

# Paediatric revision myringoplasty: outcomes and prospects

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## Abstract

Paediatric revision myringoplasty has received little attention. This study addressed the issue exclusively and reviewed the short- and long-term results of surgery in children between the ages of five and 15. Twenty-six out of 38 operated ears (68.4 per cent) were initially intact. The causes of immediate failure in decreasing order were: infection with graft necrosis, complete no-take of the graft and poor anterior adaptation of the graft. Age, size and site of perforation and surgeon's experience did not significantly affect the initial outcome of surgery. Six ears developed delayed re-perforations, thus decreasing the overall success rate to 52.6 per cent. The latter were attributable to either episodes of acute otitis media or to insidious atrophy of the tympanic membrane. Notably, none developed post-operative sensorineural hearing loss. It is concluded that the results of paediatric revision myringoplasty are rather disappointing, yet arguments encouraging its practice are favourably presented.

**Key words:** Myringoplasty; Child; Treatment Outcome

## Introduction

Myringoplasty (MP), also referred to in the literature as type I tympanoplasty, is performed to eradicate middle-ear disease, reconstruct middle-ear structure and prevent further damage to the hearing mechanism. A prominent controversy among otologic surgeons is how to manage a perforated tympanic membrane (TM) in the paediatric population. Several reports showed a high success rate of MP in children comparable to what has been achieved in adults.<sup>1,2</sup> Others found less favourable results and recommended withholding surgery before the age of eight.<sup>3,4</sup> A recent meta-analysis of paediatric tympanoplasty studies have shown a significant better outcome with advancing age.<sup>5</sup>

The issue of revision myringoplasty (RMP) is also unsettled, and study results vary between excellent results that resemble primary MP<sup>6–9</sup> and modest ones, ranging from 50 to 60 per cent.<sup>10,11</sup> Consequently, physicians treating a child who has undergone a failed first surgery, face the dilemma whether to perform RMP in children, as well as what to tell parents about the chance of a second procedure.

Thus far, RMP operations in children have not been fully discussed, being dealt with in the framework of the adult population or supplementary to observations on primary MP. Nagai *et al.*<sup>12</sup> studied the results of 87 MPs in children and found a 52.3 per cent success rate of RMP in 23 children up to 14 years of age. A previously reported study conducted

on RMP touched on the prospects of the procedure in a limited number of children <12 years, and showed that the success rate of this group was not significantly different from that of the older group.<sup>11</sup> To assess these preliminary results, we introduced in the present series a larger sample of children, and discussed the immediate and the late outcome of RMP with respect to the following parameters: (1) age of child; (2) size of perforation; (3) location of perforation; and (4) surgeon's experience.

## Materials and methods

### Study population

The retrieved charts of all consecutive children who underwent RMP between 1981 and 2000, at the Department of Otolaryngology – Head and Neck Surgery, Meir Hospital, Sapir Medical Center, Kfar Saba, Israel, formed the material of the study. The study comprised 37 children, of whom 16 were presented in a previous report<sup>11</sup> and 21 were new recruits. There were 19 boys and 18 girls varying in age from five to 15 years (mean age  $11.4 \pm 2.5$ ). For purposes of analysis, the children were divided into two age groups: five to nine years inclusive ( $n = 8$ ), and 10 to 15 years inclusive ( $n = 29$ ). Following failure of a first surgical attempt, 36 children had unilateral RMP, and one had a bilateral procedure. Thus, 38 ears were operated, 22 right ears and 16 left ones. The results of six re-revision myringoplasty (RRMP) operations were also evaluated; they

included children who at the time of operation complied with the age limit set earlier. Altogether, there were 44 RMP and RRMP procedures. The time lapse from primary operation to revision was five to 87 months (mean  $28.8 \pm 22.9$ ), and from revision to re-revision 12 to 24 months (mean  $17.3 \pm 5.7$ ). Inclusion criteria were the presence of a dry central perforation and an intact ossicular chain compatible with type I tympanoplasty, while those with other middle-ear diseases (e.g. retraction pocket cholesteatoma, damaged ossicular chain) that required tympanomastoidectomy or type II–IV tympanoplasty were excluded from the study. All children were generally healthy and had no illnesses, immunodeficiency states or craniofacial anomalies that might have affected the outcome of surgery.

