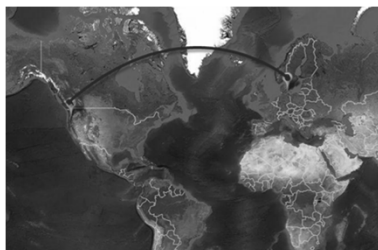




Who I Am?



VEMP

Agenda and Outcome

A G E N D A

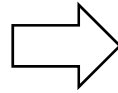
Basic A&P review

Patient Set up and Tips

Running the tests

Diagnosis/interpretation

FDA



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.

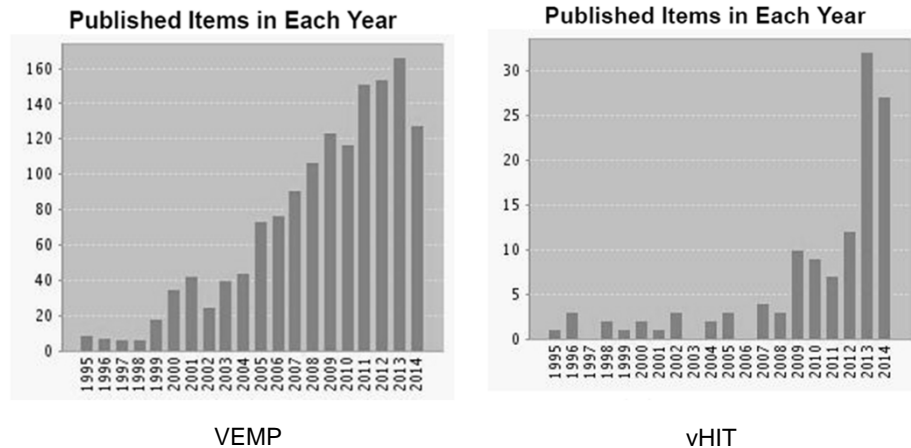
VEMP:

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!

PUBLICATION COUNT (WEB OF KNOWLEDGE)

VEMP and HIT/vHIT



Basic Review

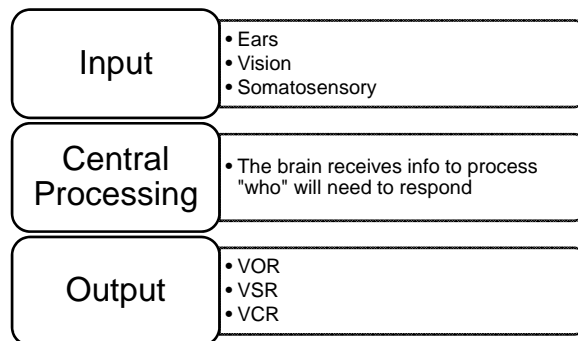
- Investigates Otolith/Vestibular Nerve Function
 - Dysfunction is characterized by feeling similar to being on a boat or elevator
 - Not usually characterized by a spinning sensation
- Short-latency electromyographic (EMG) potentials evoked in response to high-level acoustic stimuli
- Responses are 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

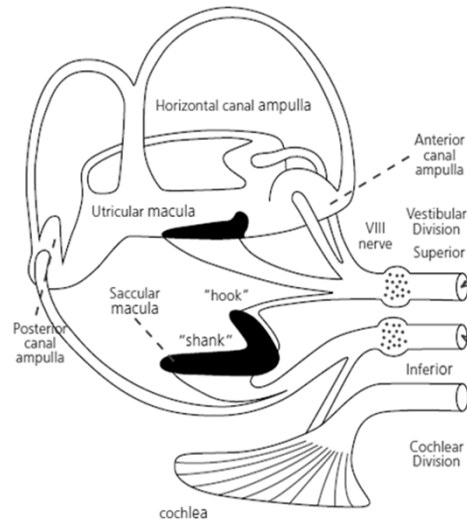


VEMP

Basic Review-Organs

Saccul: acceleration in the vertical plane (think elevator)

