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# Primary and revision myringoplasty in children: Long-term outcome and analysis of the factors influencing the results

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ABSTRACT

*Objective:* Assess the long-term outcome of pediatric myringoplasty.
*Methods:* Tympanoplasty type I, myringoplasty, was performed on 85 children (91 consecutive operations, 74 primary and 17 revisions) under 16 years of age. The perforations were sequela either to acute or chronic inflammatory middle ear disease. Medial grafting technique was employed with temporalis fascia. Adenoidectomy was performed earlier on all but five children. The preoperative observation period exceeded one year for all patients. The mean follow-up was 5.4 (SD 3.6) years.
*Results:* The long-term graft take rate was 84% for primary myringoplasty, and 53% for revision operations. The re-perforations were associated with postoperative discharge, subtotal or total perforation and revision surgery. In the cohort, sixty ears (66%) were completely healthy (intact tympanic membrane in normal position without adhesions and with good mobility) after follow-up. Spontaneous healing took place in 37% after re-perforation. The preoperative ventilation tube treatment did not affect the outcome and there were no differences between age groups. Preoperative sonotubometry or Valsalva test results did not correlate with outcome. Four ears needed a ventilation tube during the follow-up due to poor ventilation. The mean pure tone thresholds improved significantly after operation.
*Conclusions:* Myringoplasty in children is a reliable procedure without age restrictions. One year of preoperative observation excludes most unstable ears, and high tendency of spontaneous healing after re-perforation suggests the need for a lengthy follow-up before revision surgery.

## 1. Introduction

The decision to operate on a tympanic membrane perforation on a child is often not easy. The possibly compromised Eustachian tube function and the hidden tendency to otitis media with effusion (OME) make many surgeons to postpone the operation. There are relatively few reports on pediatric myringoplasty. The overall closure rate for the analyzed literature averages 77 % in older (Vrabec et al., 1999) to 83 % in more recent literature (Hardman et al., 2015). The age ranges, follow-up times, operation techniques and expertise of the surgeons vary considerably, and some publications do not present hearing or revision surgery results. This study presents the long-term outcome and analyzes the reasons of outcome for primary and revision pediatric myringoplasty operations performed by ENT specialists mainly with fascia underlay technique.

## 2. Material and methods

This was a cohort study that was based on retrospective patient chart data and the long-term follow up control. The patients and parents were enrolled to the long-term follow up and signed an informed consent. None of the contacted families declined to participate in the study. The study was approved by the Ethical committee of the Helsinki University Hospital (HUS). Institutional Research Board of HUS granted research permission. The cohort included 85 consecutive patients with altogether 91 pediatric myringoplasty (tympanoplasty type I) operations (74 primary and 17 revisions) performed at the Department of Otolaryngology – Head and neck surgery of HUS. The cohort is from the monography thesis (Silvola, 1997) of the first author (JS). The upper age limit for the primary operation was 16 years (Table 1). There were 39 girls and 35 boys in the primary operation and 9 girls and 6 boys in the revision

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**Table 1**
Patient characteristics.

| Characteristic | All ($n = 91$) | Primary surgery ($n = 74$) | Revision surgery ($n = 17$) |
|---|---|---|---|
| **Age, mean ± SD (range)** | 10.9 ± 3.0 (3.9–18.0) | 10.5 ± 2.9 (3.9–16.2) | 12.7 ± 2.6 (8.9–18.0) |
| **Sex, female (%)** | 50 (55) | 39 (53) | 9 (53) |
| **No allergies (%)** | 48/75 (64) | 40/62 (65) | 8/13 (62) |
| **Etiology, *n* (%)** | | | |
| **OME** | 50 (55) | 44 (60) | 6 (35) |
| **COM** | 21 (23) | 15 (20) | 6 (35) |
| **AOM** | 4 (4) | 4 (5) | 0 |
| **Unknown** | 16 (18) | 11 (15) | 5 (30) |
| **Preop. adenoidectomy (%)** | 86 (95) | 69 (93) | 17 (100) |
| **Preop. tympanostomy tube (%)** | 45 (49) | 37 (50) | 8 (47) |
| **Valsalva + (%)** | 25/46 (54) | 20/36 (56) | 5/10 (50) |
| **Sonotubometry + (%)** | 35/48 (73) | 31/39 (79) | 4/9 (44) |
| **Perf. size small or medium (%)** | 55 (60) | 45 (61) | 10 (59) |
| **Perf. size subtotal or total (%)** | 36 (40) | 29 (39) | 7 (41) |
| **Follow-up, mean ± SD (range)** | 5.4 ± 3.6 (0.2–13.0) | 5.4 ± 3.5 (0.4–13.0) | 5.5 ± 4.1 (0.2–13.0) |

