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Infectious complications of pediatric cochlear implants are highly influenced by otitis media

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ABSTRACT

Objective: Determine the incidence of ear infections in cochlear implant patients, evaluate the contribution of otitis media to complications, describe the bacteriology of otitis media in the cochlear implant population, the treatment provided at our center, and the long term outcome.
Methods: Data collected included age at implantation, history of otitis media or ear tubes, etiology of hearing loss, inner ear anatomy, postoperative infections, time to infection, route of antibiotic administration, and interventions for infections. Categories of infection were acute otitis media, otitis media with effusion, tube otorrhea, meningitis, scalp cellulitis, and infection at the implant site.
Results: Middle ear infections were diagnosed in 37% of implanted ears. Extension of middle ear infections into the implant site occurred in 2.8% of all implants (n = 16). Of the 16 infected devices, 10 were successfully treated with antibiotic therapy and did not require explantation. The retained implant group and explanted group both included some middle ear microbes such as *Haemophilus influenzae* and *Streptococcus pneumoniae*, as well as skin flora such as *Staphylococcus aureus*.
Conclusion: Otitis media in pediatric cochlear implant patients is a common event and usually does not lead to complications of the cochlear implant. However, when the ear infection spreads to the scalp and the implant site, it is still possible to eliminate the infection using antibiotic therapy, particularly when treatment is directed to the specific organism that is recovered from the infected space and the duration and route of antibiotic treatment is carefully considered.

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1. Introduction

Cochlear implantation (CI) has provided hearing to deaf children and the opportunity to develop speech and language that is not possible with amplification alone [1–4]. The importance of hearing at an early age is known to be critical for development of speech and language; thus, cochlear implantation for congenitally deaf children is typically pursued at an early age. Because infants are at higher risk of otitis media (OM), there has been concern about the potential infectious complications of OM in young children with CI. Currently, we do not consider recurrent OM to be a contraindication for CI.

There is uncertainty and some degree of controversy regarding how best to manage OM in children with CIs and how to address an infection that has spread to the implant bed. An infection involving a CI that is not successfully treated with antibiotics often leads to explantation of the device. If the implanted ear is the better hearing ear, or the only hearing ear, this can lead to significant hardship for the child, with inability to communicate during the time without the device or loss of speech language progress during a critical period of their development. A previous study showed that speech performance worsened in nearly 10% of patients undergoing reimplantation [5]. Because infections are the second most common reason for explantation after device failure [6], further

Abbreviations: CI, cochlear implant; OM, otitis media; MSSA, methicillin sensitive staphylococcus aureus; MRSA, methicillin-resistant Staphylococcus aureus; S. aureus, Staphylococcus aureus; AOM, acute otitis media.

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understanding of the etiology, management, and prevention of infectious complications are of great importance to this patient population.

OM has not always been viewed as an important risk factor for developing an infection of the CI site. While early studies did not report sequelae from postoperative OM in CI patients [7,8], Kempf et al. recommended that "antibiotics should be administered intravenously and a few days longer than for ears without implants," [9] (p131) while Luntz et al. treated postoperative OM with oral antibiotics and did not report any adverse events [8]. The lack of adverse events after treatment with oral antibiotics was confirmed in a later prospective study, which found no OM-related complications [10]. The question of whether myringotomy tubes are safe in the setting of a new CI has also been debated, due to a perceived concern with exposing the middle ear space to the ear canal [11]. However, a number of studies have shown no increased risk of tube-related complications after CI [12–16], and others encourage this practice in children with recurrent acute otitis media (AOM) after CI [14,17].

2. Methods

This retrospective case series was performed at an urban, academic, tertiary care center in the Midwest. All children undergoing cochlear implantation from August 1999 through October 2013 were included for study. Six experienced CI surgeons performed the procedures. The Institutional Review Board at Washington University in St. Louis approved this study.

