Background: Postoperative complications of myringotomy and tube placement often include otorrhea, tympanosclerosis, and tympanic membrane perforation. However, the incidence of sensorineural or conductive hearing loss has not been documented. Recent efforts to curb the use of preoperative audiometric testing requires documentation of this incidence.

Objective: To define the incidence of conductive and sensorineural hearing loss associated with myringotomy and tube placement.

Materials and Methods: A retrospective chart review of 550 patients undergoing myringotomy and tube placement was performed. A total of 520 patients undergoing 602 procedures (1204 ears), including myringotomy and tube placement, were assessed for preoperative and postoperative sensorineural and conductive hearing loss.

Results: No patient developed a postoperative sensorineural or conductive hearing loss. All patients resolved their conductive hearing loss after myringotomy and tube placement. There was a 1.3% incidence of preexisting sensorineural hearing loss.

Conclusions: The incidence of sensorineural or conductive hearing loss after myringotomy and tube placement is negligible and the use of preoperative audiometric evaluation may be unnecessary in selected patients, but further studies need to be done to corroborate this small data set.


Otitis media (OM) is one of the most frequent diseases of childhood, affecting at least 80% of children prior to school entry.1-4 Because of the high incidence of OM in children, each year billions of dollars are spent in the medical and surgical treatment of OM. Surgical treatment of chronic OM via myringotomy and tympanostomy tube insertion (MTT) is one of the most commonly performed operations in the United States.2,3,6 The potential risks, complications, and benefits of MTT are well documented in the literature.5,7-10 The 3 most common risks associated with MTT are postoperative otorrhea, tympanosclerosis, and persistent tympanic membrane perforation. The risk of hearing loss is routinely discussed with any patient (or parent) about to undergo an otologic procedure, including MTT. Although the risk of hearing loss is largely considered theoretical for MTT, many otolaryngologists routinely perform preoperative and postoperative audiometric studies to document the patient’s preoperative hearing status and whether it has either improved or remained stable after MTT. A recent report by Manning et al11 demonstrated a 1% incidence of preoperative sensorineural hearing loss (SNHL) in children undergoing MTT. However, no postoperative analysis was discussed. To our knowledge, no large study has been done to document the incidence of postoperative SNHL or conductive hearing loss (CHL) with MTT.

Recent concerns about the rising costs of health care have challenged physicians to continue to provide outstanding medical care for their patients, while at the same time trying to reduce costs to the patient. Currently, preoperative audiograms for MTT are obtained for various reasons, the most common being the desire to document the hearing level, the medical and/or legal implications if it is not obtained and the patient is found to have a hearing loss postoperatively, and the recent guidelines published for when MTT is appropriate.12,13 If it can be demonstrated that the incidence of hearing loss following MTT is indeed negligible, then a postoperative...
MATERIALS AND METHODS

A retrospective chart review was performed at the Medical University of South Carolina in Charleston on all patients who had undergone bilateral MTT from April 1, 1990, through July 3, 1996. A total of 1225 cases were documented from operating room records. A retrospective review of 530 charts was analyzed. Only patients who had both preoperative and postoperative audiometric studies were analyzed for this study. Thus, a total of 520 patients of the original 550 were included in our study. There was no follow-up postoperative audiogram in 30 patients because of the inability of the patients to return for examination after the surgical procedure. Of these 520 patients, 602 procedures on 1204 ears were analyzed for this frequency-specific study. Audiometric data analyzed included speech sound field awareness (SFA) and SFA threshold levels for children younger than 3 years. Pure tone averages (PTA), speech reception thresholds, and discrimination scores for children older than 3 years were assessed.

