The Journal of Laryngology & Otology
May 2001, Vol. **115,** pp. 369–373

Myringoplasty in children: anatomical and functional results

Lorenzo Pignataro, M.D., Lorenzo Grillo della Berta, M.D., Pasquale Capaccio, M.D., Arturo Zaghis, M.D.

Abstract

To assess the results of myringoplasty in children and determine the factors influencing post-operative results a retrospective study of the anatomical and functional results of 41 myringoplasties in children was performed, considering only the cases of uncomplicated perforation that did not require ossiculoplasty or mastoidectomy. The overall success rate was 80.5 per cent after a mean follow-up of 39 months. The mean post-operative air conduction threshold significantly improved in the successful cases with a mean audiological improvement of 11 dB ($p<0.05$). No post-operative sensorineural hearing loss was observed. There was a significant statistical association between the presence of a dry ear at the time of surgery and good surgical results ($p<0.01$). Surgical outcome was not affected by the patient's age, the site and size of the perforation, previous adenoidectomy, surgical technique (overlay *vs* underlay), or the status of the contralateral ear. Our findings suggest that myringoplasty is a valid procedure in the paediatric population that gives good anatomical and functional results. The status of the middle ear (i.e. the presence of a dry ear), significantly improves surgical outcome; and so careful inflammatory changes in the middle-ear mucosa should be evaluated and medical treatment considered before surgery.

Key words: Surgical Procedures, Operative; Child; Ear Middle

Introduction

It has been suggested that many factors influence the surgical outcome of myringoplasty in children, such as age, the size and site of perforation, status of the ear (dry or dischaging) and the surgical technique, but their real role is still unclear.[1–5] The reported success rate of myringoplasty is therefore extremely variable, ranging from 35 to 92 per cent (Table I),[1,3,5–18] partly because of differences in the inclusion and exclusion criteria.[1,19]

Furthermore, there is no agreement as to the timing of the procedure:[1] some authors prefer to perform surgery as soon as possible in order to prevent disease progression, ossicular chain erosion and the formation of cholesteatoma, avoid hearing loss in the speech development period, and allow swimming activities;[1,5,12,20] others prefer to delay the operation because of the high incidence of upper respiratory infections during childhood, unpredictable eustachian tube function, immature immunity,

TABLE I
RESULTS OF MYRINGOPLASTY IN CHILDREN

Author	Cases	Age	Anatomical success percentage	Follow-up (yrs)
Buchwach and Birch[7]	134	3–17	66	2
Bluestone *et al.*[6]	45	2–16	35	2
Raine and Singh[8]	114	7–16	72	3
Lau and Tos[9]	155	2–14	92	3
Ophir *et al.*[11]	172	5–12	79	1
Manning *et al.*[10]	63	5–19	78	1–5
Blanshard *et al.*[12]	59	<14	78	15
Koch *et al.*[1]	64	2–17	73	2
Shih *et al.*[13]	59	6–16	78	1
Kessler *et al.*[14]	209	<18	92	0.5
McDonald III *et al.*[15]	29	5–16	69	4
Black *et al.*[16]	100	2–17	75	2
Podoshin *et al.*[3]	51	9–14	92	3
Vartiainen and Vartiainen[17]	60	<18	90	5
Caylan *et al.*[5]	51	5–16	82	1.5
Denoyelle *et al.*[18]	231	4–17	83	3

From the Dipartimento di Scienze Otorinolaringologiche Ospedale Maggiore I.R.C.C.S., 20122 Milano, Italy.
Accepted for publication: 22 November 2000.

https://doi.org/10.1258/0022215011907893 Published online by Cambridge University Press

possible spontaneous healing, and the possibility of preventing recurrent middle-ear infection because of the adequate ventilation allowed by tympanic perforation during the period of eustachian immaturity.[1,6]

The aim of this retrospective study was to evaluate the surgical and functional results of myringoplasty in selected children with tympanic membrane perforation, and assess the factors potentially influencing their outcomes.

Materials and methods

A homogeneous series of 41 children aged eight to 14 years (mean 10.8 years) was selected from the patients who underwent myringoplasty at the Institute of Otolaryngology of the University of Milan between 1994 and 1998. The exclusion criteria were: the presence of cholesteatoma, ossicular chain pathology, tympanosclerosis, traumatic perforation, previous ossiculoplasty and prior tympanic surgery. Patients with tympanic membrane perforation but no other middle-ear abnormality were included in the study. All of the patients considered for myringoplasty underwent pre-operative audiological evaluation in a silent room, including hearing threshold. The hearing results were determined by evaluating the difference between the mean pre- and post-operative air threshold averaged over the frequency range of 0.5–3 kHz. The thresholds at 3 kHz were estimated as the means of the thresholds at 2 and 4 kHz. (Committee on Hearing and Equilibrium Guidelines for the Evaluation of Results of Treatment of Conductive Hearing Loss,[21]).

