

# The Management of Myringotomy Tubes in Pediatric Cochlear Implant Recipients

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**Objective:** To investigate the impact of myringotomy tubes (MTs) on outcomes for pediatric cochlear implant (CI) recipients.

**Design:** Retrospective case-control chart review.

**Setting:** Tertiary care pediatric hospital.

**Patients:** Sixty-two patients received an MT before CI (mean [SD] age at initial CI, 3.20 [2.45] years). Seventy-eight ears received CIs and MTs.

**Intervention:** The MTs were removed and allowed to extrude before CI (59% [n=46]) or kept in place until CI (41% [n=32]).

**Main Outcome Measures:** Otorrhea, persistent tympanic membrane (TM) perforation, and need for additional procedures were recorded. Statistical analysis was performed with the Fisher exact test.

**Results:** Forty ears (51%) required more than 1 set of MTs. Ten ears (22%) in which the MTs were removed before CI required a separate MT after CI compared with 6 ears (19%) in which the MTs remained in place until CI ( $P=.78$ ). The MTs that were present during CI were either removed with myringoplasty (31% [n=10]) or retained after surgery (69% [n=22]). All TMs in which the tubes were removed before or during CI healed. There were 3 persistent TM perforations that required surgical treatment. There were no cases of meningitis and no removals of CIs because of infection.

**Conclusions:** Myringotomy tubes do not appear to adversely affect the final outcomes of pediatric CI recipients and can be managed similarly to MTs in other otitis media-prone children. They may be left in place in children who continue to experience recurrent acute otitis media or removed in children who no longer need them.

*Arch Otolaryngol Head Neck Surg.* 2010;136(6):557-560

**M** AINTAINING A SAFE middle ear is important to the success of pediatric cochlear implants (CIs). With the widespread screening of newborn hearing and the demonstration of successful CI in patients younger than 2 years, pediatric candidates eligible for CI are increasingly identified near the peak age for developing acute otitis media (AOM).<sup>1,2</sup>

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Fifty-percent of all children experience 3 or more episodes of AOM by the age of 3 years, with a peak incidence at around the age of 1 year.<sup>3</sup> The presence of middle ear effusion or inflamed mucosa at the time of surgery may impede visualization, and recurrent AOM (RAOM) carries a high risk of infections after CI.<sup>4-6</sup> While myringotomy tubes (MTs) are a mainstay of treatment for normal-hearing children with RAOM, they are avoided by some CI surgeons because

of concerns of increased complications.<sup>7</sup> Disruption of the tympanic membrane (TM) and the presence of foreign bodies in the middle and inner ear are potential risks for dangerous seeding of the implant with infection. Without MTs, however, RAOM can persist and delay early CI.

The role of MT in CI candidates and recipients is controversial. Several studies have examined the treatment of RAOM around the time of CI focusing on the decision of whether to place an MT.<sup>6</sup> Some surgeons strive to avoid MTs and to establish TM integrity before proceeding with CI, while others treat RAOM with MT before surgery despite CI candidacy.<sup>6-8</sup>

To our knowledge, no studies to date have analyzed the overall management of the pediatric ear that has both MT and CI placement regardless of disease status. Medical and surgical interventions may still be necessary in these cases to manage the MT, and complications can develop. Since the management of MT over the entire course of CI candidacy, implantation, and follow-up has not been examined independently, we sought to evaluate its impact on the outcome for CI ears.

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**Table 1. Myringotomy Tube (MT) Management**

Variable	No. (%)
Preoperative status <sup>a</sup>	
Extruded before CI	32 (41)
Removed with myringoplasty before CI	14 (18)
MT present at CI	32 (41)
No. of MTs before surgery <sup>a</sup>	
2	22 (76)
3	2 (7)
4	4 (14)
5	1 (3)
Intraoperative status	
Removed with myringoplasty	10 (31)
Retained	22 (69)
Postoperative status	
Replaced	16 (21)
No further placement	62 (80)

Abbreviation: CI, cochlear implantation.

