Neural Response Telemetry in Cochlear Implant Users

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Abstract: Programming of multichannel cochlear implants requires subjective responses to a series of sophisticated psychophysical percepts. It is often difficult for cochlear implant patients (especially young prelinguistically deaf children) to provide adequate responses for device fitting. However, the neural response telemetry (NRT) system renders possible the measurement of the compound action potential threshold. We performed NRT examinations in 27 cochlear implant users with Nucleus 24-channel cochlear implants. Measurements were obtained from five electrodes (3, 5, 10, 15, and 20) in each patient. Our goal was to look for correlation between behavioral subjective thresholds and compound action potentials. The action potentials could be elicited in 23 patients in all measured electrodes. The NRT threshold values were highly correlated with electrical threshold levels obtained through subjective responses. Our results suggest that the electrically elicited neural responses may yield very important information for device fitting in patients with cochlear implants.

Key Words: cochlear implant; neural response telemetry

The threshold levels in cochlear implant patients are well correlated to electrically evoked brainstem responses. The electrically evoked compound action potentials, which are closely related to the electrically evoked brainstem responses, would also show a similar correlation with the behavioral threshold [1]. Determining threshold levels requires subjective responses to a series of sophisticated psychophysical percepts. This is often difficult for cochlear implant patients. However, the neural response telemetry (NRT) system renders possible the measurement of the compound action potential threshold [2].

Our goal was to look for correlation between behavioral subjective thresholds and compound action potentials.

PATIENTS AND METHOD

We performed NRT examinations in 27 cochlear implant users (23 children and 4 adults) with Nucleus 24-channel cochlear implants. We used MP1 stimulation and MP2 recoding mode. Measurements were obtained at five electrodes (3, 5, 10, 15, and 20) in each patient. The starting current level was 10 μA below the threshold level, and it was increased up to the comfort level by 5-μA steps (Fig. 1A). The *NRT-T* (threshold) was identified as the minimum intensity value when the action potential could be evoked, and the *NRT-C* was identified as the intensity value when the linearity of the amplitude growth function was changed (see Fig. 1B).

Using the MAP program (in the speech processor), we compared the subjective electrical threshold (MAP-T) and electrical comfort (MAP-C) levels with the objective NRT-T and NRT-C levels.

RESULTS

The action potentials could be elicited in 23 patients in all measured electrodes and in 3 patients in some measured electrodes. The NRT could not be evoked in the case of only 1 patient. A comparison of the subjective and objective T and C levels can be seen in Figure 2. The mean values of NRT-T and NRT-C are between MAP-T and MAP-C. Usually, NRT-T values are 10 to 20 μA above the MAP-T, and the NRT-C values are 10–20 μA below MAP-C.

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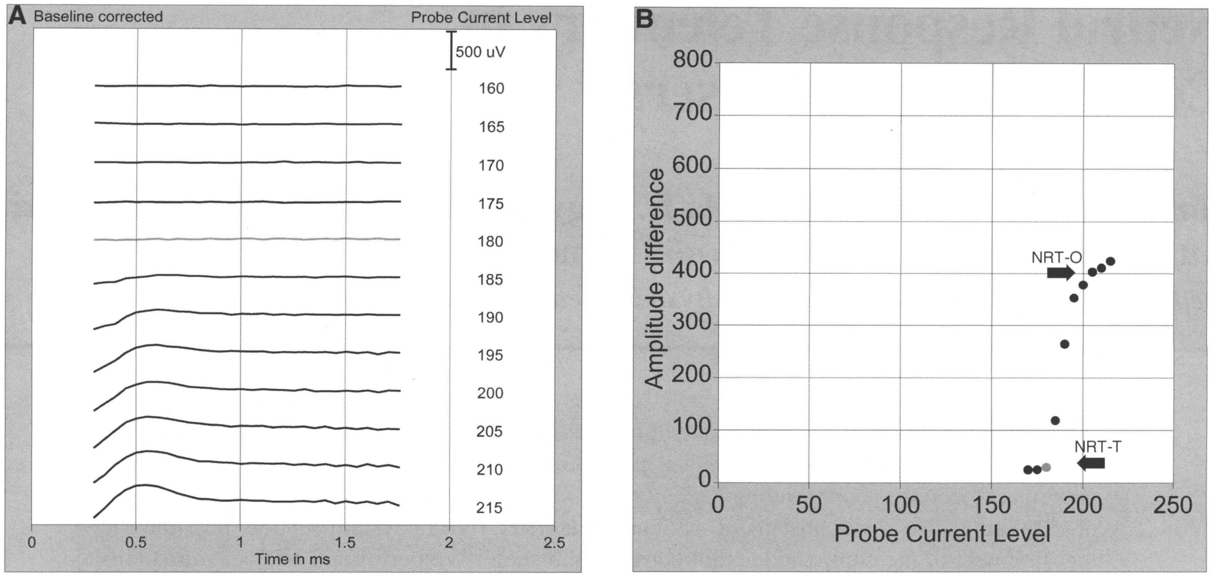

Figure 1. (A) Compound action potentials in cases of different probe stimulus intensities. (B) Amplitude growth function.

DISCUSSION

The NRT threshold values (NRT-T) were highly correlated with electrical threshold levels obtained through subjective responses [3–5]. Beyond NRT-T, neural responses increased linearly. Near the comfort level, this linearity changed in several cases (NRT-C). The subjective comfort levels were well estimated with the NRT-C values.

Our results suggest that the electrically elicited neural response thresholds do not accurately predict comfort levels in all individual cases. However, they may provide valuable information for programming the speech processor in patients who are unable to make reliable psychophysical judgments.

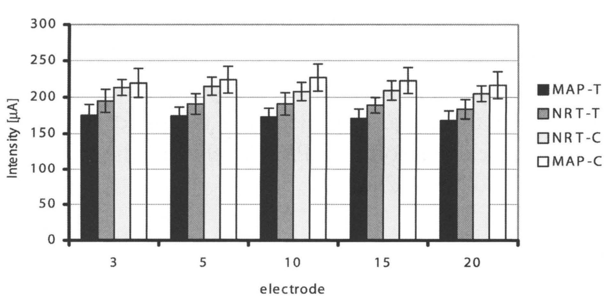

Figure 2. Comparison of subjective and objective T and C levels.

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