Intraoperative Round Window Electrocochleography and Speech Perception Outcomes in Pediatric Cochlear Implant Recipients

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Background

• Speech perception performance following cochlear implantation (CI) varies substantially in children
• Audiologic, educational, child/family, and implant factors seldom account for greater than one-quarter of the variance
• Round window (RW) electrocochleography (ECoG) can record hair cell and neural responses to acoustic stimulation and thus provide direct information about residual cochlear function
• Hypothesis: RW ECoG obtained at the time of CI will predict speech perception outcomes in children

Objectives

To describe the use of round window electrocochleography for assessing residual cochlear function in pediatric cochlear implant recipients and to investigate its utility for predicting speech perception outcomes

Methods (Continued)

Operative Setup and Recordings (Fig. 2)

• Standard trans-mastoid, facial recess approach to cochlear implantation
• Recording electrode was placed in round window niche just prior to implantation
• Tone burst stimuli at 250, 500, 750, 1000, 2000, and 4000 Hz and 90 dB nHL were delivered through a sound tube and foam ear piece in the ipsilateral ear

Results

ECoG-Total Response Across All Ears

• Significant ECoG responses in 87 of 89 (98%) ears
• ECoG-TR was normally distributed and spanned more than 60 dB (Fig. 4)
• ECoG-TR magnitudes varied by etiology and were significantly higher in ANSD subjects (Fig. 5)
• Pre-op pure tone average (PTA) was significantly correlated with ECoG-TR ($r^2 = 0.14$; $p = 0.001$) (Fig. 6)

Figure 2. Operative picture showing recording electrode in the RW niche.

Electrocochleographic Recordings

• Harmonic distortion informs about surviving hair cell and neural cells
• “ECoG-Total Response (ECoG-TR): Sum of significant 1st, 2nd, and 3rd harmonic distortion peaks across all frequencies (Fig. 3); single measure of overall cochlear health

Study Population

• IRB approval obtained from the University of North Carolina
• All pediatric cochlear implant recipients with English-speaking parents or guardians, excepting those with atretic ear canals or revision cases

Study Design

• Longitudinal cohort study with standard audiologic and speech follow-up at the Carolina Childhood Communicative Disorders Program (CCCDP)
• Historical and audiometric data collected at pre-implantation visits

Figure 1. Carolina Children’s Communicative Disorders Program

Table 1. Demographic characteristics of study subjects with PB-k testing

|| Characteristic | Number (% total or SD) |
|----------------|-----------------------|
| Sex            |                       |
| Male           | 12 (46)               |
| Female         | 14 (54)               |
| Age at Onset of Severe to Profound HL | 15 (50) |
| 1 year         | 15 (50)               |
| 2 years        | 7 (27)                |
| Hearing Stability |            |
| Stable         | 9 (35)                |
| Progressive    | 17 (65)               |
| Average Age at First Implantation, months | 48 (41) |
| Average PTA (dB nHL) | 97.8 (122.3) |
| Average ECoG Total Response (dB re: 1 μV) | 7.1 (8.8) |
| Average Duration of CI Use at Testing, months | 14.1 (5.9) |
| Average PB-k score (percent correct) | 66 (21) |

Data Analysis

• Univariate (ANOVA) and multiple hierarchical linear regression modeling to investigate association between ECoG, other clinical and biologic factors, and PB-k performance

Discussion

Predictable speech perception outcomes

• Small ECoG-TR could identify children who might require earlier, more targeted audiologic and speech interventions
• Identification of children who are performing poorly relative to large ECoG-TR $\rightarrow$ change mapping parameters?

Conclusions

• ECoG-TR is a quick and direct assessment of residual cochlear health at the time of CI
• ECoG-TR can potentially account for more variance in pediatric speech perception outcomes than other traditional factors
• This measure can offer prognostic information to caregivers and clinicians about open set speech

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