operation group with a small majority of girls altogether (50 vs. 41, 55 %). The average age of the patients was 10.5 (range 3.9–16.2) years for primary surgery children and 12.7 (range 8.9–18.0; the primary surgery was always performed at under 16 years of age) years for the revision surgery group. The mean follow-up for primary surgery group was 5.4 (range 0.4–13.0) years, and for revision surgery 5.5 (range 0.2–13.0) years. The shortest follow-up times included revision surgery cases. Traumatic perforations or cholesteatoma ears were excluded. The primary surgery perforations were sequela either to acute (5% AOM) or chronic (20 % COM) otitis media or OME (60 %). The etiology was unknown in 15 % of the patients. Preoperative adenoidectomy was performed on all but five patients in the primary operation group and on all in the revision group.

All patients were followed up for at least one year before primary surgery to allow spontaneous healing, and to exclude the development of COM or cholesteatoma. Surgery was performed by ENT specialists except for three ears operated by third- or fourth-year residents under specialist supervision. All but one of the operations were performed under general anesthesia. After myringoplasty the surgeon followed the patients generally for 1 year as a standard procedure.

Myringoplasty was performed on all 91 operations. There were four patients with bilateral perforations in the primary surgery group. Two ears in the revision group were operated twice. The medial grafting with swing door technique, described by Palva et al., in 1969 (Palva et al., 1969), was employed in 89% (66 operations) of the primary surgery ears. Eight ears (11 %) with small perforations received a local graft without extended opening of the middle ear. All ears in the revision group received a medial graft. Temporalis fascia was used as grafting material.

The first author performed the long-term follow-up including a follow-up visit and retrospective patient chart review. The follow-up visit included a thorough general otorhinolaryngological examination with otomicroscopy and audiological tests (pure tone audiometry with air and bone conduction, tympanometry, and for most patients, sonotubometric tests). Thirteen per cent of the cases were lost during the long-term follow-up and had only the patient chart information available as the last control data. All pre- per- and postoperative data was collected in a database. A re-perforation started a new follow-up in the revision surgery group, which explains the shortest follow-up times in the revision group.

The bone conduction hearing test for children is a demanding task. The children have problems in comprehending or tolerating the test, which may result in unreliable results (Harder et al., 1982). The calibration of bone conductor for children is also a demanding task especially at 4 kHz. Therefore, air conduction values at 500, 1000 and 2000 Hz were used to calculate pre- and postoperative pure tone average (PTA). In addition, pre- and postoperative air conduction values at 4 kHz were evaluated to detect any cochlear damage (>30 dB) related to the operation. The bone conduction thresholds were also measured, but air conduction thresholds were considered as more reliable and informative values. The hearing tests were performed by experienced audiometricians who worked on a daily basis with pediatric patients. Valsalva test was performed one ear per time with the other ear blocked by finger. Positive result was a sound of airflow thorough the perforation or movement of the tympanic membrane detected with otomicroscopy. Sonotubometry was performed as described by (Virtanen, 1987). Sound level increase in the ear canal synchronized with swallowing was interpreted as opening of the Eustachian tube. Sonotubometry was a routine test for myringoplasty ears at the time of data collection.

The nonparametric statistics was performed with the chi-square test using Fisher's exact values if any of the fields was less than five. The parametric audiometric values were analyzed with paired-case *t*-test. The $p$ values of less or equal to 0.05 were considered statistically significant.

## 3. Results

### 3.1. Closure of perforation

The long-term success rate for closure was altogether 78 % (71/91, Table 2). Success rate was better in primary operations (84%, 62/74) than in revision operations (53%, 9/17, $p = 0.01$). Total success rate for small or medium perforations was higher (87 %) when compared to subtotal or total perforations (64 %, $p = 0.0108$). In the primary surgery group, success rate for small or medium perforation closure (93%) was higher than for subtotal or total perforations (69 %, $p = 0.0088$), or than closure rate for small and medium perforations in revision surgery group (60%, $p = 0.0160$). The size of the perforation did not have a significant effect on closure rate in revision operations ($p = 0.6372$). The reperforation rate did not differ significantly either between children over or under 7 years of age ($p = 0.20$), or between children over or under 10 years of age ($p = 0.26$).

