An Overview of Hearing Preservation Systems

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Hearing Preservation

I know it when I see it...

Former supreme Court Justice Potter Stewart
Early Recognition of CI HP

- Dye L, House WF, O’Connor C: Measurable residual hearing following cochlear implantation. AAO-HNS, Chicago, 1987
Conservation of Residual Hearing with Cochlear Implantation

Annette V. Hodges, Jerry Schloffman, and Thomas Balkany

- Am J Otol 1997
- ~50% hearing conservation
- Unknown factors
Electric-Acoustic Stimulation of the Auditory System

New Technology for Severe Hearing Loss

C. von Ilberg\textsuperscript{a}  J. Kiefer\textsuperscript{a}  J. Tillein\textsuperscript{b}  T. Pfenningdorff\textsuperscript{a}  R. Hartmann\textsuperscript{b}
E. Stürzebecher\textsuperscript{a}  R. Klinke\textsuperscript{b}

Departments of \textsuperscript{a}Otorhinolaryngology and \textsuperscript{b}Physiology, Johann Wolfgang Goethe University, Frankfurt/Main, Germany
Von Ilberg et al, 1999

- Acute ball electrode stim of RW in cats
- Chronic ball electrode stim of RW in GPs
- Case report in CI patient w/ residual hearing
Scores with HA alone, CI alone and ipsilateral combination of both HA + CI under conditions of different numbers of active channels.

Von Ilberg et al, 1997
• How much hearing preservation is useful?
• What % of cases total HL is acceptable?

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• Insertion Depth?
• Array diameter?
• Flexible v pre-curved?
• RW v cochleostomy?
• Adjunct pharmacotherapy
The dream...

- Complete insertion
- Atraumatic
- 100% HP
- 100% of cases
Hearing Preservation Arrays*

- Med El- Flex (20, 24, 28*, 31*mm)
- Cochlear Corp
  - Hybrid S (10), Hybrid L (16), CI422 (24)*
- Advanced Bionics – Mid Scala (18.5mm)*

*Consistent hearing preservation not yet proven
Optimal Insertion Depth?
Optimal Insertion Depth...

- Deeper insertions advantageous for speech/pitch recognition
  

- Trauma inc’d with insertion depth, esp >20mm (360 deg, 1khz)
  
  (eg Adunka 2004, 2006; Gstoettner 2004)

- But…HP documented with full length arrays
What is the ideal length which ensures maximal hearing preservation in the largest number of patients in the most surgeon’s hands while maximizing speech / music?

6mm...10mm...15mm...20mm...24mm...28mm?
Cochleostomy or Round Window?
Cochleostomy or RW Insertion?

• **Round Window**
  
  Proctor et al. 1986  
  Adunka et al. 2004  
  Briggs et al., 2005  
  Roland et al., 2007

• **Cochleostomy** (anterior/inferior)
  
  Bruce et al. 2011  
  Gstoettner et al. 2004, 2006
16 studies, 170 patients

“The available data do not show that there is a benefit of one surgical approach over the other regarding the preservation of residual hearing”
Array Design: Flexible or Precurved?
CI Array Design:

- Better designs have improved HP rates
- Thin, flexible arrays appear least traumatic
  (Cochlear Hybrid L/S, Med-El Flex 20-28)
- Can well designed pre-curved arrays match?
  (AB mid-scalar?)
How Much Residual Hearing is Needed?
Residual hearing requirements…

Helbig and Baumann (2010)

• HL greater than:
  55 db @ 125hz
  70 dB @ 250 Hz
  98 dB @ 500 Hz

• Did not profit from EAS, pref’d CI alone.
Higher Performance Outcomes:

- Younger age @ implantation
- Shorter duration deafness
- Lower CI sound-field thresholds
- % electrodes in SV v ST
- Depth of array insertion
- Arrays closer to the Modiolus

Holden et al, Ear and Hearing 2013
Table 2. Hearing preservation rates 1990–2009

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Number¹</th>
<th>HP, %</th>
<th>Insert. depth mm</th>
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<tbody>
<tr>
<td>Fraysse et al.</td>
<td>1998</td>
<td>9/12</td>
<td>75</td>
<td>19</td>
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<td>Gstoettner et al.</td>
<td>2004</td>
<td>18/21</td>
<td>85</td>
<td>22–24</td>
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<td>Kiefer et al.</td>
<td>2004a</td>
<td>12/14</td>
<td>85</td>
<td>22–24</td>
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<tr>
<td>James et al.</td>
<td>2005</td>
<td>10/12</td>
<td>83</td>
<td>17–19</td>
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<tr>
<td>Balkany et al.</td>
<td>2006</td>
<td>25/28</td>
<td>89</td>
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<td>di Nardo et al.</td>
<td>2007</td>
<td>29/37</td>
<td>78</td>
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<td>Luetje et al.</td>
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<td>Skarzynski et al.</td>
<td>2007b</td>
<td>9/10</td>
<td>90</td>
<td>22–24</td>
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<td>Talbot and Hartley</td>
<td>2008²</td>
<td>223/253</td>
<td>87</td>
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<td>2008a</td>
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<td>Lenarz et al.</td>
<td>2009</td>
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HP: How are ‘We’ doing?

Talbott & Hartley, 2008 v. Ilberg 2011
More to do...

- Array optimization
- Surgical technique
- Pharmacotherapy
- Stimulus Parameters