Hearing Preservation in Cochlear Implantation

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Disclosures

• No financial relationships to disclose

• No off-label treatment of patients with devices or medications related to this presentation or underlying research

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Objectives

• Describe the history and current trends of hearing preservation (HP) in cochlear implantation

• Identify factors that are linked to hearing preservation in cochlear implantation surgery

• Classify patients that may be candidates for hearing conservation cochlear implant surgery
Is there anything new under the sun?

- Millions of people can’t hear
- We have technology to restore hearing through cochlear implants
- So what else is there to talk about???
- Thanks for attending, turn your evaluations in at the back, and have a nice day…
History and Current Need for Hearing Preservation
CI: An ever evolving art?
Restoring hearing without altering lives
Minimizing the surgical footprint
“Save the Cochleas!!!”

- 36 million American adults (17%) report some degree of hearing loss
- 26 million American (15%) between the ages of 20 and 69 have high-frequency hearing loss due to loud sounds or noise at work or in leisure activities.
- Majority of people with hearing loss are not profoundly deaf
- Are our current treatments best for the long term?
Dilemmas of a “Cochlea-Hugger”

• Can we save function? Do we even want to?
• Can we conserve anatomy? Do we want to?
• What factors affect conserved cochlear function?
• What future therapies might be in store for hearing impaired patients?
• Can we help a wider range of people without sacrificing their hearing?
Conserved Anatomy = Higher Function

126 patients with residual hearing → 55% HP rate

Those with some degree of preserved hearing scored 11% higher on CNC and 7.2% higher on AzBio compared with those with no preserved hearing
History of Cochlear Implantation

- 300 years of science, 50 years of progress
- Standing on the shoulders of giants…

Http://health.howstuffworks.com/how-to-care-for-your-ears4.htm
History of Cochlear Implantation

- 1790: Alessandro Volta – ears & electricity
- 1950: Djourno and Eyries – direct hearing nerve stimulation, performed 1st implant
- 1961: Bill House – partnership with 3M
- 1970’s: Work with multiple channels
- 1984: First FDA approved CI (over age 18)
- 1990: Approved for age 2
- 1998: Approved for 18 months old
- 2000: Approved for 12 months old
Evidence of hearing preservation...

• Hodges 1997 – series of patients with documented hearing preservation with standard implantation
• Many studies have documented hearing preservation
• Thresholds could be maintained but SPEECH???
• Low frequencies carry loudness and speech patterns → Vowels/Linguistic cues
• High frequencies carry spectral pattern recognition → Consonants/Word understanding
• Phone use and Music appreciation?
Combined Stimulation: Having Your Cake and Eating It Too

- Could the same ear receive acoustic stimulation to the basal turn and electrical stimulation to apex?
- University of Iowa shortened electrode array (1995)
- Each company has altered their electrodes to allow for preservation of hearing
  - Short, thin, soft, tapered, etc…
Factors Involved in Hearing Preservation and Current Trends
CI Surgeons are nice guys...really?

- As amicable and collegial as Neurotologists are, we wreak some serious havoc to the cochlea
- Acoustic trauma
- Mechanical trauma
- Insertion trauma
- Inflammation (bone dust or blood in the cochlea)

Modification of Cochleostomy Technique

- Standard technique for cochleostomy is use of the otologic drill (80,000 rpm)
- Contact of the drill with the ossicles causes loss of sensorineural function
- Alteration of technique may lead to improved hearing preservation
- Pilot study using 30 cadaveric temporal bones

Cipolla 2012
Example of Drill Cochleostomy Technique

Cipolla 2012
Example of Drill Cochleostomy Technique

Cipolla 2012
Example of Drill Cochleostomy Technique

Cipolla 2012
How drilling affect the cochlea?
Round Window Insertion of CI
Example of Laser Cochleostomy Technique

Cipolla 2012
Example of Laser Cochleostomy Technique

Cipolla 2012
Example of Laser Cochleostomy Technique

Cipolla 2012
Measurement of Cochleostomy Time

- Cochleostomy at 6 watts was comparable to drill use

<table>
<thead>
<tr>
<th>Experience</th>
<th>Bone</th>
<th>Watts</th>
<th>Procedure</th>
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<tr>
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</table>

Cipolla 2012
Intraop Cochleostomy Temperature

- Tmax higher in laser use but average temperature the same between techniques

Cipolla 2012
Intraop Cochleostomy Temperature

- Average temperature of the series of bones the same between techniques

![Average Temperature Chart](chart.png)

Cipolla 2012
Intraop Cochleostomy Acoustic Trauma

- Average and max sound levels consistently higher in drill use for each bone
Intraop Cochleostomy Acoustic Trauma

• Average sound levels higher in drill

![Average Noise Graph]

Noise (dB)

Laser

Drill
How implants affects the cochlea?

- Fibrosis, ossification, loss of endocochlear potential
- Rupture of Reissner’s or basilar membrane
- Scala tympani insertion is vital
Round window versus Cochleostomy

Richard 2012
How do implants affect the cochlea?

- Direct trauma to osseous spiral ligament
- Degeneration of stria vascularis
- Loss of electrolyte recycling = Loss of endocochlear potential

What is necessary for HP?

Soft surgery techniques
What is necessary for HP?

Atraumatic Electrodes and Insertion
Can you actually conserve hearing?

Pre-op

At Activation

Med El Flex28
Can you actually conserve hearing?

