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Role of tympanometric volume in paediatric tympanoplasty

Gautam Bir Singh *, Rubeena Arora, Sunil Garg [1], Shruti Ranjan, Sunil Kumar

Department of Otorhinolaryngology—Head & Neck Surgery, Lady Hardinge Medical College & Associated Hospitals, Shaheed Bhagat Singh Marg, New Delhi 110001, India

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ABSTRACT

Objective: To determine the prognostic significance of "Tympaometric Volume" for paediatric tympanoplasty type I in a select age-group of 5–8 years.
Methods: A prospective study was conducted in 30 children with chronic suppurative otitis media-inactive mucosal disease of either sex. Pre-operative tympanometric volume was recorded in all the cases and statistically analysed with the graft uptake results post-operatively. All the patients underwent tympanoplasty type I by underlay technique using temporalis fascia graft. An intact graft at the end of 6 months, and a postoperative hearing improvement of 10 dB or greater in two consecutive frequencies, was regarded as surgical and audiological success, respectively. The statistical analysis was done using Mantel Haenszel χ^2 i.e. Chi square test, and Fisher exact p value test for confirmation.
Results: We recorded an impressive surgical success rate of 87% and an audiological improvement of 70% in this study. On the basis of mean tympanometric volume of 1.6 cm^3 the patients were divided into two groups: in Group A (tympanometric volume $< 1.6\ cm^3$), and group B (tympanometric volume $> 1.6\ cm^3$). A graft uptake of 95% and 77% was recorded in Group A & B, respectively. However, the statistical evaluation of the data revealed no significant effect of this factor.
Conclusions: In this study no correlation between the tympanometric volume and the surgical success of paediatric tympanoplasty in select age group of 5–8 years was observed.

1. Introduction

The medical literature quotes a success rate of 35–92% in various studies in varying paediatric age groups [1]. However in spite of such an impressive success rate comparable to the success rate of adult tympanoplasty, a strong bias exists against paediatric tympanoplasty. Most otologists believe that there is an anatomical immaturity of the Eustachian tube in children, leading to its physiological unpredictability, and thus tympanoplasty is not as successful in children as in adults. They further reason that perforation serves as a pressure-equalizing vent in place of the Eustachian tube [2–4]. Moreover, many otologists find the surgery technically difficult in children due to a narrow ear canal [5].

Numerous factors have been cited in the medical literature which might influence the outcome of Paediatric tympanoplasty. Age, Eustachian tube function, site and size of perforation, adenoids and surgical technique all find mention in medical literature. There has been extensive research on these factors with arguments for and against each factor. However, the evidence of research over a period of time has somewhat tilted in favour of paediatric tympanoplasty and review of medical literature now cites some compelling reasons for early management of tympanic membrane perforations in view of the following facts [1,6,7]: Hearing loss leads to adverse and poor peer acceptance which undermines academic achievement. Repeated bouts of infection through a perforated tympanic membrane may lead to ossicular necrosis and cholesteatoma formation. Moreover, as cochlear reserves are excellent in children, they make ideal candidates for tympanoplasty. It is also important to note that the role of Eustachian tube in middle ear physiology is now disputed, with middle ear physiology now being better explained by the recent 'Gas Diffusion Theory' of Sade [8]. Moreover, there is increasing evidence to suggest that Chronic Suppurative Otitis Media [CSOM] cases with central perforations in pars tensa are also likely to have intratemporal and intracranial complications [9]. Hence, it would be judicious to close all perforations at an early paediatric age.

Review of literature suggests that mastoid pneumatisation is yet another factor which might influence the outcome of tympanoplasty. Its role in adult tympanoplasty is controversial [10]. Tympanometry is an established method of measuring the

* Corresponding author at: House No: 1433/Sector, 15 Faridabad 121007 [NCR], Haryana, India. Tel.: +91 0129 4012368/+91 9818836242/+91 0129 4007550.
E-mail address: gbsnit@yahoo.co.in (G.B. Singh).
[1] Current address: Department of Otorhinolaryngology – Head & Neck Surgery, Baba Ambedkar Medical College, Rohini, New Delhi, India.

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volume contained within a closed air space [11–14]. The tympanogram read out in an ear with tympanic membrane perforation is an estimate of the combined volume within the ear canal, middle ear and mastoid [11–14]. Tympanometry is an audiological tool used to obtain objective measures of tympanic membrane compliance and volume of external auditory canal/middle ear system. It is a clinically practical method of measuring the physical volume, in millilitres, of the closed air space medial to the sealed probe tip. Interestingly, the said variable has not been duly analysed for paediatric tympanoplasty. There is a marked paucity of literature on this subject. In a massive internet search using PubMed/Medline services the authors could find only one study where tympanometric volume has been studied as a predictor of success of tympanoplasty in children [11]. With this background we present our modest experience on the effect of tympanometric volume on paediatric tympanoplasty in a prospective study design. The central aim of this study was to determine the role of tympanometric volume as a predictor of success of tympanoplasty type I in the select age group of 5–8 years. To our knowledge this is the first prospective study on the cited subject.

