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Audiology Management of Single Sided Deafness in Children

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Michael Scott, AuD, CCC-A

Objectives

• Describe the possible limitations experienced by patients with single-sided deafness.

• List appropriate treatment options for patients with single-sided deafness.

• Identify important aspects of an evaluation protocol for patients with single-sided deafness.
Clinical Issue

- 1-3 in 1000 infants are born each year with Unilateral Hearing Loss (UHL) (Ear Hear 2000, Int'l Journal Pediatric Otorhinolaryngology1994)
- 3% of school-age children have UHL (Ear Hear 1998, JAMA 1998)
- 1/3 of children with UHL repeat a grade (Bess et al. 1998)
- Research has shown these children experience difficulties in the areas of:
  - Academics
  - Speech and language development
  - Behavioral issues
- A subset of children are born with or acquire single sided deafness (SSD) - no functional hearing for one ear with normal hearing in the other ear (≤ 20dB PTA)

Etiology for SSD

<table>
<thead>
<tr>
<th>Cause</th>
<th>Frequency of Occurrence</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMV – Congenital Cytomegalovirus</td>
<td>Leading cause of UHL; 2-2.5 % of all live births</td>
<td>Leung etl., 2003; Nance, 2007</td>
</tr>
<tr>
<td>Bacterial Meningitis</td>
<td>~30% result in at least UHL</td>
<td>Kutz et al., 2006</td>
</tr>
<tr>
<td>Viral/Bacterial Mumps</td>
<td>~80-95% of hearing loss result</td>
<td>Unal et al., 1998</td>
</tr>
<tr>
<td>EVAS – Enlarged Vestibular Aqueduct Syndrome</td>
<td>~20% of cases are UHL</td>
<td>Covaerts, et al., 1999</td>
</tr>
<tr>
<td>Chiari Malformation</td>
<td>~65 % UHL</td>
<td>Simons et al., 2008</td>
</tr>
<tr>
<td>ANSD – Auditory Neuropathy Spectrum Disorder</td>
<td>Most cases are bilateral but some are UHL</td>
<td>Podwall et al., 2002</td>
</tr>
<tr>
<td>Sudden Sensorineural Hearing Loss</td>
<td>~85% in children are UHL</td>
<td>Roman et al., 2001</td>
</tr>
<tr>
<td>Gap Junction Beta 2 (Connexin 26)</td>
<td>Over 80 mutations are known; most are profound</td>
<td>Kenna et al., 2001/Wilcox et al., 2000</td>
</tr>
<tr>
<td>Prematurity</td>
<td>~5% of premature babies have HL</td>
<td>Herrgard, et al., 1995</td>
</tr>
<tr>
<td>Other, unknown</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SSD Defined

**UHL**

- The better ear has a pure-tone air-conduction average of 15 dB HL or better

- Worse ear as a pure-tone air-conduction average (re: 0.5, 1.0 and 2.0 KHz) of 20 dB or worse, at two or more frequencies (above 2K) with thresholds worse than 25 dB HL.

**SSD**

- SSD is defined as unaidable hearing in one ear and normal hearing levels (20 dB or better) in the opposite ear.

- "Unaidable" is defined as profound sensorineural hearing loss OR very poor word recognition.

Adopted by the July 2005 National Workshop on Mild and Unilateral Hearing Loss (sponsored by CDC and EDHI)

SSD Defined

**WHAT IT IS:**

- Normal hearing in one ear and profound sensorineural hearing loss in the other ear.

- Normal hearing in one ear and hearing loss with poor discrimination ability (poor word recognition score) in the other ear.

**WHAT IT’S NOT:**

- SSD is different than a unilateral hearing loss that is able to benefit from a traditional hearing aid.

- SSD is different from a unilateral atresia/microtia resulting in a conductive hearing loss.
Traditional definition of SSD

Normal hearing in one ear and profound sensorineural hearing loss in the other ear.

Non-traditional definition of SSD

Normal hearing in one ear and hearing loss with poor word recognition ability in the other ear.
What does UHL/SSD look like?