#### *Pre-operative evaluation*

Children's charts were reviewed shortly before surgery, and history of previous MP was recorded. The location and extent of perforation were assessed under the operating microscope. Large perforations were considered to be those occupying one-half or more of the eardrum surface.<sup>7,11</sup> The possible presence of otorrhoea or active inflammation was ruled out. Pure tone and speech audiometry were performed with a clinical audiometer, calibrated according to ISO standards. Benefits, risks and alternatives of the procedure were discussed in the process of informed consent.

#### *Surgical techniques*

Thirty-nine TM repair operations that included RMP and RRMP were performed by means of the underlay technique. Surgery began with a post-auricular or an endaural incision, while subjects were under general endotracheal anaesthesia. The graft materials harvested included temporalis fascia in 35 ears, tragal perichondrium in two and mastoid periosteum in the remaining two. After meticulous freshening the margins of the perforations, a posteriorly based tympano-meatal flap was lifted with the annulus, and the middle-ear space was packed with gelfoam. The graft was shaped to the proper size and carefully tucked into position, medial to the remnant of the eardrum. The annulus was placed back into position, and small pellets of gelfoam were immediately placed over the grafted area and the entire external ear canal. A small tampon was then placed in the meatus; the incision was closed with absorbable sutures, and a light dressing was applied to provide protection to the ear. As a rule, children were discharged the day after operation.

In five small perforations, fat graft MP that was performed through a transcanal approach superseded conventional surgery. The ear was prepared in the usual fashion, and the edges of the perforation were carefully freshened, then, a small incision was made in the posterior aspect of the ear-lobule, and a piece of fat was extracted. The middle ear was packed with a single piece of gelfoam, and the fat graft, acting as a matrix for the eardrum to grow across, was inserted in an hourglass manner to cover

both sides of the margins of the perforation. Finally, the ear canal was covered with gelfoam. No ear dressing was used. General anaesthesia was required, nonetheless, fat graft MP is considered a minor procedure and children were discharged the same day from hospital.

#### *Post-operative evaluation*

Parents and children were instructed to follow dry ear precautions, and watch for bleeding, purulent aural discharge, temperature elevation, excessive pain or increasing discomfort. A week after surgery, all children were examined in the outpatient clinic, and dressings used for the underlay technique were removed. To assess the initial graft take, children were re-examined under the operating microscope four to six weeks after surgery. A post-operative audiogram was obtained approximately three months after surgery, and the measurements of the pre-operative and post-operative air and bone conduction thresholds over the speech frequencies (500 Hz, 1000 Hz and 2000 Hz) served to calculate the air-bone gap closure. Further follow-up appointments were scheduled at six and 12 months; thereafter they were arranged on an annual basis. Parents were advised to antedate appointments if aural discharge appeared. Duration of follow-up varied from 2.5 months to seven years (mean  $25.7 \pm 21.2$  months).

#### *Statistical analysis*

Associations between initial success of operation and age, size and location of perforation, and surgeon's experience were performed by Chi-squared test. Paired *t*-test was used to compare pre-operative and post-operative hearing results, and ANOVA with repeated measures used to evaluate the interaction between initial success of operation and hearing results. Measurements were expressed as mean  $\pm$  standard deviation (SD). Probability values of  $<0.05$  were considered significant.

## **Results**

#### *Revision myringoplasty*

Initial assessment of the graft take in all patients revealed that 26 TMs were intact, whereas 12 remained perforated. Six of the successful cases developed delayed re-perforations during the follow-up course, thus decreasing the overall success rate from 68.4 per cent (26 out of 38 ears) to 52.6 per cent (20 out of 38 ears). The time interval from RMP operation to the appearance of late re-perforations ranged from five to 84 months (mean  $22.1 \pm 28.6$ ). Table I shows the causes for immediate and delayed failures. Of the 12 patients with initial failure, five had a post-operative infection with purulent aural discharge and necrosis of the graft, four had a complete no-take characterized by disappearance of the graft with no evidence of infection, leaving an identical perforation to the pre-operative one, and three had a partial graft take at the posterior portion and a small perforation that remained anteriorly. Of