RESULTS

Of the 520 patients evaluated for this study, 320 (61.5%) were male and 200 (38.5%) were female. The ages ranged from 4 months to 78 years, although only 3 patients in this entire study were adults. The other 2 adults were 21 years old. The mean age was 45 months. The male-female ratio was approximately 3:2. The ages of the 520 patients were as follows:

<table>
<thead>
<tr>
<th>Age, mo</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-18</td>
<td>164</td>
</tr>
<tr>
<td>19-23</td>
<td>109</td>
</tr>
<tr>
<td>24-35</td>
<td>81</td>
</tr>
<tr>
<td>36-47</td>
<td>63</td>
</tr>
<tr>
<td>48-59</td>
<td>33</td>
</tr>
<tr>
<td>60-71</td>
<td>24</td>
</tr>
<tr>
<td>72-83</td>
<td>26</td>
</tr>
<tr>
<td>84-95</td>
<td>16</td>
</tr>
<tr>
<td>&gt;96</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>520</td>
</tr>
</tbody>
</table>

In the 520 patients there were 602 procedures on 1204 ears that were analyzed for this study. Of these 520 patients, 72 had to undergo either a second or third tube placement.

Of the 602 procedures of MTT, there was not one incidence of a postoperative SNHL or a CHL that was not present preoperatively.

Speech SFA assessment levels and frequency-specific sound field thresholds (averaged >500, 1000, and 2000 Hz) were the audiometric data used in this study for younger children in whom individual ear PTA scores could not be obtained (Table 1). In our study, the SFA levels and thresholds correlated within 5 dB and thus we show the threshold value and label it an SFA (sound field assessment label). We evaluated 3 different age groups for SFAs: 0 to 18 months, 19 to 36 months, and those children older than 36 months. It was thought that if the preoperative SFA level was higher than 20 dB, we would consider this abnormal. This is certainly generous since normal can be 60 to 40 dB in infants younger than 9 months, 35 to 25 dB in children aged 9 months to 18 months, and 30 to 25 dB in children aged 18 to 24 months. Postoperatively, we were looking for an SFA level of less than 20 dB. As Table 1 indicates, there were 95 patients in the 0- to 18-month age category who had a preoperative SFA level higher than 20 dB, but only 12 (12.6%) did not obtain a postoperative level lower than 20 dB. Of these 12 children, 9 demonstrated normal hearing on a subsequent audiogram within the year. Of the remaining 3, 1 increased his hearing sensitivity from no response preoperatively to an SFA level of 60 dB postoperatively. He was a child with pervasive developmental delays and on further testing was noted to have moderate SNHL on auditory brainstem response. The second child, aged 6 months, had an SFA level of 70 dB preoperatively and went up to an SFA of 45 dB postoperatively; for his age, this is actually a normal response. The same is true of our last patient who had an SFA level of 45 dB preoperatively and on postoperative evaluation had an SFA level of 40 dB.

For the age range of 19 to 36 months, there were 63 children who had a preoperative SFA level higher than 20 dB. Postoperatively, only 3 (4.8%) of the 63 children had a postoperative SFA level higher than 20 dB. Of these 3, 2 later tested with normal hearing: 1 with PTA scores and the other with auditory brainstem response. The last patient demonstrated an SFA level of 25 dB preoperatively and postoperatively, which is also within the range of normal hearing for a child aged 20 months.

Twenty-two patients older than 36 months required SFA testing because PTA could not be performed. There were 17 patients with a preoperative SFA level higher than 20 dB and 12 (70.6%) resolved to lower than 20 dB on SFA testing after tubes were put in. Of the 5 who did not improve to lower than 20 dB on their SFA test, 2 had a known preexisting SNHL that had been documented with brainstem auditory evoked responses in the past. One had cerebral palsy with a preoperative 55-dB SFA level and a 40-dB SFA level postoperatively. Another child had Down syndrome with what was thought to be a preexisting SNHL and the last patient, with Beckwith-Wiedemann syndrome, was tested 6 months later and had an SFA level lower than 20 dB.
Older children were able to be evaluated with PTAs, speech reception thresholds, and discrimination for each ear. In assessing these patients' hearing results, we looked at preoperative PTAs higher than 25 dB compared with postoperative PTAs lower than 25 dB (Table 2). We also evaluated CHL by measuring air-bone gaps of higher than 10 dB and checking a closure of this gap to within 5 dB postoperatively. We had 3 age ranges: younger than 48 months, 48 to 60 months, and older than 60 months for this portion of the study. All groups closed their air-bone gap after placement of tympanostomy tubes and no child demonstrated SNHL in the higher frequencies not included in the PTA assessment.

