

NEURAL RESPONSE, RECOVERY AND SPREAD OF EXCITATION IN COCHLEAR IMPLANTED YOUNG CHILDREN

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Introduction

In order to understand the development of hearing continuous measurements of the impedance, the neural response, the spread of excitation and the recovery function of the hearing nerve were carried out in young cochlear implanted children.

Methods

Starting with the first fitting of the speech processor the threshold of the neural response (NRT), the recovery of the hearing nerve and the spread of excitation on electrodes 22, 16, 11, 6 and 1 of "Nucleus Freedom" implants (Cochlear) were measured about every eight weeks. The stimulus level for all measurements of recovery and spread of excitation was chosen 5cl higher than the neural response threshold, as part of the children did not accept higher stimuli because of loudness.

In addition the measurements of the impedances and the NRT thresholds were repeated several times per session and per week. Furthermore measurements concerning the optimization of the measurement parameters and the influence of the stimulus level on the recovery function and the spread of excitation were carried out.

Clinical Cases

All children implanted with a Nucleus Freedom device (Cochlear), who attend the rehabilitation program at the Pediatric Center of Munich are included. Up to now six children are fitted for the first time at the age of 22 to 46 months, four of them are now implanted for already half a year.

Summary and Conclusions

Impedances decrease pantonal and seem to **stabilize within half a year**. Maximum changes are observed at the basal electrode.

The **NRT threshold tends to increase** within an interval up to **66cl** at the **apical electrodes** especially during the first four months, whereas it seems to keep more stable at the other electrodes. The basal electrode shows significant inter-individual differences of the NRT thresholds. Within half a year **60% of the electrodes** show a **minimal change of the NRT threshold of 10cl**. This should be taken into account using the NRT thresholds for the determination of the T-level.

Best results measuring the recovery function and the spread of excitation could be observed using a **gain of 40dB**.

Using a stimulus level of 5cl above the directly before measured NRT threshold (as part of the children did not accept higher stimuli) possible time dependant changes of the recovery function and the spread of excitation exceeding significantly the changes within one week can not be observed. Thus the condition of **measuring each child at the same stimulation level** in relation to the NRT threshold **should not be kept**.

Further measurements of the **NRT thresholds**, the **impedances**, the **influence of the stimulation level**, the **recovery functions** and the **spread of excitation** using the **highest possible stimulation level** within one fitting session and every eight weeks are planned.

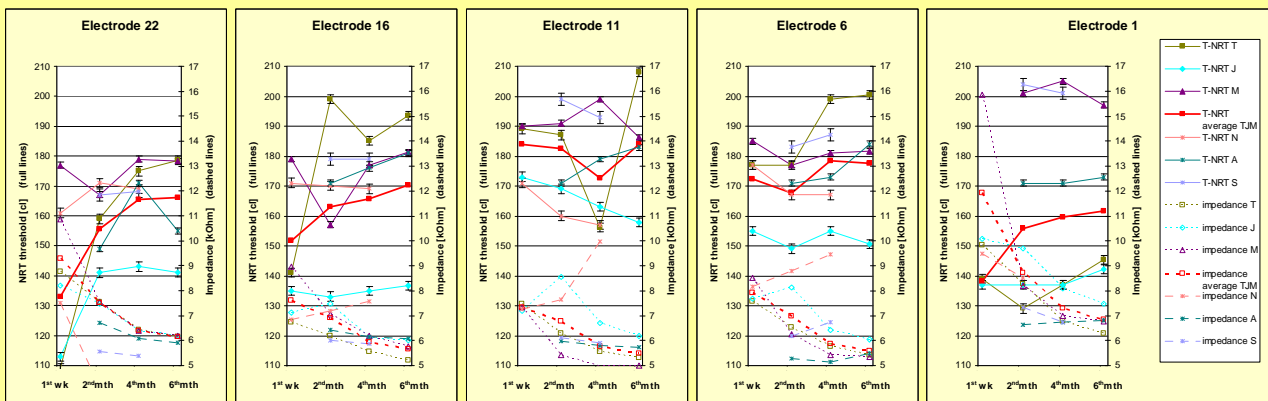


Figure 1: NRT thresholds and impedances in relation to time, „Fehlerbalken“: variation of the NRT threshold within a week

Impedances

Impedances decrease pantonal (Figure 1, dashed lines), varying within a week in an interval of 0,02-1,05kΩ around the average value (in average over all children 0,29kΩ) and over half a year in an interval of 0,29-7,63kΩ (in average 1,67kΩ). They seem to **stabilize within half a year**. Maximum changes are observed at the basal electrode.

NRT-Thresholds

The NRT thresholds vary within **one session** (at least two months after the first fitting session) in a maximum interval of **1-3cl** around the average value (in average over all children **2cl**) and within **one week** in an interval of **0-8cl** (in average **3,2cl**). **No dependency on the localization** of the electrode in the cochlear can be observed.

Figure 1 shows the development of the NRT thresholds (full lines) and the impedances (dashed lines) over half a year. At the **apical electrodes** 22 and 16 the **NRT threshold tends to increase especially** during the first four months within an interval up to **66cl**, whereas it seems to keep more stable at the other electrodes. At electrode 1 (basal) significant inter-individual differences are observed. We found no **correlation to the impedances**.

In **60% of the electrodes** there is a **minimal change of 10cl** of the NRT threshold within half a year. Figure 2 shows the percentage of electrodes with minimal changes of 5cl, 8cl and 10cl every two months.

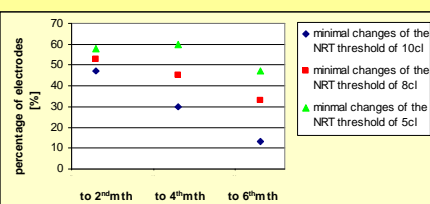


Figure 2: Changes of the NRT threshold in relation to time

Optimization of the Measurement Parameters

Contrary to the default measurement parameters of the *custom sound EP* software (Cochlear) amplitude differences are enhanced using a **gain of 40dB** at nearly all of the 30 electrodes. The negative peak (N1) is represented best using **low delays**.

The **stimulus level is limited** not only by the accepted **loudness** but also by the growing number of **artifacts** or the recordings getting **out of compliance**. The critical stimulus level varies inter-individually between **5 to 40cl** above the NRT threshold.

Recovery

Using a stimulus level of 5cl above the directly before measured NRT threshold possible time dependant changes of the recovery function and the spread of excitation exceeding significantly the changes within one week can not be observed within half a year. There are significant intra-individual changes between different probe electrodes, but **no dependency on the localization** of the electrodes in the cochlear can be observed.

Stimulating at **maximum current level** the parameters of the calculated recovery function using the algorithm which is implemented in the *custom sound EP* software change significantly less by enhancing the stimulation level to the maximum possible level. **Within a week the absolute refractory time** of the hearing nerve varies within **64 to 74µs** (in one case up to 324µs), the **saturation** within **11 to 27µV** and the **relative refractory time** within **0,27 to 0,43µs**.

Spread of Excitation

Using a stimulus level of 5cl above the directly before measured NRT threshold a spread of excitation can be observed on one up to five neighboring electrodes in 56% of the measurements. Partly no effect on neighboring electrodes and in single cases any answer can be detected. There are significant intra-individual changes between different probe and masker electrodes, but **no dependency on the localization** of the electrode in the cochlear can be observed.

Stimulating at **maximum current level nine to twelve neighboring electrodes** show **clear negative (N1) and positive (P1) peaks**. The shape of the response waveforms at every electrode keeps stable within a day and a week.