The ABCs of VEPs and ERGs

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Visual Testing Systems

- **Visual Evoked Potential**
  - VEP testing evaluates the integrity of the afferent visual sensory system
  - VEP testing measures the speed and strength of the evoked response along the visual pathway

- **Pattern Electroretinogram**
  - pERG testing evaluates the integrity of the retinal ganglion cells by measuring their response to stimulation
  - pERG testing is used to evaluate optic neuropathies and maculopathies

Neural Response of the Visual Pathway

- **Receptors**
  - Rod cells in the retina
  - Cone cells in the retina

- **Transmitters**
  - Optic nerve
  - Optic chiasm
  - Optic tract
  - Lateral geniculate nucleus
  - Optic radiations

- **VEP Generator Site**
  - Primary visual cortex
  - Extrastriate visual cortex

Structures involved in the transmission of sensory information along the pathway

Clinical Indications for VEP Testing

- Evaluate diseases of the optic nerve
  - Optic nerve atrophy
    - Primary optic atrophy – 371.11
    - Glaucomatous optic atrophy – 377.14
    - Partial optic atrophy – 377.15
  - Ischemic optic neuropathy
  - Papilledema
  - Optic disc drusen

- Identification and follow-up for multiple sclerosis
  - Helps to identify the demyelination process

Clinical Indications for VEP Testing

- Evaluate visual disturbances
  - Amblyopia
  - Subjective visual disturbances
    - Subjective visual disturbance, unspecified – 368.10
    - Visual discomfort – 368.13
  - Diplopia and other disorders of binocular vision
  - Visual field defects
    - Visual field defect, unspecified – 368.40
    - Paracentral scotomas – 368.41
  - Color vision deficiencies
  - Night blindness

pERG Fixed Testing Protocols

- Concentric Stimulus Fields
  - Protocol aids in the diagnosis of diseases that affect the retina in specific topographic patterns
    - Age-related macular degeneration
    - Diabetic macular edema
    - Toxic maculopathies

- Contrast Sensitivity
  - Protocol aids in the diagnosis of diseases that affect the retina in a diffuse pattern
  - Helps to detect the depth of macular dysfunction in diseases like glaucoma or diabetic retinopathy
Clinical Indications for ERG Testing

- Evaluate diseases of the optic nerve
  - Optic nerve atrophy
    - Primary optic atrophy – 371.11
    - Glaucomatous optic atrophy – 377.14
    - Partial optic atrophy – 377.15
- Evaluate diseases of the macula
  - Age-related macular degeneration
  - Plaquenil-induced toxic maculopathy
  - Diabetic retinopathy
    - Diabetic macular edema – 362.07
    - Ocular ischemia – 362.84

Clinical Evaluation of Glaucoma

- Ophthalmoscopy
- Fundus photography
- Intraocular pressure
- Retinal laser scan
- Visual field exam
- Corneal pachymetry
- Anterior chamber exam
- Visual evoked potential
- Electroretinogram
- Family history
- Patient history
- Visual acuity

“When To Treat Glaucoma”

- When optic nerve has an anomalous appearance
  - Vertically elongated cup-to-disc ratios
  - Asymmetry cup-to-disc ratios
- When IOP is elevated or asymmetric
- When OCT or GDx detects RNFL fallout
- When perimetry detects visual field loss
- When VEP testing reveals abnormalities
- When pERG testing reveals abnormalities

Ganglion Cell Stress vs. Cell Death

Detection of Glaucoma - Timeline

- PERG is an important indicator of retinal ganglion cell function in glaucoma
- There is some amount of reversibility or even cell shrinkage before cell death
- PERG detects glaucoma while axons are alive, up to 8 years before OCT testing

Glaucoma Suspect

- 71-year-old Black female
- Intraocular pressure measurements
  - 20 mm Hg in the right eye
  - 23 mm Hg in the left eye
- Best corrected visual acuity
  - 20/25 in the right eye
  - 20/30 in the left eye

