Acoustic and Electric Same Ear Hearing in Patients with a Standard Electrode Array

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Audiologists:
- Jill Beecher, AuD, CCC-A
- Christine Etler, AuD, CCC-A
- Lisa Stille, MA, CCC-A
### Demographics

<table>
<thead>
<tr>
<th>Subject</th>
<th>Gender</th>
<th>Age at Implant (yrs:m)</th>
<th>Duration HF S/P HL (yrs)</th>
<th>Etiology</th>
<th>Pre-op HA Use</th>
<th>Electrode Array</th>
<th>Duration Implant Use (months)</th>
<th>Current # of Active Electrodes</th>
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</thead>
<tbody>
<tr>
<td>P1</td>
<td>M</td>
<td>79:4</td>
<td>19</td>
<td>Noise</td>
<td>Bilateral</td>
<td>CI24RE</td>
<td>25</td>
<td>20</td>
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<tr>
<td>P2</td>
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<td>78:11</td>
<td>28</td>
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<td>Left only</td>
<td>CI422</td>
<td>22</td>
<td>17</td>
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<tr>
<td>P3</td>
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<td>11*</td>
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<td>37</td>
<td>Unknown</td>
<td>Bilateral</td>
<td>CI422</td>
<td>6</td>
<td>18</td>
</tr>
</tbody>
</table>

Definitions: HF S/P HL=high-frequency severe-to-profound hearing loss

*P7 hit head just prior to initial activation
Considerations: When to Use AC for Standard CI Patients

- Audiogram
  
  If post-operative thresholds are:
  
  - 125 Hz: $\leq 70$ dB HL
  - 250 Hz: $\leq 70$ dB HL
  - 500 Hz: $\leq 70$ dB HL
  - 750 Hz: $\leq 70$ dB HL

  Then: consider using an acoustic component
Considerations: When to Use AC for Standard CI Patients

- Dexterity and cognitive function of patient (or caregiver who can maintain/trouble-shoot AC)
- Persistent cerumen issues
- Out-of-pocket expense for patients
  - Insurance may not cover:
    - post-activation audiograms to monitor residual hearing
    - verification of AC
    - cost of custom earmold/replacement domes
    - replacement of out-of warranty ACs
Considerations: When to Use AC for Standard CI Patients

- Approximation to prescriptive real-ear targets (NAL-NL2)
- Soundfield threshold measures should be ≤30 dB HL for AC frequencies
- Speech recognition measures in clinic
- Subjective impressions by patient for everyday listening benefit
- Music appreciation
- When fit at initial activation, the AC may improve acceptance of the CI device (more natural versus mechanical or raspy quality)
- Patients who are not progressing with speech recognition abilities
Subject P4

Gender: M
Age at Implantation: 82y:5m
Duration HF S/P HL: 41y
Etiology: Noise Exposure
Duration Between IA & Use of AC: 16m
Current # Active Electrodes: 14
Electric Frequency Range: 188-7938 Hz

AzBio Sentences (quiet)

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Implanted Ear – Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>Pre-op</td>
</tr>
<tr>
<td>250</td>
<td>Post-op (16m)</td>
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<tr>
<td>500</td>
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<tr>
<td>750</td>
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<tr>
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<td>6000</td>
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<tr>
<td>8000</td>
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</tbody>
</table>

Hearing Level (dB HL) vs. Frequency (Hz)

-10 to 120 dB HL

- Bimodal (CI+contra HA)
  - Pre HAs
  - CI Only
- AzBio Sentences (quiet)
  - Pre HAs
  - CI Only
  - 16m
Subject P4

Gender: M
Age at Implantation: 82y:5m
Duration HF S/P HL: 41y
Etiology: Noise Exposure
Duration Between IA & Use of AC: 16m
Current # Active Electrodes: 14
Electric Frequency Range: 563-7938 Hz

Implanted Ear – Right
- Pre-op
- Post-op (16m)

AzBio Sentences (quiet)

Percent Correct

Frequency (Hz)

