LONG-TERM EFFECTS OF OTITIS MEDIA WITH EFFUSION: OTOMICROSCOPIC FINDINGS

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ABSTRACT

A cohort of 946 children who were screened for otitis media with effusion (OME) by serial tympanometry from the age of 2 to 4 years was followed up by otomicroscopy at 7.5 to 8 years of age. At school age, signs of active middle ear disease were present in 2.2% of ears that had been free from OME at preschool age, whereas 12.7% of ears that had suffered from persistent OME and 17.8% of ears that had been treated by a ventilation tube showed signs of active middle ear disease. Otopathologic sequelae (atrophy, tympanosclerosis, atelectasis, and attic retraction) were present in 13.7%, 39.8%, and 87.3% of these ears, respectively. A duration–response effect was found in the association between preschool OME and these sequelae at school age. The high prevalence of otoscopic abnormalities found in this population calls for further follow-up and evaluation of their functional implications.

Otitis media with effusion (OME) is common in young children. Despite its usually mild and transient nature, it is the most common indication for surgical intervention in childhood. The traditional aims of treatment by ventilation tubes are (1) to produce a direct improvement in hearing, (2) to modify the course of the disease toward early resolution, and (3) to prevent long-term otopathologic sequelae and developmental consequences of OME. Although tubes are effective in improving hearing in the short term, there is no evidence as yet to support the attainment of the second aim, and the extent to which the third aim can be achieved by surgical treatment is still unknown.

Observational studies have demonstrated that the presence of OME can cause structural changes of the tympanic membrane, but treatment by ventilation tubes appear to be ineffective in preventing the development of these changes. In fact, several clinical trials, in which randomized ears were treated by ventilation tubes and compared with the untreated ear of the same child, have shown that ventilation tubes can lead to atrophy and tympanosclerosis of the tympanic membrane, and to an associated degree of hearing loss. Persistent OME has also been demonstrated to have a detrimental effect on speech and language development, but it has not yet been shown that this effect can be reversed by treatment with ventilation tubes.

Since a clear view on the long-term consequences of OME and the influence of treatment with ventilation tubes is still lacking, further studies are necessary. The optimal design for such a study is a randomized controlled trial. However, withholding the widely accepted treatment for OME for a long period raises ethical issues and, in relation to practice and belief, may not be feasible, especially if attempted on a large sample in one area. Therefore an observational design was chosen to study the long-term effects of OME in a birth cohort of Dutch children who were screened for OME at preschool age. This report focuses on the structural consequences of the disease.

SUBJECTS AND METHODS

Preschool Screening

A complete birth cohort of 1439 children born in the city of Nijmegen, The Netherlands, between September 1, 1982, and August 31, 1983, was studied longitudinally. From the age of 2 to 4 years, 1328 of these children were screened for OME by tympanometry at 3-month intervals. Screening at each child’s home address was undertaken by trained audiology technicians using a Grason-Stadler model 27 screening tympanometer (Grason-Stadler, Inc., Milford, New Hampshire). The reliability and validity of the tympanometer had been tested in pilot studies, but it has not yet been shown that this effect can be reversed by treatment with ventilation tubes.

Since a clear view on the long-term consequences of OME and the influence of treatment with ventilation tubes is still lacking, further studies are necessary. The optimal design for such a study is a randomized controlled trial. However, withholding the widely accepted treatment for OME for a long period raises ethical issues and, in relation to practice and belief, may not be feasible, especially if attempted on a large sample in one area. Therefore an observational design was chosen to study the long-term effects of OME in a birth cohort of Dutch children who were screened for OME at preschool age. This report focuses on the structural consequences of the disease.


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When a flat tympanogram was found, otoscopy was performed to exclude causes other than OME, such as cerumen or a ventilation tube present. Subsequently, a second tympanogram was made; only a type B tympanogram so obtained was considered as evidence of OME. During each visit, the parents were interviewed by the audiology technician, using a structured questionnaire about ear, nose, and throat (ENT) diseases and some risk factors related to OME.