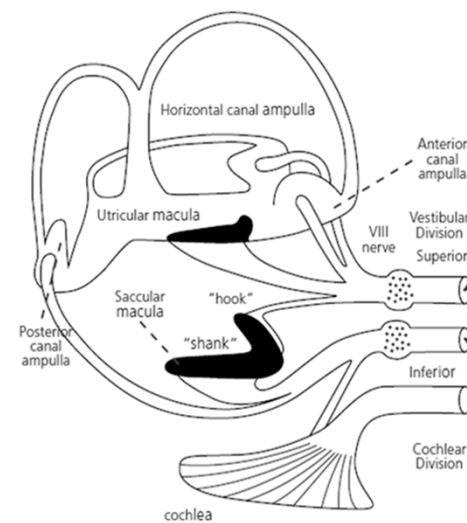
Utricle: acceleration in the horizontal plane (think driving in a car)



VEMP

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

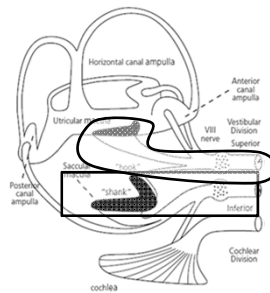
C vs O VEMP

• cVEMP

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

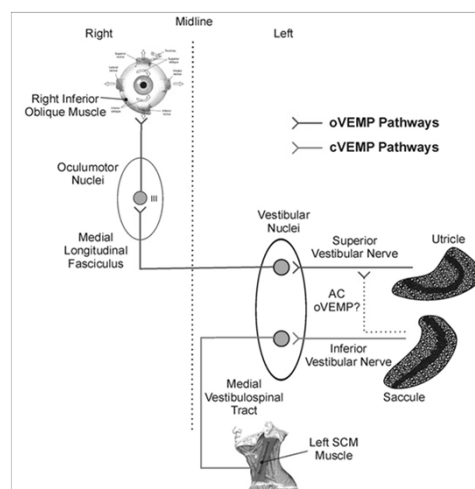
• oVEMP

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



VEMP

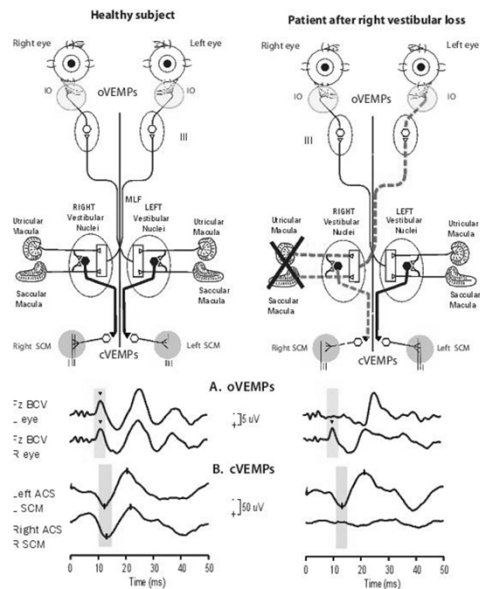
VEMP Pathway



Courtesy Kamran Barin, PhD

VEMP

VEMP Pathway

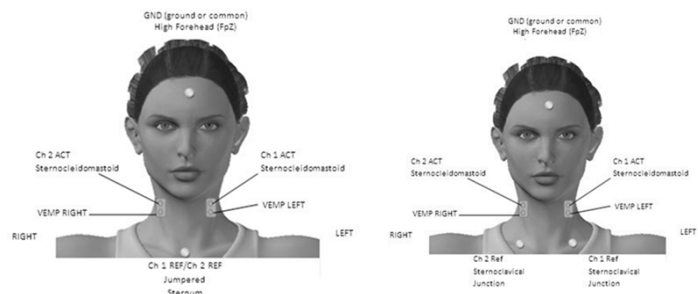
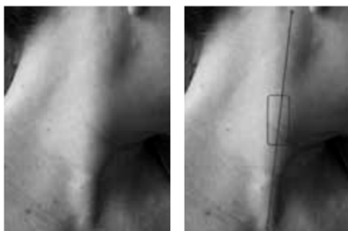


