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Acute Mastoiditis in Children with Cochlear Implants: Is Explantation Required?

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Abstract

Objective. Acute mastoiditis is an uncommon but challenging condition when it occurs in children with cochlear implant. The literature is scarce as to the management of this condition with regards to explantation. The objective of the study is to determine the need for explantation in patients with cochlear implants who suffer from acute mastoiditis.


Review Methods. A systematic review of all publications addressing the treatment of mastoiditis in cochlear implant children prior to November 2013 was conducted. Data were collected from online medical databases—PubMed, Ovid Medline, Ovid Medline in process, Embase, Cochrane Library, CINAHL, Biosis, Google Scholar, and Scopus. The review was performed in 3 phases; an initial screening review of abstracts was performed, followed by a detailed review of full articles based on inclusion and exclusion criteria, and lastly a final review to extract data from selected articles.

Results. Twelve articles were found eligible for this systematic review including a total of 43 patients. Subperiosteal abscess was present in 14.3%. All patients received intravenous antibiotics as an initial treatment, and if needed, surgical intervention was performed. Only 1 patient required explantation (2.3%).

Conclusion. Prompt, aggressive medical and if needed surgical therapy can help in saving the implant and result in a favorable outcome.

Keywords

mastoiditis, pediatric, cochlear implant, management, explantation

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Introduction

Cochlear implant (CI) has become a common procedure in the management of patients with profound hearing loss, especially those who do not benefit from hearing aids.1 Similar to what obtains in other surgical procedures, some patients suffer from complications either directly or indirectly related to CI.2 CI has been associated with electrode issues (displacements or failure), flap related problems, facial nerve palsy, disequilibrium, and infections.2-5

The incidence of middle-ear infection including acute mastoiditis in children with CI is about 1%.6 Usually, implanted materials (eg, an artificial joint, implantable pacer, etc) provoke foreign-body reaction, which sometimes culminates in outright infection of tissues surrounding or in close proximity to the foreign body. The management of this typically includes drainage of the infected material and tissue, administration of antibiotics, and extraction of the implanted material (foreign body).7-9 Although acute mastoiditis in an implanted child is relatively uncommon, it represents a management dilemma given the accompanying social, emotional, and economic issues. These concerns are particularly important in children who rely on their implants for speech development and learning.10-12

Previous reports have shown complications relating to CI; however, specific analysis of acute mastoiditis in children with CI remains to be explored due to the rarity of this condition. Therefore, the purpose of this study is to conduct a systematic review of all published articles reporting the management of acute mastoiditis in children with CI with the aim of defining the need for removing the CI in order to manage concurrent acute mastoiditis.

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Materials and Methods

Search Strategy

A systematic review of all articles published prior to November 31, 2013, pertaining to the management of acute mastoiditis in CI children. Identifying eligible articles was through a comprehensive and stepwise search through electronic databases; namely, PubMed, Ovid Medline, Ovid Medline in process, Embase, Cochrane Library, Comprehensive Index to Nursing and Allied Health Literature (CINAHL), Biosis, Google Scholar, and Scopus. The search strategy included the text words mastoiditis (all fields) or mastoiditis (MeSh terms) and cochlear implant (all fields) or cochlear implant (MeSh terms) in combination with infant (all fields), or child (all fields), oradol (all fields), or neonate (all fields), or new born (all fields), pediatric (all fields), teen (all fields), girl (all fields), or boy (all fields). Articles published from the date of database inception to the end of November 2013 and written in English, French, or Spanish were included.

Inclusion and Exclusion Criteria

We included publications discussing children 18 years or younger with CI. Included studies had to have reported children with CI that developed mastoiditis in the implanted ear following implantation, without intracranial involvement who were managed medically and/or surgically. Also required for inclusion was a report of whether the implant was explanted or not. We excluded articles reporting on patients who were more than 18 years old or where the age group was not identified. Furthermore, articles that did not discuss the management and outcome of the implanted children with mastoiditis or did not specifically describe if the patients were treated with antibiotics or surgical intervention were excluded. We also excluded articles with suspected duplicated data. Finally, commentaries, conference abstracts, letters, and replies were not considered eligible.

