Pediatric myringoplasty – Retrospective analysis over a 5-year period

Original Article

Authors

João Seixas
Centro Hospitalar Universitário de Lisboa Central, Portugal

Pedro Vaz Pinto
Centro Hospitalar Universitário de Lisboa Central, Portugal

Inês Palma Delgado
Centro Hospitalar Universitário de Lisboa Central, Portugal

Patrícia Melo
Centro Hospitalar Universitário de Lisboa Central, Portugal

Herédio Sousa
Centro Hospitalar Universitário de Lisboa Central, Portugal

Correspondência:
João Seixas
joaorseixas@gmail.com

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Abstract

Objectives: Myringoplasties are frequently performed in pediatric patients, but there is still controversy regarding the best surgical technique and factors influencing its success. The aim of this study is to characterize a population of pediatric patients undergoing myringoplasty and evaluate the following outcomes: perforation closure, audiometric results and factors affecting surgical success.
Study Design: Descriptive retrospective study
Material and Methods: We evaluated 56 patients (57 ears) with a mean age of 10.4±3.2 years (6-17 years) over a 5-year period (2016-2020)
Results: Most perforations occurred after grommet insertion. Retroauricular approach and underlay temporal fascia graft placement technique was used in most cases, with a success rate of 74% after a mean follow-up of 30 months. Pure tone average improved after the procedure. Craniofacial malformations were associated with incomplete air-bone gap closure.
Conclusions: Pediatric myringoplasty has a high success rate.

Keywords: myringoplasty; tympanoplasty; pediatrics; prognostic factors

Introduction

Although myringoplasty is frequently performed in the pediatric population, the ideal time for this procedure and factors affecting its favorable outcome remain controversial.

Dysfunction of the Eustachian tube has been associated with a lower myringoplasty success rate in children compared to adults (83% vs. 89% at 12 months).[1] Therefore, it remains uncertain whether this surgical procedure should be delayed until the Eustachian tube reaches maturity, which occurs between 7 to 10 years of age.[1,2] Conversely, the precocious correction of a perforated tympanic membrane will prevent recurrent infections resulting from contact with water and contribute to a better quality of life and hearing ability, with a consequent impact on language acquisition after successful myringoplasty.[3]

The effect of other factors related to the condition of the operated ear, such as the size and characteristics of the perforation, presence of myringosclerosis, and existence of middle ear inflammation, on the surgical outcome also remains controversial.[1,7–14]

From the viewpoint of the surgical technique, the level of expertise of the surgeon is a determinant factor regarding the surgical approach and type of graft to be used. The success rate of the application of fascia temporalis and cartilage grafts is high.[1,4,5]

This study aimed to evaluate the effect of these prognostic factors on the surgical success of myringoplasty and the functional results obtained.

Materials and Methods

This retrospective study included 56 patients (57 ears) who had undergone myringoplasty and was performed over a period of 5 years (January 2016 to December 2020) at a tertiary hospital, with the surgeries being performed by various surgeons.

Myringoplasty was defined as a surgery performed for the correction of a perforated tympanic membrane, with or without elevation of the tympanomeatal flap and without associated ossiculoplasty—corresponding to type I tympanoplasty in the Portmann classification.[6]

Patients older than 18 years were excluded, as well as those who had undergone mastoidectomy or ossiculoplasty within the same surgical period, congenital cholesteatoma exeresis, repeated tympanoplasty, placement of subannular tubes or transtympanic ventilation tubes (TTVT), and revision surgeries. Patients with a follow-up time shorter than three months were also excluded.

The demographic characteristics, medical/surgical history, presumed etiology of the perforation and its anatomical characteristics, surgical technique used, and the clinical and audiometric results were evaluated.

The audiometric results were estimated via pure-tone audiometry evaluation of the mean bone-conduction (BC) and air-conduction (AC) hearing thresholds (HTs), which were obtained from the mean values recorded at frequencies of 0.5, 1, 2, and 4 kHz. The audiometric Rinne test result was calculated based on the difference between the mean AC-HT and mean BC-HT.