In the primary myringoplasty group the Eustachian tube

**Table 2**
Perforation closure.

| Characteristic | All ($n = 91$) | Primary surgery ($n = 74$) | Revision surgery ($n = 17$) | $p$ value |
|---|---|---|---|---|
| **All (%)** | 71/91 (78) | 62/74 (84)** | 9/17 (53)** | 0.010 |
| **Small or medium (%)** | 48/55 (87)[a] | 42/45 (93)*[aa] | 6/10 (60)* | 0.0160 |
| **Subtotal or total (%)** | 23/36 (64)[a] | 20/29 (69)[aa] | 3/7 (43) | |
| **Valsalva + (%)** | 20/25 (80) | 18/20 (90)* | 2/5 (40)* | 0.0377 |
| **Valsalva - (%)** | 17/21 (81) | 15/16 (94)* | 2/5 (40)* | 0.0276 |
| **Sonotubometry + (%)** | 26/35 (74) | 24/31 (77)[b] | 2/4 (50) | |
| **Sonotubometry - (%)** | 21/23 (91) | 18/18 (100)*[b] | 3/5 (60)* | 0.0395 |
| $p$ value | [a]0.0108 | [aa]0.0088 [b]0.0377 | 3/5 (60)* | |

Valsalva + or -, those patients who preoperatively had positive or negative Valsalva maneuver in sitting position, respectively; Sonotubometry + or -, those patients who preoperatively had Eustachian tube opening or not in sonotubometry, respectively. Statistical significances of the difference between different groups were assessed with Fisher's exact test.

preoperative function tests including the Valsalva maneuver and the sonotubometry test, were performed to 36 and 39 patients, respectively. Valsalva performance did not correlate with primary operation success as two of the 20 patients with positive Valsalva had re-perforation and one of the 16 patients with negative Valsalva had re-perforation (Table 2). In contrast, there was a negative correlation in sonotubometry performance as seven out of 31 patients with positive sonotubometry had re-perforation, whereas none of the 18 patients with negative sonotubometry had re-reperforation ($p = 0.0377$). In the revision surgery group, neither Valsalva or sonotubometry performance correlated with closure success.

During the first postoperative year, 17 re-perforations appeared in the primary surgery group, and two of these healed spontaneously (Fig. 1). During the rest of the follow-up, two new perforations appeared and five perforations healed spontaneously. Most new perforations appeared within the first postoperative year, but spontaneous healing could take place even five years postoperatively. Spontaneous healing took place in 37% (7/19) of all re-perforations registered during the follow-up. Without spontaneous healing, the success-rate for the primary surgery was 74% (55/74). Sixty-five per cent (13) of the re-perforations for primary and revision operation groups together were in girls and 35% (7) in boys.

Half of the primary operation group ears (37/74) had had one or several preoperative ventilation tube insertions. This reflects the background of 44 ears with OME as etiology. Postoperatively, four ears (5%) needed a ventilation tube due to poor ventilation. All of these ears had had tube treatment before operation. In the primary surgery group six (50%) of the re-perforations developed in the cases not previously treated with ventilation tubes (6/37) and six (50%) in the cases with prior ventilation tubes (6/37; $p = 0.74$) suggesting that the preoperative ventilation tube treatment did not influence the re-perforation rate after primary myringoplasty.

In the primary surgery group five (7%) of ears had had preoperative discharge within the last 3 preoperative months and two (3%) were still moist before surgery. The other 67 ears had been dry preoperatively. Out of the 12 re-perforations that appeared in this group, nine occurred in the preoperatively dry ears (9/67, 13%) and three in the preoperatively discharged ears (3/8, 38%) which gives no statistical difference ($p = 0.08$). In the revision group all ears were dry preoperatively. For both groups together, 14 ears showed discharge during the follow-up, and 9 (64%) of these ears showed re-perforations in the long-term control. Only 3 (5%) re-perforations appeared in the 60 postoperatively dry ears. Statistically the difference was significant ($p < 0.01$) suggesting that postoperative discharge and infection is often related to re-perforations. Bacteriological culture for all 9 ears with reperforation was positive for two ears, boths with growth of Pseudomonas aeruginosa.

