Smart Note

Recording cVEMP and oVEMP
using SmartEP

What are VEMPs?

Vestibular evoked myogenic potentials (VEMPs) are short-latency electromyograms (EMGs) recorded via surface electrodes from the tonically contracted anterior neck muscles, typically the sternocleidomastoid (SCM), in response to high-level acoustic stimuli (95–110 dB nHL) at slow repetition rates (2–5 per second).

Stimuli can include broadband clicks or low-frequency tone bursts delivered through air or bone conduction. Like auditory evoked potential (AEP) testing, the EMG response is amplified, filtered, digitized, and averaged to obtain a final signal.

Proper tonic contraction of the neck muscles is critical for accurate cVEMP recordings; without it, little or no response is produced. A VEMP feedback box and/or computer monitor provides visual feedback, indicating whether muscle activation is satisfactory.

VEMP responses can also be recorded from the inferior oblique muscle; these are called ocular VEMPs (oVEMPs). These responses also require contraction of the eye muscles.

Why test VEMPs?

VEMP testing assesses saccular and inferior vestibular nerve (IVN) function and, when combined with other tests, helps diagnose conditions such as Meniere's disease, vestibular labyrinthitis, Tullio phenomenon, benign paroxysmal positional vertigo (BPPV), superior canal dehiscence (SCD), acoustic neuromas, multiple sclerosis, and spinocerebellar degeneration.

Neurological conditions like Meniere's disease, acoustic neuromas, and multiple sclerosis often result in absent potentials, while vertigo and SCD may show lower thresholds. Acoustic neuromas and multiple sclerosis can also cause latency shifts.

Meniere's disease may present with absent, reduced, normal, or enhanced VEMP responses, depending on the disease stage.

Patient Preparation

VEMP acquisition require patient participation, therefore the patient must be awake. Common patient positioning methods include:

- **Cervical VEMP (cVEMP):** There are two common methods for activating the sternocleidomastoid (SCM) muscle:
  - **Head rotation:** The patient turns their head away from the stimulated ear to unilaterally activate the SCM muscle. This can be done either in a seated or supine position.
  - **Supine flexion:** The patient lies in a supine position and lifts their head against gravity, activating the SCM muscles bilaterally.
- **Ocular VEMP (oVEMP):** The patient should sit upright in a comfortable chair and fixate their vision on a point, directing their gaze upward.

Suggested instructions for cVEMP

Have the patient lay down at 30 degrees at baseline, have the patient lift and turn their head in the opposite direction to the stimulus (e.g. when stimulating right, have the patient turn left).

It is possible to acquire from both sides simultaneously, the patient must lift their head while keeping their back in place, creating tension on both SCM muscles. To improve recording quality, patients should engage the muscles before starting acquisition.

Proper muscle activation can be assessed by looking at the feedback tools, such as the VEMP feedback box or the EMG level feedback window. The patient must try to achieve a constant level of muscle activation.

Suggested instructions for oVEMP

When acquiring oVEMP the patient must be instructed to look up at a target up and in front of them, and continue looking during the acquisition. For example, the target can be placed at approximately 36 inches (1 meter) away from the patient and 36 inches above their baseline to achieve a 45 degree angle. Blinking should be avoided as much as possible to prevent artifacts from contaminating the response. To improve recording quality, patients should be looking at the target before starting acquisition. The patient should close their eyes for 15 to 20 seconds between acquisition sets.

INTELLIGENT HEARING SYSTEMS

For additional help:
e-mail: support@ihsys.com
phone: (800) IHSYSTEMS (USA)

SNSEP090 - EN - 250611

Dual Channel Setup for cVEMP

The following shows suggested electrode placement for acquisition using a dual channel configuration on the Duet platform.