All of the children underwent myringoplasty using an overlay or underlay technique and the permeatal or post-auricular approach; a posterior tympanomeatal flap was raised to facilitate the grafting using temporalis fascia. Before graft placement, the administration of N_2O was stopped in order to prevent accumulation of N_2O in the middle ear. No routine pre-operative antibiotic therapy was given.

The considered prognostic factors were the age of the patient, the site and size of perforation, previous adenoidectomy, the status of the operated ear and controlateral ear and the surgical technique.

The presence of an intact graft at the last follow-up was considered a successful result, even in the presence of complications such as blunting of the anterior angle, tympanic membrane retraction and post-operative cholesteatoma of the external canal or tympanic membrane.

The patients were post-operatively followed up at weekly intervals for the first month, and then as needed. The mean duration of follow-up was 39 months (range eight to 60 months).

Statistical analysis was performed by means of the Chi-squared test, using Yates' correction when necessary.

Results

The mean age of the 41 patients was 10.8 years (range eight to 14 years); 23 were male and 18 female.

A postauricular approach was used in 25 and a permeatal approach in 16 cases, an overlay technique adopted in 24 cases and an underlay technique in the remaining 17.

Anatomical results

The overall success rate was 80.5 per cent (33/41): 27 of these 33 cases (approximately 82 per cent) had an intact graft take at the last follow-up visit (mean 39 months), and six (approximately 18 per cent) had secondary complications such as blunting of the anterior angle (two cases treated using the overlay technique), tympanic membrane retraction (one case treated using the underlay technique), and three cases with post-operative cholesteatoma of the external canal or the tympanic membrane.

The surgical failure in the remaining eight cases (19.5 per cent) was characterized by evidence of a re-perforation at the last follow-up visit; graft failure occurred during the first 15 months in five of these eight cases (62.5 per cent).

Audiological results

Pre- and post-operative air thresholds were available for 22 of the 33 successful cases and five of the eight unsuccessful cases. The mean pre-operative and post-operative air threshold in the successful cases was respectively 34.3 and 23.3 dB, with a mean audiological improvement of 11 dB ($p<0.05$) (Table II). The best improvement was observed at the frequency of 250–1000 Hz. The improvement was 0–30 dB in 68.2 per cent of the successful patients, and more than 30 dB in 31.8 per cent. No sensorineural hearing loss was observed after surgery.

Analysis of prognostic factors

The results concerning the factors postulated as affecting surgical outcome are shown in Table III.

TABLE II
HEARING RESULTS

Cases	Post-operative hearing level (average of 0.5–3 kHz) dB			Post-operative hearing gain (average of 0.5–4 kHz) dB				Mean pre-operative air conduction	Mean post-operative air conduction	*p* value
Successful cases	0–20	20–30	30–40	<10	10–20	20–30	>30	34.3 dB	23.3 dB	<0.05
	5	17	–	3	8	4	7			
Unsuccessful cases	0–20	20–30	30–40	<10	10–20	20–30	>30	33 dB	35 dB	
	–	2	3	5	–	–	–			
Total	5	19	3	8	8	4	7	34 dB	25.8 dB	

https://doi.org/10.1258/0022215011907893 Published online by Cambridge University Press

TABLE III
ANALYSIS OF PROGNOSTIC FACTORS: POST-OPERATIVE ANATOMICAL RESULTS

Factors	No. of ears	Successful cases (%)	*p* value
Age (years)			
8–10	15	13 (86.6)	
11–14	26	20 (76.9)	NS
Status of operated ear			
Dry	35	31 (88.5)	
Discharging	6	2 (33.3)	<.01
Perforation site			
Anterior	6	4 (66.6)	
Posterior	8	7 (87.5)	
Inferior	6	5 (83.3)	
Subtotal	21	17 (80.9)	NS
Perforation side			
Unilateral	28	25 (89.2)	
Bilateral	13	8 (61.5)	NS
Previous adenoidectomy			
Yes	26	23 (88.4)	
No	15	10 (66.6)	NS
Surgical technique			
Overlay	24	19 (79.1)	
Underlay	17	14 (82.3)	NS

NS: not significant.