TABLE I  
CAUSES OF FAILURE IN PAEDIATRIC RMP OPERATIONS

	No. of ears (per cent)*
Immediate failures	
Infection with graft necrosis	5 (27.8)
Complete no-take of graft	4 (22.2)
Poor anterior adaptation of graft	3 (16.7)
Subtotal	12 (66.7)
Late failures	
Acute otitis media	3 (16.7)
Atrophy of graft with no infection	3 (16.7)
Subtotal	6 (33.4)
Total failures	18 (100)

RMP = revision myringoplasty. \*Because of rounding percentage may not all total 100.

the six delayed failures, three had an acute episode of otitis media and three had a gradual thinning-out of the TM, with no history of trauma or evidence of infection, which eventually led to the development of a small perforation. Notably, the size of immediate re-perforations varied considerably, whereas late re-perforations were exclusively small. With respect to the subset of fat graft MP, of the five cases, three (60 per cent) were initially successful, whereas only two (40 per cent) remained intact in the long-term. Although the number of cases was too small to declare statistical significance, a similar trend can be also seen here.

Figure 1 demonstrates the immediate success rate of RMP with regard to children's age, size and location of perforation and surgeon's experience. Assessment of these parameters showed no significant difference between children <10 years of age and older children (75 per cent vs. 66.7 per cent;  $p = 1.000$ ). Likewise, no significant difference was found between small perforations and large ones occupying half or more of the eardrum surface (70 per cent vs 62.5 per cent;  $p = 0.689$ ), between anterior perforations and those located in other regions of the TM (68 per cent vs. 69.2 per cent;  $p = 1.000$ ), and between operations performed in the hands of staff members and senior residents (69.7 per cent vs. 60 per cent,  $p = 0.643$ ).

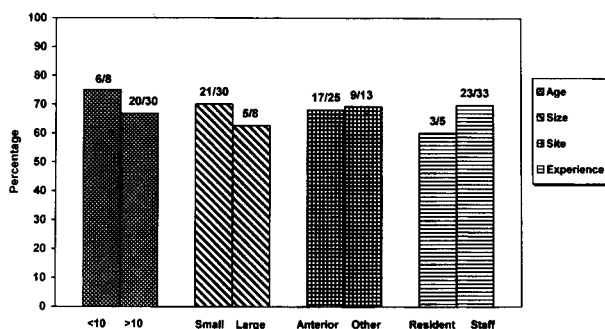


FIG. 1

The ratio of young to older children, small to large perforations, anterior perforations to perforations located elsewhere and senior residents to staff members in the initial success rate of revision myringoplasty for children (expressed in percentages; 38 ears).

TABLE II  
HEARING RESULTS OF PAEDIATRIC RMP OPERATIONS

	Mean dB	
	Pre-op	Post-op
Air conduction threshold	26.6 ± 14.2	21.2 ± 15.5
Bone conduction threshold	7.7 ± 9.9	5.8 ± 10.3
Air-bone gap	18.9 ± 7.6	15.3 ± 7.7

RMP = revision myringoplasty; dB = decibel; Pre-op = pre-operative; Post-op = post-operative.

Table II reveals that, after paediatric RMP, the mean post-operative air-bone gap closure was 3.6 dB. Furthermore, the mean air conduction threshold and the mean air-bone gap ( $p < 0.001$  and  $p = 0.005$ , respectively) improved significantly, while the change in the bone conduction did not reach statistical significance ( $p = 0.073$ ). When hearing results are plotted against initial success or failure of surgery (Table III), a significant correlation existed between the improvement of air conduction threshold and success of operation ( $p = 0.011$ ) (i.e. improvement was significantly greater in successful cases). Such a correlation was not found in the bone conduction threshold and in the air-bone gap ( $p = 0.082$  and  $p = 0.208$ , respectively). A significant sensorineural hearing loss (i.e. a loss of bone conduction thresholds by 10 dB or more) was not recorded in any of the children.

#### Re-revision myringoplasty

Six out of 18 children who ultimately failed RMP underwent RRMP, of whom three (50 per cent) had an initial graft take, whereas in the remainder the perforation failed to close. One child whose TM was initially intact developed a delayed re-perforation during the follow-up course.

