeneration (AMD), diabetic edema and the long-term toxic effects on retinal health.
- Provides quantitative information to support the clinician in the interpretation and diagnosis of retinal deficits.
- Reports and documents the results of practitioner intervention for tracking patients' response and disease progression to support medical decision-making.
- VEP and pERG testing together provide a complete objective, functional assessment of the visual pathways.
- A small study by investigators at Albert-Ludwigs University of Freiburg, Germany, showed that patients with ADHD displayed significantly elevated “background noise” on a pattern electroretinogram (PERG) compared with their healthy peers.

INTERNATIONAL PERG STANDARD

- Time is measured in milliseconds (ms)
- Amplitude is measured in microvolts (μV)
- N15-P50-N95 Complex
  - N15: Negative pulse around 15ms
  - P50: Positive pulse around 50ms
  - N95: Negative pulse around 95ms
Extensive and growing literature supports the clinical usage of PERG for the early diagnosis and tracking of Glaucoma.
PERG FUNCTION PRECEDES STRUCTURE GLC-S

PERSPECTIVE ON THE BIOMARKER ROLE OF MIDDLE-LAYER IMAGING IN PROGRESSIVE LENSOPHAGUS CELL FUNCTION AND STRUCTURAL LATEL STAGE OF MACULAR DISEASES

Main Indications
- Maculopathies
- Glaucoma

ASSESSMENT OF NEURO-VISUAL FUNCTION

pERG AMD Stimulus
STEADY STATE – PATTERN ERG CONTRAST AND CONCENTRIC STIMULUS FIELD TESTING

- BCVA
  - Patient should be tested with best corrected vision
- 85% contrast – or High 85% and Low 10% Contrast
- 24" testing distance
- Right Eye (OD) then Left Eye (OS)
  - 8 second "warm up"
  - 20 seconds at 24° - Used for Hc and Lc
  - 20 seconds at 16°


Normal Concentric Stimulus Fields | Normal Contrast Sensitivity

Abnormal Concentric - ARMD | Abnormal Contrast - Glaucoma
TECHNOLOGY CONSIDERATIONS TODAY
• Does it do something our other technology doesn’t?
• Will it provide clinical information that will impact the treatment of our patients?
• Can it be incorporated into our office?
  ▪ Space – Patient Flow - Staff
• Is it “standard of care” or “leading edge”?
• Is it “patient friendly”?
• Will it be profitable and/or Practice Builder?
  ▪ Efficiency – Billable - Referrals

BASIC PREMISE OF OUR PRACTICE.....

If it is good for the patient.....

It will be good for the practice!

VEP + ERG IS GOOD FOR THE PATIENT....
• Technology has always been a highlight of our practice
• Glaucoma went away ....but came back in 1994 with TPA’s
• Visual Fields traditionally the only measure of “function”
  ▪ Very subjective and patients don’t like the test
• But now VEP can be incorporated in any practice
  ▪ NOT subjective – and patients like the test
• For structure, we use OCT and HRT
  ▪ Objective and able to detect subtle changes
VEP + ERG – DO THEY DO SOMETHING DIFFERENT?
- Absolutely! – However, not the research based, school based systems that may or may not have been at your school
- VEP results are a representation of the functional integrity of all levels of the visual pathway including anterior seg, retina, optic nerve, LGN and visual cortex
- An objective way to measure “function” for a variety of conditions
  - Glaucoma – MS – Amblyopia – Stroke – TBI
  - InfantSEE®

DOES THE VEP + ERG IMPACT TREATMENT?
- ABSOLUTELY!
- Glaucoma
  - Adjunct to visual fields (especially low reliability)
    - We now have 3 measures of “function” to go with 2 measures of “structure”
  - Developmental Disabled Patients – unable to do VF and even OCT/HRT
- Amblyopia
  - Predictor of success and monitoring therapy

CLINICAL EXAMPLE #1 - AQ 11 Y.O. FEMALE
- Patient since 2008 in combination with IA City Ophthalmology
- Progressively more near sighted each year with good BCVA
- 4/2/2012 presented complaining of daily HA’s for 2 months and vision “not clear”. Full work ups at IA City found a seizure disorder with EEG and Johns Hopkins diagnosed malingering
- BCVA on 4/2/2012 was 20/150 OD, OS - cyclopleged
- Ocular health otherwise normal with o/d’s of .7x7 OU
- Ordered VEP and HVF
AQ – 11 Y.O. FEMALE 4-11-12 VISUAL FIELDS

• Normal Amp and Latency and essentially equal between eyes
• Another validation of no organic cause of reduced BCVA
• Since no refractive error asymmetry or strabismus "not amblyopia" – Streff Syndrome
• 6 weeks into vision therapy was 20/20 OD, OS

CLINICAL EXAMPLE #2 – JH 63 Y.O. FEMALE

• No Family History of glaucoma – had been watching her for reduced macular pigment, although no history of ARMD
• Each year, did poorly on FDT screening fields, with many fixation losses, but normal confrontations.
• 10/5/10 Exam showed advanced FDT changes from 2009 IOP was 16, 17 c/d remained at .2x.2 OU with right PPA. Pachymetry was 583, 592
• 12/3/10 Returned for VF, OCT and HRT
CLINICAL EXAMPLE #2 – VISUAL FIELDS 12-3-10

