VEMP: How do I get started?

Jill Craig, Product Manager
Learner Outcomes:

- After this course learners will be able to describe the vestibular system and structures associated with the VEMP test.
- After this course learners will be able to describe why EMG monitoring is essential for accurate cVEMP testing.
- After this course learners will be able to identify the structures involved in the cVEMP and oVEMP.

VEMP:
Other Take Aways

- VEMP is easy to perform
- VEMP provides information that other tests cannot
- VEMP provides ear specific information
- Clinical data is always emerging!
Basic Review

- Investigates Otolith/Vestibular Nerve Function
  - Dysfunction is characterized by feeling similar to being on a boat or elevator
  - Not usually characterized by a spinning sensation
- Short-latency electromyographic (EMG) potentials evoked in response to high-level acoustic stimuli
- Responses are mediated by the vestibular system
- Provides quantitative separate ear information about otolith/vestibular nerve function
Clinical Applications

- Assessment of patients with complaint of sound-evoked vestibular symptoms such as Tullio phenomenon or superior canal dehiscence (SCD)
- Assessment of the saccule and the inferior portion of the vestibular nerve in different vestibular pathologies such as Meniere’s disease or vestibular neuritis
- Assessment of utricle and superior portion of the vestibular nerve
- Assessment of young children and infants before CI
- Other emerging data: ANSD, concussion, diabetes

VEMP Basic Review

**Input**
- Ears
- Vision
- Somatosensory

**Central Processing**
- The brain receives info to process "who" will need to respond

**Output**
- VOR
- VSR
- VCR
**Basic Review-Organs**

- **Saccule**: acceleration in the vertical plane (think elevator)
- **Utricle**: acceleration in the horizontal plane (think driving in a car)

**Basic Review-Reflex**

- Otolith sense the motion
- Brain send out the message to the reflex
  - VOR (ocular)
    - Maintain visual acuity
  - VSR (spinal)
    - Maintain posture/gait
  - VCR (colic)
    - Maintain head stability
VEMP

C vs O VEMP

- cVEMP
  - Saccule/inferior nerve function
  - Sternocleidomastoid (SCM) muscle
  - Inhibitory
  - Ipsilateral

- oVEMP
  - Primarily utricle*/superior nerve function
  - Extra-ocular muscles
  - Excitatory
  - Contralateral

VEMP Pathway

Courtesy Kamran Barin, PhD
VEMP Pathway

Patient Setup-cVEMP

- Locate the sternocleidomastoid
- Locate the middle third of the muscle
- Symmetry is important!
  - Too high/too low affects results
  - Uneven L/R affects results
VEMP
Patient Setup-cVEMP Tips

• Contraindications

<table>
<thead>
<tr>
<th>Test</th>
<th>Challenge</th>
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<td>CHL as small as 5db can abolish a cVEMP result. Audiometry, tympanometry and acoustic reflex testing should be performed to assess function.</td>
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<td>Carefully assess the patient to assure SCM contraction can be achieved/maintained without pain or discomfort.</td>
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<td>Obesity</td>
<td>It can be increasingly more difficult to locate the SCM and collect a response.</td>
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VEMP
Patient Setup-cVEMP Tips

• Consider the differential electrode

• How to “pop out” the SCM
VEMP

Patient Setup-cVEMP Tips

• Remember put the electrodes on the lead BEFORE placing the electrodes
• Instruct the patient on the use of the EMG monitor
  • RED—contraction is too high
  • GREEN—just right!
  • BLUE—contraction is too low

VEMP

Patient Setup-oVEMP

• Electrodes just below the eye lid (Active = upper/Reference = lower)
  • Chin can be reference
VEMP
Patient Setup-oVEMP Tips

- Contraindications

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<tr>
<td>oVEMP</td>
<td>Absence or damage to the eye</td>
<td>Cannot make asymmetry comparisons</td>
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VEMP
Recording cVEMP

- SCM muscle is activated through contraction
- High-level acoustic stimulus presented 5/sec.
  - Saccular afferents have thresholds at 90-95 dBSPL with an increase in firing rate up to 110 dBSPL
  - Elicited by clicks or low to mid frequency tone bursts (500, 750, 1000 Hz).
    - Because the saccular afferents respond best to these frequencies. 500 Hz has the largest response (Akin, Murnane, Proffitt – 2003, Janky 2009)
    - Age plays a role in best frequency
      - If it’s absent in an older patient consider 1000 Hz

