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The effect of age on pediatric tympanoplasty outcomes: A comparison of preschool and older children

Melanie Duval *, J. Fredrik Grimmer, Jeremy Meier, Harlan R. Muntz, Albert H. Park

Division of Otolaryngology, University of Utah, 50 N Medical Drive, SOM 3C120, Salt Lake City, UT 84132, USA

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ABSTRACT

Objectives: Determine whether the outcome of tympanoplasty in preschool children is different from that of older children.
Study design: Retrospective case series.
Methods: Retrospective review of children having undergone a primary tympanoplasty by 4 surgeons for a tympanic membrane perforation between 2002 and 2013.
Results: Data from 50 children age 2–4, 130 children age 5–7 and 105 children age 8–13 years old were reviewed. Median follow-up was 7.5 months. On crude analysis, the incidence of anatomical success was not significantly different between the different age groups ($p = 0.38$), the success rate was respectively 69.4%, 68.5% and 79.1% with an overall rate of 72.5%. 5.9% of all children required later insertion of tympanostomy tubes, 10.2% in preschool children. The post-operative audiology results were similar for all groups with a mean improvement of 9 dB in the air-bone gap. When limiting the analysis to the 155 children having at least 6 months of follow-up, the rate of success was respectively 50.0%, 60.8% and 74.0% ($p = 0.10$). After multivariate analysis controlling for the effect of surgeon, approach and etiology, the odds ratio of perforation was respectively 5.48, 2.27 and 1.00 for the different age groups.
Conclusion: Children younger than 4 years of age have the worst outcome after tympanoplasty. It remains uncertain whether the benefits of hearing improvement and quality of life may outweigh that of a high rate of a residual, usually smaller, perforation. Prospective studies are needed to confirm these results and delineate the patient characteristics and technique most likely to lead to successful results.

1. Introduction

Tympanoplasty is a commonly performed procedure in children. There have been multiple studies evaluating the effect of age on success rate. However, controversy remains regarding the ideal age at which pediatric tympanoplasty should be performed. Despite the lack of definite evidence of an association between age and tympanoplasty success rate, many authors [1–3] have recommended delaying tympanoplasty until the child is older than 6 to 8 years old to allow time for Eustachian tube maturation and increase the odds of favorable outcome. In a survey by Lancaster et al. 70% of otolaryngologists reported a set age below which they would not perform a tympanoplasty, the most common age reported being 10 years old [4]. However, others have suggested adverse sequelae from persistent tympanic membrane perforations based on quality of life measures [5] and Friedman et al. [6] and Knapik et al. [7] have demonstrated excellent tympanic membrane closure rate in selected children under 7 years of age.

While multiple studies have evaluated the impact of age on success rate of tympanoplasty, studies have generally limited their analysis to children above 6 to 8 years old [8–10] or grouped a small number of preschool with older children [11–13]. Thus far, no study has specifically evaluated the success rate of tympanoplasty in preschool children. Anatomical success rate of tympanoplasty in studies having specifically evaluated children under 8 years old is presented in Table 1.

At our institution, child's age is not used to determine the timing of a tympanic membrane perforation repair. Rather, surgery will be offered after a period of observation of 6 months if the child exhibits evidence of good Eustachian tube function in the opposite ear or of the perforation is dry for at least 6 months in cases of bilateral perforations; if the perforation is large, causes significant hearing loss; or it is deemed to be high-risk for cholesteatoma formation due to a marginal location or epithelium ingrowth. The

* Corresponding author at: McGill University Department of Otolaryngology Head & Neck Surgery 2300 Tupper St, Room A-334 Montreal, QC, Canada H3H 1P3. Tel.: +1 438 825 6024.
E-mail address: melanie.duval@muhc.mcgill.ca (M. Duval).

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Table 1
Reported anatomical success rate of tympanoplasty in children below 8 years old.

Author (year)	*N*	Age (years)	Anatomical success rate (%)	Follow-up	Surgical technique
Berger (1983) [14]	26	4–8	96	>1 month	Temporalis fascia, perichondrium
Black (1995) [15]	14	2–7	56	>6 mos	Temporalis fascia
Buchwach (1980) [16]	25	3–8	64	>12 mos	Temporalis fascia
Chandrasekhar (1995) [17]	69	<7	94	>6 mos	Unknown
Charlett (2009) [18]	21	4–8	57	>2 months	Temporalis fascia, fat, perichondrium
Collins (2003) [19]	6	<6	83	>1 month	Temporalis fascia, cartilage
Denoyelle (1999) [20]	76	4–8	83	>12 mos	Temporalis fascia
Friedberg (1980) [21]	4	3–7	100	>2 months	Temporalis fascia
Friedman (2013) [6]	43	4–7	93	>1 month	Cartilage
Kessler (1994) [22]	37	2–6	81	>6 mos	Temporalis fascia
Knapik (2011) [7]	20	<6	100	>6 mos	Temporalis fascia, perichondrium
Koch (1989) [1]	10	2–7	30	>6 months	Unknown
Lau and Tos (1986) [23]	26	2–7	92	>3 months	Unknown
Te (1998) [24]	11	<8	91	>6 mos	Temporalis fascia
Umapathy (2003) [25]	23	4–8	87	>12 mos	Temporalis fascia
Cumulative data	411		84		