<sup>a</sup>Subgroup selected for further analysis.

## METHODS

### SURGICAL TECHNIQUE

All implanted ears were treated at a tertiary care pediatric hospital. The MTs were placed with the patients under general anesthesia in the operating room except for 1 case that was performed with the patient under local anesthesia in the clinic. Myringoplasty was performed using gel film or fat grafts. Tympanoplasties involved an underlay technique through a post-auricular incision without mastoidectomy. All attempted tympanoplasties in this group of patients were performed by the patient's primary otolaryngologists, not by surgeons involved in the CI program at the pediatric hospital. The CIs were performed using a standard facial recess approach unless otherwise specified. A previously described technique for external auditory canal (EAC) closure was used in 3 cases of persistent perforation.<sup>9</sup> The TM, malleus, and incus were removed, and canalplasty was performed to clear skin medial to the bony cartilaginous junction. The lateral canal skin was then everted and closed in 3 layers, isolating the middle ear. Middle ear ablation was not performed in order to preserve better radiographic visualization on follow-up surveillance imaging.

### STUDY DESIGN

Institutional review board approval was obtained. A retrospective chart review of 189 CI cases between 1998 and 2008 identified 78 ears from 62 different patients who had an ipsilateral MT. Sixteen patients received CIs by simultaneous (n=4) or sequential (n=12) bilateral placement. The mean (SD) age of the CI recipients was 3.21 (2.45) years. The mean (SD) length of follow-up was 57.8 (33.6) months. Patients were excluded for CI if they were older than 18 years. The indications for MTs and their management in the CI recipients were the same as those in the patients without a CI. Specifically, tubes were placed for RAOM that occurred at a frequency of more than 6 ear infections per year or for persistent purulent effusion that did not resolve with antibiotic treatment. In the postimplantation child, tubes were not replaced for serous otitis media unless recurrent acute infections were occurring. In the postimplantation child, tubes were placed for recurrent acute purulent infections.

Demographics, operative details, and the clinical preoperative and postoperative courses, including complications, were

recorded. Perforations were defined as holes in the TM lasting for more than 6 months. Otorrhea was defined as any drainage thought to be related to an infectious origin. Statistical analysis of ears and outcomes was performed using the Fisher exact test and 2-tailed *P* values.

## RESULTS

The characteristics of the cohort are shown below.

Characteristic	No. (%)
Sex	
Male	38 (61)
Female	24 (39)
Age, y	
≤2	41 (66)
>2	21 (34)

More than 50% of the ears underwent CI before the patients were 3 years old. The most commonly used CI was the Nucleus Freedom (Cochlear Americas, Centennial, Colorado). The details of MT management are listed in **Table 1**. Twenty-nine ears (37%) received more than 1 MT placement before CI. The 32 MTs (41%) that were present at the time of CI were more often retained (n=22) than removed (n=10). If the MTs were removed during CI, they were immediately repaired with myringoplasty. Fourteen other ears (18%) underwent MT removal with myringoplasty approximately 6 weeks before CI and had healed TMs at the time of surgery. All of the ears of the children who had their MTs removed and who had a myringoplasty either before or during the CI healed without perforations.

### COMPLICATIONS

The identifiable outcomes listed below isolated 2 complications for further analysis.

Complication	No. (%)
Otorrhea	26 (33)
Perforation	4 (5)
Meningitis	0
Explantation	0

The otorrhea group included 26 cases that resolved with outpatient treatment with otic drops without the need for additional surgery or intravenous antibiotic therapy. The 4 cases of perforation included 1 patient with CHARGE association. Because this patient continued to experience RAOM, an MT was placed in the contralateral ear, and a T tube was inserted through the persistent perforation in the implanted ear. The tube along with medical therapy controlled RAOM in the ear, and the tubes remained in place at the last follow-up visit. As shown in **Table 2**, another ear developed persistent perforation that continued with episodic drainage after any water exposure 2 years after CI. At the time of CI, the ear had a functioning MT that was kept in place. After MT extrusion occurred postoperatively, the perforation was noted and EAC closure was performed. In 2 other cases, the ears had greater than 90% perforations noted by the time of implantation, and the decision was made to proceed with simultaneous EAC closure and CI.