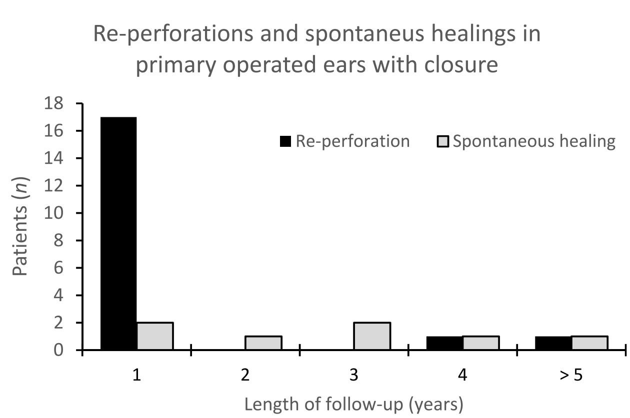


**Fig. 1.** Time-lap of reperforations and spontaneous healing during follow-up.

In both groups together, the contralateral ear showed pathological changes in the preoperative assessment in twenty-two ears (22/91, 24%). There was a perforation in 16 ears (13 in primary, three in revision groups), adhesions in three, reduced mobility in two and OME in one ear. Postoperatively, out of those 22 ears that had abnormal status in contralateral ear, four of the operated ears showed a re-perforation (two in the primary and two in the revision groups). In addition, seven ears showed reduced mobility or adhesions (five in the primary and two in the revision groups). However, the condition of the opposite ear had no statistically significant influence on the re-perforation rate ($p = 0.43$). The original diagnoses were evenly distributed for the ears with a re-perforation (four OMA, five OME and three Otitis media chronica).

Sclerotic plaques in the tympanic membrane were preoperatively found in 31 ears in both groups together. These plaques were as a rule removed during the operation. A re-perforation was found in three of these ears in the primary surgery group and in one in the revision group. Statistically, removed myringosclerosis did not predispose to a re-perforation ($p = 0.1$).

A plain mastoid X-ray was available for 59 ears. There was a clear mastoid cell system in 49% (29/59) of the examined ears and sclerotic, poorly developed cells in 49% (29/59). A re-perforation occurred in six of the sclerotic ears and in four of the ears with normal mastoids. The difference was not significant ($p = 0.4$).

In both operation groups together, 82% of the children (75/91) were tested for various allergens, and 27% (20/75) had positive findings on Prick test and 73% (55/75) had negative results. A re-perforation appeared in none of the children with positive test results, 6 occurred in the 15 children not tested, and 13 appeared in the children with negative test results. Thus, positive allergy test did not predispose to a re-perforation.

At the long-term control 63% (57/91) of the ears were completely healthy (intact tympanic membrane in normal position, good mobility, no remarkable adhesions or effusion in the tympanic cavity). Twenty ears (22%) had a perforation, 14 (15%) showed signs of poor ventilation. Eight of these needed a ventilation tube postoperatively. Sixteen (18%) ears had atrophic changes in the tympanic membrane indicating that the graft had worked only as a scaffold.

None of the ears developed a clear retraction pocket or cholesteatoma.

### 3.2. *Hearing results*

#### 3.2.1. *All ears*

The overall benefit of myringoplasty regarding hearing improvement was significant (PTA 25 ± 10 vs. 15 ± 13, Table 2, $p < 0.0001$; Paired *t*-test).

#### 3.2.2. *Primary surgery*

Pre- and postoperative hearing tests were available for 72 ears that underwent primary myringoplasty. The mean preoperative PTA value for these ears was 24 ± 10 dB (mean ± SD, Table 3). Fifty-eight (78%) of these ears had a PTA better than 30 dB and sixteen (22%) poorer than 30 dB (Fig. 2).

**Table 3**
Hearing results before and after myringoplasty.

| | All ($n$ = 83) | Primary surgery ($n$ = 72) | Revision surgery ($n$ = 11) |
|---|---|---|---|
| **Pre-op PTA in dB, mean ± SD (*n*)** | 25 ± 10[a] | 24 ± 10[b] | 27 ± 13 |
| **Post-op PTA in dB, mean ± SD (*n*)** | 15 ± 13[a] | 14 ± 12[b] | 20 ± 14 |

[a] , $p < 0.0001$ and.
[b] , $p < 0.0001$ for the statistical significance of the difference between preoperative and postoperative PTA. Paired *t*-test.

