In this article, Prof. Dr. Javier Gavilán Bouzas, explains the usefulness of an intraoperative test electrode to predict the status of the cochlear nerve in cases of Vestibular Schwannoma resection.

For these patients, Prof. Dr. Gavilán Bouzas utilizes a minimal invasive intracochlear Test Electrode (TE) to assess the viability of the cochlear nerve in order to predict the outcome of cochlear implantation.

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Usefulness of an intraoperative test electrode to predict the status of the cochlear nerve

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Key words: Cochlear nerve, test electrode, cochlear implant,

INTRODUCTION

As most patients with of severe to profound hearing loss have a cochlear origin, evaluation of the functionality of the cochlear nerve is not needed routinely. However in certain cases such as tumors of the VIII nerve, or aplasia/hypoplasia of the cochlear nerve, it may be crucial to assess its viability in order to predict the outcome of cochlear implantation

Several methods have been described to evaluate the functionality of the cochlear nerve. Promontory stimulation was used in the early days to assess the physiological viability of the cochlear nerve in conventional CI candidates. Due to its lack of specificity, it is no longer used as a routine test. More recently it has been performed to test the integrity of the cochlear nerve following Vestibular Schwannoma (VS) resection. Main limitations of this method are that it can be falsely negative in the immediate postoperative period, and that it requires an awake patient, so it cannot be used as an intraoperative test to decide if implantation should be carried out during VS surgery. Intraoperative Cochlear Nerve (CN) monitoring with ABR is a well-known test used in hearing preservation approaches for VS resection. Main limitations of this method are the likely absence of wave V in cases with preoperative high-frequency hearing loss, the usual presence of artifacts from various surgical equipment and procedures, and the delay between CN damage and its electrophysiological evidence. If an electrical instead of an acoustic stimulus is applied to the auditory pathway, eABR are obtained. While ABR are considered far-field potential, registration of the cochlear nerve compound action potential (CNAP) is another method of testing the auditory nerve. A main disadvantage of this technique is that in large tumors, placing and stabilizing the electrode in contact with the cochlear nerve can be technically challenging. Finally, neural response telemetry recordings (ECAP) have been also used to evaluate the integrity of the cochlear nerve intraoperatively. Main limitation of ECAP in testing the status of the CN is that a lesion of the nerve distal to the first neuron may not be detected.

OBJECTIVE

The goal of this study is to measure eABR and assess the functionality of the Auditory Nerve by using a minimal invasive intracochlear Test Electrode (TE) and to compare the eABRs elicited by the TE with those elicited by a CIs implanted at the same surgery. The study participants were conventional CI candidates with a healthy status of the AN.

METHODS

Ten subjects (age at implantation 55 years, range 19 - 72) were selected from the CI patient pool. All subjects were diagnosed with bilateral sensorineural hearing loss and were subsequently implanted with MED-EL Concerto cochlear implant on the non useful residual hearing side. The implantation surgery was performed using the mastoidectomy-posterior tympanotomy approach. Following identification of the round window, the test electrode was inserted in the cochlea previous to cochlear implantation. The test electrode (TE) was manufactured by MED-EL (Innsbruck, Austria) (Figure 1) and consists of four electrode contacts.

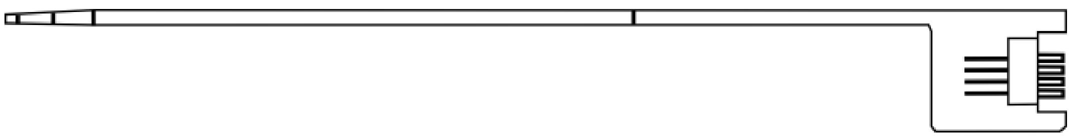

Figure 1: The MED-EL test electrode. During the surgery the electrode array is inserted into the cochlea. The second branch, a single leaflet electrode is placed under the temporalis muscle.

Setup is shown in Figure 2. Technical details for the setup, recording paradigm and data analysis are beyond the scope of this paper.