Age. The patients were divided in two groups: 15 aged ⩽10 and 26 aged ⩾11 years (this cut-off point was used because the frequency of upper respiratory infections is higher in children aged less than 10 years). The success rate was 86.6 per cent (13/15 cases) in the former and 76.9 per cent (20/26 cases) in the latter, a difference that was not statistically significant.

Site and size of perforation. Five (12.1 per cent) of the perforations were anterior, eight (19.5 per cent) posterior, six (14.6 per cent) inferior, and 22 (53.6 per cent) subtotal or total. Although a higher rate of surgical failure was observed in the case of the anterior perforations, no statistical correlation was found.

Previous adenoidectomy. Twenty-six (63.4 per cent) of the patients had previously undergone adenoidectomy, but this did not influence the outcome of surgery: there were 23 surgically successful cases in the group who underwent adenoidectomy *vs* 10 in the 15 patients who did not undergo adenoidectomy.

Status of the operated ear. Six of the 41 patients (14.6 per cent) had a discharging ear. Surgery was successful in two (33.3 per cent) of these cases and in 31 (88.6 per cent) of the 35 patients with dry ears ($p<0.01$).

Status of the contralateral ear. Twenty-eight of the 41 patients had monolateral and 13 bilateral perforations. The surgical success rate was 89.2 per cent (25/28) in the former and 61.5 per cent (eight out of 13) in the latter group (p = n.s.).

Surgical technique. Twenty-four patients (58.5 per cent) were treated using the overlay and 17 (41.5 per cent) using the underlay technique. There was no significant difference in surgical outcome (79.1 per cent *vs* 82.3 per cent, respectively).

Discussion

The disparity of surgical outcome in paediatric myringoplasty is generally attributed to different selection criteria and definitions of success. A number of studies have included patients with a variety of middle-ear disease, such as cholesteatoma or ossicular erosion;[22–24] and although most authors judged the rate of success on the basis of anatomical results, Bluestone *et al.*[6] considered the post-operative recurrence of negative middle-ear pressure or serous effusion as a surgical failure. Lau and Tos[9] reported a 92 per cent graft-take rate in the paediatric age range, but this decreases to 64 per cent if the cases with persistent otitis media or atelectasic tympanic membrane are considered failures.

The overall success rate in our series was 80.5 per cent (33/41). Of those with intact ear drum, 27 out of 33 (82 per cent) had a perfect graft at follow-up. These results are in line with the data reported in the literature.[1,3,5–18]

Six of the 33 successful cases (approximately 18.2 per cent) experienced secondary complications such as blunting of the anterior angle, tympanic membrane retraction, and cholesteatoma of the external canal or tympanic membrane. These data are also in line with those reported in other studies.[18,25]

Five of our eight failures occurred within the first 15 months, in agreement with the data reported by Gibb and Chang[26] who found that re-perforation following tympanoplasty are an inappropriate surgical technique and post-operative infection, and that a perforation discovered years after a graft has completely healed may be attributed to a new event or a persistent underlying tubotympanic disease.

In terms of prognostic factors as other authors,[9,18,26–28] we observed a statistically significant association between the presence of a discharging ear and a poor anatomical outcome ($p<0.01$). In a series of 188 children, Denoyelle *et al.*[18] found that inflammatory changes within the middle-ear mucosa independently influenced the risk of an abnormal post-operative tympanic membrane,

https://doi.org/10.1258/0022215011907893 Published online by Cambridge University Press

and suggested that such cases should be treated using more resistant graft material such as autologous cartilage.

On the other hand, in a series of 51 paediatric myringoplasty cases Caylan *et al.*[5] found that the success rate in dry ears was lower than in discharging ears, and assumed that it may be due to a possible decrease in the vascularity of the middle-ear mucosa.

