Abstract

The study will enable surgeons to have a better understanding of the long-term complications that cochlear implant patients can experience.

Outcome Objectives
- Study delayed complications following cochlear implantation
- Review some of the management plans following complications

Methods
A systematic analysis of the literature was performed from 2003 to 2013 on patients who had complications following cochlear implantation. Demographic information was recorded. Only delayed complications (occurring > 3 days postoperatively) are discussed in the current study.

Results
Our initial search resulted in 766 articles, 78 were reviewed for the study. A total of 22,510 patients were reviewed. When reported, prevalence of males was 50.7% (n = 4319). The age range was 0.2-94.9 years, with a mean age of 39.04 years. The range of follow-up was 1 month to 17 years. The total number of delayed complications was 3,017 (13.4%) with device failure being the most common (n = 499; 2.22%), most common and skin infections (n = 248; 1.10%) and mastoiditis (n = 43; 1.98%) being the second most common. Less common was cheilitis (n = 48; 0.56%) and facial nerve palsy (n = 36; 0.54%).

Conclusions
Cochlear implantation continues to be a reliable and safe procedure, with a low percentage of severe complications, in experienced hands. The patients should continue to have life time follow-up.

Introduction
Cochlear implantation (CI) has been successfully used in the management of pediatric and adult severe to profound sensorineural hearing loss.
- CI surgery is considered a relatively safe procedure in experienced hands
- Large studies shown low rates of intra and post-op complications
- Long term complications are more sparse and ill-defined
- Re-implantations and long-term complications have economic impact
- Recent studies on complications:
  - Most common long-term complications
  - Device malfunction, scalp infection, device extrusion
  - Need for unification of complications and reporting

Methods and Materials
A systematic analysis of the literature was performed from 2003 to 2013
- Complications following cochlear implantation
- PubMed and OVID using the terms "cochlear implant" and "complications"
- 766 articles → 78 were reviewed for the study
- Inclusion criteria
  - Delayed complications: occurring > 3 days post-op
  - Exclusion criteria
    - Papers without long-term follow-up record
    - Papers without delayed complications
    - Small case series < 10 patients
    - Significant cochlear malformations

Table 1. Complications of Cochlear Implants

<table>
<thead>
<tr>
<th>Complication</th>
<th>Number</th>
<th>Total Absolute (Percent)</th>
<th>Relative (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Failure</td>
<td>499</td>
<td>2.22</td>
<td>3.84</td>
</tr>
<tr>
<td>Skin infections</td>
<td>248</td>
<td>1.10</td>
<td>1.43</td>
</tr>
<tr>
<td>Vestibular concerns</td>
<td>206</td>
<td>0.92</td>
<td>4.64</td>
</tr>
<tr>
<td>Electrode issues</td>
<td>17</td>
<td>0.08</td>
<td>0.88</td>
</tr>
<tr>
<td>Recurrent otitis</td>
<td>71</td>
<td>0.32</td>
<td>0.96</td>
</tr>
<tr>
<td>Seroma/Hematoma</td>
<td>54</td>
<td>0.24</td>
<td>0.98</td>
</tr>
<tr>
<td>Taste problems</td>
<td>87</td>
<td>0.39</td>
<td>5.00</td>
</tr>
<tr>
<td>Device migration</td>
<td>64</td>
<td>0.28</td>
<td>0.73</td>
</tr>
<tr>
<td>Mastoiditis</td>
<td>43</td>
<td>0.19</td>
<td>1.98</td>
</tr>
<tr>
<td>Cheilitis</td>
<td>48</td>
<td>0.21</td>
<td>0.54</td>
</tr>
<tr>
<td>Facial nerve</td>
<td>26</td>
<td>0.12</td>
<td>0.54</td>
</tr>
<tr>
<td>Device rejection</td>
<td>12</td>
<td>0.05</td>
<td>0.33</td>
</tr>
<tr>
<td>Tympanic Membrane perforation</td>
<td>1</td>
<td>0.001</td>
<td>0.33</td>
</tr>
<tr>
<td>Chronic headaches</td>
<td>4</td>
<td>0.02</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Discussion

Device Failure: 3.84%
- Children may not be able to articulate problems with the device
- Diagnosis: clinical, audiologic, and radiographic testing to exclude medical problems, hardware or software problems
- Most pts present with normal integrity testing
- Most failures: fracture of casing or loss of hermetic seal

Skin Infections: 1.43%
- Pre 1994 vs post 1994 cochlear implantations
  - Pre-use large incision rate of 2.35%
  - Post-use small incision only 1.10%
  - Significant difference → smaller incisions better
- Large retrospective review had skin issues in 5.3%
- 60% required revision and 45% needed re-implantation
- Time to infection was 1.5 months to 7 years

Facial Nerve: 0.63%
- Time periods: within two days: associated with edema or nerve injury
- After three days theories:
  - Reactivation of herpes virus after tympanomastoid surgery
  - Perineural
  - Tympanoetmal flap or manipulation of the chorda tympani
- Neural edema and vasospasm
- Treatment:
  - Corticosteroids for facial nerve weakness
  - Assess vascular, corticosteroids, antivirals and physiotherapy

Mastoiditis: 1.98%
- Brito et al. - review of 550 patients
  - 5 children treated IV antibiotics, and tubes
  - 1 adult got a persistent perforation followed by cheilitis

Discussion cont.

Electrode Issues: 0.88%
- Electrode failure, electrode migration, electrode slip out, non-auditory stimulation, electrode exposure

Recurrence: 0.24%
- Older studies: higher incidence of problems
  - Hoffman et al: 4.3% incidence
  - Webb et al: 6.5% incidence

Recurrent Otis Media: 0.96%
- Postoperative otitis can arise from wound flap infections
- Other causes: tympanosclerosis
    - Staph aureus, MRSA, Aspergillus

Taste: 5.0%
- Chorda tympani syndrome: changes in sense of taste, mouth dryness or tongue paresthesia
  - Wagner et al. 2010 review pt with taste complaints
  - Subjective feeling of taste dysfunction in 4 patients permanent
  - Only 1 patient had objective findings on taste testing

Device Migration: 0.73%
- Causes: local infection, possible silicone allergy, technique of placement
- Methods to secure device:
  - Creation of small perichondrial pocket or bony well
  - Suturing the device down to bone

Cheilitis: 0.56%
- Mean time to development was 45 months
- Brito et al (2012) reported 6 patients with cheilitis
- All required subsequent operative interventions
- Developed 18-84 months after surgery
- Late onset demonstrates need for extended follow up

Meningitis: 0.29%
- Worldwide, about 20 new cases yearly
- Prevention
  - Strict adherence to vaccinations per CDC guidelines
  - Seal the cochleostomy site intra-operatively
  - Aggressive treatment of CI patients with acute otitis media

Conclusions
Cochlear implantation continues to be a reliable and safe procedure, with a low percentage of severe complications, in experienced hands. The three most common delayed complications found in this study include device failure, skin infections, and vestibular concerns. Although low in percentage, the possibility of long-term complications warrants life time follow-up for the patient.