## MT MANAGEMENT

The analysis of outcomes with respect to MT management is provided below.

MT Management	No. (%)
Present at CI	6 (19)
Removed or extruded before CI	10 (22)
Multiple placements before surgery	5 (17)
No replacement before surgery	11 (22)

With respect to MT being removed or maintained before surgery, an ear that had no tube at the time of CI was just as likely to require an MT placement after CI as an ear in which the tube was left in place until the time of CI. Six ears (19%) with an MT at CI compared with 11 (22%) without an MT required another MT after implantation ( $P=.78$ ). Three ears in which the MT was removed before CI developed AOM and mastoiditis several months after surgery and required reinsertion of the MT for the continued management of RAOM. In each of these cases, once the tubes were placed no further sequelae developed. Performing multiple MT replacements before CI also had no significant effect on whether ears required MT placement after CI ( $P=.77$ ). Ears with more than 1 set of MTs before CI required MT placement after surgery 17% of the time compared with 22% if no MT replacement was needed before surgery. All cases of otorrhea and perforation identified were successfully managed. No cases of meningitis or explantation due to seeding of the CI were identified.

### COMMENT

The minimization of potential infectious complications is a priority for the CI surgeon who is operating on a child with a history of MT placement. While manipulation of the TM with MT insertion, MT exchange, or perforation repair is not without risks, in the current study the management of the MT before CI did not adversely affect outcomes.<sup>10</sup> The occurrence of otorrhea and perforation was successfully managed with standard surgical and medical therapies, rarely requiring more extensive procedures. Most ears were implanted before the patient was 3 years old, when RAOM is most common, and all ears received both CI and MT without the development of meningitis or explantation due to infectious seeding of the CI.

In our retrospective chart review, we focused on the overall success and long-term management of ears with CI and MT. Ears without a history of MT placement were not evaluated. The way in which we managed the tubes in our CI recipients reflects the evolution of the literature and of our own approach to implantation in children with RAOM. Initially, the establishment of an intact TM was emphasized, and MT removal with myringoplasty was performed. As the age at implantation continued to decrease, we realized the importance of having a clear middle ear at the time of surgery. If the tubes were clean and free of squamous or inflammatory debris, they were left in place in children still experiencing otitis media or replaced if needed. The low rate of complications that we observed in ears in which we not

**Table 2. External Auditory Canal (EAC) Closure**

Case No./Age, y	No. of MTs	Comments
1/1	2	Delayed EAC closure 36 mo after CI
2/5	1	Failed tympanoplasty twice before EAC closure at CI
3/3	2	EAC closure at CI

Abbreviations: CI, cochlear implantation; MTs, myringotomy tubes.

only left the tubes in at the time of CI but also liberally replaced the MT if needed after surgery made us realize that we could handle these patients like our other patients with RAOM.

The strength of this study lies in its demonstration that the presence of MT before, during, and after CI can be managed with a limited therapeutic burden without placing the success of the CI or the patient at undue risk. Furthermore, the management of MTs, including removal and replacement, does not necessarily reduce the need for additional MT therapy after CI. As in the 3 patients who developed AOM and mastoiditis months after CI and who responded to the insertion of previously removed MTs, the maintenance of tubes might help to protect the still RAOM-susceptible implanted ear after implantation and spare the patient additional procedures. The rates for the development of perforation coincide with those in previously published reports. The frequency of persistent perforation at 5% is comparable to the overall 3% rate that has been documented in studies of cohorts who received MTs for serous otitis media.<sup>10-12</sup> The major limitation of this study is the assumption that all patients were treated entirely at 1 center. The measured 33% rate of otorrhea in CI recipients with MT is within the wide range of reported MT otorrhea in implanted and nonimplanted ears (10%-50%).<sup>6,10</sup> The actual number of otorrhea episodes may be underestimated in our study, as there may have been cases managed elsewhere. We reported only those cases managed at the CI center. We do feel as if the number of perforations reported is accurate, as those children with CIs who require otologic surgery are encouraged to come back to the CI center for further treatment. In prior studies of CI and either otitis media with effusion or AOM, the resolution of effusions with MT appeared to facilitate CI.<sup>4,6,8</sup> The larger number of cases ( $n=78$ ) in the current study supports the suggestion that MTs can be placed in the perioperative setting without major complications and provides a close analysis of specific outcomes related to their management.

