What are ABRs?
Auditory Brainstem Responses are potential differences generated when a person's ear is stimulated with any kind of sound wave; stimulus that may be provided via air conduction or bone conduction. The potential difference originates in the VIII cranial nerve and the auditory brainstem system. These potential differences can be evoked using controlled stimulation, allowing acquisition of these differences by averaging the acquired signal over a specified period of time. The ABR response is commonly found between one and fifteen milliseconds from the time of stimulation.

The recordings acquired will contain certain peaks and valleys. A standard ABR recording will contain seven peaks, some more identifiable than others, peak five being the most prominent. The amplitudes, latencies, and relationship between those peaks and valleys can be used to diagnose certain pathological conditions. ABR responses are most commonly acquired using surface electrodes.

Why use Bone Conduction?
Patients with certain auditory conditions, particularly those affecting the external and middle ear, may be difficult to test using standard air conduction stimulation. To bypass problems with external and middle ear, such as ear canal occlusion in newborns, it is necessary to use bone conduction. Vibration applied to the mastoid can deliver equivalent stimulation to that of the insert earphones. However, bone conduction is limited in the range of test frequencies and intensities that it can supply. Bone Conduction testing can help determine the amount and type of hearing loss at specific frequencies, (i.e. hearing threshold), and the presence of any air-bone gap. ABR Bone Conduction testing can provide information about existing conductive hearing problems in the ear canal or middle ear.

Patient Preparation
The patient must be placed in a comfortable and quiet environment, preferably a sound booth where the patient lies down on a comfortable bed. It is recommended to have the patient relax or sleep to reduce the amount of artifact. Electrodes and Bone Conductor may be placed in the following configuration:

- **Inverting (-)**: Nape.
- **Non-Inverting (+)**: High Forehead.
- **Ground**: Contralateral Mastoid or Shoulder.
- **Bone Vibrator**: Test Ear Mastoid.

![Bone single channel electrode setup](image)

When testing both ears, in a dual channel system, place the corresponding inverting electrodes on the mastoids, place the ground electrode on the lower forehead and place the two non-inverting leads, using a Y-adaptor, above the ground electrode on the high forehead. Make sure to keep the Bone Conductor away from the electrodes to avoid stimulus artifacts. Consult the SmartEP manual for additional electrode placement options.

The Bone Vibrator unit must be switched from the left to the right mastoid when testing the right ear. A contralateral offset masking, of usually 40 dB above stimulation level, may also be provided using insert earphones.

Electrode Usage
Surface electrodes are sufficient for acquiring ABR recordings. Clean and prepare electrode pacing sites in order to reduce the impedance and acquire a clearer recording. You must use pediatric electrodes with infants.
Setting up SmartEP

Complete the following steps to set up SmartEP for bone conduction acquisition:

1. From the main menu, select [Stimulus > Modality > Auditory > ABR].
2. Click on the [EEG and Amplifier] button in the control panel and set the filters, notch filter, artifact rejection ratio and region, and desired amplification for each channel, as necessary.
3. Click on the [Stim] button in the control panel and select the appropriate stimulus to be applied. Keep the window open.
4. Turn ON and set the desired masking level, if necessary, usually 40 dB above stimulus.
5. Select “Bone Vibrator” from the stimulator options and click [OK] to close the dialog box. You may save your settings for future use with the [Save] button on the Control Panel.

Carefully select your filter settings in the EEG and Amplifier dialog box. Lack of filtering may result in excessive artifact, excessive filtering may result in waveforms that are too smooth to assess correctly. EEG and Amplifier settings may need to be adjusted more than once.

Recommended Settings

It is recommended to run this test two to four times, using the following settings:

- **Stimulus**: click or 500 Hz Blackman tone.
- **Duration**: 0.1 milliseconds for click; 5 cycles for 500 Hz tone.
- **Masking**: recommended; use a value of “40”, set the level option to “tracking”, and activate the “contralateral” check box.
- **Rate**: 7.1 per second, slower rate used to enhance wave I.
- **Polarity**: alternating.
- **Transducers**: bone conductor.
- **Masking Transducer**: insert earphones.
- **Intensity**: 55 dB HL, to a maximum of 60 dB HL. Please note: Air conduction and Bone conduction latencies should be similar using default calibration values, assuming proper conduction between the bone vibrator and the bone through the skin.
- **Filters**: 30 - 3000 Hz for adults; 30 - 1500 Hz for smoother recordings.
- **Notch Filter**: OFF; turn ON only when power line noise is present.
- **Amplification (gain)**: 100K.
- **Analysis Time window**: 0 - 12 milliseconds.
- **Sweeps**: 1024.
- **Electrode Placement**: midline array.

Marking Peaks

To accurately diagnose a condition, you must first place the applicable labels on the recently acquired recording. Peaks I to VII may be marked when recognizable follow these steps for each of the labels:

1. Right click at the point of the recording where the label is to be placed.
2. Select the peak to be marked (I – VII).
3. Once placed, drag the top marker of the labels to the top of the peak.
4. Drag the bottom marker to the valley following the peak.

The graph shows suggested label placing for an acquired ABR.

Analysis

Select Print Pages or Print Page from the SmartEP main Menu to print a report of the currently displayed signals. See the SmartEP manual for other report generation options.

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