*Surface EMG is averaged*
VEMP

EP200 VEMP Monitor

- **High**...is above the Max value
- **Good**...is between the Min value and the Max value
- **Low**...is below the Min value

VEMP Monitor

- **Min uV**: 50
- **Max uV**: 70

Running the test-cVEMP

Average EMG for first measurement = 98 uV
Running the test-cVEMP

- After running the left and right, mark P1 and N1 for one left and one right tracing
  - You may choose to add the two runs and use the added waveform
- Then select the asymmetry ratio icon
  - It is only active when the R/L have been marked and highlighted
- If SCCD is a concern, drop the dB to 70 and run again
  - Some run this first
VEMP

Importance of EMG monitoring

VEMP is an amplitude measure: If no correction is made to account for R/L differences in tonic level of EMG, VEMP data cannot be analyzed accurately.

Consequences of disregarding effects of EMG

AR for Uncorrected EMG Level: 527μV - 172μV x 100 = 51%
527μV + 172μV

AR for Corrected EMG Level: 7.5μV - 5.7μV x 100 = 14%
7.5μV + 5.7μV

Atkin & Murnane, 2009

VEMP

Recording oVEMP

• Inferior oblique activated through contraction (25-30 degrees up/back)
• High-level acoustic stimulus presented 5/sec.
• Utricle/ “predominately utricle”
  • Superior nerve also has some saccular fibers
*EMG averaging is not needed*
Running the test-oVEMP
VEMP

Quick Tips

• Testing guidelines/recommendations have been published
• Several normative papers exist
  • Janky
  • Piker
  • Murnane
  • Many more

• Asymmetry Ratio
  • Most often proposed is 35-40% difference (cVEMP) to be clinically significant
• Latency delays are indicative of central pathology
• High AR or low thresholds are indicative of peripheral pathology
• cVEMP amplitudes:
  • Decrease with age
  • Are affected by the stimulus frequency and level
• cVEMP in children expect:
  • Shorter latencies
  • Larger amplitudes
CHALLENGING DISCUSSION

Bone conducted VEMP

• Many systems do not have enough output to generate the response
• In its place some use a triggered tendon hammer or mini shaker at Fz

VEMP

Diagnosis/Interpretation

Differentiating Superior and Inferior Vestibular Neuritis

<table>
<thead>
<tr>
<th>Clinical Test</th>
<th>Healthy Response</th>
<th>Superior Vestibular</th>
<th>Inferior Vestibular</th>
<th>Vestibular Mischia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal head turn</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>Right head impulse test in the plane of the ipsilateral superior canal</td>
<td>✔️</td>
<td>✔️</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>oVEMP 500s beneath the contralateral eye to bone conduct stimulation</td>
<td>✔️</td>
<td>✔️</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Vestibular Division Superior</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✗</td>
</tr>
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*) Ian S. Curthoys, PhD
The Interpretation of Clinical Tests of Peripheral Vestibular Function
The Laryngoscope: Volume 122, Issue 6, pages 1342–1352, June 2012
### VEMP Cheat Sheet

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<tr>
<th>Disorder</th>
<th>cVEMP</th>
<th>oVEMP</th>
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<tbody>
<tr>
<td>Meniere's</td>
<td>Reduced amplitude on affected side</td>
<td>Increased amplitude</td>
</tr>
<tr>
<td>SSCD</td>
<td>Reduced threshold (99% of have abnormally low thresholds!)</td>
<td>Increased amplitude and reduced threshold</td>
</tr>
<tr>
<td>VN</td>
<td>Reduced amplitude on affected side</td>
<td>Absent</td>
</tr>
<tr>
<td>VM</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>MS</td>
<td>Prolonged latency</td>
<td>May be abnormal</td>
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### Limitations of Vestibular Testing

- VNG/ENG and rotational tests only assess the horizontal semicircular canal and the vestibulo-ocular reflex of the vestibular system.
- What does normal VNG/ENG mean? Only that the horizontal semi-circular canal and the vestibulo-ocular reflex is functioning normally.
- VEMP assesses the saccule, utricle, inferior and superior vestibular nerve which no other tests assess.
  - *Add vHIT and it's a complete VESTIBULAR ORGAN PARTY!*
VEMP
FDA Importance

- Will lead to (hopefully) a CPT code
  - No FDA—no code
- Otometrics EP200 is the only device cleared for VEMP testing. This means:
  - Customer support
  - Training
- The result is better patient care!

Thank you!
Questions?
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