Benefits of Cochlear Implantation Among Adults and Children with Unilateral Hearing Loss

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Disclaimer

I declare that I have no proprietary interest in any product, instrument, device, service, or material related to this presentation.

I have previously served on the audiology advisory board for MedEl Corporation.

Senior author (CLWD) is on the surgical advisory board for Cochlear, AB, and MEDEL.

I will be discussing off-label use of a cochlear implant.
Background

- Improved outcomes in speech understanding and localization (Firszt et al., 2012; Haensen et al., 2013; Blascoe & Redleaf, 2014)

- Binaural advantage
  - Two ears are better than one for listening in noisy situations (Blonkhorst & Plomp, 1988; Licklider, 1948)

- Binaural disadvantage, interference
  - Overall performance is worse when listening with interaural asymmetries compared to listening with the better hearing ear (Shinn-Cunningham et al., 2001; Rothpletz et al., 2004)
Specific aims

• **Aim 1.** Does cochlear implantation restore speech understanding abilities to the ear implanted among adults and children with unilateral hearing loss (UHL)

• **Aim 2.** Does cochlear implantation result in a binaural advantage among adults and children with UHL: improved speech understanding in diffuse noise, improved self perceived spatial hearing

• **Aim 3.** Does cochlear implantation reduce overall listening effort for adults and children with UHL
Participants

- **Inclusion**
  - Children 7 years of age and older
    - Single words score less ≤ 50%, ear to be implanted
    - Onset of UHL greater than 6 months and less than two years
    - Contralateral hearing thresholds ≤ 30 dB HL through 2K Hz
  - Adults 18 years of age and older
    - Single word score ≤ 50%, ear to be implanted
    - Onset of UHL greater than 6 months and within two years
    - Contralateral hearing thresholds ≤ 30 dB HL through 2K Hz

- **Exclusion**
  - Known cognitive deficits
Test Measures

• Speech understanding in quiet
  • Preoperative aided (presented at 60 dB SPL, contra ear masked) post-activation (direct audio input, comfortable loudness level)
    • CNC words (Peterson & Lehiste, 1962)
    • AzBio sentences (Spahr & Dorman, 2012)
  • Speech understanding in noise
    • HINT sentences adaptively (Nilsson et al., 1998) in an R-SPACE 8-speaker array
  • Questionnaires
    • Speech Spatial Hearing Questionnaire-Comparative (SSQ-C; Noble & Gatehouse, 1990)
  • Listening effort
    • Dual task paradigm

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Speech, Spatial and Qualities of Hearing Questionnaire – Comparative (SSQ-C)
Listening effort

• Dual task paradigm
  • Primary task (speech in noise)
    • CNC words, 0° azimuth
    • Restaurant babble, R-SPACE 8-speaker array, 60 dB SPL(A) with 0 dB SNR
  • Secondary task (reaction time)
    • Button response to a square presented amongst long and tall rectangles
<table>
<thead>
<tr>
<th></th>
<th>Pre-operative</th>
<th>3-months post activation</th>
<th>6-months post activation</th>
<th>12-months post activation</th>
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<td>AzBio Sentences</td>
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<td>Speech in noise (R-SPACE)</td>
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<td>SSQ-C</td>
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<td>Synchrony Flex 28</td>
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11 - 61 years mean 41 years
10 Right
6 Left
8 MED EL
7 Cochlear
1 AB
Study Participants (n=16)

Ear implanted

Ear not implanted
Results: Speech Understanding

- **Pre**: CNC SSD 43.7%, AzBio SSD 9.1%, CNC Bilateral 14.2%
- **3 Mos N=13**: CNC SSD 54.0%, AzBio SSD 30.0%, CNC Bilateral 39.9%
- **6 Mos N=11**: CNC SSD 60.3%, AzBio SSD 58.0%, CNC Bilateral 72.5%
- **12 Mos N=7**: CNC SSD 48.8%, AzBio SSD 66.0%, CNC Bilateral 63.0%
Results: Speech in Noise, 6 mos, n = 11

R-SPACE HINT

* p = .03

-0.7

1.2

Cl On

Cl Off

dB SNR
Results: Self perceived benefit; SSQ-C (n= 11)

-5
-4
-3
-2
-1
0
1
2
3
4
5

Much Better

Much Worse

Speech
Spatial
Qualities

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Results: Self perceived benefit; tinnitus (n= 14)
Results: Listening effort (n=7)

CNC Words

Percent (%) correct

Device On
Quiet
0 dB SNR
Device Off
Results: Listening effort, 12 mos (n=7)

Reaction Times

- Baseline
- Device On
- Device On
- Device Off

Quiet

0 dB SNR
Summary

• Preliminary results demonstrate that cochlear implantation for adults with unilateral hearing loss allows:
  • improved speech understanding for the implanted ear, though mean percent scores are lower than mean percent correct scores of adults with bilateral hearing loss
  • Improved speech understanding in noise measured in diffuse noise
  • Improved self perceived benefit for tinnitus and SSQ-C
  • Negligible benefit for listening effort

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Questions & Discussion