PATH MEDICAL Academy

Welcome to the new PATH MEDICAL NEWSLETTER. This publication is intended to highlight features of our products, tips on best practices, and how to use PATH MEDICAL devices. We hope that you find the information valuable and would love to have your feedback and suggestions for topics. Please write to us at academy@pathme.de.

Electrical Electrophysiologic Evaluation

Cochlear implants are designed to take acoustic signals and turn them into electrical signals that are transmitted to the brain. More specifically the processor picks up sounds, puts them into frequency bands, and converts them into digital form that is then sent to the receiver. The receiver takes the frequency information and sends signals to the appropriate inner electrodes that stimulate the auditory nerve. The auditory nerve uses the electrical signal to transmit to the brain. The cochlear implant needs to be programmed to establish how much electrical stimulation is needed to just detect a signal (T level) as well as the upper limit of comfort (C level); thus, creating an electrical dynamic range. For older children and adults this can be accomplished using behavioral methods. For young infants and children, those with syndromic associations/multiple disabilities, and those cases where there was a complication during surgery and close follow-up is required to assess the integrity of the implant, objective measures need to be used. Two methods that will be discussed are the electrically evoked auditory brainstem response (eABR) and the electrically evoked stapedial reflex threshold (ESRT).

The eABR

The eABR is an objective approach for evaluating the function of the auditory pathway up to the level of the brainstem (Wang et al., 2015; Zhang et al., 2021). Like the ABR that is recorded to acoustic stimuli, it is recorded from the scalp and occurs within the first 10 ms after electrically stimulating the auditory nerve. Unlike ABR, the eABR is usually recorded from the contralateral side.

The eABR can be done pre-operatively as a prognostic test before cochlear implant (CI) or auditory brainstem implant surgery, especially in patients with suspected/or confirmed hypoplastic cochlear nerves. For pre-operative assessment, an extracochlear transtympanic electrode at the round window niche (Causon et al., 2019) is often used. Post-operatively, the EABRs can be measured using electrodes from the implant array to help guide CI programming or assess the integrity of the device. The eABR detection threshold is thought to estimate a patient's T levels (Guenser et al., 2015; Mittal et al., 2015; Truy et al., 1998).

However, there is limited research looking at the correlation between eABR thresholds and C and T levels.

Typically, the electrical stimulus is applied by a cochlear implant fitting system that sends the electrical stimulus to the cochlear implant coil. The coil transmits the digitized information across the skin to the internal receiver/stimulator where it decodes the incoming signal and sends information in each frequency band to different electrodes within the cochlea which in turn stimulate the VIII nerve. A trigger cable from the CI computer/program is used to signal the EP system to start data collection. An example of the setup can be seen in Figure 1 (left).

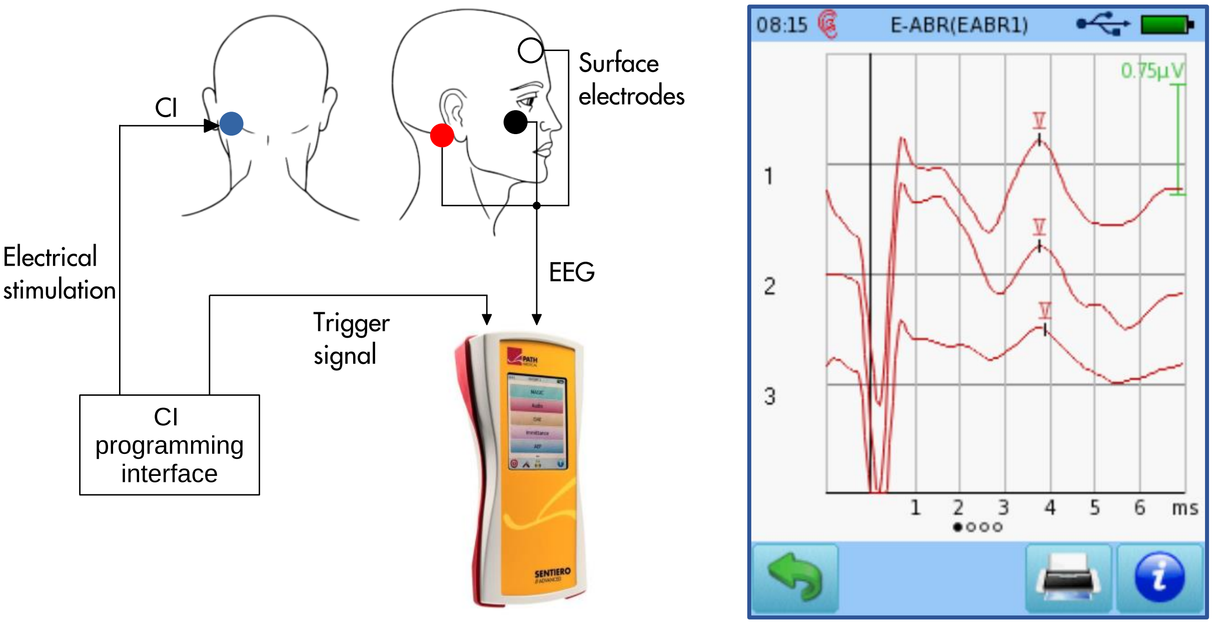

***Figure 1**. Schematic of the equipment setup for conducting eABR (left) and example of eABR test results collected on the PATH MEDICAL SENTIERO // ADVANCED*