2.1. Data collection

Study data were collected (PV, KH) from inpatient and outpatient records, and entered into a Research Electronic Data Capture (REDCap) database, a secure, web-based application designed to support data capture for research studies [18]. In the case of questions regarding a specific episode of care, the surgeon caring for the patient was asked to clarify the record in the electronic chart. Data that were collected included age at implantation, implant manufacturer, history of preoperative ear tubes or ear infections, history of meningitis, known reasons for hearing loss, whether ear tubes were present at the time of surgery, abnormal anatomy, history of genetic syndromes, postoperative infections, time to infection, route of antibiotic administration, and surgical interventions used for management of postoperative infections. Recorded postoperative events included AOM, OM with effusion, tube otorrhea, meningitis, wound site infection, or implant infection. Device explantation was also included as an outcome.

2.2. Study definitions of infections

In our chart review, AOM was defined by history and physical exam with some of the following signs and symptoms: history of otalgia, poor sleep, fussiness, or fevers, accompanied by physical findings of erythema of the ear drum and the presence of middle ear fluid diagnosed by either the otolaryngologist or pediatrician. A wound infection was characterized by erythema, swelling, and sometimes pain at the incision without swelling or bogginess at the receiver-stimulator. Implant infection was defined as redness, swelling and/or pain with palpation over the receiver-stimulator, sometimes accompanied by purulent drainage from the incision, fever, or elevated white blood count.

2.3. Data analysis

A descriptive analysis of patient characteristics, types of infections, culture results, treatment and final outcome was performed. Infectious organisms and site of infection were analyzed in order to assess the frequency with which otitis led to infection at the CI site, how often such spread of OM resulted in a need for prolonged antibiotic therapy, and whether spread of organisms from OM to the implant resulted in explantation.

3. Results

During the study period, 568 ears were implanted in 421 patients. The median age at first implantation was 3.6 years (Range: 7 months–21 years), and for the second implant, median age was 4.6 years (Range: 7 months–20 years). The median length of follow up was 5.2 years (Range: < 1 month–15 years). Table 1 includes characteristics of the study population.

Middle ear infection was the most common postoperative infection, (n = 210 infections in 103 ears) and 18% of ears experienced OM at least once after implantation (See Fig. 1). The median interval from the time of implantation to the first episode of postoperative otitis was 6 months with a range of 1 week–65 months. The next most common infection in implanted ears was otitis externa (n = 26, 4.6%). Infection of the internal device occurred in 22 ears (3.8%) with 16 of these implant infections originating from OM and 6 without evidence of middle ear infection. One patient developed fulminant pneumococcal meningitis accompanied by bilateral acute otomastoiditis. This patient was treated with device removal, surgical drainage of the mastoid

Table 1
Characteristics of the study population (n = 568 implants, 421 patients).

Patient characteristics	n	Percentages
Age (Years)		
0-2	147	26%
2-6	194	34%
6-21	227	40%
Gender		
Male	281	49%
Female	287	51%
Type of Implantation		
First implant	514	90%
Explant-reimplant	54	10%
Laterality		
Unilateral	383	68%
Bilateral sequential	110	19%
Bilateral simultaneous	74	13%
Manufacturer		
Cochlear Corporation	336	59%
Advanced Bionics	200	35%
Med-El	31	6%
Cause of Hearing Loss		
Unknown	382	67%
History of Bacterial Meningitis	39	7%
Connexin 26/30	36	6%
History of Congenital CMV	33	6%
Large vestibular aqueduct	31	5%
Auditory neuropathy	14	2%
Wolfram syndrome	1	<1%
Trauma: fracture through both otic capsules	1	<1%
Risk Factors for Hearing Loss		
History of aminoglycoside antibiotic use	21	4%
History of Measles	2	<1%
History of Rubella	1	<1%
Active neurosarcoidosis	1	<1%
Other Medical Conditions		
Intracranial hemorrhage	3	<1%
Ventilator-dependent in NICU	3	<1%
Insulin-dependent Diabetes Mellitus	2	<1%
Lung transplant	2	<1%
Cerebral palsy	2	<1%
Cystic fibrosis	1	<1%

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