Surgical success, which was used as the primary endpoint of the study, was defined as the presence of an intact tympanic membrane post-surgery and an audiometric Rinne test result below 10 dB. Moreover, the rates of tympanic membrane integrity were calculated at 12 and 24 months using survival analysis.

As secondary endpoints, the correlations between the surgical outcome and various prognostic factors were examined—age (below or above 10 years), probable cause of the perforation, presence of craniofacial malformation, existence of rhinitis, previous placement of a TTVT, status of the contralateral ear at the time of surgery, size of the perforation, anteroinferior quadrant involvement, marginal perforation, presence of myringosclerosis, middle ear mucosal inflammation at the time of surgery, level of expertise of the surgeon, surgical approach, calibration of the external auditory canal, type of graft used, and season of the year at the time of surgery.

Descriptive statistics were presented as frequencies (n) and percentages (%) for categorical variables and means and standard deviations for continuous variables. The χ^2 test of independence, Wilcoxon test, and Student's t-test were used to assess the relationship between the prognostic factors and surgical outcome, according to the variables to be examined. Significance was set at $P < 0.05$. Statistical analyses were performed using the JASP 0.16 software for MacOs X.

Results

In this study, out of an initial total of 126 ears, 69 ears were excluded. Among the 57 ears that were analyzed, one case of bilaterality was detected. Most of the patients were men (56%). The mean age at the time of surgery was 10.4 ± 3.2 years (range, 6–17 years), with 37% of the participants being younger than 9 years, 40% being aged 9–12 years, and 23% being older than 12 years. The clinical characteristics of the study population are listed in Table 1.

Regarding the presence of comorbidities, 32% patients had a history of rhinitis, and 9% presented with craniofacial malformations, including cleft palate (n = 1), Down syndrome (n = 1), craniosynostosis (n = 1), KBG syndrome (n = 1), and Barakat syndrome (n = 1). Before undergoing myringoplasty, 52% patients had undergone placement of a TTVT. It was possible to identify the probable etiology of the perforation in 50 patients. In most cases, the perforation was detected after the placement of a TTVT (Shepard tubes in 92% of post-tube perforations), whereas in 40% of cases, it was observed after recurring otitis or acute suppurative otitis media. In one case, the perforation was the result of trauma. The contralateral ear did not exhibit any alterations in 54% cases, whereas the remaining patients had chronic otitis media with perforation (21%), otitis media with effusion (4%), and pars tensa retraction (4%). Finally, 17% patients had a history of tympanoplasty in the contralateral ear.

Table 1
Clinical characteristics of the study population (n = 57 ears)

	N	%
Sex		
Male	32	56%
Female	25	44%
Laterality		
Right	32	56%
Left	25	44%
Presence of rhinitis	18	32%
Presence of craniofacial malformation	5	9%
Previous TTVT placement		
Shepard	28	49%
Goode	2	3%
Probable cause of the perforation		
TVTT placement	25	46%
Otitis media	23	40%
Trauma	1	2%
State of the contralateral ear		
Normal	31	54%
Tympanic perforation	12	21%
Post-tympanoplasty status	10	17%
Pars tensa retraction	2	4%
Otitis media with effusion	2	4%

Regarding the characteristics of the perforations, most patients exhibited a central location (91%), which involved only one quadrant of the pars tensa (60%), with the anteroinferior quadrant being affected most often (73%). Moreover, 16% of the perforations were subtotal and involved the tympanic annulus in 7% cases. Approximately one-third of the cases had myringosclerosis foci (32%).

The retroauricular approach was used in 98% of the cases, with the transcanal approach being used in only one patient. A fascia temporalis graft was used in most of the ears (93%), with a cartilage graft or mixed graft (fascia and cartilage) being employed in 2% and 5% of cases, respectively. The underlay technique (96%) was preferred over the onlay technique (4%). Umbo sectioning was performed in 7% of cases, and external auditory canal calibration was conducted in 11% of cases. At the time of surgery, 89% of the ears had no signs of inflammation. Surgical complications were recorded in only one case in the form of late development of ipsilateral facial paresis of grade II in the House–Brackmann classification (2nd postoperative day), with full recovery.

