Impact of Otorrhea and Positive Cultures on Tympanoplasty Outcomes

Muhamed Masalha MD[1,3], Lev Shlizerman MD[1], Salim Mazzawi MD[1], Ophir Handzel MD[4,6], Firas Kassem MD[5,6], Daniel Briscoe MD[2,3], and Kfir Siag MD[1]

Departments [1]Otolaryngology Head and Neck Surgery and [2]Ophthalmology, Emek Medical Center, Afula, Israel
[3]Rappaport Faculty of Medicine, Technion–Institute of Technology, Haifa, Israel
[4]Department of Otolaryngology Head and Neck Surgery, Tel Aviv Sourasky Medical Center, Tel Aviv, Israel
[5]Department of Otolaryngology Head and Neck Surgery, Meir Medical Center, Kfar Saba, Israel
[6]Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

ABSTRACT **Background:** Chronic suppurative otitis media is a long-standing middle ear infection with a perforated tympanic membrane. Tympanoplasty is the mainstay of treatment. Most surgeons prefer to operate on dry ears; however, this may be difficult to achieve.

Objectives: To investigate the effect of otorrhea and positive cultures on the outcome of tympanoplasty

Methods: This retrospective analysis reviewed patients with chronic suppurative otitis media who underwent tympanoplasty 2008–2015. Patients were divided into three groups: active discharge and bacterial growth, active discharge without bacterial growth, and no ear discharge. Surgical outcomes were compared among the groups.

Results: Among 101 patients included, 43 ears (42.6%) had discharge preoperatively, 58 (57.4%) were dry. Overall closure rate was 81.2% (82/101). Preoperative active discharge closure rate was 88.3% (38/43) and without discharge 75.9% (44/58). There were 38 positive cultures preoperatively and five negative cultures. Cultures were not obtained in 58 cases. Success rates were 89.5%, 80%, and 75.9%, respectively. No significant difference was found between patients who had positive or negative cultures before the procedure ($P > 0.48$) or among the three groups ($P = 0.25$). The most common bacteria were Pseudomonas aeruginosa (n=17), followed by Staphylococcus species (n=10). None was significantly associated with operative failure ($P = 0.557$). The postoperative air threshold difference was not affected by culture results ($P = 0.3$).

Conclusions: Tympanoplasty success rates and postoperative air threshold differences were not affected by the presence of preoperative otorrhea or positive ear cultures. Surgery can be performed even when the ear is not dry.

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KEY WORDS: microbiology, otitis media, *Pseudomonas aeruginosa*, tympanic membrane perforation, tympanoplasty

Chronic suppurative otitis media (CSOM) is a long-standing infection of the middle ear and mastoid cells, which is characterized by continuous or intermittent otorrhea through a perforated tympanic membrane. It is one of the most common chronic infectious diseases, mainly affecting children [1,2]. The disease affects 65–330 million people worldwide, primarily in developing countries [2]. Sixty percent of these patients have a significant hearing impairment. CSOM has an estimated incidence of 31 million new cases per year, with 22.6% in children younger than 5 years old [3].

Tympanoplasty is the mainstay of treatment and has a high success rate of 75–95.7% [4-6]. The surgery's main objectives are to obtain a permanently dry ear and closure of the perforation. Although some authors suggested that the success rate is lower in children compared to adults [5], and it is generally recommended to delay operative repair until 6 to 8 years of age, controversy concerning the optimal time to perform tympanoplasty in the pediatric patient still exists among otolaryngologists. Some authors have suggested that tympanoplasty may be considered at any age [7]. Large preoperative tympanometric volume may be associated with a better chance of surgical success [8].

While tympanoplasty is an established procedure, many surgeons prefer to perform the surgery on dry ears, avoiding active episodes of secretions [9]. However, patients may present with frequent or chronic otorrhea, making it more challenging to have dry ears at the time of surgery. In such cases, some physicians obtain preoperative cultures followed by targeted antibiotic treatment [10-12], while others may conduct the surgery on actively secreting ears. In our practice, we obtain cultures and initiate antimicrobial therapy accordingly before surgery to achieve a dry ear. However, patients are scheduled for the procedure even in the presence of active discharge.

The purpose of this study was to analyze the effect of otorrhea and positive cultures before and during tympanoplasty on the outcomes of the procedure. The influence of other variables, such as patient's age and sex, type of bacteria isolated, and preoperative antimicrobial treatment, were also investigated.

PATIENTS AND METHODS

This retrospective study was approved by the local Institutional Review Board (IRB) and was conducted in accordance with the Declaration of Helsinki (14-0119).

The study population comprised patients with chronic perforated otitis media, all ages, both sexes, who underwent tympanoplasty at a department of otolaryngology head and neck surgery in a tertiary medical center from January 2008 to January 2015. Patients with incomplete medical records lost to follow-up or with cholesteatoma were excluded.

