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Residual Hearing with Cochlear Implant Surgery

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Learner Outcomes

• 1) Describe the pathophysiological events that occur inside the cochlea after a cochlear implant is inserted
• 2) Describe the potential benefits of hearing preservation in cochlear implantation
• 3) List a few of the areas of research for future cochlear implant hearing preservation
Benefits of Hearing Preservation: Improved speech perception*

- N = 126 ears
- Mean preop low freq PTA: 55.4 dB HL
- 55% hearing preserved (Mean postop LF PTA: 93.6 dB HL)
  - 11 points higher on CNC word testing
  - 7.2 points higher on AzBio in quiet

*Carlson, et al., 2011

(Very) Brief History of Cochlear Implants
Initial CI Candidacy

Conservation of Residual Hearing with Cochlear Implantation

Annelle V. Hodges, Jerry Schloffman, and Thomas Balkany

University of Miami Ear Institute and Department of Otolaryngology–Head and Neck Surgery, Miami, Florida
Electric-Acoustic Stimulation of the Auditory System
New Technology for Severe Hearing Loss

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Electro-Acoustic (EAS) or Hybrid™ Hearing

• Acoustic (low frequencies)
  
  AND
  
  • Electric (mid to high frequencies)
Cochlear Corporation Hybrid™
Hybrid™ Candidacy (Cochlear Corp.)

EAS Candidacy (Med-El)
What is the goal of Hybrid Hearing?

Audibility 125 - >6000Hz

Electric hearing is critical for speech understanding

Acoustic hearing
- Frequency resolution
- Sound quality
- Improved understanding in background noise
- Low frequency cues for vowels and consonants

*Hybrid Hearing is labelled and approved by the FDA for Hybrid L24 implant only

Nucleus Electrode Options
Hybrid L24 Hearing Zone Coverage

Hybrid Devices: Problems

- What happens if hearing naturally deteriorates in the low frequencies?
- (1 year postop: CNC words 72% in standard length/15% in hybrid in cases of hearing loss*)

*Friedman, et al., 2015
Hybrid Device Problem: Solution

- Use FULL length electrode with hearing preservation!
- Lateral wall electrode array, with varying insertion depths

Slim Straight Electrode (CI522)

Nucleus Electrode Options
Residual Hearing Preservation After Pediatric Cochlear Implantation

*Ryan F. Brown, *†‡Timothy E. Hullar, ‡§Jamie H. Cadieux, and *†||Richard A. Chole

Hearing Preservation Via a Cochleostomy Approach and Deep Insertion of a Standard Length Cochlear Implant Electrode

*†Hain Alexander Bruce, †James Edward Homewood Mills Bates, *Christine Melling, *Deborah Mawman, and *†Kevin Michael John Green

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Diagram showing hearing levels before operation (Pre Op) for both right and left ears across different frequencies.
Benefits of Hearing Preservation

- Improved hearing in noise\textsuperscript{1,3}
- Improved spectral discrimination/pitch perception\textsuperscript{1}
- Enhanced music perception\textsuperscript{2}
- Improved timing cues\textsuperscript{3}

\textsuperscript{1}Gfeller, K., et al., 2007
\textsuperscript{2}Gfeller, K., et al., 2006
\textsuperscript{3}Gifford, RH, et al., 2013
Med-El Electrode Options

**Standard**
- 24 electrode contacts along 26.4 mm
- 2.4 mm spacing between contacts

**FLEX28™**
- 19 electrode contacts along 23.1 mm
- 2.1 mm spacing between contacts

**FLEX24™**
- 19 electrode contacts along 20.9 mm
- 1.9 mm spacing between contacts
What Happens When Cochlear Implant Placed Inside Cochlea?
1998

Souter, 2011
New bone formation

Inflammation

Fibrous tissue
Other Causes of Hearing Loss from Cochlear Implantation

- Loss of perilymph
- Drilling on cochlea (acoustic trauma)
- Mechanical vibration dampening effects of electrode

“Soft Surgery”
Lehnhardt, 1993
Position of Cochlea, RIGHT

Cochleostomy
Options to Prevent Hearing Loss from Cochlear Implantation

- Loss of perilymph → Minimal round window opening
- Inflammation → Steroids
- Drilling on cochlea → No drilling
- Mechanical vibration damping effects of electrode → Thinner electrode
- Damage to inner ear structures → Thinner electrode / Round window insertion
Some Challenges for Hearing Preservation

Round Window
Benefits of Hearing Preservation

- Improved hearing in noise
- Enhanced ability to appreciate music
- Improved spectral discrimination/pitch perception
- Improved timing cues
- Constant awareness of sound (even when the CI is not worn)
Benefits of Hearing Preservation

- Less “mechanical” quality of sounds
- Less dizziness
- Faster time to hearing with the implant
- Allows opportunity for more advanced future treatments (e.g. different type of implant; gene therapy; hair cell regeneration)

Future

- Drug eluting electrodes
- Drug eluting gels
- Drug coated implants
- Fully implantable cochlear implant
Summary

• Hearing preservation with traditional length cochlear implant
• Immediate benefits for hearing: some able to wear Hybrid device
• Long-term benefits if residual hearing deteriorates

THANK YOU!

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References


References


• Lehnhardt E [Intracochlear placement of cochlear implant electrodes in soft surgery technique]. HNO. 1993 Jul;41(7):356-9. [Article in German]


References