Indications for Treatment

Generally, Dutch physicians and otolaryngologists prescribe decongestant nose drops and mucolytic agents for middle ear effusion when it first presents itself. Antibiotics are rarely given for OME. Ventilation tubes are usually inserted when bilateral middle ear effusion and hearing loss persist after a period of 2 to 3 months. Asymptomatic OME, without noticeable hearing loss or signs of acute infection can remain undetected or untreated much longer.

Follow-Up

In the autumn of 1990, 1160 children who still lived in the Nijmegen area were invited to take part in a follow-up study. Of these children, by then 7.5 to 8 years of age, 946 participated. The examinations took place at the Department of Otorhinolaryngology of the University Hospital Nijmegen between September 1990 and February 1991. They included an ENT and developmental history, an otologic examination, tympanometry, and pure-tone audiometry.

All otologic examinations were carried out by the same otolaryngologist (AS) using a Zeiss microscope (Carl Zeiss, Inc., Oberkochen, Germany). An otoscopic diagnosis of OME or acute otitis media (AOM) and the presence of otorhhea, a perforation, or a ventilation tube were noted. Abnormalities of the tympanic membrane, such as aural polyps, tympanosclerosis, retraction, and the presence or absence of a localized retraction pocket or cholesteatoma were recorded for the four quadrants of the tympanic membrane. Retraction or atelectasis of the pars tensa was graded according to Sadé and Berco, with an additional category added to indicate no atelectasis. Stage I indicates a slight retraction of the pars tensa membrane, and stage II indicates incudo-pexy. In stage III the tympanic membrane touches the promontory, and in stage IV the tympanic membrane adheres to the promontory. Attic retractions were classified according to Tos and Poulsen. Type A: compliance $\geq 0.2$ mL and pressure $>-100$ daPa. Type C: compliance $\geq 0.2$ mL and $-100 \geq$ pressure $>-200$ daPa. Type C: compliance $\geq 0.2$ mL and $-200 \geq$ pressure $>-400$ daPa. Type B: compliance $<0.2$ mL or pressure $\leq -400$ daPa.

The "no OME" group: 270 right ears that never showed a type B tympanogram between the ages of 2 and 4 years.

The "persistent OME" group: 251 right ears that showed a type B tympanogram at least two consecutive screens between the ages of 2 and 4 years, but were not at any time treated by a ventilation tube.

The "transient OME" group: 272 untreated right ears that could not be classified in groups 1 or 2.

The "ventilation tube" or "VT" group: 101 right ears that were treated by a ventilation tube at some stage between the ages of 0 and 8 years.

Data were missing on more than three preschool screens for 52 right ears. These ears were excluded from the classification.

For the ears in each of these four groups, a preschool OME duration score was calculated, defined as the proportion of type B tympanograms out

Analysis Design

All data sampled on the ears at preschool and school age were analyzed separately for the right and left ear to avoid the statistical problems in tests that assume independence. Since the results of the analyses for the right and left ear were similar, only those for the right ear are presented in the main tables. Where trends of marginal significance were observed on small numbers, the left ear data are reported also to enhance reliability.

For a systematic analysis and representation of the data, the ears were classified into three groups, according to the quarterly tympanometric findings at preschool age, and a fourth group of ears treated by ventilation tubes:

1. The "no OME" group: 270 right ears that never showed a type B tympanogram between the ages of 2 and 4 years.
2. The "persistent OME" group: 251 right ears that showed a type B tympanogram on at least two consecutive screens between the ages of 2 and 4 years, but were not at any time treated by a ventilation tube.
3. The "transient OME" group: 272 untreated right ears that could not be classified in groups 1 or 2.
4. The "ventilation tube" or "VT" group: 101 right ears that were treated by a ventilation tube at some stage between the ages of 0 and 8 years.
of all the available tympanometric measurements performed at 2 to 4 years of age of that ear (maximum 9). This score ranged from 0 to 100. Differences in outcome variables among the four groups were statistically evaluated by a chi-square test or by Fisher's exact test when the expected count in any cell was less than five. Two-tailed probabilities are presented.