Study Selection

Initially, 3 authors (FZ, IC, and OVA) performed a complete and comprehensive databases search to screen the articles’ titles, abstracts, and keywords. Then 2 authors (FZ and IC) reviewed the full text to determine eligibility of the articles and screened the references of these articles to find further eligible articles. After selecting the eligible articles, the third author (OVA) reassessed selected articles for final inclusion.

Quality Assessment

The articles that were found eligible were assessed for quality using a modified version of Downs and Black (DB) scale.13

Statistical Analysis

All qualitative variables were reviewed, recorded, and stored in an electronic database. The statistical analysis using Statistical Package For Social Sciences (SPSS) version 21 and Microsoft Excel 14.3.6 was performed. Descriptive statistics were used to report variables like age of implantation, gender, duration from implantation to mastoiditis, diagnosis, treatment options, and the duration of antibiotic treatment.

Results

Number of Studies and Study Designs

The literature search yielded 76 articles, 1 article was added through screening references of selected articles. Following independent and joined review, 18 articles were selected for full review, however 12 articles that met our inclusion and criteria were eligible for qualitative analysis. Publishing dates were from 2000 to 2013. Of these articles, 11 were retrospective reviews,14-24 while only 1 was a prospective cohort study.25 This resulted in low DB scores (Figure 1).

Population and Demographics

The 12 included studies had a total of 43 CI-children who developed acute mastoiditis in the implanted ear. Gender was identified in 17 of 43 patients, 9 of which were females. Age of implantation was determined in 5 of 12 studies, with a mean age of 39.2 months (Table 1).

Clinical Presentation

A typical clinical picture of acute mastoiditis was defined as otalgia in the presence of postauricular swelling, erythema, and tenderness. Although the symptoms were not clearly described in all articles, for the purpose of this review, we considered the diagnosis of the author to be accurate.

Data regarding the presenting symptoms were documented for 17 out of 43 patients. Postauricular swelling was a presenting feature in all 17 patients. Otalgia was present in 7 patients, whereas only 4 patients had fever.

The mean duration from implantation to the development of mastoiditis was 17.2 months (8/12 studies reported durations). Overall, 3 patients developed recurrent episodes of mastoiditis.
Investigation and Diagnosis

All the reports that documented their investigations used CT scan to confirm the diagnosis and to rule out intracranial involvement. Bacterial culture results were presented in 4 of 12 studies. The organisms isolated were *Streptococcus pneumoniae* (4 cases), *S. pyogenes*, *Staphylococcus aureus*, *Pseudomonas sp.*, and *Haemophilus influenzae*. Subperiosteal abscess was present in 14.3% of all patients.

Treatment and Outcome

All articles reported the treatment modalities. Medical treatment alone was used in 3 studies, whereas a combination of medical and surgical treatments was reported in the remaining articles. Surgical treatments employed included the use of pressure equalizing tubes (PET), mastoidectomy, and/or incision and drainage of an abscess.

Less than half of the publications discussed the antibiotic regimen. In these studies, the antibiotic of choice was intravenous ceftriaxone administered for a duration ranging from 3 days to 6 weeks. All patients treated with less than 10 days of IV ceftriaxone received oral antibiotics (cefazidime or cephalaxin) for up to 3 weeks.

Only 1 patient was explanted due to the failure of initial medical and surgical therapies developing signs suggestive of device malfunction (pain on stimulation). This patient had previously suffered from meningitis prior to the implantation and subsequently developed an acute otomastoiditis causing pain on stimulation 10 months after the implantation. The patient was initially treated with multiple courses of antibiotics and incision and drainage, but the infection persisted. This explains the decision to explant in this particular patient as it was deemed unsafe to keep the implant in place.

Three patients had recurrence of mastoiditis, 2 of whom were treated medically, while the third required PET.

All patients who were not explanted recovered completely with normal functioning implants (Table 2).