The surgical success rate at three months after surgery was 89% (51/57). The ears were followed up for a mean period of 30 ± 21 months (range, 3–69 months), with recurrence of perforation being observed in 16% (n = 9) of patients within a mean period of 14.6 ± 11.9 months (range, 4–45 months), representing an overall clinical failure rate of 26% (n = 15) regarding the maintenance of tympanic membrane integrity.

Survival analysis revealed success rates of 77% ± 6% and 71% ± 9% at 12 and 24 months, respectively (Figure 1).

Figure 2 illustrates the relationship between age and surgical success of myringoplasty. Among the patients with residual or recurrent perforation (n = 15), three underwent new myringoplasty with surgical success, whereas one patient exhibited spontaneous closure of the perforation. At the last observation, otoscopy revealed pathological alterations in 25% of the operated ears, including structural alteration of the tympanic membrane (7%), otitis media with effusion (3%), and residual perforation (15%). Audiometrically, the closure of the perforation afforded a significant improvement in the hearing ability. The AC tonal threshold improved from 24.5 to 20.7 dB (P = 0.037), and the Rinne test result decreased from 21.2 to 13.4 dB (P = 0.002), with a Rinne result <10 dB in 51% of the ears (Table 2).

The analysis of the prognostic factors that may have contributed to the recurrence of the perforation in the follow-up period of the study revealed that none of the factors were statistically significant (P < 0.05) (Table 3).

Regarding the functional results, the presence of a craniofacial malformation was the only factor that significantly decreased the probability of gap closure of the audiometric Rinne test (P = 0.034).

Figure 1
Kaplan–Meier survival analysis of the recurrence of perforation over time (n = 57)

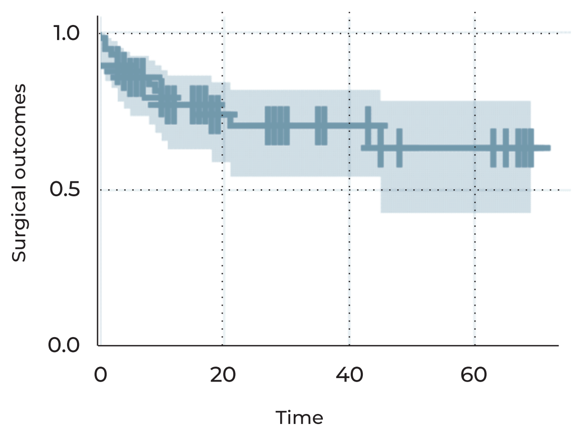
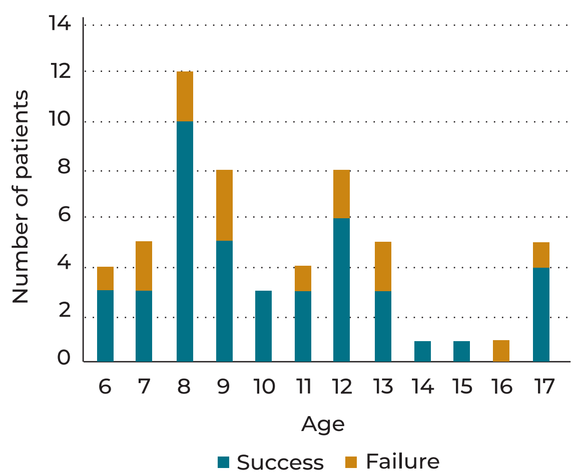


Figure 2
Relationship between age and surgical success of myringoplasty (n = 57)



Discussion

Surgical success regarding the closure of perforations was used as the primary endpoint of this study, which had a mean total follow-up period of 30 months. At three months, the surgical success rate was estimated to be 89%, whereas in the whole follow-up period, the tympanic membrane was kept intact in 74% of ears. Survival analysis revealed success rates of 77% and 71% at 12 and 24 months, respectively. These results agree with those in the international literature, which reports success rates of 76–90%, as evaluated at varying postoperative time points between 1