#### Discussion

RMP for children is dealt with in few reports, either adjunctive to deliberations on RMP in the general population, or secondary to MP in children;<sup>11,12</sup> indeed, a Medline search of the literature from 1966 until December 2001 produced no results, and no article bore a similar or a related title. The present study addresses the matter of RMP exclusively, with special emphasis attached to the potential problems that revolve around the operation in the paediatric population. It indicates that the success rate is 68.4 per cent for the short-term and 52.6 per cent for the long-term. These results are comparable to those found in our previous report, which disclosed the surgical outcome of RMP in 16 children and 54 adults,<sup>11</sup> yet they fall behind other publications on primary MP in adults<sup>13,14</sup> and most reports on paediatric MP.<sup>1,2</sup> Apparently, these results stem from a relatively low rate of initial closure and a high rate of late failures, and sum up to a rather disappointing outcome of RMP for children.

To establish the grounds for the aforementioned results, possible determinant factors relevant to the success of paediatric RMP are presented herein. It seems that neither the condition of the middle-ear

TABLE III  
THE MEAN HEARING RESULTS OF INITIAL SUCCESS VERSUS INITIAL FAILURE OF PAEDIATRIC RMP

	Initial success ( <i>n</i> = 23)		Initial failure ( <i>n</i> = 10)	
	Pre-op dB	Post-op dB	Pre-op dB	Post-op dB
Air conduction threshold	28.7 ± 16.4	21.1 ± 18.3	21.8 ± 5.2	21.3 ± 5.8
Bone conduction threshold	8.7 ± 11.4	5.7 ± 12	5.4 ± 4.9	6.2 ± 4.8
Air-bone gap	20 ± 8.8	15.4 ± 8.2	16.4 ± 2.9	15.1 ± 6.8

RMP = revision myringoplasty; Pre-op = pre-operative; Post-op = post-operative; dB = decibel.

mucosa, the graft material, nor the surgical technique had a significant bearing on the initial success rate. Similar methods to primary MP were applied, only dry ears were operated, in most cases the graft material was temporalis muscle fascia, and the underlay technique was employed almost exclusively; notwithstanding, the encouraging success rate of MP was not repeated.<sup>1,2,13,14</sup> Other reasons for the inadequate success rate may be attributed to either a technical fault of the surgeon, or to reasons associated with the operated ear. On the whole, three different causes for initial no-take of the graft were discerned: (1) infection with purulent aural discharge and necrosis of the graft (five out of 12; 41.7 per cent); (2) complete disappearance of the graft with no evidence of infection (four out of 12; 33.3 per cent); and (3) poor anterior adaptation (three out of 12; 25 per cent). Evidently, only the latter possibility may be considered a technical fault, as in these cases, the perforation closed posteriorly, whereas the anterior portion remained with a smaller perforation, owing to inaccurate placement or tucking of the graft into position under the anterior edge of the perforation. On the other hand, the two other more common causes of immediate failure are not, in all probability, associated with technical problems. Evidently, post-operative infections developed in previously dry ears, while proper operating room measures and sterility precautions were taken. Furthermore, a complete disappearance of the graft occurred despite the fact that most revision operations were performed by experienced staff-members, who retained an excellent surgical record in primary RM.<sup>15</sup> Hence, it is suggested that most immediate failures are not necessarily linked to technical faults, but rather to causes associated with the operated ear, and may reflect the consequences of a reduced blood supply on a site that already suffered from chronic inflammation and a previous unsuccessful MP intervention.

The data show that age, perforation size, site and experience of the surgeon were of little significance for the outcome of the initial graft take. Our results pertaining to the size of perforation are in concert with those of Packer *et al.*<sup>6</sup> and Gibb and Chang,<sup>7</sup> but differ from those of Sadé *et al.*<sup>15</sup> who disclosed that small perforations fared better than larger ones. With respect to the site of perforation, our results also differ from those of Sadé *et al.*,<sup>15</sup> Halik and Smyth<sup>10</sup> and Bhat and De<sup>16</sup> who found that anterior perforations had a higher failure rate than all other sites. According to Halik and Smyth,<sup>10</sup> this phenomenon was connected to visualization difficulties that caused limited exposure of the surgical field.