Courtesy Ian Curthoys

VEMP

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

Test	Challenge	Description/Detail
cVEMP	Conductive Hearing Loss (CHL)	CHL as small as 5db can abolish a cVEMP result. Audiometry, tympanometry and acoustic reflex testing should be performed to assess function.
cVEMP	Cervical Spine Problems	Carefully assess the patient to assure SCM contraction can be achieved/maintained without pain or discomfort.
cVEMP	Tinnitus or sound sensitivity	Due to the high level of the stimulus used for this test, patient comfort should always be considered.
cVEMP	Obesity	It can be increasingly more difficult to locate the SCM and collect a response

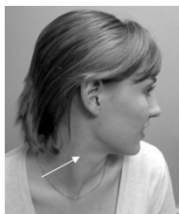
VEMP

Patient Setup-cVEMP Tips

- Consider the differential electrode



- How to “pop out” the SCM



Picture taken from British Society of
Audiology VEMP Guidelines

VEMP

Patient Setup-cVEMP Tips

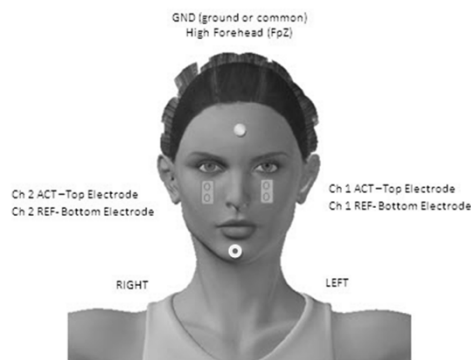
- Remember put the electrodes on the lead BEFORE placing the electrodes
- Instruct the patient on the use of the EMG monitor
 - RED—contraction is too high
 - GREEN—just right!
 - BLUE—contraction is too low



VEMP

Patient Setup-oVEMP

- Electrodes just below the eye lid (Active = upper/Reference = lower)
 - Chin can be reference



VEMP

Patient Setup-oVEMP Tips

- Contraindications

Test	Challenge	Description/Detail
cVEMP	Conductive Hearing Loss (CHL)	CHL as small as 5db can abolish a cVEMP result. Tympanometry and acoustic reflex testing should be performed to assess middle ear function.
cVEMP	Cervical Spine Problems	Carefully assess the patient to assure SCM contraction can be achieved/maintained without pain or discomfort*.
cVEMP or oVEMP	Tinnitus or sound sensitivity	Due to the high level of the stimulus used for this test, patient comfort should always be considered.
cVEMP	Obesity	It can be increasingly more difficult to locate the SCM and collect a response
oVEMP	Absence or damage to the eye	Cannot make asymmetry comparisons

VEMP

Recording cVEMP

- SCM muscle is activated through contraction
- High-level acoustic stimulus presented 5/sec.
 - Saccular afferents have thresholds at 90-95 dB SPL with an increase in firing rate up to 110 dB SPL
- 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

Running the test-cVEMP

Edit Protocol - VEMP (500 Hz Tone Burst)

500 Hz Tone Burst

Stimulus

Left Ear: ☒ Stimulus, ☐ Masking, ☒ VEMP Monitor

Right Ear: ☐ Stimulus, ☐ Masking, ☐ VEMP Monitor

Intensity: Stimulus 97 dB nHL, Masking 0 dB HL, ☐ Synchronous Masking

Transducer: Insert Phone, Polarity: Rarefaction

Click: Duration 100 us, ☐ Tone: Frequency 500 Hz, Envelope Blackman, Ramp (cycles) 2, Plateau (cycles) 0

Channels: ☒ Ch 1 On, ☒ Ch 2 On

Amplifiers: Gain 5k, 5k

Filters: High Pass 10 Hz, Low Pass 1 kHz, Notch ☐ On, Artifact ☐ On, ☐ Electrode Switching

Acquisition: Sweep Time (ms) 100, Delay (ms) -20, Sweeps 150, Rate (/sec) 5.1, Display Scale (uV) 40.00, ☐ External Trigger