Patient age has generally been considered as influencing surgical outcome but the data reported in the literature are equivocal.[27,29] Vrabec *et al.*[30] found better success with advancing age, but other authors have reported no significant correlation between age and surgical outcome.[27,31] The former result may be due to the lower incidence of upper airway infections and better eustachian tube function in later age, and the relative immaturity of the immune system in younger children. We found no statistical difference in the success rate between our two age groups, a result that is in line with the findings of Caylan *et al.*[5] and Vartiainen *et al.*,[17] this may have been due to the fact that our patients were aged eight to 14 years and were thus probably unaffected by the inefficient tube function observed in children under the age of seven.[32]

The site of perforation did not statistically affect outcome in our series, as has been previously reported by others.[1,3,5,14,18] However, our finding of a higher rate of surgical failure in patients with anterior perforation supports the data reported by Halik *et al.*[29] and may have been due to the more limited vascularization of the anterior part of the eardrum.[33]

With regard to the role of adenoidectomy, the data in the literature are equivocal: Gianoli *et al.*[20] found significantly higher tympanoplasty success rates in patients treated with adenotonsillectomy or adenoidectomy, but a retrospective study by Vartiainen[17] on 60 paediatric patients treated with type I tympanoplasty showed that all of the failures occurred in patients who had previously undergone adenoidectomy or adenotonsillectomy. We did not find any statistically significant difference between our patients who had or had not undergone previous adenoidectomy, a result that is in line with those published by most authors.[3,6,7,30]

The success rate was 89.2 per cent in our cases with monolateral disease and 61.5 per cent in those with bilateral peforation, without any statistical correlation. The discrepancy between our results and those of Kessler *et al.*[14] and Denoyelle *et al.*[18] who found that a pathological contralateral ear independently influences the risk of an abnormal post-operative tympanic membrane, seems to be related to the fact that our cases did not show any inflammatory changes in the contralateral ear.

No significant difference was found when comparing the two surgical techniques of overlay and underlay: the success rate was 79.1 per cent in the former and 82.3 per cent in the latter. The two patients experiencing blunting of the anterior angle had undergone an overlay procedure, a finding that is in accordance with the results of Hicks *et al.*[34] and Puhakka *et al.*[35] who found that blunting of the anterior meatal angle was more frequent when the overlay technique is used.

With regard to the audiological results, the mean air conduction thresholds of the successful cases were significantly better post-operatively ($p<0.05$), as has been reported by other authors.[9,16,18,36] Unlike Yung,[37] who found poorer post-operative hearing results in patients with posterior perforations, we found no difference in hearing levels regardless of the site of the perforation.

Conclusions

This study shows that myringoplasty is a valid treatment modality for tympanic membrane perforation in the paediatric population. The status of the middle ear (i.e. the presence of a dry ear) significantly improves surgical outcome; and so preoperative inflammatory changes in the middle-ear mucosa should be carefully evaluated and its medical treatment considered. The evidence of a good audiological result in anatomically successful cases is associated with a highly probable return to normal function and lifestyle at any age.

References

1 Koch WM, Friedman E, McGill TJI, Healy GB. Tympanoplasty in chlidren. *Arch Otolaryngol Head Neck Surg* 1990;**116**:35–40
2 Juantegui M, Garin P, Gersdorff M. Myringoplasty: anatomical and functional results with a three years follow up. *Rev Laryngol* 1994;**115**:45–8
3 Podoshin L, Fradis M, Malatskey S, Ben-David J. Type I Tympanoplasty in children. *Am J Otol* 1996;**17**:293–6
4 Albu S, Babighian G, Trabalzini F. Prognostic factors in tympanoplasty. *Am J Otol* 1998;**19**:136–40
5 Caylan R, Titiz A, Falcioni M, De Donato G, Russo A, Taibah AA, *et al.* Myringoplasty in children: Factors influencing surgical outcome. *Otolaryngol Head Neck Surg* 1998;**118**:709–13
6 Bluestone CD, Cantekin EI, Douglas GS. Eustachian tube function related to the results of tympanoplasty in children. *Laryngoscope* 1979;**89**:450–8
7 Buchwach K, Birck H. Serous otitis media and type I tympanoplasties in children. *Ann Otol Rhinol Laryngol* 1980;(suppl **89**):324–5
8 Raine CH, Singh SD. Tympanoplasty in children: a review of 114 cases. *J Laryngol Otol* 1983;**97**:217–21
9 Lau T, Tos M. Tympanoplasty in children: an analysis of late results. *Am J Otol* 1986;**7**:55–9
10 Manning SC, Cantekin EI, Kenna MA, Bluestone CD. Prognostic value of Eustachian tube function in pediatric tympanoplasty. *Laryngoscope* 1987;**97**:1012–6
11 Ophir D, Porat M. Myringoplasty in the pediatric population. *Arch Otolaryngol Head Neck Surg* 1987;**113**:1288–90
12 Blanshard JD, Robson AK, Smith I, Maw AR. A long term view of myringoplasty in children. *J Laryngol Otol* 1990;**104**:758–62
13 Shih L, De Tar T, Crabtree JA. Myringoplasty in children. *Otolaryngol Head Neck Surg* 1991;**105**:74–7
14 Kessler A, Potsic WP, Marsh R. Type 1 tympanoplasty in children. *Arch Otolaryngol Head Neck Surg* 1994;**120**:487–90
15 McDonald III RR, Lusk RP, Muntz HR. Fasciaform myringoplasty in children. *Arch Otolaryngol Head Neck Surg* 1994;**120**:138–43
16 Black JH, Hickey SA, Wormald PJ. An analysis of the results of myringoplasty in children. *Int J Ped Otorhinol* 1995;**31**:95–100