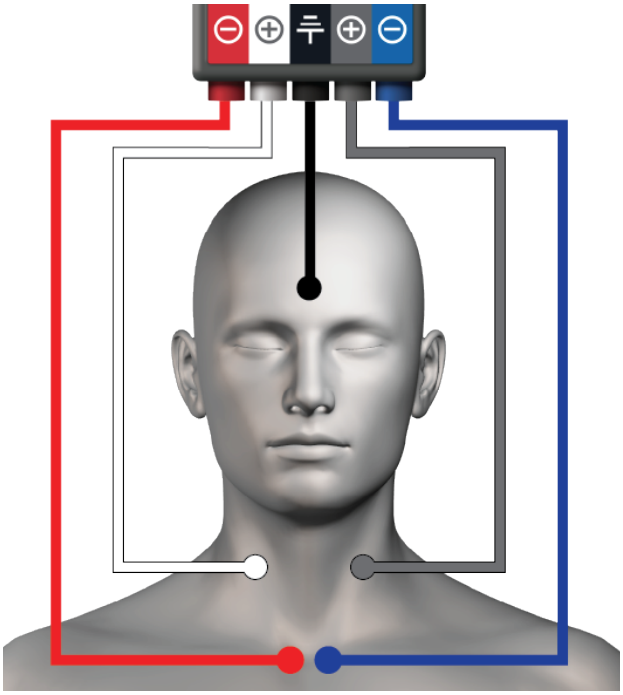

Fig.1 - cVEMP electrode placement for Duet

This setup may also be achieved using 4 electrodes by joining the inverting (-) electrode positions using a Y adapter, and placing the joined electrode at the sternoclavicular junction.

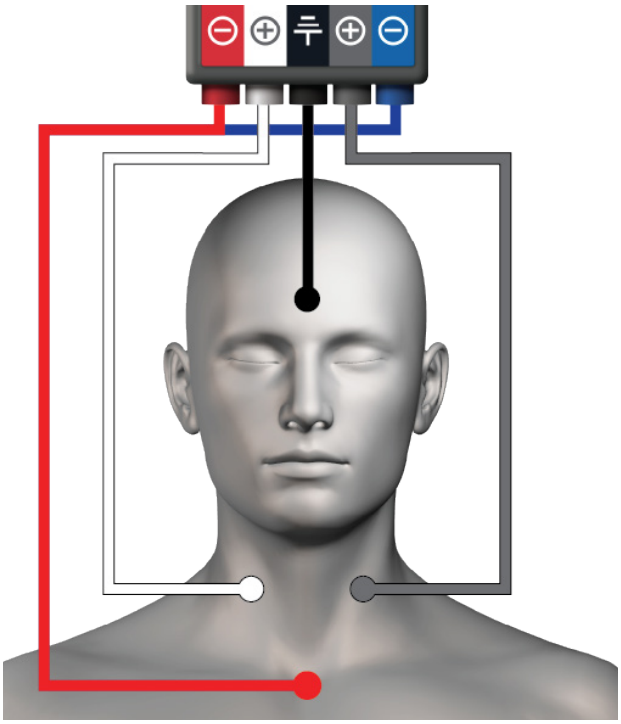

Fig.2 - cVEMP electrode placement for Duet

These setups may also be used with the Universal Smart Box (USB) platform.

Single Channel Setup for cVEMP

The following shows suggested electrode placement when using a single channel on the Aria platform. For this setup, the channel designation must be set to Midline.