Med El Standard
Can you actually conserve hearing?
ORIGINAL ARTICLE

Atraumatic round window deep insertion of cochlear electrodes

HENRYK SKARZYNSKI, ARTUR LORENS, MAŁGORZATA ZGODA, ANNA PIOTROWSKA, PIOTR HENRYK SKARZYNSKI & AGATA SZKIELKOWSKA
Atraumatic round window deep insertion of cochlear electrodes

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Graph showing implanted ear frequency (Hz) and dB levels over time.
...As is Cochleostomy

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

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

*Manchester Auditory Implant Centre; and †University of Manchester, Manchester, U.K.

• Deep Insertion of CI
• 12/14 Hearing preserved
HP with Deep Insertion of CI

- Complete insertion of electrode in 59.1% (13/22)
- Hearing preserved in 77.3% (17/22)
  - PTA shift:
    - Less than 10 dB: 18.2% (4/22)
    - Between 11 and 30 dB: 40.9% (9/22)
    - Larger than 31 dB: 18.2% (4/22)
Steroids Can Be Protective

The Role of Preoperative, Intratympanic Glucocorticoids for Hearing Preservation in Cochlear Implantation: A Prospective Clinical Study

Gunesh P. Rajan, MD, DM, FSCS, FRACS; Jafri Kuthubutheen, MBBS, FRACS; Naveen Hedne, MBBS; Jay Krishnaswamy, M.Sc.Aud

Fig. 4. Stability of hearing preservation over time comparing the interventional groups (Flex soft + IT, Flex EAS pediatric, Flex EAS adult) and the control group (Flex soft). Note the higher stability of hearing thresholds in the interventional group as well as the higher preservation rates in the interventional Flex soft group.
Electrode Design Affects Destination

- 35% (7/20) of Contour electrodes deviate from ST to SV
- 50% (5/10) of AB electrodes deviate from ST to SV
- Only 2 Med El used
Electrode Design Affects Destination

• 35% (7/20) of Contour electrodes deviate from ST to SV
• 50% (5/10) of AB electrodes deviate from ST to SV
• Only 2 Med El used
Conservation is Possible in Revisions

Unusual Electroacoustic Device Failure and Electroacoustic Reimplantation With Hearing Preservation

*Ameet Kamat, †Lisa Goldin, and *Ronald A. Hoffman

Hearing Preservation and Hearing Improvement After Reimplantation of Pediatric and Adult Patients With Partial Deafness: A Retrospective Case Series Review

*†Janitha Jayawardena, *‡Jafri Kuthubutheen, and *§Gunesh Rajan

*Division of Otolaryngology, Head and Neck Surgery, School of Surgery, University of Western Australia; †Department of Otolaryngology, Head and Neck Surgery, Royal Perth Hospital; and §Department of Otolaryngology, Head and Neck Surgery, Fremantle Hospital, Perth, Western Australia, Australia
HP is Possible but Is It Helpful? Who are Candidates?
Improved Outcomes with Hybrid CI\(^1\)

- Improved function in noise
- Improved melody recognition
- Improved word understanding by 20-30%\(^2\)

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Hybrid Technology and Better SRT

Mowry 2011

**A**

Hybrid technology and better SRT

**B**

Low-Frequency Average Thresholds at .125, .25, .5 kHz (dB HL)
Cochlear Implant Candidacy

- Severe-profound SNHL
- Poor understanding
- No benefit of HA
- Intact auditory nerve
- Cochlea well-formed
- Desire to hear
- Family support
- Rehabilitation resources

![Graph showing frequency and sound pressure level](image)
Cochlear Implant Candidacy

Medicare criteria:
• Bilateral moderate-to-profound SNHL
• ≤ 40% in best-aided listening condition on open set recorded test
• Intact auditory nerve and “acoustic areas of the CNS”
• Free from middle ear infection

Pediatric- variable
• Severe-profound SNHL bilaterally
• Limited benefit from proper amplification
• Family commitment and realistic expectations
• No medical contraindication
Who should consider cochlear implants?

http://soundingboard.earfoundation.org.uk/resources/?cat=4&sub_cat_id=7&page=40
A Need For Expanded Criteria?

• Help for those who are not implant candidates yet are not served well by HA
• Severe HFSNHL yet preserved LF hearing
• Poor understanding in the implant ear

http://www.audiologyonline.com/articles/article_detail.asp?article_id=1546
Results With Cochlear Implantation in Adults With Speech Recognition Scores Exceeding Current Criteria

Hosam A. Amoodi, Paul T. Mick, David B. Shipp, Lendra M. Friesen, Julian M. Nedzelski, Joseph M. Chen, and Vincent Y. W. Lin

Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada
Benefits of Implantation - Adults

Improvement of understanding from 60% to 91%
Benefits of Implantation - Adults

<table>
<thead>
<tr>
<th>Hearing handicap inventory</th>
<th>Treatment</th>
<th>Mean</th>
<th>Mean differences</th>
<th>Significance (2-tailed)</th>
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<tr>
<td>Total score</td>
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<td>67.71</td>
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<tr>
<td></td>
<td>Posttreatment</td>
<td>34.22</td>
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</tbody>
</table>
BE A CONSERVATIONIST

- **REUSE**...the acoustic advantage of the apical region of the cochlea
- **REDUCE**...cochlear trauma and inflammation
- **RECYCLE**...the endocochlear electrolyte flow and endocochlear potential by conserving the anatomy
Thank You!

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