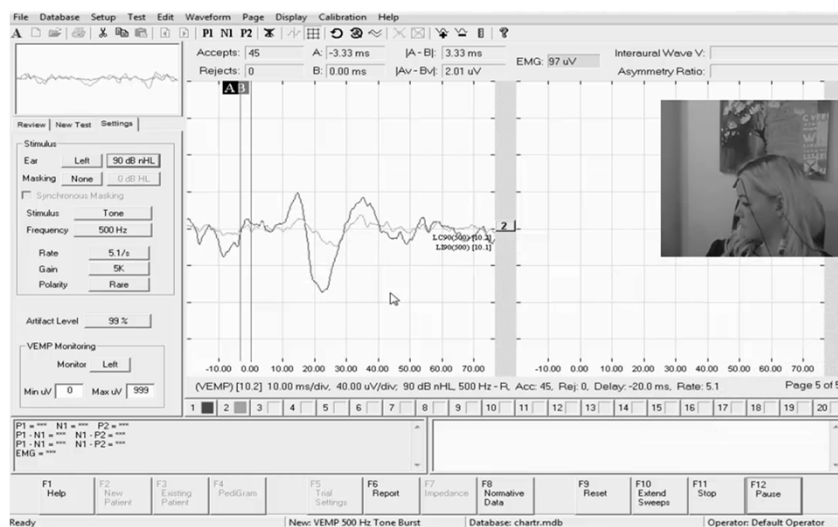
VEMP Monitor: Min (uV) 0, Max (uV) 999

Default Settings Save... OK Cancel Help

Pressing 'Save...' will save changes to trial settings permanently.
Pressing 'OK' will save changes to trial settings only for this session.

VEMP

Running the test-cVEMP



VEMP

EP200 VEMP Monitor

Review New Test Settings

Stimulus

Ear: Right 90 dB nHL

Masking: None 0 dB HL

☐ Synchronous Masking

Stimulus: Tone

Frequency: 500 Hz

Rate: 5.1/s

Gain: 5K

Polarity: Rare

Artifact Level: 99 %

VEMP Monitoring

Monitor: Right

Min uV: 50 Max uV: 70



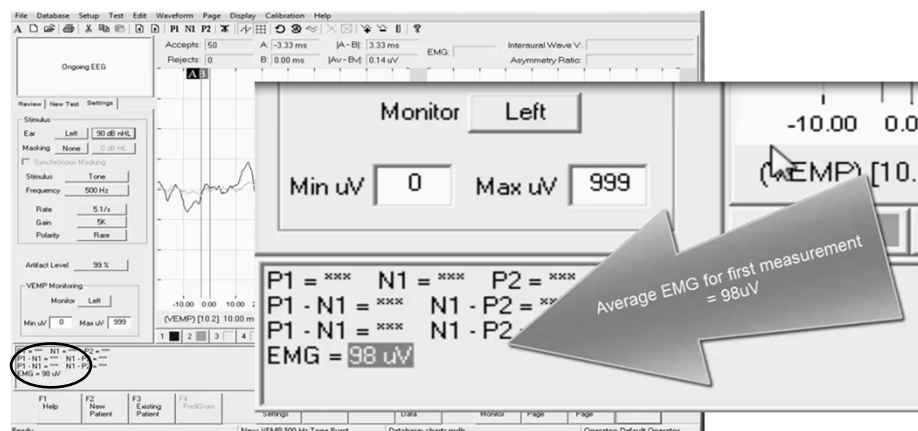
High....is above the **Max** value
 Good.... is between the **Min** value and the **Max** value
 Low.....is below the **Min** value

F1 Help	F2 New Patient	F3 Existing Patient	F4 Program	F5 Trial Settings	F6 Report	F7 Impedance	F8 Normative Data	F9 Start VEMP Monitor	F10 Previous Page	F11 Next Page	F12 Collect
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Ready VEMP 95 dB