RESULTS

Study Population

The composition of the study population is presented in Table 1. The participation rate at the follow-up was 82%. To determine whether the children examined at school age were representative of the original population, comparisons were made with the data on all 1328 children examined at preschool age. Non-participants did not differ substantially from participants in respect of their ENT history or their tympanometric findings at 2 years of age.

Figure 1 shows the distribution of the preschool OME duration scores in each of the four groups of right ears defined above. Mean percentage duration scores were 0 for the no OME, 18 for the transient OME, 53 for the persistent OME, and 44 for the ventilation tube group. Despite the fact that the ventilation tube group was defined irrespective of the persistence of preschool OME, the duration scores for this group and those of the persistent OME group overlapped to a large extent. A further OME history from ages 4 to 8 years (questionnaire-based data, see below), however, was found in 89.1% of the surgically treated ears compared with 29.5% of the ears from the persistent OME group. This suggests that, up to the age of 7 to 8 years, the surgically treated ears were generally those most affected by OME.

Active Middle Ear Disease

The otoscopic findings at the follow-up examination were assigned to one of two categories:

1. Signs of active middle ear disease defined as OME, AOM, or otorrhea, along with a ventilation tube still present or a perforation of the tympanic membrane in the course of AOM.
2. Abnormalities of the tympanic membrane interpreted as sequelae of previous middle ear disease; that is atrophy, tympanosclerosis, atelectasis of the pars tensa, and attic retraction.

Neither these two categories of abnormality nor their subcategories are mutually exclusive.

Table 2 shows the prevalence of active middle ear disease, a perforation, or a ventilation tube still present at 7 to 8 years of age among the four groups of ears classified according to the persistence of OME at preschool age and surgical treatment. Some form of active middle ear pathology was present in 80.7% of the right ears of the entire population, and 23.3% showed a ventilation tube still present at 7 to 8 years of age. For all four groups, most of the middle ear disease was OME. A strong association was found between the persistence of preschool OME (as expressed by the classification no OME versus persistent OME) and the total occurrence of active middle ear disease or perforations at school age ($\chi^2 = 21.3; df = 1; p < .001$). These continuing abnormalities were most prevalent in children who were treated by a
ventilation tube at some stage up to the age of 8 years, especially when the presence of a ventilation tube at follow-up was also considered an expression of middle ear dysfunction.

### Otopathologic Sequelae

The presence of active middle ear disease, a perforation, or a ventilation tube may influence the interpretation of structural sequelae of the tympanic membrane. Tos et al previously concluded that otopathologic sequelae cannot be clearly visualized until middle ear effusion and inflammatory changes have disappeared. Likewise, abnormalities caused by ventilation tubes can only be assessed reliably some time after extrusion of the tube. Therefore, ears showing signs of active middle ear disease, a perforation, or a ventilation tube were analyzed separately. Since the data on sequelae for those ears were considered less reliable, they are not presented in this report.

The prevalence of otopathologic changes at 7 to 8 years of age in the four groups of right ears is presented in Table 3. Serious retraction pockets in the pars tensa were found in three right ears, all from the ventilation tube group. None of the ears examined at school age showed cholesteatoma, but one ear from the transient OME group that exhibited otorrhea was found to have an attic cholesteatoma when operated upon several months later. The frequency of structural changes of the tympanic membrane at school age correlated well with the persistence of preschool OME. The group of ears treated by a ventilation tube showed the highest percentage of all structural changes. The total figures in the right-hand column suggest that often a combination of these changes was found. The difference between the surgically treated and untreated ears from the persistent OME group was largest, for atrophy (χ² = 99.8; df = 1; p < .001) and tympanosclerosis (χ² = 79.9; df = 1; p < .001), as expected for abnormalities known to be most directly related to treatment by ventilation tubes. For atelectasis of the pars tensa and retraction of the pars flaccida of the tympanic membrane, the difference between the OME affected ears with and without surgical treatment was present, but less obvious (χ² = 9.6; df = 1; p = .002 and χ² = 11.6; df = 1; p = .001, respectively).