Discussion

Worldwide, there are more than 80,000 implanted children. It is estimated that about 7% to 15% of them would develop complications in their post-implantation period.

Although many studies have reported post CI complications and comorbidities, very few have discussed the management of the acute mastoiditis in CI patients, especially in children. Due to its low incidence, a single center’s reported experience is inherently limited. A number of systematic analyses have focused on complications and comorbidities of CI, but

### Table 1. Number of Patients with Cochlear Implants who Developed Mastoiditis in Each Study and the Mean Age of Implantation.

<table>
<thead>
<tr>
<th>Lead Author</th>
<th>Number of Patients</th>
<th>Mean Age of Implantation b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migirov17</td>
<td>11</td>
<td>41</td>
</tr>
<tr>
<td>Stratigouleas20</td>
<td>1</td>
<td>X</td>
</tr>
<tr>
<td>Lin16</td>
<td>1</td>
<td>X</td>
</tr>
<tr>
<td>Bhatia15</td>
<td>1</td>
<td>132</td>
</tr>
<tr>
<td>Ramos18</td>
<td>2</td>
<td>X</td>
</tr>
<tr>
<td>Rodriguez19</td>
<td>5</td>
<td>28.44</td>
</tr>
<tr>
<td>Kemp22</td>
<td>5</td>
<td>X</td>
</tr>
<tr>
<td>Lescanne23</td>
<td>2</td>
<td>31.5</td>
</tr>
<tr>
<td>Luntz25</td>
<td>2</td>
<td>X</td>
</tr>
<tr>
<td>Potsic24</td>
<td>3</td>
<td>X</td>
</tr>
<tr>
<td>Achiques21</td>
<td>2</td>
<td>X</td>
</tr>
<tr>
<td>Osborn14</td>
<td>8</td>
<td>33.75</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>39.2</td>
</tr>
</tbody>
</table>

*X indicates information not available.

### Table 2. Diagnoses and Management Utilized in Each Study.

<table>
<thead>
<tr>
<th>Lead Author</th>
<th>Duration from Implantation to Mastoiditis</th>
<th>Subp Abscess Presence (%)</th>
<th>Surgical Treatment (%)</th>
<th>Abx Duration b</th>
<th>Explantation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migirov17</td>
<td>12</td>
<td>36.4</td>
<td>27.3</td>
<td>3-5d IV + PO</td>
<td>0/11</td>
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<tr>
<td>Stratigouleas20</td>
<td>12</td>
<td>0</td>
<td>100</td>
<td>X</td>
<td>0/1</td>
</tr>
<tr>
<td>Lin16</td>
<td>36</td>
<td>0</td>
<td>100</td>
<td>14d IV</td>
<td>0/1</td>
</tr>
<tr>
<td>Bhatia15</td>
<td>10</td>
<td>0</td>
<td>100</td>
<td>X</td>
<td>1/1</td>
</tr>
<tr>
<td>Ramos18</td>
<td>X</td>
<td>0</td>
<td>100</td>
<td>X</td>
<td>0/2</td>
</tr>
<tr>
<td>Rodriguez19</td>
<td>39.76</td>
<td>60</td>
<td>60</td>
<td>5-10d IV + 21d PO</td>
<td>0/5</td>
</tr>
<tr>
<td>Kemp22</td>
<td>X</td>
<td>0</td>
<td>100</td>
<td>X</td>
<td>0/5</td>
</tr>
<tr>
<td>Lescanne23</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>X</td>
<td>0/2</td>
</tr>
<tr>
<td>Luntz25</td>
<td>X</td>
<td>0</td>
<td>0</td>
<td>X</td>
<td>0/2</td>
</tr>
<tr>
<td>Potsic24</td>
<td>9.3</td>
<td>0</td>
<td>0</td>
<td>X</td>
<td>0/3</td>
</tr>
<tr>
<td>Achiques21</td>
<td>X</td>
<td>50</td>
<td>50</td>
<td>X</td>
<td>0/2</td>
</tr>
<tr>
<td>Osborn14</td>
<td>7.6</td>
<td>25</td>
<td>87.5</td>
<td>X</td>
<td>0/8</td>
</tr>
</tbody>
</table>

Abbreviations: Subp Abscess, mastoiditis with subperiosteal abscess; Abx, antibiotics; IV, intravenous; PO, per os.