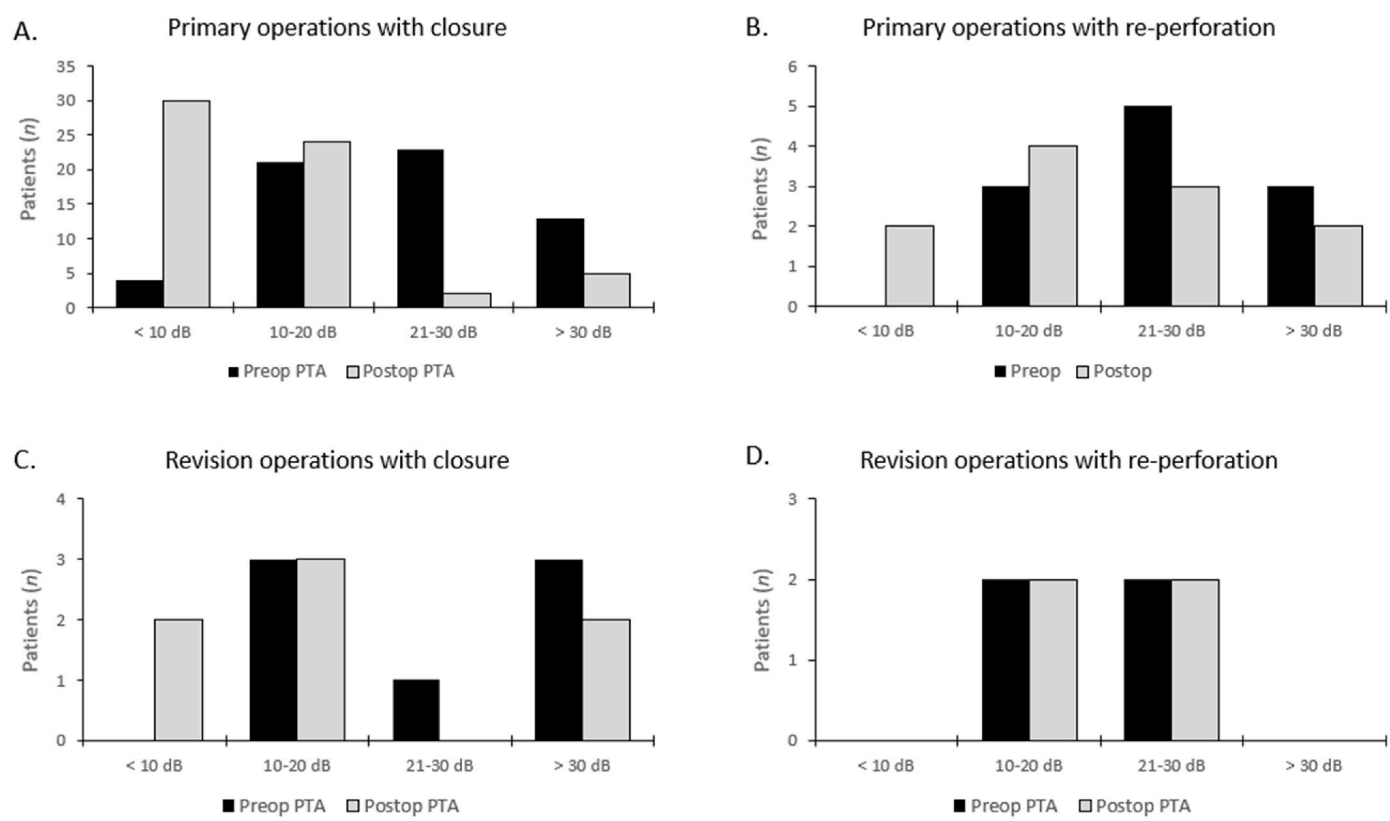


**Fig. 2.** Hearing results for primary and revison operations included ears with re-perforations.

The mean postoperative PTA 14 ± 12 dB was significantly better than preoperative hearing ($p < 0.0001$). In the group of successful closure 50 % of the patients had preoperative PTA worse than 20 dB whereas postoperatively only 10 % had PTA >20 dB (Fig. 2A). In the group of primary operations with re-perforation 8/11 (73%) of the patients had preoperative PTA worse than 20 dB whereas postoperatively 5/11 (45 %) had PTA >20 dB (Fig. 2B).

Most ears that gained better hearing had only slightly reduced hearing preoperatively (PTA less than 20 dB). Seven patients had poorer than 30 dB hearing postoperatively. They also had poorer than 25 dB hearing preoperatively. The reasons for poor hearing results were short and fixed malleus for two ears, scar tissue in the attic in two, one congenital stapes anomaly, adhesions between the pars tensa and the promontory in one ear. In addition, four patients had moderately poor hearing pre- and postoperatively (20–30 dB). Two of them showed tympanosclerosis, one showed adhesions between the promontory and the pars tensa and one had cheilopalatoscisis with poor Eustachian tube function and bilateral large perforations (20–30 dB hearing in both).