Since the duration of preschool OME varied considerably within the four persistence groups presented in Table 3, another classification of the ears was chosen to study the association between the proportion of time spent with OME at preschool age and otopathologic sequelae at school age. Three groups of right ears were defined with preschool OME duration scores ranging from 11 to 32, 33 to 52, and 53 to 100. Table 4 shows the prevalence of tympanosclerosis, atrophy, atelectasis, and attic retraction at school age as a function of duration. The surgically treated ears were excluded from this analysis.

A duration–response relation appears to be present between each outcome parameter at school age (atrophy, atelectasis, and attic retraction) and duration of preschool OME. For tympanosclerosis the difference between the three groups was not statistically significant.

Information on the OME history in the period between the end of the preschool screening and the follow-up examination (i.e., from age 4 to 8 years) was obtained from the questionnaires. The OME history was considered positive when parents had suspected a hearing loss or the child had failed the hearing test at school, leading to an audiometrically confirmed hearing loss or an otoscopic diagnosis of OME (children with a congenital or familial hearing loss were excluded). These answers were verified and overruled by physician’s or otolaryngologist’s questionnaire responses when they were available. Table

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### Table 2. Signs of Active Middle Ear Disease, Perforation, and Ventilation Tube at 7–8 Years of Age in Four Groups of Right Ears*

<table>
<thead>
<tr>
<th>Preschool OME Persistence Groups</th>
<th>OME Percentage</th>
<th>AOM Percentage</th>
<th>Otorrhea Percentage</th>
<th>Perforation Percentage</th>
<th>VT Still Present Percentage</th>
<th>Total Percentage (VT Excluded) Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No OME (reference group) (n = 270)</td>
<td>2.2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>--</td>
<td>2.2</td>
</tr>
<tr>
<td>Transient OME (n = 272)</td>
<td>7.4</td>
<td>0.06</td>
<td>0.0</td>
<td>0.4</td>
<td>1.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Persistent OME (n = 251)</td>
<td>12.1</td>
<td>&lt;.001</td>
<td>0.0</td>
<td>0.4</td>
<td>0.4</td>
<td>12.7</td>
</tr>
<tr>
<td>Ventilation tube (n = 101)</td>
<td>12.0</td>
<td>&lt;.001</td>
<td>2.0</td>
<td>0.05</td>
<td>0.02</td>
<td>17.8</td>
</tr>
</tbody>
</table>

*Ears classified according to the persistence of OME at preschool age and surgical treatment

p-value associated with chi-square test or Fisher’s exact test for the transient OME, persistent OME, and ventilation tube groups as related to the no OME group (i.e., reference group)

VT = ventilation tube
Table 3. Otopathologic Sequelae at 7–8 Years of Age in Four Groups of Right Ears*

<table>
<thead>
<tr>
<th>Preschool OME Persistence Groups</th>
<th>Otoscopy at 7–8 Years of Age: Percentage of Group Total/p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tymanosclerosis</td>
</tr>
<tr>
<td></td>
<td>%</td>
</tr>
<tr>
<td>No OME (reference group) (n = 264)</td>
<td>0</td>
</tr>
<tr>
<td>Transient OME (n = 251)</td>
<td>2.4</td>
</tr>
<tr>
<td>Persistent OME (n = 219)</td>
<td>3.7</td>
</tr>
<tr>
<td>Ventilation tube (n = 64)</td>
<td>47.6</td>
</tr>
</tbody>
</table>

*Ears classified according to the persistence of OME at preschool age and surgical treatment (96 right ears with signs of active middle ear disease, perforation or ventilation tube still present excluded)

p-value associated with chi-square test or Fisher's exact test for the transient OME, persistent OME, and ventilation tube groups as related to the no OME group (i.e., reference group); stages 1 and ≥2 of atelectasis of the pars tensa and attic retraction are combined in the statistical tests.

5 shows the effect of a positive OME history between the ages of 4 and 8 years on the otoscopic findings at 7 to 8 years of age, in each of the three groups of ears that were not treated by a ventilation tube.