The Effects of SSD

- Difficulty *localizing* the sound source
- Difficulty *hearing in noisy/reverberant situations*
- Difficulty *understanding soft speech*
  - Especially from the side of the poor hearing ear
- Difficulty *hearing from a distance*
- *Turns head* to hear better
- Often *miserstands* what people say
- Frequently asks *people to repeat* or asks, “What?”
Binaural Benefits

• Summation/Redundancy – “two ears are better than one”
  • The input from both ears together results in 3-6dB additional gain

• Localization — ability to use time and spacial cues to determine the location of a sound source
  • Duplex Theory of Sound Localization: time dependent (interaural time difference – ITD) low frequencies dominate; intensity dependent (interaural intensity dependent – IID) high frequencies dominate

• Squelch Effect/ Binaural Release from Masking
  • ability to extract information from noise

• Binaural Release from Masking - spatially separating sounds of interest (target) and interference (noise). The spatial separation with 2 ears affects spectral and temporal differences which help the listener – not available to some with UHL or SSD

Effects of the Body

• Head Shadow Effect—
  • Effect on sound to reach the other ear
  • Head can attenuate overall intensity 6-12 dB
  • High frequencies don’t bend around the head

• Pinna Effect —
  • Effect of external ear, and/or pinna Amplification of 5-20dB from free-field 1.7Hz – 7kHz
  • Response of the pinna “filter” is highly dependent on the overall direction of the sound

• Shoulder Effect —
  • Frequencies 1-3kHz are reflected from the upper torso of the human body.
  • The reflection produces echoes that the ears perceive as a time delay.
  • The reflectivity of the sound is dependent on the frequency.
**Environmental Effects**

- Acoustics
- Reverberation
  - Sounds echo off of surfaces – degrades signal
- Noise
  - Interferes with signal
- Distance
  - Reduces the intensity of sound

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**Concerns Reported By Patients**

- I’m afraid that my good ear will go deaf.”
- “I get nervous when I have a cold and I can’t hear out of my good ear.”
- “I can’t tell where the sound is coming from.”
- “I have to turn my head to hear people”
- “I have to look at people to hear them.”
- “People think I’m just not listening to them.”
Impact of SSD

Speech and Language

- Slower development of 2 word utterances (Kiese-Himmel 2002)
  - Not typically delayed in using first words (12.7 months)
  - Delay in use of two-word phrases (23.5 months)
- Some studies suggest a “catch up” in oral language and verbal intelligence scores.
- Increased difficulty listening in noise (Ruscetta et al, 2005)
- Greater difficulty localizing makes it difficult to pick up the subtle sounds in conversation
- Brain re-organization, according to fMRI studies of the brain (Schmithorst et al, 2005)
- Poorer language skills than their normal hearing siblings (Lieu et al. 2010)
- Minimal studies are available that discuss the impact on speech and language development of children with UHL or SSD

Impact of SSD

Social/Emotional

- Appear to have selective hearing
  - Easier to understand speech in quiet than in noise
- Difficulty understanding in group learning sessions that are noisy.
- Feel left out or insecure due to the constant effort needed to listen. Can misunderstand conversations with friends.
- Experience fatigue due to extra effort to listening
  - Noisy classes or poor acoustics can exacerbate this
- Easily distracted, frustrated or appear disinterested
  - Some have evident behavior or social problems
- May experience difficulty multi-tasking
- Increased difficulty following conversation can increase education risks and difficulty with communication
- Greater listening effort required (Hicks, 2002)
Impact of SSD

Educational

• Approximately 1/3 of students will repeat a grade. (Bess et al. 1998)
• Approximately 30% of students will receive additional educational assistance.
  • Receipt of IEP services and higher baseline cognitive levels are predictors for improvement
• Children often have difficulty learning sound/letter associations
• Teachers/parents may report behavioral problems or academic weakness
• May seem to be a step behind with classroom learning
• Children with UHL require an approx. 5.5-6.5 dB greater SNR than those with normal hearing
  • Children with UHL should be eligible for same school services as a child with bilateral HL

Karen Anderson, PhD
www.successforkidswithhearingloss.com

UNILATERAL HEARING LOSS

Possible Impact on the Understanding of Language and Speech

• Child can "hear" but can have difficulty understanding in certain situations, such as hearing fluid or distant speech, especially if poor ear is turned toward the person speaking.
• Will typically have difficulty localizing sounds and voices using hearing alone.
• The unilateral listener will have greater difficulty understanding speech when environment is noisy and/or reverberant, especially when normal ear is towards the overhead projector or other competing sound source and poor hearing ear is towards the teacher.
• Exhibits difficulty detecting or understanding soft speech, from the side of the poor hearing ear, especially in a group discussion.

Possible Social Impact

• Child may be accused of selective listening due to discrepancies in speech understanding in quiet versus noise.
• Social problems may arise as child experiences difficulty understanding in noisy cooperative learning, or recess situations.
• May minimize peer conversations and feel rejected or ridiculed.
• Child may be more fatigued in classroom due to greater effort needed to listen, if class is noisy or has poor acoustics.
• May appear immature, disinterested, or frustrated, with behavior or social problems sometimes evident.

