Variability and Patient Characteristics of Interaural Depth of Insertion in Children with Bilateral Cochlear Implants

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INTRODUCTION

Cochlear implant (CI) electrode array depth of insertion (DOI) can affect speech perception outcomes. DOI determines, in part, the degree of frequency-to-place disparity in the inner ear. Evidence from bilateral CI users suggests that asymmetrical DOI between ears, or interaural "mismatch", can negatively affect binaural benefit. Mismatch might occur due to asymmetrical anatomy, differences in electrode type, or surgical approach. A previous study completed by this team demonstrates that DOI can be reliably measured in children using cochlear view x-rays.

Study Aims:

1. Describe incidence of mismatch in bilaterally implanted children
2. Determine patient characteristics associated with mismatch or shallow DOI including:
   - Simultaneous v sequential implantation
   - Abnormal Cochlear anatomy
   - Cochleostomy v round window insertion
   - Electrode array type

METHODS

- IRB approved prospective, observational study
- All patients underwent ear-specific cochlear view x-rays on postop day 1
- Patients with inadequate x-rays (off axis) excluded
- Linear DOI, defined by distance (mm) of the proximal electrode from the round window, measured by two pediatric in randomized, blinded fashion
- Severe interaural mismatch defined as 3mm (Goupell et al., 2013)
- Chart review was completed to identify demographic and audiological characteristics detailed in hypothesis

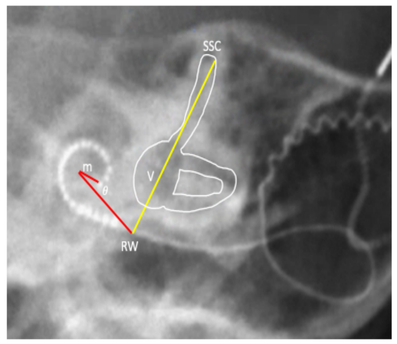

Figure 1. Measure of DOI on cochlear view x-ray.

HYPOTHESES

The following hypotheses were made:

- Interaural mismatch will be associated with:
  - Sequential v simultaneous implantation
  - Abnormal v normal cochlear anatomy
  - Lateral wall v perimodiolar arrays
- Shallower insertion depth will be associated with:
  - Abnormal v normal cochlear anatomy
  - RW insertion v cochleostomy
  - Lateral wall v perimodiolar arrays

RESULTS

1. Severe interaural mismatch is found in 5.8% (n=1) of patients (see figure 2). This 16-year-old female patient was simultaneously implanted using the cochleostomy approach with CI 512 internal devices. Notably, this patient has abnormal fibrotic cochlea as identified by abnormal T2 signal.
   - Mean age= 2.96 (4.08)
   - Males = 71% (n=12)
   - Mean LDOI = 0.92 mm (0.94).
2. The descriptive data collected is shown in the tables below.

	Surgery Sequence	Cochlear Anatomy	Electrode Array	Surgical Approach	Mismatch
1	Sequential	Normal	Lateral	Round Window	No
2	Sequential	Normal & Abnormal	Perimodialar	Round Window & Cochleostomy	No
3	Simultaneous	Normal	Perimodialar	Cochleostomy	No
4	Simultaneous	Normal	Perimodialar	Cochleostomy	No
5	Simultaneous	Normal	Perimodialar	Cochleostomy	No
6	Simultaneous	Abnormal	Perimodialar	Cochleostomy	No
7	Simultaneous	Normal	Perimodialar	Cochleostomy	No
8	Simultaneous	Abnormal	Perimodialar	Cochleostomy	No
9	Simultaneous	Normal	Perimodialar	Cochleostomy	Borderline
10	Simultaneous	Abnormal	Perimodialar	Cochleostomy	Severe
11	Simultaneous	Normal	Perimodialar	Cochleostomy	No
12	Simultaneous	Abnormal	Lateral	Cochleostomy	No
13	Simultaneous	Normal	Perimodialar	Cochleostomy	No
14	Simultaneous	Normal	Perimodialar	Cochleostomy	No
15	Simultaneous	Normal	Perimodialar	Cochleostomy	No
16	Simultaneous	Normal	Perimodialar	Cochleostomy	No
17	Simultaneous	Normal	Perimodialar	Cochleostomy	No

Table 1. Demographic information of each patient.

Surgery Sequence		Cochlear Anatomy		Surgical Approach		Array Type	
Simultaneous n=30	Sequential n=4	Normal n=25	Abnormal n=9	RW n=3	Cochleostomy n=29	Perimodiolar n=30	Lateral Wall n=4
2.5 (1.09)	**2.6** (0.88)	**2.15** (1.05)	**2.4** (1.07)	**2.6** (0.89)	**2.15** (1.07)	**2.5** (1.07)	**2.4** (1.03)

Table 2. Mean DOI (and SD) in each demographic category.

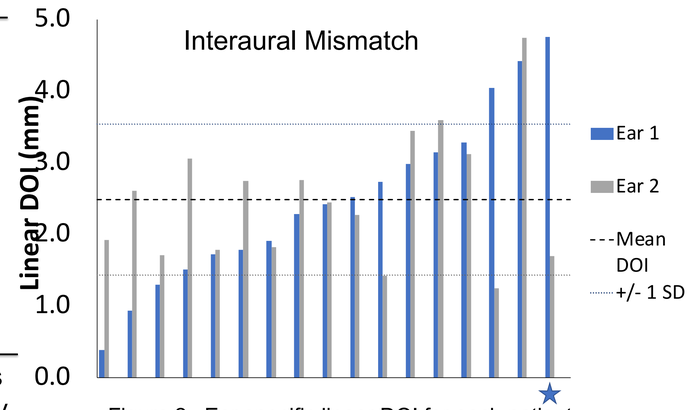

Figure 2. Ear specific linear DOI for each patient. Star indicates patient with severe mismatch.

DISCUSSION

- The incidence of mismatch is extremely low.
- No variables studied were strongly associated with interaural mismatch or depth of insertion.

Severe mismatch as measured by linear depth of insertion (3mm) occurred in only 5.8% (n=1) of subjects in this study. This may be associated with the patient's cochlear fibrosis. It should be noted that one other subject had a near-severe mismatch of 2.8 mm. Thus subject was implanted elsewhere so we do not know about cochlear anatomy. Due to such low incidence of mismatch, these data should be considered preliminary. Future research by this team includes evaluation of incidence of shallow and deep insertion depth. Additionally, the team will identify if any of the demographic data is associated with shallow or deep linear depth of insertion.

LIMITATIONS

- Small sample size
  - Limited age range
  - Sequential, abnormal anatomy, and round window insertion limited sample size
  - Unable to do analysis on severe mismatch

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