Except for tymanosclerosis and atrophy in the persistent OME group, a positive OME history at the ages of 4 to 8 years resulted in a higher prevalence of otopathologic sequelae in both ears at the follow-up examination. This effect was most substantial for attic retraction.

Acute Otitis Media

It is of interest whether a past history of acute otitis media (AOM) exacerbates the otopathologic sequelae of OME. Information on the AOM history of the children was obtained from questionnaires that were available for the periods 0 to 2 years, 2 to 4 years, and 4 to 8 years. The AOM history was considered positive when children had experienced otalgia or otorrhoea, leading to a medical diagnosis of AOM in any of these three periods. Again, where possible the answer was verified and overruled by the physician’s or otolaryngologist’s questionnaire. Up to the age of 8 years, 86% of the surgically treated ears had a positive AOM history, as opposed to 56% of the ears from the persistent OME group ($\chi^2 = 18.8; df = 1; p < .0001$). For the transient OME and no OME groups these percentages were 54 and 45, respectively.

The prevalence of tymanosclerosis, atelectasis, and attic retraction at school age was unaffected by the AOM history. However, in the untreated ears with a negative AOM history the prevalence of atrophy at school age was no longer associated with the persistence of preschool OME. The prevalence of atrophy was 2.1% for the no OME, 2.6% for the transient OME, and 2.0% for the persistent OME group. In ears with a positive AOM history these prevalences were 5.1%, 5.9%, and 14.5%, showing that the ears with both persistent OME and a positive AOM history were especially at risk to develop atrophy ($\chi^2 = 10.5; df = 1; p = .001$). In surgically treated ears the prevalence of atrophy was not significantly influenced by the AOM history.

Ventilation Tubes

The effect of repeated ventilation tube insertion on the frequency of otopathologic sequelae is presented in Table 4. Tymanosclerosis and atelectasis

Table 4. Otopathologic Sequelae at 7–8 Years of Age as a Function of the Preschool OME Duration Score*

<table>
<thead>
<tr>
<th>Preschool OME Duration Score</th>
<th>Otoscopy at 7–8 Years of Age: Percentage of Group Total/p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tymanosclerosis</td>
</tr>
<tr>
<td></td>
<td>%</td>
</tr>
<tr>
<td>11–32 (n = 256)</td>
<td>2.3</td>
</tr>
<tr>
<td>33–52 (n = 120)</td>
<td>2.5</td>
</tr>
<tr>
<td>53–100 (n = 86)</td>
<td>4.6</td>
</tr>
</tbody>
</table>

*Ears treated by a ventilation tube excluded. Results for right ears

p-value associated with chi-square test on three classes of OME duration

369
occurred most frequently in the ears that were treated by more than one ventilation tube. This difference was not statistically significant, perhaps because of the relatively small number of subjects. For atrophy and attic retraction the effect of more than one tube was small or not consistent. Further analysis of the degree or extent of otopathologic sequelae revealed that the more generalized tympanosclerotic and atrophic changes and the most advanced stages of atelectasis and attic retraction were found most frequently in the ears that were treated more than once by a ventilation tube.

Finally, to test the hypothesis that early treatment of OME can prevent structural changes of the tympanic membrane, the prevalence of sequelae was studied in ears treated before and after the age of 4 years. Table 6 shows a non-significant trend for all abnormalities, except for attic retraction, to occur more frequently in the ears that had their first tube inserted before the age of 4 years compared to those that were treated after that age.

**DISCUSSION**

This study gives further evidence that OME in early life causes long-term abnormalities of the tympanic membrane. It also suggests that these abnormalities cannot be prevented by treatment with ventilation tubes, as otopathologic sequelae were most prevalent in the surgically treated ears. The functional significance of these tympanic membrane changes was limited: in this population they contributed to a conductive hearing loss of less than 5 dB.10

Generalization of the present findings may be restricted by the non-experimental design of the study. Most importantly, the duration of disease may not be fully comparable in the treatment and no-treatment groups, which makes it difficult to distinguish between the effects of disease and of treatment. The three untreated groups showed good contrast regarding their preschool OME duration score. For the ventilation tube and persistent OME groups the distribution of this score appeared similar (see Fig. 1). However, the temporary presence of a ventilation tube during preschool screening in children treated surgically at that age would have affected their duration score. Therefore, they cannot be simply compared with the untreated children. A further history of middle ear disease (OME and AOM) was found in more children in the ventilation tube group than in the persistent OME group, suggesting that, up to 7 to 8 years of age, the surgically treated ears were the ones most persistently affected by middle ear disease.