Late re-perforation of a TM that had an initial successful graft take may occur with relentless frequency up to 11 years after surgery.<sup>10,17</sup> Jurovitzki and Sadé<sup>18</sup> followed 540 successful MPs for 12 years and found that 14 per cent of the TMs ultimately re-perforated. Tos<sup>19</sup> reported that 45 out of 387 (11.6 per cent) developed late re-perforations over a period of 15 years. In both studies no mention was made of patients' age, though it is a plausible assumption that in studies of this magnitude different age groups, including children, were recruited to the study. Another work conducted by the principal author (G.B.) and colleagues on paediatric MP showed that as high as 18 per cent had delayed re-perforations.<sup>3</sup> In the present study, six out of 26 children (23.1 per cent) with an initial take of the graft developed during the follow-up period (from five months to seven years; mean 22.1 ± 28.6 months) late re-perforations. Apparently, this rate is higher than that mentioned earlier on paediatric MP and almost twofold higher than that of Jurovitzki and Sadé<sup>18</sup> and Tos.<sup>19</sup> In three failures, re-perforation emerged during episodes of acute otitis media, frequently found in children before school age or before reaching the age of 10 and even in older ones. In the remaining three, a gradual thinning-out of the TM, which happened without any insult such as trauma or ear infection, resulted in a small and dry perforation. The cause of the latter has yet to be established, presumably it may derive from prolonged eustachian tube insufficiency associated with middle-ear negative pressure and atelectasis of the TM that eventually ruptured, or from reduced blood supply and aseptic necrosis of the TM.

Sensorineural hearing loss after MP is a recognized phenomenon. Halik and Smyth<sup>10</sup> recruited a non-homogeneous group of children and adults, and found that 17 out of 605 (2.8 per cent) had various degrees of sensorineural hearing loss; in six out of 605 (one per cent) worsening of bone conduction thresholds exceeded 20 dB; notably no mention was made of their age. Others found a low complication rate of 0.2 per cent.<sup>6</sup> As to RMP, Gibb and Chang<sup>7</sup> and Vartiainen<sup>8</sup> did not observe the same complication among their study sample (55 and 38 cases, respectively), whereas Blanshard *et al.*<sup>20</sup> reported a deterioration of 15.5 dB in bone conduction thresholds in two out of four children after RMP. In our previously reported series one adult had a loss of 15 dB of bone conduction thresholds.<sup>11</sup> In the present study, all 38 operated ears were free of the complication. The aforementioned findings suggest that the results of RMP in children are not different from that of adults, and that a second operation



designed to correct TM perforation does not increase the likelihood of developing significant cochlear damage in the paediatric population.

It cannot be ignored that the initial results of RMP for children were unsatisfactory, let alone the late surgical outcome of the procedure. Apparently, these data and the fact that children, particularly younger ones, are susceptible to frequent upper airway and ear infections as well as to poor eustachian tube function, may deter treating physicians from choosing repeated surgery and persuade them to take more conservative measures to deal with the problem. Nevertheless, attaining success in RMP surgery, especially at an early age, has significance with regard to lessening the progression of ossicular pathology, ameliorating hearing, minimizing aftercare and enhancing quality of life (i.e. bathe freely, swim, or participate in other sport activities that involve water) and, as such, contributing to children's health and future physical and mental development. Furthermore, children who develop a late thinning out of the graft 'gain' a smaller perforation that can be corrected through fat graft MP, which is considered a much less traumatic procedure. At any rate, re-perforation may occur even years after the operation, and in the meantime children and parents enjoy the fruits of surgery. Taking these considerations into account, we would tell parents whose child already failed one attempt that RMP operation is advisable no less than for the adult candidate. Nevertheless, the decision ultimately remains with the parents.

### Conclusions

The following conclusions may be drawn from the data on paediatric RMP: (1) the results of the procedure are disappointing and stem from a relatively low rate of initial perforation closure and a high rate of late failures; (2) the parameters age, size and site of perforation, and surgeon's experience have no bearing on the initial outcome of surgery; (3) technical faults of the surgeon accounted for a small number of the failures, suggesting that most failures are probably related to causes associated with the operated ear; (4) the procedure does not increase the likelihood of developing sensorineural hearing loss in children; and (5) despite the modest success rate of paediatric RMP, arguments that encourage its practice are favourably discussed.

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