### 3.2.3. *Revisions surgery*

Pre- and postoperative hearing tests were available for 11 ears that underwent revision myringoplasty. In these ears the average preoperative PTA was 27 ± 13 dB. Postoperatively, all ears showed a hearing gain (including the ears with a new perforation) with an average PTA of 20 ± 14 dB (Table 2), but the difference was not statistically significant.

## 4. Discussion

Professor Tauno Palva (1925–2019) was supervisor for the monography thesis that the material of the current study is based on. The material is revisited and reanalyzed. This article illustrates the aspects he considered important for pediatric myringoplasty operation. The myringoplasty method has not changed much since then and there is not an abundant literature on this always-actual topic. Earlier results on adults in this hospital (Palva and Ramsay, 1995) with partly same surgeons and same premises for surgery, showed an 80 % perforation closure success-rate. The 84% long-term closure rate in the current study for primary pediatric myringoplasty is surprising, as pediatric myringoplasty is generally considered more demanding than operations in adults. However, here has spontaneous healing an important role. Spontaneous healing was not examined in the adult series.

Strengths: The major strength of this study is that the results are based on a long-term physical control with high attendance rate. The study explored many variables, including Eustachian tube function tests and hearing tests. Many confounding factors, like adenoidectomy, allergy, and surgeon's experience were analyzed and did not influence the results.

Limitations: The material is revisited, which can be considered as a limitation, but the major fundaments for myringoplasty have not changed essentially in the last decades. The size of revision cohort is relatively small, but it still allowed statistical analyzes.

In earlier analyzes age seemed to be an important factor (Vrabec et al., 1999; Denoylle et al., 1999; Kessler et al., 1994) regarding the success rate. Recent reports have concluded that age is (Duval et al., 2015; Kumar et al., 2010; Bruno et al., 2022; Rozendorn et al., 2016) or is not (Foulon et al., 2022; Sánchez Barrueco et al., 2015; Abood et al., 2020) an important factor. In this study, age did not have an effect on success rate. There is still no conclusive answer to age-limit for pediatric myringoplasty. The relatively high average age (10.5 years) for children operated in this series illustrates the policy of careful waiting before operation, since the tendency to OME diminishes with age. However, if the child can co-operate, and there are no other reasons to wait, there seems not to be any obvious reason for a definite age limit for pediatric myringoplasty.

Spontaneous healing was an important factor for healing among these children. This is possibly one reason for the better closure rate in children compared with the adult results from the same hospital (Palva and Ramsay, 1995). The tendency to spontaneous healing encourages to a wait-and-see policy before a re-operation. In addition, the waiting time for at least one year helps to identify the ears with tendency to discharge. Thus, if a new perforation appears, there is no hurry to schedule a revision operation.

Berger (Berger et al., 1983) and Kessler (Kessler et al. 1994) reported almost equal results for primary and revision operations, whereas Ophir (Ophir et al., 1987) had better (88% vs. 79%) and Blanshard (Blanshard et al. 1990) poorer results for revision operations. Later literature shows sparse analysis of revision surgery. The revision group in this study was small, but the poorer success-rate is clear. Most studied factors affecting the success rate were similar for primary and revision surgery ears. This implies that these ears presented technical difficulties or other problems that were not satisfactory solved in the primary operation and further accumulated in the revision group.

One study on pediatric myringoplasty did not find correlation between the size or site of the perforation and the success rate (Caylan et al., 1998), whereas in the review form Hardman (Hardman et al. 2015) the size of the perforation was concluded as important factors. In adults, Palva and Ramsay (Palva and Ramsay 1995) concluded that repair of total and anterior perforations is technically more demanding than that of small and central perforations, and more experienced surgeons had better results than younger ones. Black (Black et al. 1995) had similar conclusions. The present study shows clear correlation between the success rate and the size of the perforation, and it seems obvious that subtotal or total perforations present a challenge to the surgeon.

AOM and OME are more frequent in boys than in girls (Alho et al., 1995). The perforations or re-perforations were not male predominant in the present series. The gender distribution before operation did not differ statistically, and most re-perforations (13/20) in all operations appeared in girls. Gender was not related to re-perforations in this study.

The re-perforations were clearly associated with postoperative discharge, and the development was either due to a recurring infection or to an activation of a dormant epitympanic/mastoid inflammation. In most ears, but not all, the re-perforations appeared during the first postoperative year. This indicates that not all re-perforations are a result of technical failure with the operation. Ophir (Ophir et al. 1987) did not find correlation between periods of preoperative discharge and re-perforations, and myringoplasty has been recommended for moist ears (Caylan et al., 1998). We agree with Gersdorff (Gersdorff et al. 1995) and Abood (Abood et al. 2020) that preoperative tendency to discharge, or moisture on the mucous membrane, or the presence of contralateral disease, are clear warnings of possible postoperative infections. However, a dry period as long as one year, as in this study, does not exclude all such ears. A possible trapped inflammatory process or ventilation hinders in the attic should always be searched and treated.