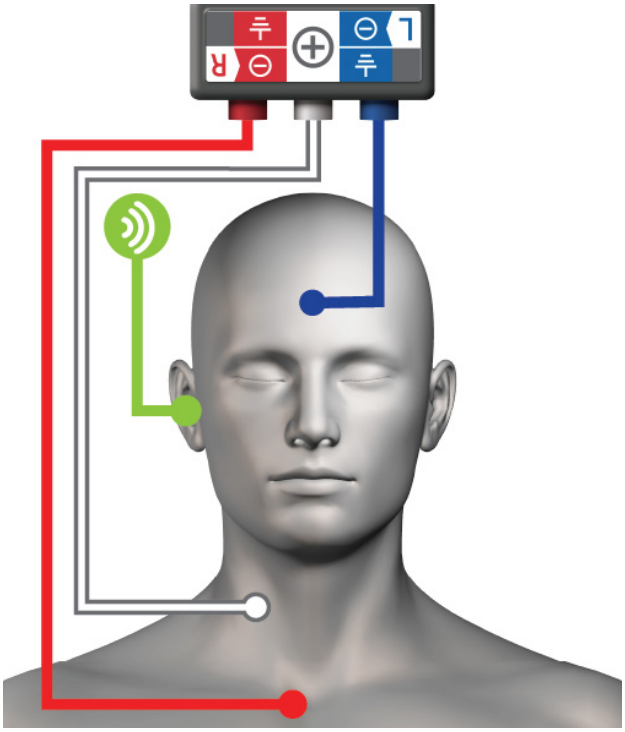

Fig.3 - cVEMP placement right side for Aria

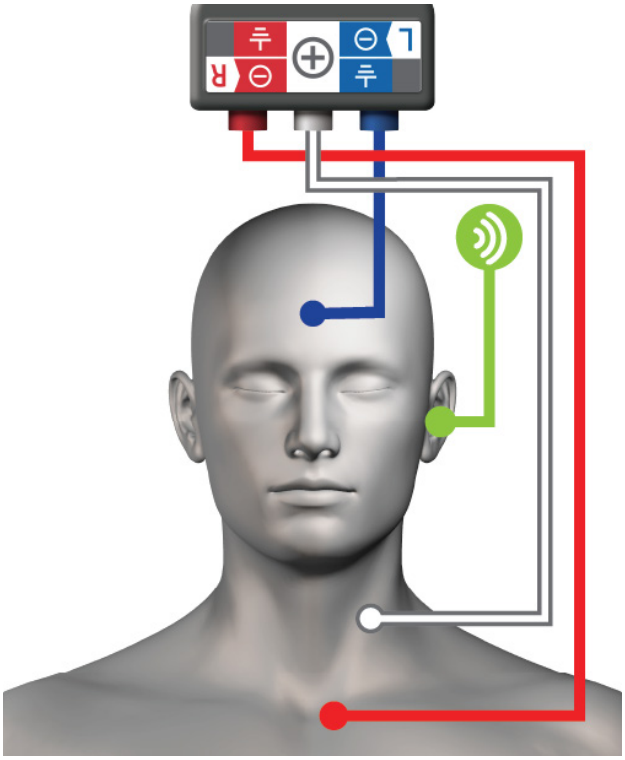

Fig.4 - cVEMP placement left side for Aria

Dual Channel Setup for oVEMP

The following shows suggested electrode placement for acquisition of ocular VEMP responses for dual channel systems.

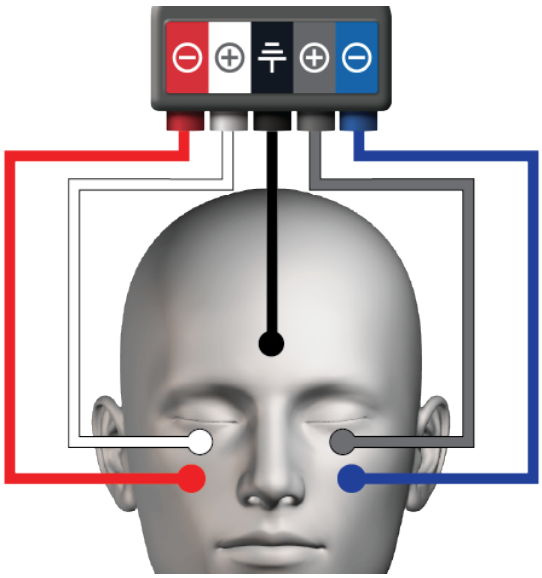

Fig.5 - oVEMP electrode placement for Duet

The electrodes can also be positioned on the inferior oblique muscle in a belly-tendon setup as indicated in the following figure.

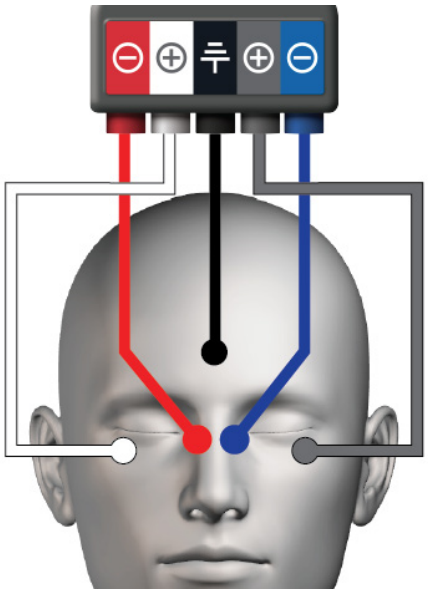

Fig.6 - oVEMP belly-tendon setup for Duet

This setup may also be achieved using 4 electrodes by joining the inverting (-) electrode positions using a Y adapter, and placing the joined electrode at the bridge of the nose.

These setups may also be used with the Universal Smart Box (USB) platform. The USB box uses an external amplifier, simply match the polarities on images above to the polarities indicated on the amplifier box, making sure to keep the channels

Single Channel Setup for oVEMP

The following shows suggested electrode placement for a single channel on the Aria platform, or a Duet in single channel mode with a single channel patient cable. For this setup, the channel designation must be set to Midline.