Patients were divided into three groups according to the status of middle ear cultures obtained in the preoperative evaluation, usually 2 to 4 weeks before surgery. The groups were: active discharge and bacterial growth in culture, active discharge and sterile culture, and no ear discharge. No culture was obtained in the third group.

The surgical outcomes of the groups were compared. Surgical success was defined as an intact tympanic membrane at the follow-up evaluation, routinely scheduled 3 to 6 months after surgery.

Hearing improvement was determined by significantly improved air conduction threshold (ACT) after the surgery (ACT before surgery vs. ACT after surgery) in pure tone audiometry and calculated in speech frequencies of 500, 1000, and 2000 Hertz (Hz).

Electronic medical records were reviewed for patient demographics, preoperative clinical findings, microbiological investigation, antimicrobial treatment, and success of surgery.

Candidates for tympanoplasty were examined before surgery by otomicroscopy. In patients with secreting ears, the middle ear discharge was collected with cotton swabs from the perforation margins using a sterilized ear speculum. Direct contact with the external auditory canal surface was avoided.

Each discharge sample was immersed in Stuart transport medium and transported to the microbiology laboratory, where it was inoculated onto blood agar plates, MacConkey's agar, Columbia Nalidixic acid agar, potato dextrose agar, and chocolate agar plates. All plates were aerobically incubated at 37°C. Blood and chocolate agars were incubated under 5% (v/v) carbon dioxide, while other agar types were incubated under ambient air conditions. Plates were examined 24 and 48 hours later. Bacteria were identified by MALDI-TOF mass spectrometry. Antimicrobial susceptibility testing was performed for pathogenic bacteria. Cultures that were negative on two occasions were defined as no growth or negative cultures.

Preoperative audiometric testing was performed up to 6 months before surgery.

All patients underwent tympanoplasty under general anesthesia through an endaural, transcanal, or a postauricular approach. All surgeries were performed by a senior otologist usually accompanied by a resident.

A posterior tympanomeatal flap was elevated to access the perforation. The margin of the perforation was debrided circumferentially. The remnant of the tympanic membrane was rotated forward, and the ossicular chain was inspected. Granulation or scar tissue surrounding the ossicles were removed when present. An ossicular chain disruption was repaired with an appropriate titanium prosthesis.

A graft consisting of cartilage and a perichondrium was used to reconstruct the eardrum in all cases. Ossiculoplasty was performed in six patients. Pieces of Gelfoam were placed into the middle ear to support the graft, and the graft was placed in the medial aspect of the tympanic membrane. The tympanic membrane and tympanomeatal flap were returned, and the external canal was filled with Gelfoam, soaked with ciprofloxacin ear drops. In the case of a post-auricular approach, the incision was closed with absorbable sutures. A dressing was then placed over the ear. Patients were admitted for one night after surgery and released the following day after the dressing was removed.

Patients were asked to perform a second audiogram 8 weeks after surgery and were examined in the outpatient clinic 3 to 6 months following surgery. When available, preoperative and postoperative audiograms were compared.

Otomicroscopy was performed at each visit, and the integrity of the tympanic membrane was assessed. When suspicious secretions were observed, samples were collected before the surgery.

Statistical analyses were performed using SAS 9.3 software (SAS Institute Inc., Cary, NC, USA). The mean, median, and standard deviations were calculated for the continuous variables. The Kruskal-Wallis test and Wilcoxon test were used for statistical comparisons. Frequency and percentage were calculated for the categorical variables and compared using chi-square or Fisher's exact test. Statistical significance was set at $P < 0.05$.

RESULTS

The study population included 165 patients, but 64 patients were excluded due to incomplete data documentation, lost to follow-up, or intra-operative diagnosis of cholesteatoma. The final sample consisted of 101 patients (51 males and 50 females). The mean age was 28.8 ± 17 years (range 8–4).

All 101 patients underwent surgery due to a perforated tympanic membrane. Among them, 19 had no history of secretions, and 82 had a history of chronic discharge with recurrent exacerbations. Overall, surgery was successful in 81.2% (82/101) of patients, 65 (79.3%) with a history of chronic ear discharge, and 17 (20.7%) with a history of a dry ear. No significant difference was found between the two groups ($P = 0.51$). The remaining 19 patients (18.8%) had a persistent perforation of the tympanic membrane. There were no statistically significant differences in age or sex between patients with successful or unsuccessful operations [Table 1]. Seven patients had postoperative complications (6.9%). Six were treated for local wound infection with no residual consequences, and one had ipsilateral incomplete facial nerve paralysis.