Preoperative high resolution computer tomography was not routinely in use during this study. The plain mastoid x-ray is not in common use anymore, but it might work as low radiation screening method to reveal ears with mastoid pathology. However, this study does not support the need of radiological examination before pediatric myringoplasty for primary surgery.

The problem with literature review on pediatric myringoplasty is that hearing results are presented with a large variety of methods and calculations. Pediatric myringoplasty gives good hearing results for both primary and revision surgery, a finding also reported by other authors as reviewed earlier (Vrabec et al., 1999; Hardman et al., 2015; Duval et al., 2015; Sánchez Barrueco et al., 2015). In this series, the best hearing gain was in the ears that already had only mild hearing loss. It is not unusual that children can have negative bone conduction measurements. Then a PTA of 20 dB can at the same time represent a 20 dB Air-Bone (AB) gap. Bone conduction measurement with children is an audiological challenge in regard to calibration. A child of 6 years of age has a different skull compared with a child on 14 years of age. Therefore, we rely more on air-conduction PTAs when reporting results. A hearing level of 20 dB PTA or better should be the goal, as most ears fulfilled the 30 dB criteria already preoperatively. This fact also emphasizes the need to present pre- and postoperative PTA results for children instead for AB gaps. To gain this goal, the surgeon should be prepared and have competence to extend the operation to attic exploration and to ossicular chain reconstruction.

This study addressed special interest to Eustachian tube function. However, even as we used advanced technology in terms of sonotubometry, we could not show that ET function has an effect on success rate. Middle ear ventilation in children is probably too complex to be measured with the methods used. In addition, sonotubometry as method is not validated for children. It is a demanding task to teach the children with reduced Eustachian tube function to train with the Valsalva maneuver. This study indicates that the value of Valsalva maneuver training may be limited. It is also possible that the material is biased for which children that were willing to do Valsalva maneuver or attend the sonotubometry test. There is a need to study this problem with prospective clinical trials. However, the results suggest that re-perforations are simply not a result of just poor ME ventilation.

None of the ears developed a retraction pocket or cholesteatoma.

Permanent tympanic membrane perforations after tube extrusion are reported in 0.5%–3% of treated ears (Karma et al., 1982), and many heal spontaneously. Preoperative tube treatment might warn of tendency to ventilation problems postoperatively, but it was a non-significant factor in this study. The need of postoperative tube treatment in 5 % of the ears in this study is comparable with the earlier studies referred with values ranging from 2% to 5% (Silvola, 1997). The parents should be advised that some children might need a ventilation tube postoperatively.

The results of pediatric myringoplasty are usually reported as the percentage of closure of the perforation as success rate. However, success should be defined as an intact tympanic membrane with normally ventilated middle ear, and good hearing. In this series, 63% (57/91) of ears were completely healthy after the follow-up. The 37 % of ears with problems is the same portion as for ears with atelectasis in the tympanic membrane after pediatric cholesteatoma operations in this hospital (Silvola and Palva, 1999). These ears were then accumulated in the revision group partially explaining the poor revision results (29% with completely healthy ears).

A congested mucous membrane, moisture or mucus in crevices of the middle ear, the presence of inflammatory webs and adhesions in the tympanic cavity, as well as reduced mobility or defects in the ossicles, should alert the surgeon. The same conclusion was found in an earlier study in this department (Palva and Virtanen 1982). The surgeon should not be contended to plain closure of the perforation. An experienced surgeon investigates not only the continuity of the ossicular chain but also other pathology around the ossicles and should be prepared to repair these problems in the same operation.

In conclusion, a pediatric myringoplasty is not that simple in about one third of the operations.

## References


Abood, A., Torzynski, B., Ovesen, T., 2020. Pediatric type 1 tympanoplasty – does age matter? Int. J. Pediatr. Otorhinolaryngol., 110219

Alho, O.-P., Oja, H., Koivu, M., Sorri, M., 1995. Chronic otitis media with effusion in infancy. Arch. Otolaryngol. Head Neck Surg. 121, 432–436.

Berger, G., Shapira, A., Marshak, G., 1983. Myringoplasty in children. J. Otolaryngol. 12, 228–230.