In 24 ears (31%), TMs healed after MT removal and myringoplasty. The most extensive procedure that we used to control complications was EAC closure, which was performed in 3 patients (4%) for control of perforation. Each of these 3 patients had extremely large perforations (>90%). Also, of the 3 patients, only 1 had a perforation resulting from tubes left in place at the time of the CI. The other 2 patients were children who had had tubes placed before CI and presented with very large perforations that had failed previous attempts at repair at another facility. In the 1 case that we had in which the perforation developed after a tube was left in at the time of

CI, the patient developed a 100% perforation and the decision was made to perform a staged EAC closure rather than to attempt a tympanoplasty in the face of such a large perforation and an existing CI. Previously published studies have abdicated extensive surgical procedures, such as a subtotal petrosectomy, a staged tympanomastoidectomy, and a middle fossa or subfacial approach, for CI in ears with chronic infections.<sup>13-18</sup> While many of these techniques were investigated adequately in adult ears when RAOM could not be controlled or when there was a history of radical cavity from previous surgery, some authors have suggested that extensive staged procedures are indicated in cases involving dry perforation to close the TM in candidate ears before CI.<sup>14,18</sup> In the case of small TM perforations that have a high chance of success with myringoplasty or tympanoplasty, these procedures should be performed with great care taken to avoid injury to or dislodgment of the intracochlear electrode. Closure of the EAC after or during CI is another relatively simple procedure that can protect the electrode from damage and creates a safe, contained middle ear cavity for long-term management of CIs.<sup>9</sup> We like to use this technique in cases in which tympanoplasty success may be compromised owing to previous surgical procedures or extensive perforations or when we are faced with a perforation at the time of the implantation. Ensuring the removal of all skin from the external canal and the absence of active inflammation at the time of closure is crucial. Computed tomographic scans obtained 18 months after surgery are used to monitor for the development of any cholesteatoma. Further computed tomographic scanning can be performed if clinically warranted.

In conclusion, successful CI can be consistently achieved in ears with a history of MT placement. Specific MT management over the course of CI does not appear to adversely affect the final outcomes in cases involving pediatric ears. More extensive operations are rarely needed and are not prevented by initial conservative attempts at MT management.

**Submitted for Publication:** June 6, 2009; final revision received November 12, 2009; accepted December 16, 2009.

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**Author Contributions:** Drs Barañano and Woolley had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Barañano, Sweitzer, and Woolley. *Acquisition of data:* Barañano, Sweitzer, Mahalak, Alexander, and Woolley. *Analysis and interpretation of data:* Barañano, Sweitzer, and Woolley. *Drafting of the manuscript:* Barañano, Sweitzer, Mahalak,

Alexander, and Woolley. *Critical revision of the manuscript for important intellectual content:* Barañano and Woolley. *Statistical analysis:* Barañano, Sweitzer, and Woolley. *Obtained funding:* Woolley. *Administrative, technical, and material support:* Mahalak, Alexander, and Woolley. *Study supervision:* Woolley.

**Financial Disclosure:** None reported.

**Previous Presentation:** This study was presented in part at the American Society of Pediatric Otolaryngology Meeting under the title "Outcomes for Pediatric Cochlear Implant Patients With Myringotomy Tubes"; May 21, 2009; Seattle, Washington.

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