Potential Educational Accommodations and Services

• Allow child to change seat locations to direct the normal hearing ear toward the primary speaker.
• Student is at 10 times the risk for educational difficulties as children with 2 normal hearing ears and 1/3 to 1/2 of students with unilateral hearing loss experience significant learning problems.
• Children often have difficulty hearing sound/letter associations in typically noisy kindergartens and grade 1 settings.
• Educational and audiologic monitoring is warranted.
• Teacher assistance is beneficial.
• Typically will benefit from a personal FM system with low power or a sound-field FM system in the classroom, especially in the lower grades.
• Depending on the hearing loss, may benefit from a hearing aid in the impaired ear.
AAA Clinical Practice Guideline

• Children with UHL are at increased risk
  • speech and language delays
  • Academic difficulties

• Amplification options to consider for children with SSD
  • FM
  • CROS
  • Transcranial CROS

• Supporting evidence is limited

SSD Evaluation Process at CCHMC

• Key Participants
  • Audiologists (specializing in SSD)
  • ENT surgeons
  • SLPs (specializing in hearing loss)
  • Aural Rehabilitation audiologist
  • Teachers
  • Parents/patients

• Referrals
  • Newly identified patients with SSD or existing patients with SSD are referred for an SSD Evaluation.
  • Education is the primary goal
  • Referrals are typically placed by audiologists and ENT physicians
  • Significant education was necessary to get audiologists and ENTs on board

• Evaluation Process
  • Hearing test
  • Speech in Noise Testing
  • Functional Outcome Measures
  • Teacher Input – Functional Listening Evaluation
  • Discuss Amplification options
SSD Evaluation Process at CCHMC

• Early Diagnosis
  • Earlier diagnosis = Better outcome.
  • Tests may include: ABR, OAE, tympanometry, reflexes, functional outcome measures, detailed patient and family history, ENT management, complete sensorineural work-up including vision and balance
• Primary goal is education so parents can make the best decision
  • Educate about the issues patients with UHL/SSD may experience
  • Discuss all appropriate amplification options
  • Provide tools to evaluate child’s performance at home and in school
• Some patients do not chose amplification and are only monitored by audiology
  • Follow 6 months for infants and at least annually for older kids to evaluate performance and monitor thresholds

SSD Evaluation Process at CCHMC

• Parent motivation plays a large part in treatment plan
  • Speech and language delay
  • Educational concerns
  • Concerns for future delays or problems
• Speech evaluation and AR evaluation can be beneficial for monitoring and/or tracking treatment outcomes
• Possible indicators for who may be more at risk w/ UHL
  • Lower cognitive ability
  • Age of onset
  • Right ear hearing loss
  • Severe to profound loss (SSD)
Issues to Consider

• Some disabilities are not easily identifiable at the time of consideration for candidacy
• Disabilities such as autism or apraxia may not be identified until a child is 2-4 years of age
• A language, learning, or cognitive disorder will still be present after a child receives treatment. It is important that everyone understands that the implant is not going to resolve all issues.

“Despite the best efforts of many professionals, it is often difficult to diagnose learning disabilities, reduced cognitive function, and soft neurologic deficits in very young children...”
-Walzman, 2000

The SSD picture here at CCHMC

<table>
<thead>
<tr>
<th>Total</th>
<th>181</th>
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<tr>
<td>Ages</td>
<td>1.5-27</td>
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<tr>
<td>below 3</td>
<td>14</td>
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<tr>
<td>In study</td>
<td>10</td>
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<thead>
<tr>
<th>Etiology</th>
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<tbody>
<tr>
<td>Unknown</td>
<td>67</td>
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<tr>
<td>sensory (EVA, TBF, etc)</td>
<td>27</td>
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<tr>
<td>Neural (absent nerve)</td>
<td>43</td>
</tr>
<tr>
<td>Other</td>
<td>44</td>
</tr>
<tr>
<td>Total</td>
<td>137</td>
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<th>Treatment</th>
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<tr>
<td>CROS</td>
<td>36</td>
</tr>
<tr>
<td>Baha/Ponto</td>
<td>26</td>
</tr>
<tr>
<td>FM</td>
<td>5</td>
</tr>
<tr>
<td>TE</td>
<td>17</td>
</tr>
<tr>
<td>None</td>
<td>89</td>
</tr>
<tr>
<td>Total</td>
<td>178</td>
</tr>
</tbody>
</table>
SSD Protocol