In the office visits preceding surgery, 43 patients (42.6%) had ear discharge, with an 88.3% (n=38) success rate. The success rate was 75.9% (n=44) among the group of 58 patients (57.5%) who did not have discharge. No significant difference in success rate was found between groups ($P = 0.2$) [Table 1]. Among the patients with ear discharge, 31 (72.1%) received antibiotics and 12 (27.9%) did not. The surgery was successful in 27 (87.1%) who received antibiotics and 11 (91.6%) who did not. This difference was not significant ($P = 0.67$).

Preoperative hearing tests were available and well-documented for 97 patients. Preoperatively, the air and bone thresholds were not significantly different between the groups whose surgery was successful or failed.

Preoperative cultures were obtained in all 43 patients with ear discharge. There were 38 positive cultures and five negative cultures. Cultures were not obtained for 58 patients because of a dry ear in the preoperative evaluation. Surgical success rates were 34/38 (89.5%), 4/5 (80%), and 44/58 (75.9%), respectively. No significant difference was found between patients who had positive or negative cultures before the procedure ($P > 0.48$) or among the three groups ($P = 0.25$) [Table 1].

Table 1. Patient demographics, preoperative examinations, and surgical outcomes

Demographics	Total (N=101)	Successful (N=82)	Failed (N=19)	*P*-value
Sex				
Male	51 (50.5%)	44 (86.3%)	7 (13.7%)	0.19
Female	50 (49.5%)	38 (76.0%)	12 (24%)	
Age, years (median, range)	28.7 ± 16.9, (21, 8–74)	29.3 ± 17.0 (23, 8–74)	26.1 ± 16.9 (18, 10–63)	0.41
Discharge	43 (42.6%)	38 (88.3%)	5 (11.7%)	0.2
No discharge	58 (57.4%)	44 (75.9%)	14 (24.1%)	
Culture				
Positive	38 (37.6)	34 (89.5)	4 (10.5)	0.25
Negative	5 (5.0)	4 (80.0)	1 (20.0)	
Not conducted	58 (57.4)	44 (75.9)	14 (24.1)	

Table 2. Impact of cultured bacteria on operative results

Bacteria cultured	Successful	Failed	*P*-value
Pseudomonas aeruginosa	16 (94.1%)	1 (5.9%)	
Staphylococcus species	7 (70.0%)	3 (30.0%)	
Streptococcus species	2 (100%)	0 (0.0%)	
Mixed flora	5 (100%)	0 (0.0%)	
Fungal species	4 (100%)	0 (0.0%)	
Haemophilus influenzae	1 (100%)	0 (0.0%)	
Serratia marcescens	1 (100%)	0 (0.0%)	

Among the 38 patients with a positive culture, 17 had *Pseudomonas* (one case with concurrent other bacteria growth), 10 *Staphylococcus* species (one case with concurrent additional bacteria growth), 2 *Streptococci*, and 11 had other bacteria. The operation success rate did not differ between the different types of bacteria ($P = 0.12$) [Table 2].

Of 82 successful surgeries, 45 patients had a well-documented air threshold following surgery. There was a statistically significant improvement in air threshold postoperatively (preoperative: 35.1 ± 15.0 dB, postoperative: 24.6 ± 17.2 dB, $P < 0.001$). Among these patients, 18 had a positive culture, one had a negative culture, and a culture was not taken in 26 patients. The air threshold was significantly improved in the positive culture group postoperatively, with an average difference of 11.4 ± 14.2 dB (15, -30, -30). There was also a significant improvement in air thresholds in the no-culture group postoperatively, with an average difference of 10.6 ± 10.3 dB (10, -10, -35). Improvement in hearing thresholds was similar between the positive and no-culture groups ($P = 0.3$).

Of the 38 patients with positive culture results, 16 received systemic combined with local antibiotic treatment. An additional 15 patients received only local antibiotics and 7 did not receive any preoperative treatment. The surgery was successful in 27 of the treated patients (87.1%). All seven non-treated patients had a successful outcome. No significant difference was observed between the groups ($P = 0.57$).

DISCUSSION

The preoperative evaluation of patients with CSOM undergoing tympanoplasty is of great importance for the patient and the surgeon. When encountering an episode of active ear discharge before the scheduled intervention, the decision to postpone the surgery can be inconvenient, and repeated otorrhea may significantly delay surgery by this approach. It is important to base the decision whether to operate or to postpone the surgery in the case of a discharging ear on precise data. The optimal choice is based on each individual case.

In our study, the overall success rate of tympanoplasty was 81.2%. These results are compatible with previous studies [5,10,13,14]. However, some authors reported different results [4]. The variability between studies may be influenced by multiple factors including age, surgeon, follow-up period, graft material, surgical technique, and the cause, size, and the location of the perforation [5].

The success rate of the surgery was not compromised by an active or recent ear discharge usually 2 to 4 weeks before surgery. Treating the secreting ear with antibiotics did not improve the outcomes. Moreover, a history of CSOM was not found to negatively affect surgical outcomes when compared with a history of dry perforation. This finding is supported by a similar report [6].