main arguments for early repair of tympanic membrane perforation in children include improved hearing for optimization of speech and language development, prevention of chronic ear disease and allowing children to enjoy water activities.

2. Objective

The objective of this study was to evaluate the success rate of primary tympanoplasty performed in pre-school children as compared to that of older children. The primary outcome measure evaluated was the status of the tympanic membrane at the end of the period of follow-up. Secondary outcome measures evaluated were need for tympanostomy tubes, cholesteatoma formation and improvement in hearing thresholds.

3. Methods

A retrospective review of children 13 years old or younger having undergone a primary tympanoplasty between 2002 and 2013 at a tertiary care pediatric hospital by four pediatric otolaryngologists was performed. Approval from the University of Utah and Primary Children's Hospital ethics review board was obtained. Four surgeons performed all tympanoplasties included in this study and all worked regularly with residents. Surgical technique, approach and graft material varied between the surgeons. Exclusion criteria included revision tympanoplasty, cholesteatoma, concomitant or previous ipsilateral mastoidectomy, concomitant ossiculoplasty, concomitant tympanostomy tube insertion and tympanic membrane retraction pocket without a perforation. Data collected included age at time of surgery, gender, etiology of perforation, status of the contralateral ear, prior adenoidectomy, characteristics of the perforation, type of graft used, surgical technique, complications and duration of follow-up. Hearing results were evaluated by reviewing pre- and post-operative speech reception thresholds (SRT) and pure-tone average air-bone gap (ABG). Air-bone gap was calculated according to the American Academy of Otolaryngology—Head and Neck Surgery guidelines published in 1995 [26]. Post-operative audiogram was usually performed at 6 to 12 weeks post-operatively.

Patients were separated into 3 age categories: 2–4 years old, 5–7 years old and 8–13 years old. These age groups were designed to compare the outcome in pre-school children to those older than 8 years of age.

3.1. Outcome

A satisfactory outcome was defined as an intact tympanic membrane at the end of the follow-up period. Status of the tympanic membrane was determined by the operating surgeon at follow-up visits using otoscopy and/or micro-otoscopy. A persistent perforation was defined as a perforation noted within 6 months post-operatively and a recurrent perforation was defined as any perforation noted more than 6 months post-operatively. Secondary outcomes evaluated included post-operative tympanic membrane or middle ear cholesteatoma, need for tympanostomy tube and audiologic responses (ABG and SRT).

3.2. Analysis

Data analysis was performed using Stata version 12. Chi-square test was used to analyze categorical data and *t*-test was used to analyze continuous data. A *p*-value less than 0.05 was considered significant on crude analysis for possible inclusion of the variable into the multivariate analysis. A paired *t*-test was used to evaluate the difference between pre-operative and post-operative hearing results. An analysis of variance (ANOVA) was used to determine whether hearing results were statistically different between the three different age groups. A logistic regression was performed to evaluate the association between age group and post-tympanoplasty perforation as well as determine which factors were associated with anatomical success. A subgroup logistic regression analysis was also performed including only children with 6 months or more of follow-up.

4. Results

A total of 284 tympanoplasties in 259 children were performed between 2002 and 2013 by four pediatric otolaryngologists. The median follow-up duration was 7.5 months (range 1 to 106 months). One hundred fifty-five children had 6 or more months of follow-up.

Distribution of patient's and surgical characteristics is presented in Table 2. The overall incidence of intact tympanic membrane for the whole duration of follow-up was 72.5% overall and 63.2% in patients with at least 6 months of follow-up. The incidence of an intact tympanic membrane by age group was 69.4% in children age 2–4, 68.5% in children age 5–7 and 79.1% in children age 8–13. There was no statistically significant evidence of a linear association between rate of perforation post-tympanoplasty and age (OR = 0.91, 95% CI 0.82–1.01). Mean prevalence of intact tympanic membrane at the end of the follow-up period by age is presented in Fig. 1. On crude analysis, factors that were most strongly associated with increased odds of post-tympanoplasty perforation were use of acellular dermis ($p = 0.004$), transcanal approach ($p < 0.001$) and surgeon ($p = 0.004$). There was no association between post-tympanoplasty perforation and season