- Older Patients (CROS or BCD)
  - BKB-SIN (pre- and post-treatment)
    - 0° azimuth, 50 dB HL presentation level
  - WRS in noise (pre- and post-treatment)
    - 50 dB HL presentation level with +5 dB SNR
  - Functional Outcome Measures
    - HEAR-QL
    - PBQ

- Younger Patients (BCD Softband)
  - EAR Plug in good ear
    - SAT
    - LINGs
    - Soundfield thresholds
  - Functional Outcome Measures
    - LITTLEARS
    - PEACH
Amplification Options

- **Bone Conduction Devices**
  - Bone anchored hearing aids using a surgically implanted post (Baha, Ponto)
  - Bone anchored hearing aids using surgically implanted magnets (Sophono, Baha Attract)
  - Behind-the-ear aid – no surgery required (TransEar)

- **Contralateral Routing of Signal (CROS)**
  - Good ear receives sound from a wireless transmitter on deaf side

- **Cochlear Implants**
  - Only option that actually delivers sound to impaired ear
  - May be considered when cochlea is completely formed and auditory nerve is intact
  - ENT is involved in determination for CI candidacy
  - Not currently an FDA approved treatment for SSD

- **Hearing Assistance Technology (FM) system**
  - Speaker’s voice transmitted wirelessly through a microphone to a receiver on the listener’s ear (personal FM, soundfield FM)

- **No Treatment**
  - Close monitoring of better hearing ear and educational performance

Current Bone Conduction Devices

- **Cochlear Baha 5**
- **Oticon Medical Ponto Plus**
- **Sophono Alpha II**
- **TransEar**
Bone Conduction Devices

- How the devices work
  - Sound is picked up by the bone conduction device and transferred through the bone in the skull to the good cochlea.
  - Better ear must have normal hearing (PTA no worse than 20dB at 500, 1000, 2000 & 3000 Hz).

- Wearing options
  - Surgically implanted abutment or magnet – only available for children over 5 years.
  - Softband (non-surgical).

- Contraindications
  - No surgery for patients under 5 years.
  - Softband option available on all surgical BCDs.
  - Patients incapable of maintaining abutment hygiene.
  - Magnetic option is available.
  - Patients who have asymmetrical hearing loss.
    - BiCros may be a better option.

Bone Conduction Device Case Study: Softband

3 year old male with left SSD

- Diagnosed at 7 weeks via ABR.
  - Enrolled with early intervention services.

- SSD evaluation at 11 months.
  - Parents report he becomes frustrated and fussy in noisy restaurant situations. They also report he experiences difficulties localizing to sounds.

- BCD softband trial.
  - Parents report he is less frustrated and grumpy in noisy situations. He was more interactive and less distracted by sounds.
  - Did not need to search for sounds as frequently.

- Private speech evaluation.
  - Receptive and expressive language was mildly deficient.
### Bone Conduction Device Case Study: Softband (cont.)

**3 year old male with left SSD**

- Fit with personal device at 13 months
  - Enrolled in Ohio Valley Voices toddler program
    - Ohio Valley Voices is a certified early intervention Moog program that provides an auditory oral curriculum
- Functional Outcome measure (LittLEARS) completed at 23 months
  - Indicated he was meeting auditory milestones
- BCD Check at 3 years
  - Parent reports concerns for repetitive language and minimal spontaneous conversation.
  - DDBP Evaluation (developmental pediatrician)
    - Diagnosed with ASD and enrolled in private speech therapy
    - Receives speech, OT/PT at school
  - Minimal aided testing able to be completed

### Bone Conduction Device Case Study: Surgical

**7 year old female with right SSD**

- Diagnosed with moderately-severe to severe SNHL of unknown etiology at 2 months via ABR
- Fit with BTE hearing aid at 5 months with full-time use
- Aural Rehabilitation baseline evaluation at 12 months exhibited age-appropriate skills
- Significant change in thresholds at 2.5 years
  - Recommendations: discontinue HA use, monitor speech/language and auditory skills
- Patient seen for routine monitoring at 4 years (SSD Evaluation)
  - Parental concerns with localizing, hearing in background noise and her speech
    - Cros trial
      - Patient refused full-time use despite parental efforts
      - Teacher noticed some improvement in classroom
  - BCD softband trial
    - Patient reports that she "likes" the BCD and that she can hear people "all around" her
    - Parent and teacher noted benefit when wearing device
- Speech evaluation at 4 years
  - Demonstrated a speech sound disorder
  - Intelligibility in connected speech was reduced compared to her production at the single word level
Bone Conduction Device Case Study: Surgical (Cont.)