Black, J.H., Hickey, S.A., Wormald, P.J., 1995. An analysis of the results of myringoplasty in children. Int. J. Pediatr. Otorhinolaryngol. 31, 95–100.

Blanshard, J., Robson, A., Smith, I., Maw, A.R., 1990. A long term view of myringoplasty in children. J. Laryngol. Otol. 104, 758–762.

Bruno, C., Guidi, M., Locatello, L.A., Gallo, O., Trabalzini, F., 2022. Current outcomes of myringoplasty in a European referral children's hospital. Int. J. Pediatr. Otorhinolaryngol. 160, 11124.

Caylan, R., Falcioni, M., De Donato, G., Russo, A., Taibah, A., Sanna, M., 1998. Myringoplasty in children: factors influencing surgical outcome. Otolaryngol. Head Neck Surg. 118, 709–713.

Denoylle, F., Roger, G., Chauvin, P., Garabedian, E.N., 1999. Myringoplasty in children: predictive factors for outcome. Laryngoscope 1, 47–51.

Duval, M., Grimmer, J.F., Meier, J., Muntz, H.R., Park, A.H., 2015. The effect of age on pediatric tympanoplasty outcomes: a comparasion of preschool and older children. Int. J. Pediatr. Otorhinolaryngol. 336–341.

Foulon, I., Philips, D., Lichtert, E., Buyl, R., Topsakal, V., Gordts, F., 2022. Pediatric myringoplasty: a study of effectiveness and influencing factors. Int. J. Pediatr. Otorhinolaryngol. 153, 110990.
Gersdorff, M., Garin, P., Decat, M., Juantegui, M., 1995. Myringoplasty: long-term results in adults and children. Am. J. Otol. 16, 523–525.
Harder, H., Jervall, L., Kylen, P., Ekvall, L., 1982. Calculation of hearing results after tympanoplasty. Clin. Otolaryngol. 7, 221–229.
Hardman, J., Muzaffar, J., Nankivell, P., Coulson, C., 2015. Tympanoplasty for chronic tympanic membrane perforation in children: systematic review and meta-analysis. Otol. Neurotol. 36, 796–804.
Karma, P., Sipilä, M., Kokko, E., 1982. Long-term results of tympanostomy treatment in chronic secretory otitis media. Acta Otolaryngol (Stockh). Suppl 386, 163–165.
Kessler, A., Potsic, W., Marsh, R., 1994. Type I tympanoplasty in children. Arch. Otolaryngol. Head Neck Surg. 487–490.
Kumar, S., Acharya, A., Hadjihannas, E., Panagamuwa, C., McDermott, A.L., 2010. Pediatric myringoplasty: definition of success and factors affecting outcome. Otol. Neurotol. 31, 1417–1420.
Ophir, D., Porat, M., Marshak, G., 1987. Myringoplasty in the pediatric population. Arch. Otolaryngol. Head Neck Surg. 113, 1288–1290.
Palva, T., Ramsay, H., 1995. Myringoplasty and tympanoplasty- results related to training and experience. Clin. Otolaryngol. 20, 329–335.
Palva, T., Virtanen, H., 1982. Pitfalls in myringoplasty. Acta Otolaryngol. 93, 441–446.
Palva, T., Palva, A., Kärjä, J., 1969. Myringoplasty. Ann. Otol. Rhinol. Laryngol. 78, 1074.
Rozendorn, N., Wolf, M b, Yakirevich, A., Shapira, Y., Carmel, E., 2016. Myringoplasty in children. Int. J. Pediatr. Otorhinolaryngol. 90, 245–250.
Sánchez Barrueco, A., Lora Pablos, D., Villafruela Sanz, M.A., Almodóvar, Álvarez C., 2015. Pediatric myringoplasty Prognostic factors in surgical outcome and hearing treshold recovery. Acta Otolaryngol. 135, 1233–1237.
Silvola, J., 1997. Long-term Results of Middle Ear and Mastoid Surgery in Children. University of Helsinki: Academic Dissertation, ISBN 952-90-8819-1. ISBN.
Silvola, J., Palva, T., 1999. Long-term results of pediatric primary one-stage cholesteatoma surgery. Int. J. Pediatr. Otorhinolaryngol. 48, 101–107.
Virtanen, H., 1987. Sonotubometry. An acoustic method for objective measurement of auditory tubal opening. Acta Otolaryngol. 86, 93–103.
Vrabec, J.T., Deskin, R.W., Grady, J.J., 1999. Meta-analysis of pediatric tympanoplasty. Arch. Otolaryngol. Head Neck Surg. 125 (5), 530–534.