https://doi.org/10.1258/0022215011907893 Published online by Cambridge University Press

17 Vartiainen E, Vartiainen J. Tympanoplasty in young patients: The role of adenoidectomy. *Otolaryngol Head Neck Surg* 1997;**117**:583–8
18 Denoyelle F, Roger G, Chauvin P, Garabedian E-N. Myringoplasty in children: predictive factors of outcome. *Laryngoscope* 1999;**109**:47–51
19 Potsic WP, Winawer NMR Mrash RR. Tympanoplasty for the anterior-superior perforation in children. *Am J Otol* 1996;**17**:115–8
20 Gianoli GJ, Worley NK, Guarisco JL. Pediatric tympanoplasty: the role of adenoidectomy. *Otolaryngol Head Neck Surg* 1995;**113**:380–6
21 Committee on Hearing and Equilibrium Guidelines for the Evaluation of Results of Treatment of Conductive Hearing Loss. *Otolaryngol Head Neck Surg* 1995;**113**:186–8
22 Berger G, Shapira A, Marshak G. Myringoplasty in children. *J Otolaryngol Otol* 1974;**88**:1223–36
23 Adkins WY, White B. Type I tympanoplasty: influencing factors. *Laryngoscope* 1976;**86**:67–9
24 Sade J, Berco E, Brown M, Weinberg J Avraham S. Myringoplasty: short and long term results in a training program. *J Laryngol Otol* 1981;**95**:663–5
25 Gersdorff M, Garin P, Decat M, Juantegui M. Myringoplasty: long term results in adults and children. *Am J Otol* 1995;**16**:532–5
26 Gibb AG, Chang SK. Myringoplasty (A a review of 365 operations). *J Laryngol Otol* 1982;**96**:915–30
27 Booth JB. Myringoplasty, the lessons of failure. *J Laryngol Otol* 1974;**88**:1223–36
28 Tos M. Late results in tympanoplasty. *Arch Otolaryngol* 1974;**100**:302–5
29 Halik JJ, Smyth GDL. Long-term results of tympanic membrane repair. *Otolaryngol Head Neck Surg* 1988;**98**:162–9
30 Vrabec JT, Deskin RW, Grady JJ. Meta-analysis of pediatric tympanoplasty. *Arch Otolaryngol Head Neck Surg* 1999;**125**:530–4
31 Lee K, Schuknecht HF. Results of tympanoplasty and mastoidectomy at the Massachussetts Eye and Ear Infirmary. *Laryngoscope* 1971;**81**:529–43
32 Strong MS. The eustachian tube: basic considerations. *Otolaryngol Clin North Am* 1972;**5**:19–27
33 Applebaum EL, Deutsch EC. An endoscopic method of tympanic membrane flourescein angiography. *Ann Otol Rhinol Laryngol* 1986;**95**:439–43
34 Hicks GW, Wright JW. A review of 925 cases of tympanoplasty using formaldehyde-formed fascia grafts. *Laryngoscope* 1988;**98**:150–3
35 Puhakka H, Virolainen E, Rahko T. Long-term results of myringoplasty with temporalis fascia. *J Laryngol Otol* 1979;**93**:1081–6
36 Wehrs RE. Hearing results in tympanoplasty. *Laryngoscope* 1985;**95**:1301–6
37 Yung MW. Myringoplasty: hearing gain in relation to perforation site. *J Laryngol Otol* 1983;**97**:11–7

Address for correspondence:
Lorenzo Pignataro, M.D.,
Dipartimento di Scienze Otorinolaringologiche,
Ospedale Maggiore, I.R.C.C.S.,
Via F. Sforza 35,
20122 Milano, Italy.

Fax: +39 02 55180809

Dr L Pignataro takes responsibility for the integrity of the content of the paper.
Competing interests: None declared