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Emerging Issues in Cochlear Implantation

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Learning Objectives

- Discuss the rationale for implanting children under 12 months of age.
- Discuss the possible effects of co-morbidities on children implanted under 12 months of age.
- Discuss the risks and benefits of cochlear implantation in children under 12 months of age.
FDA Approved Devices

- Advanced Bionics
- Cochlear
- Med El

FDA General Guidelines for Candidacy

- 12 months of age or older
- Moderately-severe to profound SNHL
- Little benefit from hearing aids (hearing aid trial)
- Presence of cochlea and auditory nerve
- Medically able to undergo procedure and follow-up
- Parental counseling: Understanding of process and postoperative course, realistic expectations, motivation, device choice
- Rehabilitation and educational planning
Emerging Issues

- More residual hearing
- Bimodal fittings
- Bilateral fittings
- New programming techniques
- Adolescent, long-term deafened
- Geriatric
- SSD
- ABI
- <1

Cochlear Implantation in Children Under 12 Months of Age
FDA General Guidelines for Candidacy

- Moderately-severe to profound SNHL
- Little benefit from hearing aids (hearing aid trial)
- Presence of cochlea and auditory nerve
- Medically able to undergo procedure and follow-up
- Parental counseling: Understanding of process and postoperative course, realistic expectations, motivation, device choice
- Rehabilitation and educational planning

Newborn hearing screening has led to early ID of profound hearing loss.

- 85% - 99% of newborns are being screened within a day of being born, remainder within first few months.
- On average and over all degrees of hearing loss, children achieve higher levels in all areas when intervention commences within the first 6 months of life.
Research has demonstrated that profoundly deaf children have significant delays in auditory and linguistic skills despite the early use of amplification.

Pediatric CI has provided greater access to sound which has promoted an increase in the skills.

Recent studies have shown development of auditory/oral language skills on par with normal hearing children following implantation at 1-3 years of age in some implanted children.

In order to catch-up, however, implanted children have to learn at a faster rate than their normal hearing peers.

If implantation occurred at a younger age, the gap might be narrower or non-existent.
Implanting Under One

- Safety
- Candidacy
  - Certainty of testing and deafness
- Programming issues
- Efficacy
  - Auditory
  - Linguistic

Safety

- Anesthetic Risks
- Surgical Risks
  - Blood volume concerns
  - Infectious risks
  - Scalp flap issues
  - Device migration
  - Skull shape and thickness
  - Facial nerve issues
Agreement

Surgery can be performed safely BUT it requires

- Good pediatric anesthesia
- Minimal blood loss
- Infectious risks
- Scalp flap issues
- Device migration
- Skull shape/thickness
- Facial nerve issues

- Colletti et al 2005
- Waltzman and Roland 2008
- Johr et al 2008
- Cosetti and Roland 2010
- McKinney 2017
- Kim et al 2017
Candidacy

- Accurately establish degree of hearing loss with behavioral and objective testing

- Quantify auditory/linguistic behaviors using age appropriate measures

Pre-operative Evaluation (Pediatric)

- Case history
  - Medical, otologic, audiologic, communication, educational, and psycho-social factors
- Audiologic- unaided and aided testing
  - Behavioral measures
  - Objective measures
    - ABR, OAE
    - Age appropriate speech perception testing
- Medical
- Otologic
- Radiologic
- Assessment of speech and language development
- Assessment of cognitive development
- Family and school support
- Counseling- expectations
Speech Perception Testing (age appropriate)

<table>
<thead>
<tr>
<th>AGE RANGE</th>
<th>SPEECH-READING</th>
<th>CLOSER-SET</th>
<th>WORDS</th>
<th>SENTENCES QUIET</th>
<th>SENTENCES NOISE</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 mo. – 2 yrs.</td>
<td>IT-MAS, LittleEars, P.E.A.C.H.</td>
<td></td>
<td>Ling 6 sound test</td>
<td></td>
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</tr>
<tr>
<td>2 yrs. – 4 yrs.</td>
<td>Craig Lipreading Inventory</td>
<td>ESP (Low Verbal) NU-Chips Minimal Pairs</td>
<td>GASP MLNT LNT</td>
<td>Common Phrases</td>
<td>Common Phrases</td>
</tr>
<tr>
<td>5 yrs. – 9 yrs.</td>
<td>Craig Lipreading Inventory CID Sent.</td>
<td>ESP (standard) NU-Chips Minimal Pairs 4-Choice Spondee</td>
<td>PB-K (full list)</td>
<td>HINT-C HINT Pediatric AZ-Bio</td>
<td>HINT-C HINT Pediatric AZ-Bio</td>
</tr>
<tr>
<td>12 yrs. – 17 yrs.</td>
<td>Craig Lipreading Inventory CID Sent.</td>
<td>MTS 4-Choice Spondee</td>
<td>CNC (full list)</td>
<td>HINT Pediatric or Adult AZ-Bio</td>
<td>HINT Pediatric or Adult AZ-Bio</td>
</tr>
</tbody>
</table>