Table 2
Audiometric results

Preoperative		Postoperative		Variation		p value
Mean BC-HT	3,6 ±9,1 dB	Mean BC-HT	5,3 ±9,6 dB	Mean BC-HT	+ 1,3	p=0,014*
Mean AC-HT	24,9 ±12,9 dB	Mean AC-HT	20,7 ±16,6 dB	Mean AC-HT	- 4,2	p=0,006*
Audiometric Rinne test	21,2 ±7,2 dB	Audiometric Rinne test	15,4 ±12,1 dB	Rinne	- 5,8	p=0,002*

Table 3
Relationship of the patient characteristics, preoperative perforation, and surgical technique characteristics with recurrence of the perforation (n = 57)

Prognostic factor	Without recurrence	With recurrence	P-value
Age			0,825
<10 years	21	7	
>10 years	21	8	
Craniofacial malformation			0,467
No	39	13	
Yes	3	2	
Rhinitis			0,143
No	31	8	
Yes	11	7	
Probable cause of the perforation			0,344
TTVT placement	16	7	
Otitis media	18	8	
Trauma	1	0	
Previous TTVT			0,410
No	22	6	
Yes	20	9	
Status of the contralateral ear			0,463
Normal	25	6	
Postoperative tympanoplasty	7	3	
Perforation	7	5	
Retraction	1	1	
Otitis media with effusion	2	0	
Season of the year (surgery)			0,379
Spring	9	4	
Summer	6	2	
Autumn	15	2	
Winter	14	7	
Subtotal perforation			0,602
No	36	12	
Yes	6	3	

Prognostic factor	Without recurrence	With recurrence	P-value
Involvement of the anteroinferior quadrant			0,512
No	12	3	
Yes	30	12	
Marginal perforation			0,951
No	39	14	
Yes	3	1	
Presence of myringosclerosis			0,865
No	29	10	
Yes	13	5	
Middle ear inflammation			0,570
No	37	14	
Yes	5	1	
Surgeon expertise			0,832
Interno	27	10	
Especialista	15	5	
Type of graft			0,464
Fascia temporalis	38	15	
Cartilage	1	0	
Mixed (cartilage and perichondrium)	3	0	
Surgical technique			0,439
Underlay	41	14	
Onlay	1	1	
Umbo sectioning			0,876
No	36	14	
Yes	6	1	
Auditory canal calibration			0,680
No	38	13	
Yes	4	2	

and 12 months after surgery. [1,7–14] According to Sanchez Barrueco , the risk of recurrence after 6 months is lower than 2%. [9] Conversely, the results of our study, which had a particularly long follow-up period, are in agreement with those described by other authors, who demonstrated a risk of perforation later at a mean period of 14.3 months. [5] Among the patients evaluated in this study, the surgical technique used most commonly was the retroauricular approach with a fascia temporalis underlay graft. Although more laborious than other techniques, this approach allows optimal exposure, especially of the anteroinferior quadrant, which was involved in 73% of the cases in our cohort. According to the literature, the success rate of fascia temporalis graft is similar to that of mixed grafts composed of cartilage and perichondrium, although they are often selected for different indications.[1]

Patient age is one of the most frequently discussed prognostic factors in terms of perforation recurrence, mainly because of the theoretical effect of the function of the Eustachian tube on the surgical outcomes. However, in practical terms, it is difficult to quantify this effect. Yegin et al. did not find a relationship between the dimensions of the Eustachian tube and tympanoplasty success.[15] Similarly, Ribeiro et al. did not identify a significant relationship between tympanometry results and surgical success.[16]

In our experience in clinical practice, age alone is not a determining factor for the success of myringoplasty, and other factors, such as the stability of the nasosinusal pathology and status of the contralateral ear, are considered to be more important. Although Rozendom et al. concluded that patients younger than 9 years have worse clinical outcomes,[17] most of the existing evidence suggests that age does not have an independent effect, which is in accordance with the results of this study.