All prevalences reported in this study are by ear. On the assumption that right and left ears are not fully dependent, the prevalences per child will be higher. Further analyses of the present data per child might reveal whether host factors are also involved in the development of otopathologic sequelae.

Despite its limitations, this study succeeded in replicating results of previous reports, such as those from Tos et al.1 In addition, this study provides new information concerning a wider variety of otopathologic changes upon which a consistent interpretation can be imposed.

### Active Middle Ear Disease

The prevalence of active middle ear disease, perforations, and ventilation tubes still present in this population as a whole (see Table 2) was remarkably high and similar to the otoscopic findings at 7 years of age in the New Zealand cohort followed by Chalmers et al.14 In the present population, 11% of the

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Table 5. Prevalence of Otopathologic Sequelae at 7–8 Years of Age for Ears with a Positive History of OME from the Age of 4 to 8 Years versus Those with a Negative History*

<table>
<thead>
<tr>
<th>Preschool OME Persistence Groups</th>
<th>OME History 4–8 Years (Negative)</th>
<th>Otoposcopy at 7–8 Years of Age: Percentage of Group Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>L</td>
</tr>
<tr>
<td>No OME</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neg n = 240 n = 234</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pos n = 24 n = 27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient OME</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neg n = 218 n = 214</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pos n = 33 n = 29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistent OME</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neg n = 162 n = 168</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pos n = 57 n = 62</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Ears treated by a ventilation tube excluded
Chi-square test or Fisher’s exact test for subgroups with a positive OME history at 4–8 years of age versus those with a negative history:

$p = .05$, $p < .05$, $p < .001$, otherwise not significant
children assessed at school age had been treated with a ventilation tube on at least one occasion. More than one third of their ears still were not free from active middle ear disease or needed a ventilation tube to secure middle ear ventilation. Presence of a perforation was usually associated with a history of ventilation tubes. Preschool tympanometry appeared to be a reasonable predictor of middle ear disease at school age, as in both groups with persistent OME at pres­ school age (the persistent OME and ventilation tube groups) the prevalence of OME at school age was high, whereas the children who did not have type B tympanograms at preschool age were less likely to suffer from middle ear disease at school age.

Otopathologic Sequelae

In the untreated ears, a strong association was found between the persistence of early OME and abnormalities of the tympanic membrane considered to be sequelae of OME. A similar trend was demonstrated by Tos et al in their cohort of 7-year-olds. In both Tables 3 and 4, a duration–response relation was found for atrophy, atelectasis, and attic retraction, suggesting that the development of these abnormalities was related to the proportion of time spent with OME. Tympanosclerosis almost exclusively occurred in the ears treated by a ventilation tube.

The questionnaire data on the OME history of the children from 4 to 8 years of age only partially filled the gap in information between the end of the preschool screening and the follow-up at school age. This information is likely to be more biased than the tympanometric data. Nevertheless, irrespective of persistence at 2 to 4 years, a further history of OME between the ages of 4 and 8 resulted in higher prevalences of atelectasis and attic retraction at 7 to 8 years of age in the untreated ears (see Table 5). As expected, the differences for atrophy and tympanosclerosis were not so obvious in the untreated ears.

