Implantable Hearing Technology for Children with SSD: Candidacy and Management
Presenters:
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Jackie Brown - Teacher of the Deaf, LSLS Cert AVT Education and Development Manager
Elise Alexander - Speech Pathologists, LSL Cert AVT
Where is Hear and Say?

- Cairns
- Townsville
- Sunshine Coast
- Darling Downs
- Brisbane
- Gold Coast

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Overview

- Terminology
- Causes and Incidence
- Effects
- Treatment options
- Candidacy and Management
- Case studies
- Summary
Terminology

- Unilateral Hearing Loss (UHL) and Single Sided Deafness (SSD) often used interchangeably

- Single Sided Deafness (SSD) - severe to profound hearing loss (>70dBHL) in one ear with normal thresholds (20dBHL or better) on the contralateral ear

(Giardina et al., 2014; Cire, 2012; Valente et al., 2006)
Potential causes of UHL & SSD

Abnormality of the anatomy
- Temporal bone abnormality
- Nerve abnormality/absence
- Microtia/Atresia

Genetic (Connexin 26)

Acquired
- Viral infection (MMR)
- Illness (Menieres)
- Trauma (fracture of temporal bone)
- Acoustic neuroma

Idiopathic
Incidence SSD

- Precise incidence unknown
- Prevalence is estimated at 3 to 6% of population
- Estimate 0.6–1/1000 in newborns
- In children and teenagers - 2 to 5/1000

(Hassepass, et al., 2013; Giardina et al., 2014; Ching, 2015)
Binaural Hearing Effects

Head shadow

Localisation

Binaural Squelch

Binaural Summation
Binaural Hearing Effects

Head shadow
The attenuation or reduction of sound which occurs when the head is between the signal and the opposite ear.

Signal received by contralateral normally hearing ear

Signal presented to ear with microtia/atresia
Localisation

- The ability to detect the direction of sound
- Can be useful for both environmental sounds and when tracking multiple speakers within group conversations
Binaural Hearing Effects

Binaural Squelch

Binaural Summation
Effective listening in the classroom

- **Hear the teacher**
  - In quiet
  - In background noise
  - Over distance
  - From any direction

- **Hear other students**
  - From any direction
  - Whispers

**SSD**

- ✓ Yes
- ? Binaural squelch
- ? Binaural summation
- ? Localise/headshadow

- ? Localise/headshadow
- ? Headshadow/binaural squelch
Effective listening in the classroom
UHL and SSD

- May result in delays in:
  - Speech and language
  - Educational progress
  - Emotional/Social development

  - Behavioural problems (Lieu, 2013)
  - For children not identified with major learning problems, are they reaching their full potential?
  - Proactive early intervention for children with SSD/UHL is recommended

Lieu (2013), Martinez-Cruz et al. (2009) and Fischer & Lieu (2014).
Treatment options

- No treatment
- Hearing aid
- Cros Aid
- FM system / Soundfield system
- Bone conduction aid
  - e.g. Ponto, Baha, Contact Mini, Bone Bridge
- Middle ear implant
- Cochlear implant
Hear and Say Experiences UHL & SSD

- Children Enrolled with UHL & SSD = 69
- 7% attend for weekly support
- 38% attend for fortnightly support
- 17% attend for monthly support
- 38% attend a monitoring program (6 monthly assessments)

Recommend annual monitoring of better hearing ear

- 64% Single Sided Deafness
- 28% Unilateral Hearing Loss

28% Unaided
Hear and Say Experience SSD

Hearing Implant Program:

- 10 SSD cases
  - 8 with CI
  - 2 bone conduction

- 6 in pre-implant assessment phase
Candidacy Criteria

Audiology

- Assess all ears individually—whether a unilateral or bilateral hearing loss
- Candidacy criteria for CI for SSD the same as for bilateral hearing loss
- Parent and teacher report
- Hearing aid and BC trial
- Expectations important
Candidacy Criteria

Listening and Spoken Language

• Access to all speech frequencies
• Listening skills
• Speech and language progress
• Functional:
  • Distance
  • In noise/group settings
  • Parent and teacher report
Post Implant Re/Habilitation

- How Long?