Of the children younger than 48 months, there were 24 who had preoperative PTAs higher than 25 dB and postoperatively 23 children (95.8%) improved their speech reception thresholds to lower than 25 dB. The 1 patient who did not respond to tube placement had a previously profound SNHL in the right ear that had been diagnosed previously by auditory brainstem response. This child had also been exposed to significant ototoxic drugs at the time of birth.

Of the 31 children aged 48 to 60 months, there were 24 children who had PTAs lower than 25 dB preoperatively and 24 also had PTAs lower than 25 dB postoperatively.

In those 127 children older than 60 months, 35 had preoperative PTAs higher than 25 dB, while 5 had postoperative PTAs higher than 25 dB. Of these 5 patients who did not respond to tube placement, 1 had Down syndrome and 1 year later, on retesting, was found to have normal hearing. Another child had a tympanomastoidectomy performed on the right side with removal of the incus and head of malleus 1 year before MTT. After the MTT, he closed his air-bone gap, but his PTA was still approximately 25 to 30 dB. This was consistent with results of a postoperative tympanomastoidectomy audiogram. The last 3 patients were all adults who were known to have mixed hearing loss preoperatively and all closed their air-bone gap postoperatively, but their existing SNHL did not change.

Therefore, all patients had the CHL air-bone gap closed, and no patient had an SNHL directly related to MTT. The incidence for preexisting SNHL in our patient population was 7 patients of 520, for an incidence of 1.3%. This is similar to the findings of Manning et al, but higher than expected in a community setting.

### Table 2. Pure Tone Average (PTA) Results

<table>
<thead>
<tr>
<th>Age, mo</th>
<th>Total No. of Patients</th>
<th>Preoperative PTA &gt; 25 dB</th>
<th>Postoperative PTA &gt; 25 dB</th>
<th>Air-Bone Gap &gt; 10 dB</th>
<th>Closure of Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;48</td>
<td>41</td>
<td>24 (58.5)</td>
<td>23</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>48-60</td>
<td>33</td>
<td>24 (72.7)</td>
<td>24</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>&gt;60</td>
<td>127</td>
<td>35 (27.6)</td>
<td>30</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>Total</td>
<td>201</td>
<td>83 (41.3)</td>
<td>77</td>
<td>141</td>
<td>141</td>
</tr>
</tbody>
</table>

Myringotomy and tube placement is the most common pediatric operation performed. Although the postoperative complications of otosrhea, tympanic membrane perforation, and tympanosclerosis are well documented, the incidence of hearing loss after MTT is not. Although otolaryngologists believe that MTT does not alter hearing, and indeed is used to improve hearing, no recent large study exists that documents this therapy.

The total number of procedures (1204) may be considered a small sample size considering the number of tubes placed throughout the country, but it does give insight to the complication of hearing loss associated with MTT. In our study, there was no evidence of hearing loss, SNHL, or CHL associated with MTT. We suspect this result is universal, but further studies at other institutions will need to corroborate this. If the assumption that MTT does not cause hearing loss is true, then the next question to be answered is if preoperative audiometric studies are necessary for all children. A preoperative test, or any test for that matter, is usually performed because the outcome will either assist in the diagnosis or influence our decision-making process for the treatment of that patient.

The decision to perform MTT is usually indicated for chronic OM with effusion of more than 3 months' duration, since up to 90% of children are clear of an OM with effusion in 3 months' time and after 3 months it is less likely to resolve on its own. A preoperative audiogram in this situation may not change the decision to perform MTT. Therefore, a postoperative hearing evaluation to document normal or abnormal hearing levels may be all that is required.