7 year old female with right SSD

- Balance evaluation at 4 years due to concerns with being "clumsy"
  - Vestibular: right peripheral vestibular system weakness but has compensated functionally
  - PT: vestibular dysfunction with a lack of postural awareness recommended Occupational Therapy for lack of coordination and body awareness
- BCD surgery for abutment at 5 years
  - Patient reports being very happy with device and parent notices significant improvement when she wears the device
  - FM/Roger use in school
  - Accommodations made for testing
    - Patient receives test questions (i.e. spelling words) from teacher vs. computer w/ monaural headphone

Bone Conduction Hearing Aid

- TransEar by Ear Technology
  - Sound is picked up by a speech processor behind the ear
  - Sound is then sent to the transfer unit in the ear to vibrate the bony portion of the ear canal
  - Sound is perceived by the good cochlea
TransEar Case Study

7 year old male with no academic concerns
• Cochlear Nerve Deficiency
• Tried traditional amplification, but...
  • Patient reported that sound was “not clear”
  • Binaural speech perception testing suggested a decrease in performance when compared to testing with the left ear alone
• Parents report that patient frequently asks, “What?”, misunderstands what has been said, turns head towards speaker to hear, has difficulty hearing in noise and from a distance
• Interested in pursuing non-surgical option for added security and improved auditory awareness

TransEar Case Study (Cont.)

7 year old male with no academic concerns
• Fit with loaner softband bone conduction device
• Parents and teachers immediately report a change in behavior (focus) when wearing the device
• However, concern with headband, use during sports, especially with helmets, etc.
• Wanted to try the TransEar, knowing that this will occlude the ear canal
• Subjectively and objectively found the softband bone conduction device to be superior, but…
• Still preferred to use the TransEar during certain activities, while using the Ponto in all other situations.
• After 2 years of device use, the following results are still observed:

<table>
<thead>
<tr>
<th>Speech Perception Testing</th>
<th>Gradiol Sound</th>
<th>Actual Right Ponto</th>
<th>Actual Right TransEar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discrimination of Speech in Noise</td>
<td>UN</td>
<td>64%</td>
<td>94%</td>
</tr>
<tr>
<td>Discrimination of Speech in Noise with Masker</td>
<td>UN</td>
<td>76%</td>
<td>75%</td>
</tr>
<tr>
<td>Discrimination of Speech in Noise with Masker (Staggered)</td>
<td>UN</td>
<td>60%</td>
<td>75%</td>
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<tr>
<td>Discrimination of Speech in Noise (Staggered)</td>
<td>UN</td>
<td>60%</td>
<td>75%</td>
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<tr>
<td>Discrimination of Speech in Noise (Staggered) with Masker</td>
<td>UN</td>
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<td>75%</td>
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<td>Discrimination of Speech in Noise (Staggered) with Masker (Staggered)</td>
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<td>60%</td>
<td>75%</td>
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<tr>
<td>Discrimination of Speech in Noise (Staggered) with Masker (Staggered) (Staggered)</td>
<td>UN</td>
<td>60%</td>
<td>75%</td>
</tr>
</tbody>
</table>
CROS

- Phonak CROS II/Widex CROS
  - The audio signal from the un-aidable ear is sent wirelessly, in real time, from the transmitter to the receiver hearing instrument in the better ear.

![Diagram of CROS system](image)

CROS Case Study

13 year old female with Right SSD
- Diagnosed with right SSD at age 6.5 years
  - Unknown etiology
  - Hx of cortical dysplasia and left hemiparesis.
    - Hx of dizziness and clumsiness. Vestibular evaluation normal. PT Balance evaluation suggested vestibular hypofunction. Received vestibular rehabilitation.
    - PT/OT off and on for gait abnormality and upper extremity strength
  - No significant educational concerns or difficulties hearing in everyday environments reported
  - Recommendations: monitor hearing
- Referred for SSD evaluation at age 10
  - Functional outcome measures and BKB-SIN completed prior to treatment
  - Completed trial with Cros
    - Functional outcome measures (PBQ & HEAR-QL) and aided testing indicate benefit with Cros
    - Patient very motivated to pursue personal devices
  - Fit with personal Cros system following insurance authorization

![Graph showing hearing levels](image)
CROS Case Study (Cont.)