The resulting waveform, in general, does not show the early waves, particularly wave I but also wave II, mostly due to artifact from the implant. It should be noted that the wave latencies for the eABR are shorter than those found when using acoustic stimuli with wave V occurring at about 4 msec. This is due to directly activating the neural pathway with the implant and there is no time delay from the transducer through the auditory pathway that occurs with acoustic stimulation. That is, with acoustic stimulation there is a delay from the transducer to the oval window and subsequent cochlear and synaptic delays, which are not seen with electrical stimulation. This also means that there is no change in latency with changes in stimulation level as shown in Figure 1 (right). In addition, just like traditional ABRs, muscle artifact can be seen in the recording but unlike traditional ABRs, where the postauricular muscle (PAM) artifact can be seen, there can also be artifact from the facial nerve, which occurs earlier than the PAM artifact.

The ESRT

ESRT is another objective measure that can be used to assist in the mapping of the cochlear implant when a patient cannot cooperate behaviorally for the mapping. Like acoustic reflex thresholds where the admittance of the ear is monitored in response to varying amounts of sound input, ESRT monitors the admittance change of electrical signals delivered through the CI. The goal is to find the lowest level of electrical stimulation that elicits a contraction of the stapedius muscle (see Figure 2 for an example). The test is typically done on the contralateral ear, although it has been reported that the use of higher-frequency probe tones is more successful in obtaining results and also for lower ESRT levels (Wolfe et al., 2017; Guo et al., 2021). In addition to helping with mapping, the test can also be used intraoperatively to verify the coupling of a CI to the auditory nerve.

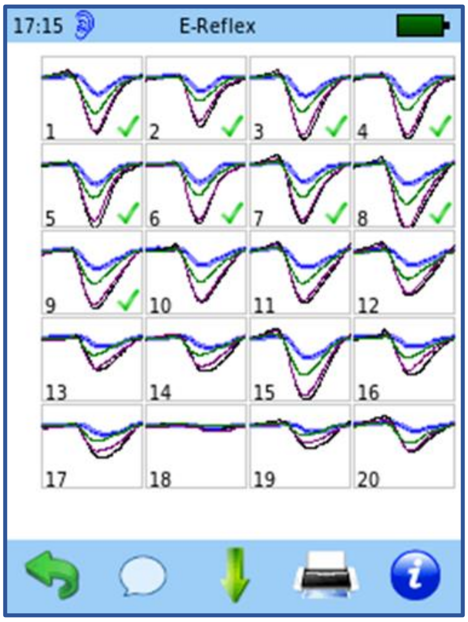

***Figure 2**. Example of ESRT test results collected on the PATH MEDICAL SENTIERO // TYMP DIAGNOSTIC*

There is a strong correlation between postoperative ESRT and the comfort levels of patients (setting upper stimulation levels) and have been found to be stable over time (Kosaner, Anderson, Turan, & Delibl, 2009; Lira de Andrade et al., 2014; Lorens, Walkowiak, Piotrowska, Skarzynski, & Anderson, 2004; Wolfe & Kasulis, 2008). However, other studies have shown that the ESRT thresholds may overestimate comfort level (Spivak & Chute, 1994; Walkowiak et al., 2011).

The clinical usefulness of ESRT may be considered limited in the literature, as responses are not observed in 20-30% of cochlear implant (CI) users (Hodges et al., 1997; Spivak & Chute, 1994). The reasons for this may be due to abnormal middle ear function (e.g., abnormal tympanogram), injury to the stapedial muscle during surgery, or facial nerve issues.

On the other hand, there is a majority of 70-80% of CI users for whom the use of ESRT makes the fitting process much faster, easier and less stressful than subjective testing methods. Another advantage of the test is that it is faster to conduct than the eABR. The setup is similar to eABR with the use of the cochlear implant for stimulation and a trigger cable to signal the recording device when to start the measurement. As with acoustic stimulation, the lowest level of electrical stimulation presented via the CI software that elicits a repeatable 0.02 deflection from baseline is considered the threshold for an acoustic reflex.

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