The location and size of the perforation are among the other prognostic factors of surgical success that have been discussed at length in the literature. According to most of the studies, the size of the perforation seems to be more important than its location.[1,10,11,19] However, in our cohort, it was not possible to establish a statistically significant relationship between surgical success and the presence of a large perforation (subtotal), its location, or tympanic annullus involvement.

There are contradictory findings in the literature regarding the effect of myringosclerosis[17,20] and previous placement of a TTVT[9,10] on the surgical outcome. In this study, no significant relationship with the surgical success rate was observed. Conversely, the presence of middle ear mucosal inflammation at the time of surgery did not have an impact on the results of this study, which is in agreement with other studies.[1]

Simon et al. studied the effect of allergic rhinitis on the success of myringoplasty but did not find an association,[5] similar to the findings reported here.

According to previous studies, the effect of craniofacial malformations on myringoplasty success is not significant.[5,9] Nevertheless, in this study, the presence of these malformations affected the audiometric results significantly and negatively. Notably, two out of the five patients with craniofacial malformations (one patient with Down syndrome and another with cleft palate) developed otitis media with effusion after the closure of the tympanic perforation. Owing to the risk of this complication, several authors have advocated for the placement of a TTVT at the time of closure of the perforation in patients with craniofacial malformations,[4,21] which is not part of the clinical practice at our center.

Regarding the audiometric results, the mean hearing threshold and the audiometric Rinne test result improved significantly. However, although the ossicular chain seemed to be intact in patients undergoing myringoplasty, an audiometric Rinne below 10 dB was obtained in only 51% of cases. In this study, the presence of cranial malformations alone negatively affected the closure of the audiometric Rinne. It is extremely difficult to compare audiometric results between different studies because of the heterogeneity of the evaluation criteria used and their mode of presentation. The meta-analysis by Tan et al.[1] is considered a reference, in which 42% of the patients under evaluation achieved closure of the audiometric Rinne, compared to 51% patients in our sample. In fact, it is difficult to predict these results, probably because of the formation of scar tissue or the thickening of the tympanic membrane. This issue, which is widely known among otologists, should be discussed with the patients' families.

This study has several limitations, including its retrospective design and the inherent difficulty in obtaining systematized and complete clinical data for all patients. Therefore, it was not possible to include the history of the previous adenoidectomy, which would have been interesting for the analysis of the results because this factor has been described as being associated with a better clinical prognosis.[10,16] The fact that the surgeries were not all performed by the same surgeon introduces variability regarding the technique used and the outcomes, which was another important limitation. In turn, the characterization of the size and location of the perforation was conducted subjectively by the surgeon during the operation without referring to any quantitative measures, which hampered the objective comparison of the patients in the cohort. Moreover, the description of eventual surgical or postoperative complications in the medical records of all patients was insufficient, which precluded the descriptive analysis of these variables. Finally, there may have been a selection bias because patients being followed up at a tertiary pediatric hospital have a high prevalence of other otorhinolaryngological risk factors, such as craniofacial malformations and severe nasosinusal pathology.

The key strengths of this study include the long postoperative follow-up of the patients (30 ± 21 months) and the inclusion of a significant number of children younger than 9 years (37%), which allowed the representative evaluation of this particular age group.

Conclusion

Myringoplasties, which are mainly performed by a retroauricular approach with the placement of a fascia temporalis underlay graft, yielded a long-term success rate of 74% in this study after a mean follow-up period of 30 months. This surgical technique afforded a significant functional gain based on the decrease in the mean hearing threshold and audiometric Rinne results. The presence of cranioencephalic malformations alone negatively affected the closure of the audiometric Rinne. No statistically significant association was detected between the remaining variables and the closure of the perforation or postoperative audiometric results.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

Data Confidentiality

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

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Availability of scientific data

There are no datasets available, publicly related to this work.

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