13 year old female with Right SSD
• Hearing Aid Check age 11
  • No concerns for changes in hearing or problems with devices
  • Functional outcome measures and aided testing indicate continued benefit with Cros
  • Parent expressed concerns with her reading and writing skills, as well as difficulty with following directions and processing
   - Speech referral with Hi SLP:
     - mild dysarthria and generalized weakness
     - cortical dysplasia is a strong factor in her expressive language impairment
   - 6 months of therapy – discharged
• Hearing Aid Check age 13
  • Patient reported wearing Cros device consistently and doing well since starting school
  • New complaints of dizziness: referred for updated balance testing and referral to Neurology
  • Functional outcome measures and aided testing indicate continued benefit with Cros
  • Speech in Noise testing completed (noise to good ear, speech to bad ear): 72% unaided vs 92% aided

Cochlear Implant
Depending on etiology…

Cochlear Implants
• Only option that actually delivers sound to impaired auditory pathway
• May be considered when cochlea is completely formed and auditory nerve is intact
• Very much etiology dependent
• Success also very much depends on age at implant
• NOT currently approved by the FDA
Problem:

Auditory deprivation: what is happening to an “unstimulated” auditory pathway? (Gray 2009)

Cochlear Implant

• Pediatric Candidacy
  • 12 months of age or older
  • Profound sensorineural hearing loss (>90 dBHL)
  • Little or no benefit from appropriately fit hearing aids
  • High motivation and realistic expectations from family, possibly patient as well
  • No medical/surgical contraindications
  • Etiology that does not impact the function of the auditory nerve
Cochlear Implant Case Study

16 year old male

- Sudden SNHL
- Diagnosed with perilymphatic fistula
- Reported tinnitus
- Initially treated with steroids, with no improvement noted
- Went through SSD Consultation, only interested in a treatment that might restore hearing to the right ear

Elected to receive a cochlear implant after thoroughly discussing the pros, cons and possible outcomes

First post-activation appointment: reported that tinnitus is alleviated by the implant, but limited discernable benefit

Subsequent follow-up: continues to improve speech perception and auditory access

However, not yet consistently using the device for best possible outcome
HAT / FM Systems

- Roger / FM System
  - Primarily for school use
  - The speaker’s (i.e. teacher) voice is sent directly to the listener’s better ear wirelessly
  - May be used alone or in conjunction with other technology

No Device

- What we tell parents
  - Always remember that not selecting a device is an option…
  - We will continue to monitor your child’s hearing loss and auditory progress
  - If one option doesn’t seem right for you now, it might in the future
  - Even if you don’t have concerns right now, concerns may arise in the future
Conclusions

- Treatment options for UHL/SSD are often overlooked as the patient typically has one good hearing ear.
- Despite evidence reported in past literature regarding the difficulties experienced by patients with UHL/SSD, they often do not receive intervention.
- Difficulties reported in the literature and anecdotally by patients, parents, and educators include:
  - poor speech perception in background noise
  - decreased localization ability
  - and academic challenges
- While one intervention may not provide sufficient benefit for one patient, another could perceive a more favorable outcome

Next Steps: SSD Studies

- Formal Study on SSD outcomes
- Looking at various treatment options (excluding cochlear implants), and their respective outcomes
- Enrolled School-Aged children
- Study-group self-selection
- Preliminary data only
- Currently have 22 subjects enrolled
- Data collection still underway
SSD Studies

• Preliminary Results:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>CROS</th>
<th>No Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution</td>
<td>70%</td>
<td>30%</td>
</tr>
<tr>
<td>BKB-SIN Score</td>
<td>1.1dB average improvement</td>
<td>No difference</td>
</tr>
<tr>
<td>PBQ Score</td>
<td>9% point improvement</td>
<td>3% point impr.</td>
</tr>
<tr>
<td>HearQL Score</td>
<td>17% point improvement</td>
<td>5% point impr.</td>
</tr>
</tbody>
</table>

• On the Horizon:
  • Considering additional test measures and methods (eye tracking localization) for clinical viability
  • Developing a protocol to study cochlear implantation in very young patients with SSD

Special Thanks!

• Lori Garland, MS
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• Jareen Meinzen-Derr, PhD
• Dan Choo, MD
• John Greinwald, MD
• Our Patients
Thank you for your time!

References/Resources

- Cochlear Corp. www.cochlearamericas.com
- Oticon Medical. www.oticonmedical.com
- Phonak www.phonak.com
- Sophone www.sophone.com