Ophthalmoscopy

CD Ratio = 0.80/0.75
CD Ratio = .80/.80
Optical Coherence Tomography

- Abnormal RNFL thickness in both eyes
- Abnormal TSNIT curve profile analysis
- Optic cup depth is moderate
- Clinically significant asymmetry between the eyes

Visual Field Examination (30-2)

- Normal VEP waveform morphology in each eye
- Normal P100 peak time for both low-contrast and high-contrast VEP responses
- No abnormal symmetry between the eyes

Visual Field Examination (60-4)

Visual Evoked Potentials

Pattern Electroretinogram

- Normal pERG waveform in both eyes
- Three equally spaced sinusoidal-like peaks
- Magnitude of the pERG response in normal in both eyes
- Above 1.2 microvolts
- Magnitude D value is more than half the value of the Magnitude

Angle-Closure Glaucoma

- 60-year-old black woman presenting for an eye examination on 10/20/2013
- Wants to know if eyeglasses will improve her vision – currently uses OTC readers
- Best corrected visual acuity
  - 20/20 - in the right eye
  - 20/20 - in the left eye
- Intraocular pressure
  - 18 mm Hg in the right eye
  - 21 mm Hg in the left eye

Best corrected visual acuity:
- 20/20 - in the right eye
- 20/20 - in the left eye

Intraocular pressure:
- 18 mm Hg in the right eye
- 21 mm Hg in the left eye
**Ophthalmoscopy**

- CD Ratio = 0.50/0.50
- CD Ratio = 0.60/0.65

Normal optic disc coloration

Temporal pallor of the left optic disc

**Ultrasound Biomicroscopy**

- UBM determines the mechanism of elevated intraocular pressure by showing the relationship between the peripheral iris and the trabecular meshwork.
- In eyes with a narrow angle, the mean anterior chamber depth in primary angle-closure is 1.8 mm, which is 1 mm shorter than in normal eyes.

UBM identifies the pathologic processes pushing the iris and lens forward and predicts the risk of developing closure.

- Pupillary block
- Plateau iris syndrome
- Anterior lens position


**Optical Coherence Tomography**

- Abnormal RNFL thickness in the left eye
- Abnormal TSNIT curve profile in the left eye
- Abnormal sector plot analysis in the left eye
- Clinically significant asymmetry between the eyes

**Visual Field Examination (30-2)**

- Isolated paracentral scotoma
- Inferior nasal step

**Visual Field Examination (60-4)**

**Visual Evoked Potentials**

- Mildly delayed peak time of the low-contrast VEP response in the right eye
- Normal VEP waveform shape in each eye
- No clinically significant asymmetry between the eyes
**Pattern Electroretinogram**

- Abnormal pERG response in both eyes
- Three equally spaced sinusoidal-like peaks are not present in either eye
- Magnitude of the pERG response is low in both eyes (below 1.20 uV)
- Magnitude D value is less than half the value of Magnitude in both eyes

**Macular Degeneration**

- 61-year-old white woman presenting for an emergency eye examination on 11-6-2013
- Chief complaint is recent onset “floaters” in the right eye – symptoms began two days earlier
- 40-year history of full-time PMMA and gas permeable contact lens wear
- Patient presents for the examination wearing her contact lenses (~ 7.00 in each eye)
- Best corrected visual acuity
  - 20/30 in the right eye
  - 20/30- in the left eye

**Ophthalmoscopy**

**Optic Disc Hemorrhage**

- Posterior vitreous detachment produces a secondary hemorrhage on the optic nerve
- Optic nerve hemorrhage at 10:00 results from vitreopapillary traction
- Should be able to visualize Weiss ring in the vitreous cavity

**OCT Scan of the Maculas**

**Visual Field Examination**
Abnormal pERG response in the left eye

- Three equally spaced sinusoidal-like peaks are not present
- Magnitude value is normal (1.20 μV)
- Magnitude D value is abnormal (0.31)
- Less than half the value of the Magnitude