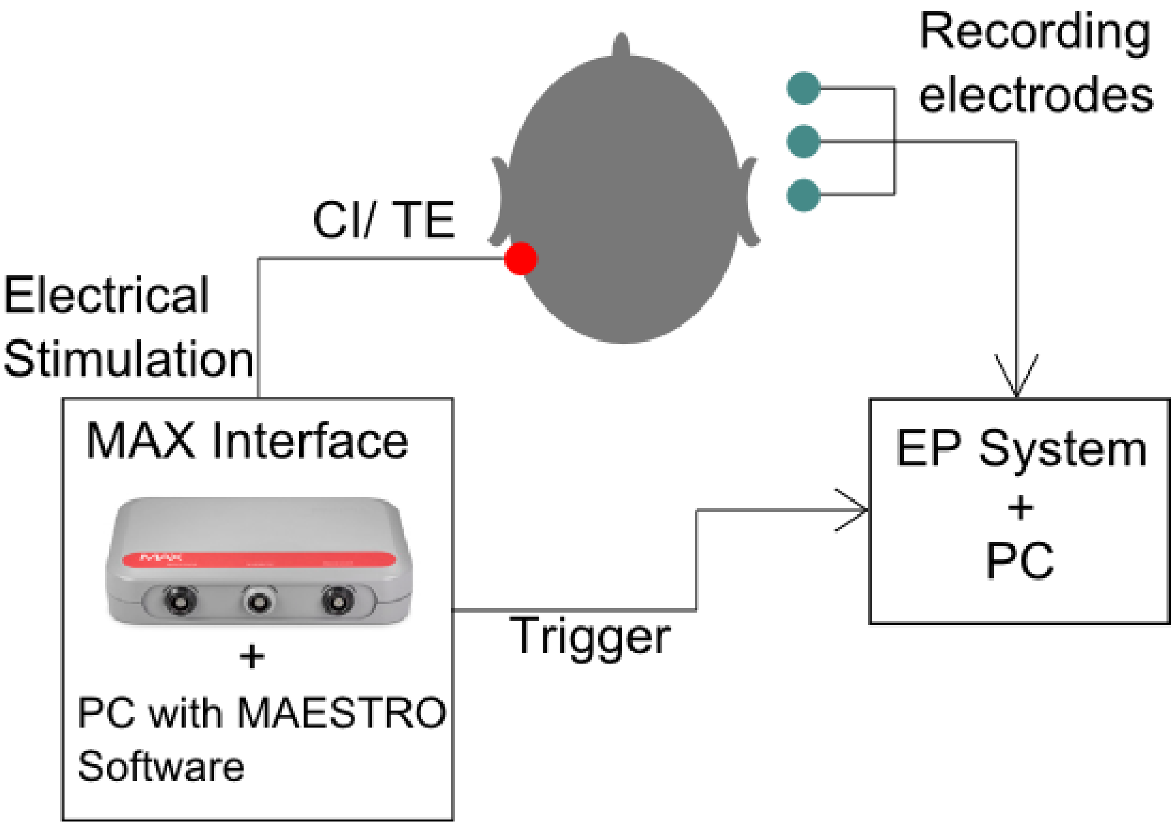

Figure 2: Intraoperative setup for recording eABR signals with the test electrode and the cochlear implant. The electrophysiological recording device (EP) receives trigger signals from the MAX interface.

eABR responses were recorded to electrical stimulation inside the cochlea with the test electrode and then, after the cochlear implant was inserted, the electrical stimulation was performed for the selected electrodes of the cochlear implant. Same stimulating levels as for the test electrode were used. The corresponding eABR responses were recorded. This amounts to 5 conditions in each patient. In total 50 conditions were recorded.

Biphasic pulses were applied via all electrode combinations. To assess the quality of an eABR waveform, scoring criteria from Gibson et al. were chosen. The waveforms in each session were classified by detecting wave III and V by the algorithm and visual assessment of the waveform. The speech performance was evaluated with monosyllables, disyllables and sentence recognition tests.

RESULTS

In all 10 patients responses to electrical stimulation could be evoked (Figures 3 and 4).