Preoperative audiograms allow us to document improved hearing, an important goal of MTT. However, if other studies corroborate ours, then we can conclude that hearing loss is improved with MTT and that any postoperative hearing loss is probably preexisting. Furthermore, if the audiogram results are abnormal preoperatively, further therapy (amplification) or evaluation is going to await the postoperative audiological evaluation. The reason for waiting until after performance of MTT is that the accuracy of determination of the degree and configuration of SNHL is hindered by the coexisting CHL associated with middle ear effusions. This, coupled with the fact that the incidence of previously undiagnosed SNHL in pediatric patients is low, estimated at approximately 0.1% by Manning et al and 1.3% in our study, again demonstrates that preoperative audiometric testing may not always be indicated.

However, the question of what to do with a normal preoperative audiogram may be more difficult. Although our personal bias is for MTT for effusions of more than 3
months, recent guidelines advocated by the Agency for Health Care Policy and Research state that for children aged 1 to 3 years, if the patient does not have a 20-dB hearing loss after 3 months of chronic OM with effusion, then tube placement should not be considered for at least 4 to 6 months. We are not convinced that MTT is only indicated in children aged 1 to 3 years who demonstrate this degree of hearing loss. Indeed, in our study, 50% of the children aged 4 to 18 months and 33% of the children aged 19 to 36 months may not have qualified by audiometric criteria. Other factors, such as the child's ability to distinguish sounds, pain, irritability, and sleep cycle interruptions, are not considered in these guidelines. Furthermore, depending on the patient's age, normal sound field hearing levels may range from 25 to 60 dB.

Providing excellent medical care in a more cost-efficient manner is a goal in all of medicine. Audiological evaluations may vary from $25 to $75. If we use an average of $50 for the cost of preoperative audiological evaluation, the savings generated in our study of 602 procedures alone is more than $30,000. Savings on a national basis could be significant.

Finally, the medical and/or legal implications of discovering an SNHL after placement of tubes when a preoperative audiological evaluation is not performed warrants consideration. As long as MTT is not performed in the posterior-superior quadrant, with subsequent injury to the ossicular chain, there should be no reason to believe that MTT would cause an SNHL or CHL. Our study of 602 procedures without any demonstration of SNHL or CHL after MTT in 1204 ears supports this conclusion. Thus, an SNHL discovered after properly performed MTT can be assumed to have been preexisting, especially if our results are corroborated.

Naturally, the decision to either omit or perform preoperative audiometry must be predicated on sound clinical judgment. For children or adults with syndromes known to be associated with hearing loss, those who fit the high-risk criteria for SNHL, those with other significant medical problems, or those cases in which the parents or physician are concerned about the child's hearing, preoperative and postoperative audiometric evaluation is probably warranted. Another indication for preoperative audiometry would be if one is trying to decide whether to perform MTT earlier than 3 months of chronic OM with effusion. In those children with preexisting SNHL, MTT is often done earlier so as not to compound the already existing SNHL with a CHL.

The decision to perform preoperative audiograms for patients undergoing MTT is still controversial. Our findings lend support that routine preoperative audiometry in a patient undergoing MTT may be unnecessary if the patient is otherwise healthy and likely to be compliant with timely follow-up for postoperative audiometric evaluation. Ultimately, it should remain the physician's decision when to obtain any clinical testing.

In conclusion, we find that (1) no SNHL or CHL was noted after MTT in 1204 ears; (2) incidence of preexisting SNHL was about 1%; a preexisting CHL other than that caused by fluid was not seen in our study, but this can occur; and (3) the decision to perform preoperative audiological testing should be made on an individual basis by the physician since it may not be necessary in all patients.

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Reprints: Peter C. Weber, MD, Department of Otolaryngology, Medical University of South Carolina, 171 Ashley Ave, Charleston, SC 29425.

REFERENCES