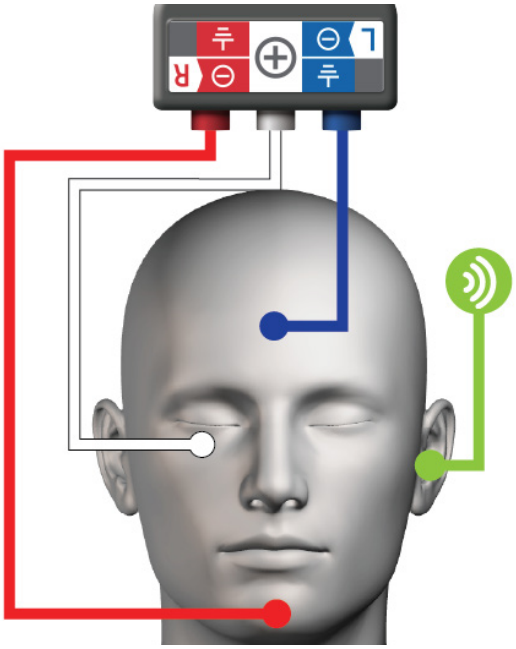

Fig.7 - oVEMP single channel right side for Aria

To acquire from the left side, simply move the white electrode to the corresponding position on the opposite side.

For single channel acquisition, the electrodes can also be positioned on the inferior oblique muscle in a belly-tendon setup. For this setup, the channel designation must be set to Midline.

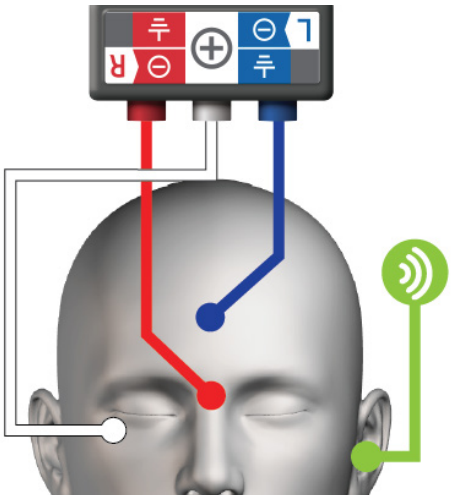

Fig.8 - oVEMP belly-tendon right side for Aria

To acquire from the left side, simply move the white electrode to the corresponding position on the opposite side.

SmartEP Recording cVEMP and oVEMP

Hardware Setup Considerations

It is highly recommended to use the Patient Feedback box or the patient feedback window. In the feedback window, a green bar graph, a happy face and/or a continuously playing video (If selected) will indicate proper muscle activation. A red level, a sad face and a paused video will indicate that the required levels have not been achieved. Any Mpeg or AVI file may be used for patient feedback.

Stimulator Placement

For air conduction

- cVEMP: The stimulus is presented ipsilaterally via an earphone inserted into the ear canal of the side being tested. Recording is from the ipsilateral sternocleidomastoid muscle.
- oVEMP: The stimulus is presented ipsilaterally via an earphone inserted into the ear canal of the side being tested. Recording is from the contralateral inferior oblique muscle (under the eye opposite the stimulated ear).

For bone conduction

- cVEMP: The stimulus is presented ipsilaterally via a bone conductor (BC) placed on the mastoid of the side being tested. Recording is from the ipsilateral sternocleidomastoid muscle. Be careful to ensure the BC maintains firm contact with the mastoid, as the device may slide as the patient turns their head.
- oVEMP: The stimulus is presented via a bone conductor (BC) placed on the mastoid of the side being tested or on the forehead (Fz). Recording is from the contralateral inferior oblique muscle (under the eye opposite the stimulated mastoid). Be careful to ensure the BC maintains firm contact with the mastoid, as the device may slide as the patient looks up.

Setting up SmartEP

Load the settings files for cVEMP and oVEMP that were provided by IHS by clicking on the **[Load Settings]** button from the Control Panel.

If you do not have VEMP settings files, contact IHS Support to obtain a copy of these files. Settings filed must be placed in the Settings_EP folder, and Stimulus files must be placed in the Stim_EP folder.

Note that due to the output intensity required for Bone Conduction VEMP, you should only use the B-81 bone vibrator.

For manual setup:

1. On the SmartEP main menu, select **[Protocol > Modality > VEMP]**.
2. Click on the **[Amplifier]** button and set the filters and gain as desired for each channel. Single channel setups must have the channel designation set to Midline. Click **[OK]** to set the changes and close the window.
3. Click on the **[Stim]** button in the control panel to choose the stimulus. Click **[OK]** to set the changes and close the window.
4. Choose your intensity, rate and number of sweeps.