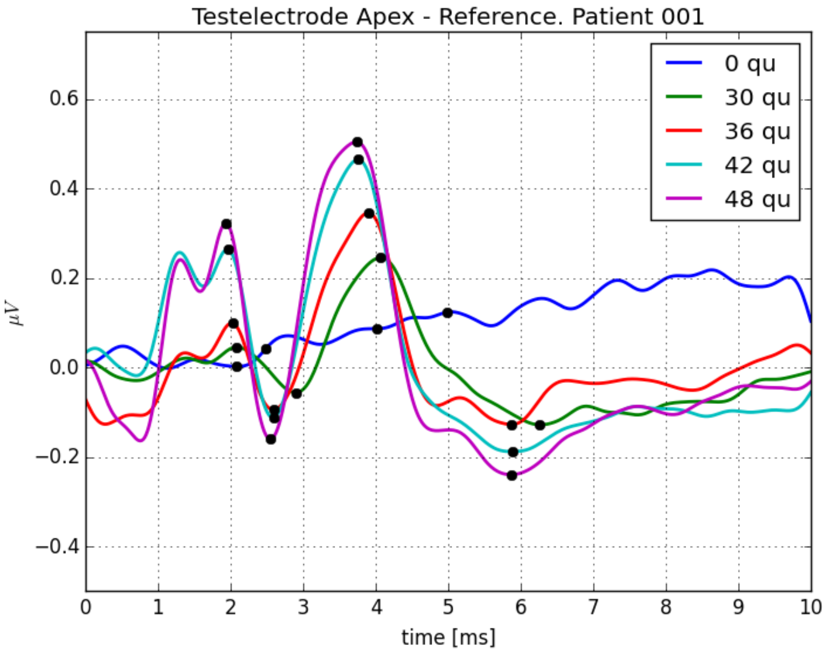

Figure 3: Responses to biphasic pulses applied with the TE in Patient 001. There is a significant increase in amplitude in waves III-V, when higher charges are applied. Black dots indicate maxima/ minima of waves III and V as detected by the algorithm.

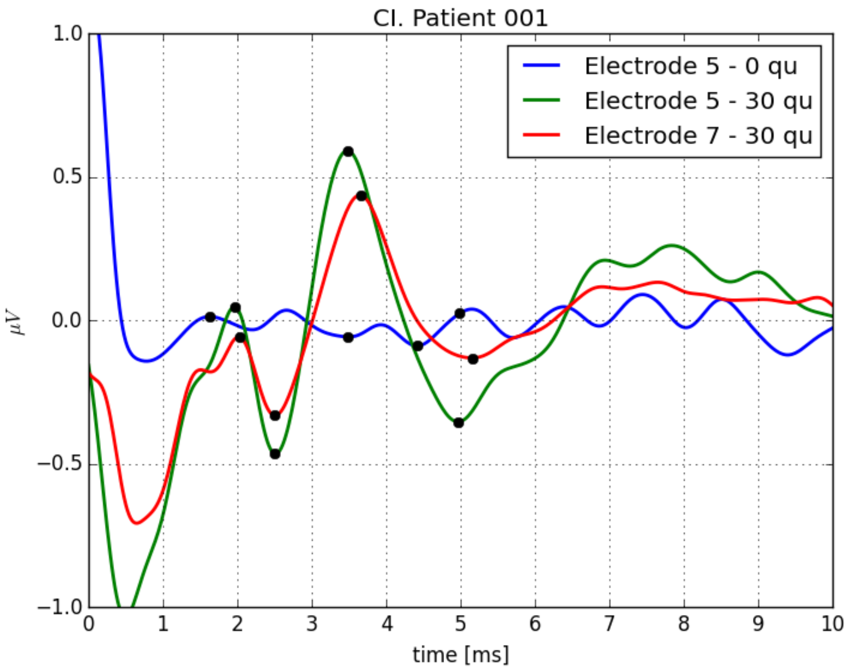

Figure 4: eABR evoked with the CI in subject 001. Clear responses of waves III and V can be observed with a charge of 30 qu on electrodes 5 and 7. The same conventions apply as in Figure 3.

In all cases both the intra-cochlear test electrode and the cochlear implant elicited responses and there were no statistical differences in latencies or amplitudes after stimulation with the test electrode or CI. The responses showed a clear increase in amplitude of waves III and V when higher stimulation charges were applied. In all cases the maximum and minimum of waves III and V were identified. The wave III latencies were at the same level in all conditions and showed no statistical difference ($p=0.95$, one-way ANOVA). Latencies for wave V were also at the same level with no statistical difference ($p=0.8$, one-way ANOVA).

All patients in this study obtained useful hearing by their implants and are using their implants daily. Auditory performance three months after the initial stimulation of the CI showed open-set speech recognition in all tested patients (74% - 100% sentence recognition in silence).

CONCLUSIONS

Our results suggest that the intra-cochlear testing electrode may be a suitable method to test the integrity of the auditory nerve by recording eABR signals. This allows for future development to further research on the status of the auditory nerve after tumor removal and correlations with auditory performance.