- How do we do individual ear work with one normally hearing ear?

- What do we do?
Post implant SSD Habilitation

- Length of therapy/habilitation depends on age
- For some auditory habilitation or learning (older children)
- Younger children—focused individual ear work
  - Noise attenuation plug
  - Direct audio input
- Future—live voice work in audiology booth with non-CI ear masked
Case Studies
Case 1; DOB: 17/09/2009

- **Aetiology:** Unknown
- **Implant Details:** Left - Freedom implant, CP810 speech processor
- **Date of Switch On:** 30/10/2013
- **Age at Switch On:** 4 years; 1 month

**Hearing Age (with Implant) as of 23/06/15:** 1 year; 7 months
Case 1; DOB: 17/09/2009

Audiology Progress Update

<table>
<thead>
<tr>
<th>Left Aided Thresholds</th>
<th>0.5kHz</th>
<th>1kHz</th>
<th>2kHz</th>
<th>4kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Implant (H/aid) (dBSPL)</td>
<td>50</td>
<td>45</td>
<td>35</td>
<td>70</td>
</tr>
<tr>
<td>12 Months Post Implant (CI) (dBSPL)</td>
<td>30</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phoneme Detection and Imitation (PLOTT)</th>
<th>Detection</th>
<th>Imitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>18/09/2013 (Pre CI)</td>
<td>5/7</td>
<td>3/7</td>
</tr>
<tr>
<td>11/11/2014</td>
<td>7/7</td>
<td>7/7</td>
</tr>
</tbody>
</table>
Case 1; DOB: 17/09/2009

Listening and Spoken language

Unable to complete assessment pre-CI due to poor behaviour

CELF-P2 Index Scores
6 and 12 months post CI
Case 1 Video
Case 2; DOB: 12/06/2012

Aetiology: Unknown

Implant Details: Right - Freedom implant, CP910 speech processor

Date of Switch On: 22/01/2014

Age at Switch On: 1 years; 6 months

Hearing Age (with Implant) as of 27/05/15: 1 year; 5 months
Case 2; DOB: 12/06/2012

### Audiology Progress Update

<table>
<thead>
<tr>
<th>Right Aided Thresholds</th>
<th>0.5kHz</th>
<th>1kHz</th>
<th>2kHz</th>
<th>4kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Implant (H/aid) - (dBSPL)</td>
<td>60</td>
<td>60</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>6 Months Post Implant (CI) - (dBSPL)</td>
<td>30</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

### Phoneme Detection and Imitation (PLOTT)

<table>
<thead>
<tr>
<th></th>
<th>Detection</th>
<th>Imitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Pre CI)</td>
<td>?/7</td>
<td>?/7</td>
</tr>
<tr>
<td>29/04/2015</td>
<td>7/7</td>
<td>7/7</td>
</tr>
</tbody>
</table>
## Case 2 Speech Perception

<table>
<thead>
<tr>
<th>Manchester Junior Words 6 mths post CI</th>
<th>Right CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Score</td>
<td>50%</td>
</tr>
<tr>
<td>Phoneme Score</td>
<td>80%</td>
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</table>
**Case 2; DOB: 12/06/2012**

**Pre Implant**

<table>
<thead>
<tr>
<th>Developmental Area</th>
<th>Above Expected Range</th>
<th>Within Expected Range</th>
<th>Below Expected Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory Skills</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Early Communication Skills</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receptive Vocabulary</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Expressive Vocabulary</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Receptive Language</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Expressive Language</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Speech</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Cognitive Skills</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Social Interaction Skills</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Fine Motor Skills</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Gross Motor Skills</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
**Case 2; DOB: 12/06/2012**  
3 months CI use