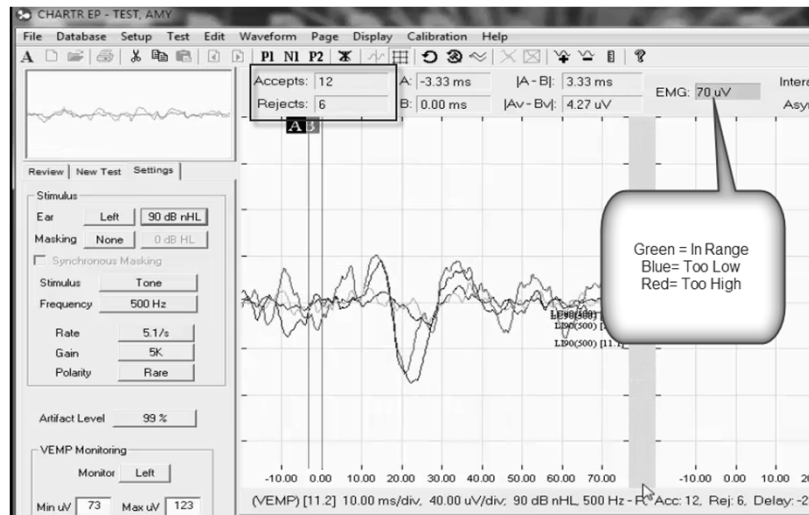
VEMP

Running the test-cVEMP



VEMP

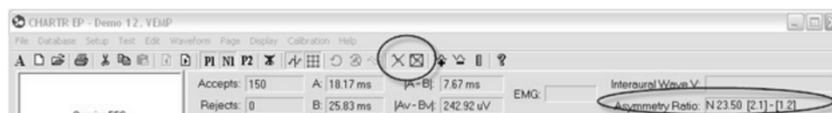
Running the test-cVEMP



VEMP

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 SSCD is a concern, drop the dB to 70 and run again
 - Some run this first

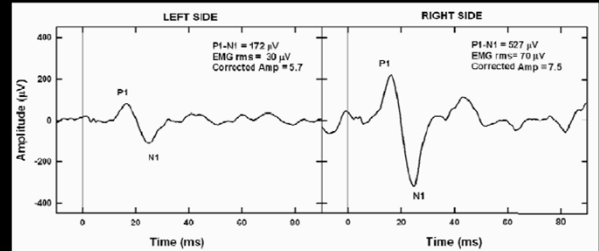


VEMP

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:

$$\frac{527\mu\text{V} - 172\mu\text{V}}{527\mu\text{V} + 172\mu\text{V}} \times 100 = 51\%$$

AR for *Corrected* EMG Level:

$$\frac{7.5\mu\text{V} - 5.7\mu\text{V}}{7.5\mu\text{V} + 5.7\mu\text{V}} \times 100 = 14\%$$

Akin & Murnane, 2008

Courtesy Owen Murnane

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

VEMP

Running the test-oVEMP

Edit Protocol - VEMP (Ocular VEMP)

Ocular VEMP

Stimulus

Left Ear: ☒ Stimulus ☐ Masking ☐ VEMP Monitor

Right Ear: ☐ Stimulus ☐ Masking ☐ VEMP Monitor

Intensity

Stimulus: 97 dB nHL

Masking: 0 dB HL

☐ Synchronous Masking

Transducer: Insert Phone

Polarity: Alternating

Click

Duration: 100 us

Tone

Frequency: 500 Hz

Envelope: Blackman

Ramp (cycles): 1

Plateau (cycles): 0

Channels

☒ Ch 1 On ☒ Ch 2 On

Amplifiers:

Gain: 100k

Filters:

High Pass: 1 Hz

Low Pass: 1 kHz

Notch: ☐ On

Artifact: ☐ On

☐ Electrode Switching

Acquisition

Sweep Time (ms): 50

Delay (ms): -10

Sweeps: 150

Rate (/sec): 5.1

Display Scale (uV): 4.00

☐ External Trigger

VEMP Monitor

Min (uV): 4

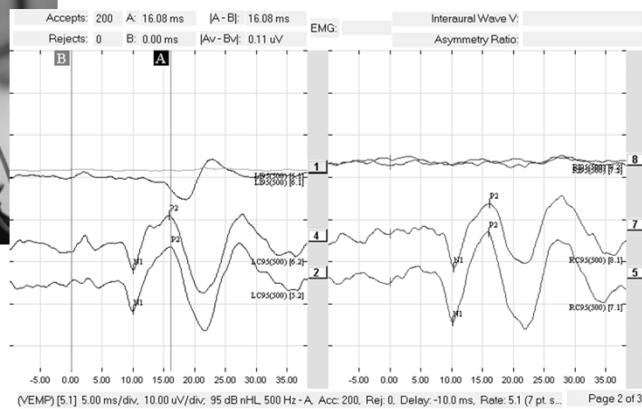
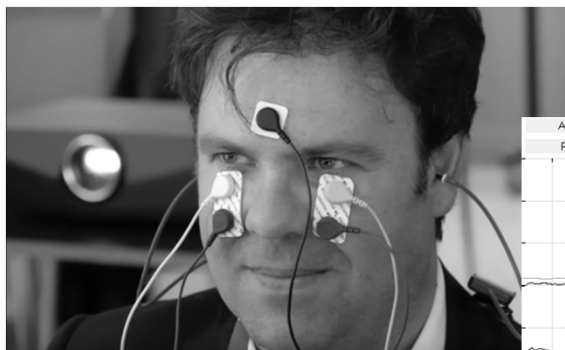
Max (uV): 12

Default Settings Save... OK Cancel Help

Pressing 'Save...' will save changes to trial settings permanently.
Pressing 'OK' will save changes to trial settings only for this session.

VEMP

Running the test-oVEMP



VEMP

Quick Tips

- Testing guidelines/recommendations have been published
 - BSA (http://www.thebsa.org.uk/wp-content/uploads/2014/04/VEMP_Guidance_v1.1_20121.pdf)
 - International Guidelines ([http://www.clinph-journal.com/article/S1388-2457\(14\)00036-4/abstract](http://www.clinph-journal.com/article/S1388-2457(14)00036-4/abstract))
- Several normative papers exist
 - Janky
 - Piker
 - Murnane
 - Many more

VEMP

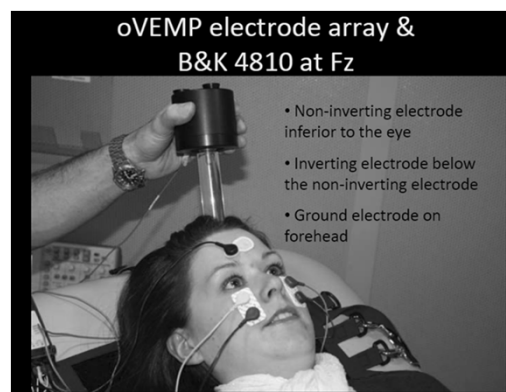
Quick Tips

- 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 it's place some use a triggered tendon hammer or mini shaker at Fz

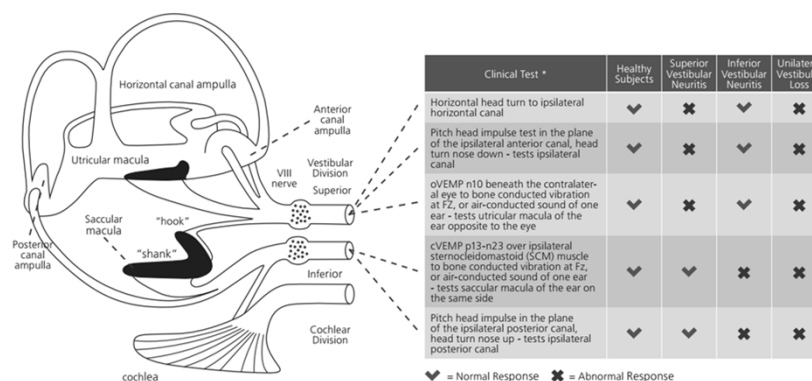


Courtesy: Owen Murnane

VEMP

Diagnosis/Interpretation

Differentiating Superior and Inferior Vestibular Neuritis



*) 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

Disorder	cVEMP	oVEMP
Meniere's	Reduced amplitude on affected side	Increased amplitude
SSCD	Reduced threshold (99% of have abnormally low thresholds!)	Increased amplitude and reduced threshold
VN	Reduced amplitude on affected side	Absent
VM	Normal	Normal
MS	Prolonged latency	May be abnormal

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?
jcraig@gnotometrics.com

www.futurefitting.com

www.icsimpulse.com

 facebook.com/otometrics

 twitter.com/otometrics