Hearing Level (dB HL)
Subject P3

Gender: M  
Age at Implantation: 73y:0m  
Duration HF S/P HL: 11y  
Etiology: Noise Exposure  
Duration Between IA & Use of AC: 9m  
Current # Active Electrodes: 19  
Electric Frequency Range: 188-7938 Hz

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### AzBio Sentences (quiet)

<table>
<thead>
<tr>
<th></th>
<th>Pre HAs</th>
<th>6m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bimodal (CI+contra HA)</td>
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</tr>
<tr>
<td>CI Only</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Impacted Ear – Right

- **Pre-op**
- **Post-op (18m)**
Subject P3

Gender: M
Age at Implantation: 73y:0m
Duration HF S/P HL: 11y
Etiology: Noise Exposure
Duration Between IA & Use of AC: 9m
Current # Active Electrodes: 19
Electric Frequency Range: 688-7938 Hz

AzBio Sentences (quiet)

Percent Correct

- Pre HAs
- 6m
- 12m (AC)
- 18m (AC)

Implanted Ear – Right

Pre-op
Post-op (18m)
Subject P3

Gender: M
Age at Implantation: 73y:0m
Duration HF S/P HL: 11y
Etiology: Noise Exposure
Duration Between IA & Use of AC: 9m
Current # Active Electrodes: 19
Electric Frequency Range: 688-7938 Hz

AzBio Sentences (+5 dB SNR)

- CI only
- Hybrid
- Bimodal
- Combined

18 months

Hearing Level (dB HL) vs. Frequency (Hz)

Implanted Ear – Right
- Pre-op
- Post-op (18m)
Subject P10

Gender: M  
Age at Implantation: 73y:8m  
Duration HF S/P HL: 18y  
Etiology: Noise Exposure  
Duration Between IA & Use of AC: 0 mos  
Current # Active Electrodes: 20  
Electric Frequency Range: 438-7938 Hz

AzBio Sentences (quiet)

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>750</th>
<th>1000</th>
<th>1500</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>6000</th>
<th>8000</th>
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</thead>
<tbody>
<tr>
<td>Hearing Level (dB HL)</td>
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<td>Pre-op</td>
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<tr>
<td>Post-op (6m)</td>
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</tbody>
</table>
Subject P10

Gender: M
Age at Implantation: 73y:8m
Duration HF S/P HL: 18y
Etiology: Noise Exposure
Duration Between IA & Use of AC: 0 mos
Current # Active Electrodes: 20
Electric Frequency Range: 438-7938 Hz

AzBio Sentences (+5 dB SNR)

6 months

- 0
- 20
- 40
- 60
- 80
- 100

Percent Correct

CI only Hybrid Bimodal Combined

Implanted Ear – Right

Pre-op
Post-op (6m)

Hearing Level (dB HL)

Frequency (Hz)

125 250 500 750 1000 1500 2000 3000 4000 6000 8000
Does your own voice, other people's voices, and everyday sounds seem clear and natural?

Scale: 0 = not at all (minimum) - 10 perfectly (maximum)
Localization in Quiet
(Front-Facing)

Total RMS Error

- P2 (22m)
- P3 (18m)
- P5 (12m)
- P7 (6m)
- P8 (6m)
- P10 (3m)
- P12 (3m)
- Mean

m=months post-activation

Bimodal
Combined

The University of Iowa
Conclusion

• Preliminary speech recognition data show that patients with a standard electrode array who have various levels of low-frequency acoustic hearing can benefit from the combination of acoustic and electric hearing in the same ear.

• Even if a patient was initially activated using a full frequency range (i.e. 188-7938 Hz), the clinician should consider trying an acoustic component if a patient has residual low frequency hearing and demonstrates lack of progress with speech recognition or sound quality issues.

• Preliminary results suggest that patients generally report better subjective ratings when using an acoustic component with CI compared to cochlear implant alone.

• Further investigation is warranted to determine when to use an acoustic component in an ear implanted with a standard electrode array when functional acoustic hearing has been maintained versus cochlear implant alone.