Suggested Settings

Air Conduction Stimulus (cVEMP & oVEMP):

- Transducer: Insert Earphones
- Polarity: Rarefaction
- Rate: 5.1 per second
- Intensity: 100-105 dB nHL
- Stimulus Type: 500 Hz Blackman or Trapezoidal Tone Burst with a duration of 2 cycles (4000 us)

Bone Conduction Stimulus (cVEMP & oVEMP)

- Transducer: B81 Bone Conductor
- Polarity: Alternating
- Rate: 5.1 per second
- Intensity: 68 dB nHL
- Stimulus Type: 500 Hz Blackman or Trapezoidal Tone Burst with a duration of 1 cycle (2000 us)

cVEMP Recording parameters:

- Gain: 5 k
- High Pass Filter: 10 Hz
- Low Pass Filter: 1000 Hz for Duet, 1500 Hz for Aria
- Analysis time window: -30 to 50 ms
- Mode: Ipsilateral
- Sweeps: 150-250 (sets of 50, then averaged)
- Artifact Rejection: Off

oVEMP Recording parameters:

- Gain: 100 k
- High Pass Filter: 10 Hz
- Low Pass Filter: 1000 Hz for Duet; 1500 Hz for Aria
- Analysis time window: -30 to 50 ms, 20 ms pre-stimulus region.
- Mode: Contralateral
- Sweeps: 3 runs of 50 each, then averaged
- Artifact Rejection: enabled

Setting the Acceptance Region

To obtain repeatable responses, a minimum level of muscle activation should be determined before acquisition.

Ask the patient to perform the activation task for both sides, while you monitor the calculated Min in the VEMP EMG Feedback window. Set the Acceptance Range Min field to the lowest of the two values. Some general recommendations:

- Leave the max set to 1000 uV.
- For cVEMP, the min should be at least 50 uV, higher values are better if possible.
- For oVEMP, the min should be around 4uV, older patients may need as low as 1uV.

Acquisition

After the software settings are ready and the patient is set up:

1. Set the Acceptance range.
2. Click **[Acquire]** to start recording.
3. Repeat the acquisition for the opposite side.

Marking Peaks

1. Click on the peak label you wish to mark (P1 or N1) from the tool bar, it will turn red when chosen.
2. Click the location on the waveform where the label should be placed.
3. For P1, make sure the top marker is located at the top of the peak.
4. To obtain waveform amplitudes, drag the bottom marker of P1 to the location of N1. Note that for cVEMP waveforms the P1 marker is typically placed earlier than N1. In oVEMP waveforms, the P1 marker is placed later than N1. The selection of this placement is based on current general usage at the time of this writing.

Some users like to reverse the position of the inverting and non-inverting electrodes; this simply creates an inverse of the recording. Ensure to adjust the peak placement accordingly.

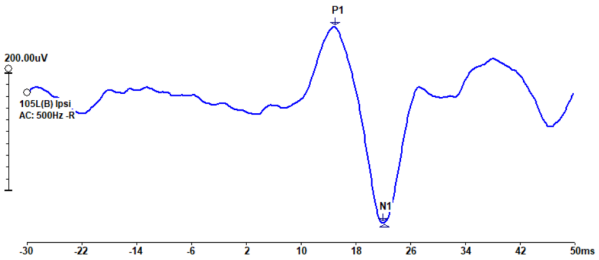

Fig. 1. - Sample cVEMP waveform and suggested labeling

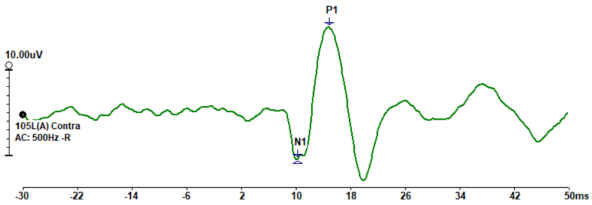

Fig. 2. - Sample oVEMP waveform and suggested labeling

Since label placement is subjective, all results must be evaluated by an audiologist or medical professional trained in VEMP techniques.

To compare left and right recordings select one of each while holding the **[Ctrl]** key on the keyboard, and then clicking on **[Process > Compare]** from the SmartEP main menu. A window will show the latency and Peak values and ratios. The comparison info may be copied to the current page by clicking on the **[Yes]** button in the comparison screen.