2. Materials & methods

A prospective study was conducted at the department of ENT, Lady Hardinge Medical College and Associated Hospitals, New Delhi in the year 2011–2013. The study was approved by the "Medical Division" of the "University Board of Studies", University of Delhi, New Delhi.

The cohort study sample comprised of 30 paediatric patients of either sex suffering from chronic suppurative otitis media-mucosal disease in the age group of 5–8 years. This was a consecutive sample.

The following inclusion criteria were adopted in this study:

(1) An informed consent was mandatory.
(2) Patients having Chronic Suppurative Otitis Media—Mucosal disease [CSOM], both unilateral and bilateral, were included.
(3) Patients having a perforation in pars tensa for a minimum period six months
(4) A dry ear for a period of 4 weeks.

In addition, the study also excluded the following:

(1) Patients with Cholesteatoma in the ear.
(2) Patients with granulation tissue in the ear.
(3) Patients with previously operated ear.
(4) Patients with only one hearing ear.
(5) Patients with hearing loss out of proportion to the size of perforation.
(6) Patients with any congenital anomalies like cleft lip, cleft palate and syndromal diagnosis.

All patients were clinically evaluated and a detailed ear examination was done in all the cases. The paediatric patients underwent routine investigations for general anaesthesia and a pre anaesthetic clearance was mandatory for them prior to surgery. All the patients underwent a PTA [pure tone audiogram] prior to surgery. The hearing was measured at frequencies: 250, 500, 1000, 2000, 3000, 4000 & 8000 Hz. For the purpose of this study the hearing was analysed at frequencies of 500, 1000, 2000 and 3000 Hz, since normal human speech comprises mainly of sounds of these frequencies.

Children also underwent tympanometry for measuring tympanometric volume. The probe for tympanometry consists of a loudspeaker which constantly emits a low-frequency tone (226 Hz); a microphone measuring the sound pressure level in the ear canal; and a manometer, which is equivalent to pneumatic otoscopy.

The probe of tympanometry was used to calculate tympanometric volume by varying pressure from −300 daPa to +300 daPa air pressure and was expressed in cubic centimetres (cm^3; 1 cm^3 equivalent to 1 ml). A type B tympanogram with a large tympanometric volume is seen in a perforated tympanic membrane. The volume recorded theoretically measures the volume of the external ear canal, middle ear space and mastoid cavity.

In our study a diagnostic audiometer (Brand: Interacoustics Audiometer, Model No: AD-229) was used. The impedance audiometer used was of Amplaid, A766 with a probe tone frequency of 226 Hz.

To evaluate the significance of tympanometric volume (TV) in paediatric tympanoplasty, the mean tympanometric volume was calculated: 1.60 cm^3. On the basis of this volume patients were divided into two groups: Group-A having TV less than 1.6 cm^3 and Group-B having TV more than 1.60 cm^3.

Thereafter all the patients underwent tympanoplasty type I: post auricular, inlay technique using temporalis fascia graft under general anaesthesia. All the cases were operated by the principal investigator: first author. The patients were put on antibiotics post-operatively [amoxycillin + clavulinic acid], anti-allergic [cetrizine] and analgesic [ibuprofen + paracetamol]. Stitch removal and pack removal was done on the 7th post-operative day and thereafter all medication was withdrawn. A regular follow-up in ENT–OPD was kept for all the patients on a monthly basis at the end of 1st, 2nd and third month post-operatively. A final follow-up was done at the end of 6th month post-operatively.

An intact graft and a minimum of 10 dB hearing improvement in two consecutive frequencies at the end of 6th month were taken as a measure of graft and audiological success [15,16]. Residual perforations were regarded as a failure.

The data pertaining to tympanometric volume was recorded in a Proforma and put to statistical analysis. As the sample size was small, proportions were analysed for significant differences by using the following tests:

(1) Mantel Haenszel χ^2 i.e. Chi square test and,
(2) Fisher exact p value test for confirmation, wherever applicable.

Epi-info version 7 software was used for the above statistical tests.[2]

3. Results

In our sample of 30 paediatric patients 15 were males and 15 were females. An impressive success rate of 87% with an

Table 1
Overall success rates.

Total cases	Surgical success	Audiological success
30	26 [87.7%]	18 [69.23%]*

* 18 of the 26 cases with intact graft had an audiological improvement.

[2] It would be prudent to note that paediatric tympanoplasty success rate varies from 35% to 90% and there is no study on paediatric tympanoplasty in the age group of 5–8 years exclusively. Thus on the basis of presumption of 80% success rate in the select age group, the sample size was calculated to a minimum of 20 cases. However, keeping in view the drop outs and to make the study statistically more viable: finally a sample size of 30 patients was assigned for this study by the board of studies.