Table 6. Prevalence of Otopathologic Sequelae at 7–8 Years of Age as a Function of the Number of Treatments with Ventilation Tubes and Age of First Insertion

<table>
<thead>
<tr>
<th>Treatment History</th>
<th>Tympanosclerosis</th>
<th>Atrophy</th>
<th>Atelectasis</th>
<th>Attic Retraction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>L</td>
<td>R</td>
<td>L</td>
</tr>
<tr>
<td>Ventilation Tube Insertions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>n = 41</td>
<td>n = 38</td>
<td>41.6</td>
<td>44.7</td>
</tr>
<tr>
<td>≥2</td>
<td>n = 22</td>
<td>n = 21</td>
<td>59.1</td>
<td>66.7</td>
</tr>
<tr>
<td>After 4 years</td>
<td>n = 33</td>
<td>n = 31</td>
<td>36.7</td>
<td>46.4</td>
</tr>
<tr>
<td>Before 4 years</td>
<td>n = 30</td>
<td>n = 28</td>
<td>57.6</td>
<td>58.6</td>
</tr>
</tbody>
</table>

Chi-square test for subgroups treated once versus those treated twice or more by ventilation tubes and treated after versus before the age of 4 years, p > .1 for all

Ventilation Tubes

Much research has addressed structural changes of the tympanic membrane after insertion of ventilation tubes for OME. The most conclusive data have come from prospective randomized trials in which children with bilateral OME were treated with a unilateral tube, the other ear receiving no treatment or myringotomy alone. Follow-up, at 1 to 15 years after treatment, showed tympanosclerosis and atrophy to be the most common sequelae of treatment with ventilation tubes for OME. Tympanosclerosis was reported to occur in 30 to 53% of the ventilated ears as opposed to in 0 to 21% of the untreated ears or those treated with myringotomy. The prevalence of atrophy ranged from 9 to 67% in the ventilated ears and from 0 to 15% in the other ear. The data on the par­s tensa changes in the present study are consistent with these results. As opposed to the findings of Bonding and Tos, the prevalence of attic retraction in the present study population was also significantly higher in the ears from the ventilation tube group than from the persistent OME group (see Table 3). This was probably attributable to the persistence of OME after the age of 4 years in the ventilation tube group rather than to the insertion of the tube itself.

Maw recently suggested, on the basis of a prospective clinical trial, that a one-time insertion of a ventilation tube brings about the same prevalence and severity of tympanosclerosis as repeat tube insertion. In 1983, Tos et al had come to a similar conclusion. These authors did not report on other types of possible damage to the tympanic membrane by repeat tube insertion. The present study, along with another Danish study, found a higher prevalence of tympanosclerosis, though not statistically substantiated, to be associated with more than one tube. The higher prevalence of atelectasis in the ears treated by more than one tube, as demonstrated in Table 6, was probably more closely related to the higher OME load in children treated
by more than one tube than to the actual number of tubes.

Most abnormalities of the tympanic membrane were slightly more frequent in ears that were treated before the age of 4 years than after that age, probably because children treated while young are more likely to be treated on a second occasion. It seems justifiable to conclude, along with Tos et al., that age at the time of first treatment does not greatly influence structural changes of the tympanic membrane.

**Acute Otitis Media**

A prospective study in children treated by ventilation tubes for acute otitis media showed that in these children less severe pathology of the tympanic membrane occurred than in children treated for persistent otitis media with effusion. Animal studies also have shown that pathologic changes in the middle ear and tympanic membrane associated with sterile effusions are different from those associated with an infectious process in the middle ear. In the present study, a positive or negative history of acute otitis media, based on questions about otalgia and otorrhea, did not alter the prevalence of any abnormality of the tympanic membrane, other than atrophy. Repeat bouts of otorrhea in ears with persistent OME might result in an increased risk of atrophy.

**CONCLUSION**

In conclusion, a strong association was demonstrated between OME at preschool age and the prevalence of active middle ear disease and abnormalities of the tympanic membrane at school age. The finding of a duration–response effect in this association suggests that the persistence of early OME is important for the development of otopathologic sequelae. By far, most abnormalities of the tympanic membrane were present in surgically treated ears. The observational design of this study, however, does not allow for the effects of OME to be distinguished completely from those of its treatment. The high prevalence of otoscopic abnormalities found in this population calls for further follow-up and evaluation of their functional implications.

**REFERENCES**


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