**✓ = level at last assessment**  
**✓ = level at this assessment**

<table>
<thead>
<tr>
<th>Developmental Area</th>
<th>Above Expected Range</th>
<th>Within Expected Range</th>
<th>Below Expected Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory Skills</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Early Communication Skills</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Receptive Vocabulary</td>
<td>✓ ✓</td>
<td></td>
<td></td>
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<td>Expressive Language</td>
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<tr>
<td>Speech</td>
<td>✓ ✓</td>
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<tr>
<td>Cognitive Skills</td>
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<tr>
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<td>✓ ✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Motor Skills</td>
<td>✓ ✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Case 2 Speech and Language Results

PLS-5
Pre Implant, 3 months, 9 months, 15 months post CI

Average Range

<table>
<thead>
<tr>
<th>Date</th>
<th>Auditory Comprehension</th>
<th>Expressive Communication</th>
<th>Total Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.10.2013</td>
<td>125</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>29.04.2014</td>
<td>115</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>28.10.2014</td>
<td>125</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>28.04.2015</td>
<td>130</td>
<td>130</td>
<td>130</td>
</tr>
</tbody>
</table>
Case 2 Video
Case 3; DOB: 20/02/2008

- **Aetiology:** no VIIIth nerve
- **Implant Details:** Right – BAHA attract implant, BAHA 4 processor
- **Date of Switch On:** 11/04/2014
- **Age at Switch On:** 6 years; 2 months
- **Hearing Age (with Implant) as of 23/06/15:** 1 year; 2 months
Case 3; DOB: 20/02/2008

Listening and Spoken Language:

Pre implant:
- Expressive Language below average range
- Emergent literacy below average range
- Other areas within average range

Teacher feedback:
- lacks independence,
- play, social skills, speech and language skills are immature
- Has his own agenda and does not follow directions well in the classroom setting.
- Needs more support during group activities
Case 3; DOB: 20/02/2008

**Audiology Progress Update**

- Wears for all waking hours
- Significant improvement observed re: behaviour, listening attention and concentration when wearing the processor
Case 4; DOB: 29/08/2001

- **Aetiology:** LVA
- **Implant Details:** Left – CI512 implant, CP910 speech processor
- **Date of Switch On:** 02/04/2015
- **Age at Switch On:** 13 years, 7 months
- **Hearing Age (with Implant) as of 19/06/15:** 2 months
Case 4; DOB: 29/08/2001
Audiology

### Left Cochlear Implant Assisted Audiogram:

<table>
<thead>
<tr>
<th>Date</th>
<th>0.5kHz</th>
<th>1kHz</th>
<th>2kHz</th>
<th>4kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/6/15 8 weeks Post-implant (Left CI)</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

*All testing performed with masking in contralateral ear*

<table>
<thead>
<tr>
<th>Date</th>
<th>Recorded live voice, via audio cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>14/05/15 6 weeks Post-implant (CI)</td>
<td></td>
</tr>
<tr>
<td>Paediatric Speech Intelligibility (PSI)</td>
<td>70% correct</td>
</tr>
<tr>
<td>Phoneme Detection and Imitation (PLOTT)</td>
<td>7/7 Detection 0/7 Imitation</td>
</tr>
</tbody>
</table>
Case 4; DOB: 29/08/2001

LSL Progress Update:

Pre Implant
- Difficult to hear friends
- Difficult with noise in the classroom and learning
- Difficulties with localisation

Post Implant (8 weeks post switch on)
- Hearing better in the classroom
- Hearing new sounds she has never heard before (train track squeaking, washing machine noises at home)
- Now able to hear where a bicycle was approaching her from on the way home from school
- Finding participation in conversations with friends easier
Case 4 Video
Summary

• Binaural listening advantages
• Need standard guidelines and protocols
• Recommend all children enrol in EI
• Positive outcomes with treatment options
• Not only about S&L outcomes
• More research required:
  • Effectiveness of EI
  • Localisation assessment
  • Measuring listening effort
References

  http://dx.doi.org/10.1016/j.ijporl.2014.07.005


References


References

- Vol. 22, No. 3, pp. 177–187; Lippincott Williams & Wilkins.