Evaluations should be performed regularly post-implantation
Programming

- Device programming: objective and subjective techniques
- Subjective: standard play audiometry
- ECAP (electric compound action potential): measurement of whole nerve action potential: NRT, NRI, ART
- EART- electrically elicited acoustic reflex threshold

Efficacy

- Auditory

- Linguistic

- Evidence that implanting <12 months improves long-term outcome?
Auditory

- Limited published data show trend towards benefit:
  - Lesinski-Schiedat et al 2004
  - Colletti et al 2005
  - Waltzman & Roland 2005
  - Tajudeen et al 2010
  - Dettman et al 2016

Linguistic

- Preliminary reports show receptive and expressive language skills grow at rates comparable to normal hearing peers i.e. greater than those implanted above >12 months of age.
  - Miyamoto et al 2003, 2005
  - Colletti et al 2005
  - Dettman et al 2007
  - Tait et al 2008
  - Leigh et al 2013
Summary

- Full insertions without perioperative complications

- No difficulty with device programming

- Developing auditory/oral language skills

- EXPERIENCED SURGEONS, CENTERS

NYU Cochlear Implant Center

- ~175 CI in Children <1
  - Age range 6 mo. - 11 mos. But most are ~ 9 months
  - Simultaneous bilateral
  - Reimbursement issues - many just over 12 mos

- Originally driven by parents with several deaf children
Summary

- Full insertions without perioperative complications
- No difficulty with device programming
- Developing auditory/oral language skills
- EXPERIENCED SURGEONS, CENTERS

Conclusions

- Implantation in children <12 months of age can be performed safely.
- Provides early and effective access to sound leading to functional benefit beyond what can be obtained with conventional amplification with trend towards better development than later implantation.
- Must have appropriate post-implantation intervention.
On-going Issues

- Surgical/postoperative risk
- Appropriate diagnostic, programming, intervention experience
- Parental pressure
- Off-label in US
- Reimbursement

- Does early implantation increase the probability of age appropriate oral language/speech development beyond what can be obtained with later implantation in the long-term?

Additional disabilities

- Recognized and unrecognized

- Auditory neuropathy

- Cautious re: expectations due to unidentified disabilities including cognitive issues, learning disabilities, etc

- NYU current study
Undiagnosed disabilities in children <12 months who receive CI

Purpose

- The purpose of this study was to examine a cohort of patients with bilateral severe to profound SNHL who received CI <12 months of age for the incidence and impact of cognitive, behavioral, medical issues that either developed over subsequent years or were not evident prior to implantation.
Methods

- 108 children <12m were implanted 2000-2013
- 93/108 (86%) met inclusion criteria i.e. were followed at NYU for a period of 3 years or more
- IT-MAIS preoperatively
- Age appropriate monosyllabic words post-operatively

Results

- 79/93 (84%) had no preop concerns
- 14/93 (16%) were diagnosed with issues preop which could potentially affect outcome (meningitis, EVA, CHARGE)
- 8/79 (10%) who were not identified as having a disability preop were later identified. The mean age of postop diagnosis was 7 years of age.
- Later diagnoses included: ADD, ADHD, Asperger's, difficulty with executive functioning, cognitive issues, learning disabilities, neurological deficits
Results

- PBK monosyllabic word test was administered to 5/8 children 3-5 years postop. Mean score = 95%
- 3/8 children were administered the CNC monosyllabic word list 3-8 years postop. Mean score = 90%
- No difference in performance from the groups with no diagnosed disabilities preop or postop
- Group with diagnosed disabilities preop had poorer performance postop likely due to severity of disabilities

Summary and Conclusions

- Preliminary results show that children implanted <12m of age diagnosed with additional disabilities several years following implantation obtain substantial though benefit from their implants.
- Early implantation allows for development to full potential although performance is dependent on the severity of the disability.
- While early implantation is beneficial, during parental preoperative counseling it is important to address the benefits or early implantation, the need for rehabilitation and potential unknown confounding factors which can affect performance and overall outcome.
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Thank you