PromBERA: A preoperative eABR: An update

Objective promontory stimulation eABR test for measuring the integrity of the auditory nerve in prospective CI candidates.

Abstract: Prior to cochlear implantation, audiological tests are performed to determine candidacy in subjects with a hearing loss. This is usually done by measuring the acoustic auditory brainstem response (ABR). Unfortunately, for some subjects, a reproducible ABR recording cannot be obtained, even at high acoustic levels.

Having a healthy stimulating auditory nerve is required for cochlear implantation in order to benefit from the electrical pulses that are generated by the implant and to improve speech comprehension. In some subjects, this prerequisite cannot be measured using routine audiological tests.

In this study, the feasibility of recording electrically evoked auditory brainstem responses (eABR) using a stimulating transtympanic electrode, placed on the round window niche, together with MED-EL clinical system is investigated.

The results show that it is possible to record reproducible eABR measurements using PromBERA. The response was also confirmed with intraoperative eABR measurements that were stimulated using the implanted CI electrode array. Similarities between the intraoperative measurements and the preoperative recorded waveforms were observed.

In summary, the integrity and excitability of the auditory nerve can be objectively measured using the PromBERA in subjects where standard clinical testing procedures are unable to provide the information required.

Keywords: promontory stimulation, electrical stimulation, electrical auditory brainstem response, transtympanic, cochlear implant, auditory nerve

1 Introduction

Promontory Stimulation is a well-established tool to stimulate the cochlea preoperatively with a temporary transtympanic needle placed in the middle ear [1]. It has been shown that electrically evoked Auditory Brainstem Response (eABR) measurements recorded with Promontory Stimulation is an useful objective measurement in cochlear implant (CI) candidates for testing and evaluating the presence and excitability of the auditory nerve and auditory pathway before cochlear implantation [2]. This test is especially important for subjects where it is difficult or not possible to determine CI candidacy based on other preoperative audiological tests. It has also been demonstrated that correct placement of the electrode tip on the round window (RW) niche, instead of the promontory, plays an important role on the efficacy of the electrical stimulation delivery [3].

In this study, we aim to investigate the feasibility of this measurement using the MED-EL clinical system, consisting of clinical software Maestro, MAX Programming Interface, Stimulator Box and the transtympanic electrode.

2 Methods

Eleven subjects underwent standard audiological tests for CI candidacy (Table 1), and the PromBERA test was performed on subjects where CI candidacy could not be determined. Under local anaesthesia, a transtympanic rounded-bent tip electrode was placed temporarily on the RW niche and the surface ground electrodes were placed on the zygomatic bone and the angle of the mandible; electrical impedance was checked and electrical stimulation was provided with the MED-EL Stimulator Box and the MED-EL clinical Maestro v7.0 software. Electrode placement was confirmed with Impedance Field
Telemetry (IFT) when the electrode impedance was lower than 5 kΩ.

Biphasic alternating pulses with a phase duration of 100 µs and a stimulation rate of 34 Hz were used. The amplitude of the electrical pulses was increased with 100 μA/step until a response was detected.

Electrical stimulation was provided by the CI electrode array for intra-operative measurements recorded immediately after insertion. Measurements were recorded from one apical, mid, and basal electrode. Biphasic alternating pulses with a phase duration of 40 µs with an increasing amplitude pattern were used until a response was detected (Figure 1).

Figure 1: Setup for PromBERA measurements with the MED-EL system. The Stimulator Box provides electrical pulses for PromBERA measurements (EP, evoked potential), whereas the electrical stimulation is provided by the implanted CI for intra-operative eABR measurements.

Using either the MEB9400 (Nihon Kohden) evoked potential device or the GSI Audera (Grason-Stadler) triggered using Maestro software and the MAX Programming Interface. Surface recording electrodes were applied to the contralateral mastoid (inverting), high forehead (non-inverting), and lower forehead (ground). The bandpass filter was set to 50-3000 Hz and the average number of sweeps were 1000 and 1500 for pre-/intra-operative and post-operative eABR recordings, respectively.

Table 1: Subject demographics.

<table>
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<th>Subject</th>
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<th>Etiology</th>
<th>Age at test</th>
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<td>PHL</td>
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<tr>
<td>S11</td>
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<td>Trauma</td>
<td>42</td>
</tr>
</tbody>
</table>

3 Results

Positive PromBERA results were confirmed in all subjects with presence of reproducible auditory responses after electrical stimulation (Figure 2). The mean latency of the wave eV response was 4.23 ms (+/- 0.53 ms). Five subjects underwent CI implantation and intraoperative eABR measurements were recorded using the CI electrode array (Figure 3).

Intraoperative eABR measurements across 4 subjects confirmed stimulation of the auditory nerve and auditory pathway. The mean latency of wave eIII was 1.94 ms (+/- 0.23 ms) and the mean latency of wave eV was 3.75 ms (+/- 0.24 ms).

Figure 2: PromBERA results elicited by trans-tympanic electrode placed on the RW niche for each subject. Red and blue marks indicate response peaks eIII and eV, respectively, while dashed marks indicate the troughs used for amplitude calculation. The subject number is indicated on the left axis and the vertical scale bar is depicted on the top.
4 Conclusion

These preliminary data show the validity of PromBERA. Intra-operative eABR results measured with the CI electrode array are similar to the results measured preoperatively with PromBERA. Finally, PromBERA with a MED-EL clinical system measurements are easy to record and can be used preoperatively to determine CI candidacy. Further data will be collected to compare intra-operative eABR with preoperative PromBERA in a wider group of subjects.

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Author Statement

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References