3/1/11 IOP 19, 18 gonio open
6/28/11 VEP
Right is essentially normal Amp / Latency
Left shows reduced High Contrast Amp but increased Low Contrast Latency
Order repeat VF

CLINICAL EXAMPLE #2 – HRT AND OCT 12-3-10

CLINICAL EXAMPLE #2 – FOLLOW UP AND VEP

3/1/11 IOP 19.18 gonio open
6/28/11 VEP
Right is essentially normal Amp / Latency
Left shows reduced High Contrast Amp but increased Low Contrast Latency
Order repeat VF
CLINICAL EXAMPLE #2 – JH 63 Y.O. FEMALE

• The belief was that she was a poor visual field test taker
• She did have progressively changing FDT’s, but normal nerves (except PPA), normal pressures and no FmHx of GLC
• The right OCT was interpreted as being related to the PPA the left was normal
• The first HVF’s were unreliable, but of concern
• The VEP showed more of a GLC concern OS rather than OD, but the follow up HVF’s clearly showed GLC changes OU
  • So…..I started treating
• What if I had waited until the 1 year follow up HVF?

INCORPORATING IN OUR PRACTICE

• Space – 4 feet by 7 feet in a corner
• Patient Flow
  • We schedule 15 minutes – usually 4-8 total
  • Incorporating in glaucoma care - coming
• Staff
  • Trained all paraoptometrics
  • We use primarily a “special test” para
  • More efficient and more consistent results

OUR GLAUCOMA PROTOCOL – INCLUDING VEP

• Annual exam – include photos - dilated
• 3 or 4 month visit – non dilated
  • IOP – Gonio – VEP (95930)
• Next 3 or 4 month visit – dilated
  • HVF – HRT – OCT
  • Initially did many VEP with this visit at the beginning to get initial data on our patients. Slows the flow in our system because it is preferred to do VEP un-dilated
LEADING EDGE

- VEP + ERG data for glaucoma is decades old, just didn’t have a system that was truly office-based until Diopsys NOVA
- Normative data comparison makes it much easier as a clinician to interpret the information and implement clinically
- We are no longer the only practice in the area that offers VEP/ERG
- Because of the multiple uses – our practice continues to be recognized as “the most high-tech” in the area
  - Referrals from patients, pediatricians, neurologists

OFFICE-BASED VEP/ERG IS PATIENT FRIENDLY

- Even on a “great hair day” – skilled technicians can attach the leads without much disruption
- Patients appreciate the simplicity – no stress when taking the test
- Easily understood report of findings for the patient – excellent patient education
- Relatively quick and easily incorporated with an office visit
- Patients tell their friends about the test – it is very accepted

PROFITABILITY

- We have had TWO coverage issues with any insurers including Illinois Medicaid CPT code – 95930/92275
- Medicare Allowable in “rest of IL” reimburses $123.20 / $149.87
  - OCT (92133) = $43.21 ($40.12)
  - Fundus Photos (92250) = $73.67 ($63.67)
  - HVF (92083) = $61.45 ($55.45)
- In Illinois there are no diagnosis codes associated/limited to CPT code – 95930 or 92275
  - No frequency limitations, but except for TBI/Stroke or Amblyopia – we will limit it to annually
- 2013 Revenue exceeded $80,000 from 95930 and 92275
OUR MOST COMMON DIAGNOSIS CODES

• 377.14 – Glaucomatous Atrophy (cupping) of optic nerve
• 368.4X – Visual Field Defect (abnormal VF – screening FDT)
• 368.0X – Amblyopia
• 377.11 – Primary Optic Atrophy
• 377.00 - Papilledema
• 368.12 – Transient Visual Loss
• 362.xx (now for pERG
• LCD’s list well over 80 diagnosis codes

YOU DO YOUR OWN MATH

• How many 365.xx patients do you have?
• How many 368.xx patients do you have?
• How many 377.xx patients do you have?
• How many 362.xx patients do you have
• If you do a screening FDT or other visual field – how many of them do you currently bring back for a full visual field – you should now consider adding a VEP to the battery of tests
• How many patients each year come in with “unspecified visual disturbance or transient visual loss”?

REFERRALS AND MARKETING = MORE PROFITS

• Neurologists have recognized my partner as very neuro oriented and now that we have VEP and ERG they are referring to our practice.
• We’ve successfully treated 2 “malingering” or “Streff Syndrome” patients and because the VEP was an additional test to rule out organic cause – pediatricians are referring patients for testing AND vision therapy
• Patients are telling friends that “their doctor has a VEP” and it is converting to new patients – children and glaucoma
IN SUMMARY – VEP + ERG

• Good for The Patient
  • Patients accept and understand the technology
  • Objective data with no patient stress

• Good for The Practice
  • Valuable clinical data for a variety of diagnoses
  • Easily incorporated into practice flow
  • A source of professional and patient referrals
  • One of the highest reimbursed procedures in the practice

QUESTIONS?

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