Cochlear Physiology & Speech Perception
Outcomes in a Pediatric Population

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Disclosures

- **Consultant** for
  - MED-EL Corp.
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- **Research** support
  - MED-EL Corp.
  - Cochlear Corp.
  - Advanced Bionics Corp.

- **Study Institution**
  - UNC Chapel Hill
Background

• Performance **varies** substantially across all populations

• **Variables** affecting outcomes
  – Audiologic
  – Educational
  – Child/family
  – Anatomic/implant
  ~ 25% of variance

• **RW ECoG** can record hair cell & neural responses
  Direct information about residual cochlear function
Hypothesis

- **RW ECoG** obtained at the time of CI will predict speech perception outcomes in children
Objectives

• Assess ability to record ECoG during pediatric CI
  Acoustic stimulation, RW electrode

• Investigate it’s potential to predict speech perception outcomes
Patients

• **IRB obtained** at study institution

• **All** pediatric CI candidates w/ English speaking parents
  – No revision cases
  – Present EAC
Study Design

- Longitudinal cohort study
  standard audiologic & speech f/u

- Historical and audiometric data
  collected at pre-implantation visits

- Intraoperative data collection
Intraoperative Set-up

- **Standard approach**
  trans-mastoid, facial recess

- **Recording electrode**
  at RW niche

- **Tone burst stimuli**
  Sound tube & ear foam
  250, 500, 750, 1000, 2000, 4000 Hz @ 90 dB nHL
Electrocochleography (ECoG)

- **Harmonic distortion**
  informs about surviving hair cells and neural component

- **ECoG-TR**
  Single measure of overall cochlear health
  sum of 1st, 2nd, and 3rd harmonic distortion peaks
  across all frequencies
Electrocochleography

- Condensation/rarefaction
  Example for 500 Hz response
- FFT energy spectrum
- Harmonic distortion peaks
  first and second harmonics
- Total response (ECoG-TR)
  sum of significant peaks at the first,
  second, and third harmonics
  across frequencies
Speech Perception Testing

- Battery of age-appropriate speech perception tests
  open & closed set

- Subset evaluated with PB-k
  Open set @ 9-12 months post-op
Data Analysis

• Univariate (ANOVA) & multiple hierarchical linear regression modeling

• Investigate association between
  – ECoG
  – Other clinical and biologic factors
  – PB-k performance
Results – ECoG-TR all Ears

• Significant ECoG responses in 87/89 ears (98%)
• ECoG-TR
  – showed normal distribution
  – Varied by etiology (ANSD higher)
• PTA significantly correlated with ECoG-TR
  \( r^2 = .14; p = .001 \)
Normal Distribution

![Histogram with normal distribution curve](image)

- **Mean**: 6.08
- **Std. Dev.**: 14.158
- **N**: 89

The histogram represents the distribution of **ECoG Total Response** (dB relative to 1 uV) with a normal distribution curve overlay. The number of patients is indicated on the y-axis, while the ECoG response values are shown on the x-axis.
ECoG TR by Etiology

![Box plot showing ECoG Total Response (dB re: 1 µV) for different etiologies: Meningitis, Genetic, Unk. or Congenital, CMV, EVA, ANSD. The etiologies are ordered along the x-axis from left to right.]
PTA & ECoG

$r^2 = 0.14$

$N = 89$

$p = 0.001$
Results – Other Factors

• **ECoG-TR**
  – Significant, positive correlation with **PB-k scores** in 26 subjects (28 ears), accounting for **32% of the variance**

• **Preoperative PTA**
  – Significant, inverse correlation with PB-k scores
    \[ r^2 = .37, \ p = .001 \]

• **Univariate analysis:**
  – Duration of CI use
  – Age at PB-k testing
  – Progressive nature of HL
    
    Correlated w/ **PB-k**
Correlation ECoG-TR & PB-k

$\text{r}^2 = 0.32$
$p = 0.002$
$n = 28$
Correlation PTA & PB-k

$r^2 = 0.37$
$p = 0.001$
$n = 28$
Significant Factors

- **Univariate Analysis**
  - **Categorical**
    - progressive hearing loss
  - **Continuous**
    - Duration of CI use
    - Age at testing
    - PTA
    - ECoG TR

- **Multivariate Analysis**
  - **Continuous**
    - ECoG TR
    - adjusted $r^2 = .29$, $p = .04$
Significant Factors

• Hierarchical Models
  – Adding
    • Duration of CI use
    • PTA
  – To model with ECoG-TR
  – Increased the predictive capacity of the model adjusted $r^2=.49$
Discussion

• **ECoG-TR**
  - direct assessment of *residual cochlear health*
  - Can potentially *account for more variance* than traditionally recognized factors
  - *Prognostic* information
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