*X indicates information not available.

The PO regimen shown in the table was started immediately after the IV.
implant stimulation was a key feature in one of the cases. Symptoms exclusively seen in children with CI. Pain on almost similar to those seen in non-implanted children with acute mastoiditis, attention has to be given to some rare symptoms exclusively seen in children with CI. Pain on implant stimulation was a key feature in one of the cases presented in this review who required explantation. This symptom suggests device malfunction, which is an indication for explanting the device even if the infection was eradicated. Observing such alarming symptoms alongside those of mastoiditis are particularly important in identifying patients who may eventually require explantation. Unfortunately, none of the articles discussed in depth the duration of the symptoms prior to the presentation, which makes it difficult to evaluate the severity of each case.

The approach to managing an implanted child with acute mastoiditis requires quick and precise medical decisions. The physician has to be aware that failure to control the disease can result in implant-related technical damages and, more seriously, deterioration of the child’s medical condition. It is suspected that meningitis in patients with CI is caused by direct spread of bacteria through the middle and inner ear. The common thing about the patients in this review is that all of them had received antibiotics immediately after diagnosis, regardless of the need for surgical intervention. Fifty percent of the patients did not require surgical intervention and responded well with the prescribed antibiotic regimen. Although, one subperiosteal abscess was treated with antibiotics alone due to its relatively small size, it is still encouraged to drain all abscesses in close proximity to the implant. Based on the data presented in this study, intravenous antibiotics is suggested to be continued for at least 7 days followed by 3 weeks of oral antibiotics, even if surgery is indicated. Most of the eligible articles in this review did not discuss the use of PET in their management. Nevertheless, Osborn et al. illustrated the benefit of early surgical intervention and the use of PET in the presence of mastoiditis. In a case series comprising of 8 patients, 5 out of 6 patients who received PET did not have any abscess, and all 8 patients recovered fully with a functioning implant.

Cochlear implant comes with a share of psychosocial issues to both the family and the child. It is estimated that psychological disorders are up to 5 times more common in deaf children. There is also a learning curve and adjustment to the new implant, as well as the maintenance and complications associated with it. Interestingly, some children with CI perform better than their average normal-hearing peers, therefore children with CI do not necessarily lag behind. Consequently, counseling patients with CI, and their families requires an understanding of their psychological stress.

Prior to making any decision, it is necessary for the physician and surgeon to carefully assess the options when faced with complications or comorbidities related to the implant. In this review, we have presented issues relating to the development of a mastoid infection in close proximity to a foreign body.

It is important to recognize that the key to preserving the implant in patients with mastoiditis is the prompt initiation of aggressive medical and if needed, surgical therapy.

Our review has a few limitations; owing to the rarity of this condition, the sample size of cases in this systematic review is small. Extrapolations and conclusions should therefore be made with caution. Another limitation is that articles written in languages other than English, French, or Spanish were excluded. This possibly implies a potential selection bias. Nevertheless, this review provided scientific evidence demonstrating a trend toward a favorable implant outcome in children with CI when treated aggressively with antibiotics.

To our knowledge, this is the first systematic review addressing the fate of the implant device in implanted children with acute mastoiditis.

Conclusion

Acute mastoiditis after cochlear implantation is relatively uncommon. When present, aggressive therapy, in form of intravenous antibiotics with or without surgery, should be initiated promptly in order to prevent further complications and save the implant.

Acknowledgment

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Author Contributions

Faisal Zawawi, study design, data collection and analysis, first draft preparation; Isabel Cardona, data collection and manuscript review; Olubunmi V. Akinpelu, data collection and manuscript review; Sam J. Daniel, study design, manuscript review.

Disclosures

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