Our results oppose the general assumption that elective surgery for CSOM should be postponed with an actively secreting environment as a wet ear is not an accurate indication of the presence of pathogenic organisms [12]. Reports in the literature regarding this issue are contradictory. In a meta-analysis by Vrabec et al. [10], the success rate of tympanoplasty in children with a preoperative ear infection was not different from those with dry ears. In another meta-analysis, Tan et al. [5] found that tympanoplasty closure rates among patients with active discharge were not significantly affected. In contrast, the incidence of postoperative infection in a large series by Govaerts and co-authors [11]. ranged from less than 5% in dry perforations to more than 10% in surgeries on actively draining perforations and cholesteatoma. In our opinion, surgery should not be delayed due to a secreting ear.

Furthermore, no significant difference was found between patients with positive or negative cultures before the procedure, or when compared to patients who had dry ears in the preoperative evaluation and did not require a culture.

The most common pathogenic bacterial species identified preoperatively was *Pseudomonas aeruginosa* (n=17), followed by *Staphylococcus* species (n=10). The type of bacteria did not affect the surgery results [Table 2]. This finding is consistent with the study by Yang et al. [15], who found that preoperative culture growth of methicillin-resistant *Staphylococcus aureus* (MRSA) did not have a significant effect on hearing improvement or on the complication rate of tympanoplasty. The bacterial spectrum reported in the literature varies widely, with many publications showing a high prevalence of *P. aeruginosa* and *S. aureus*, followed by *Streptococcus epidermidis*, *Klebsiella pneumoniae*, *Proteus* species, and *Corynebacterium* species [1,2,12,16,17].

Prolonged CSOM may increase the frequency of infection with mixed strains, including aerobic and anaerobic organisms, among individuals with chronic infection. In addition, culture results may not adequately represent the proportions of the pathogens because only a dominant pathogen may have been detected. It can explain the wide variability in the bacterial growth spectrum reported in the literature.

In our sample, 31 patients with positive culture (81.5%) received preoperative antibiotics, and 7 (18.5%) did not. The better surgical outcome in the non-treated patients may be due to the small number of patients. Nevertheless, the difference in the surgical success rate between the groups was not significant. It seems that ear infection with bacterial growth before surgery does not affect the success rate of tympanoplasty.

In a randomized, controlled study by Tong et al., bacterial eradication was achieved with topical ofloxacin solution before tympanoplasty. Nonetheless, the success rate of surgery in terms of perforation closure was not improved [13].

Carlin et al. investigated the effect of 8 weeks of postoperative prophylactic, systemic antibiotics in tympanoplasty Type-I. Prophylaxis neither eradicated bacterial pathogens found in preoperative ears nor prevented their development during the postoperative period [12].

A randomized study on prophylactic oral antibiotics among 130 patients showed no difference between the treated group and the non-treated group in either graft success or audiometric results [18]. The results of our study and these reports confound the benefits of preoperative antibiotic treatment to eradicate bacterial growth.

However, other studies advocated the use of preoperative antibiotics. Govaerts and colleagues [11] demonstrated a significant improvement in the postoperative tympanoplasty infection rate of patients with draining ears who received preoperative cefuroxime compared to those who received placebo. We advise obtaining a culture and treating discharging ears with local antibiotics before surgery. We do not think systemic antibiotics are required for routine cases, even if bacterial growth was found. Culture results can be beneficial in case of complications, revision surgery, or patients with a higher risk of infection.

The role of resistant bacteria as pathogens in CSOM will likely increase, especially with prolonged treatment with local antibiotics. A recent publication reported that ear surgery during active infection of resistant *P. Aeruginosa* resulted in a 73% success rate [19].

In the current study, preoperative cultures were positive in 38 (88.4%) of the specimens obtained. This result is in accordance with a previous publication [17]. Some authors described a higher growth rate of 95.5% [20], whereas others reported a lower yield of 59.9% [21].

Ear discharge is usually obtained by inserting a sterile cotton tip on an applicator through the external auditory canal, followed by withdrawal and transport in a sterile test tube for microbiological examination. This method has been criticized as inadequate because the tip of the applicator cannot reach the focus of infection in the middle ear and anaerobic organisms will not be isolated [22]. However, another study found that the reliability of conventional ear swabs was 88.0% compared with middle ear aspiration [16]. In our study, negative cultures were evident in 5 (11.6%) cultures. In some cases, the absence of bacterial growth may be attributed to antimicrobial treatment before the preoperative encounter. Under bacteriostatic conditions, the proliferation of pathogenic bacteria may be reduced.

In our center, all patients are examined 3 to 6 months after surgery. The follow-up period varies in published reports and may contribute to the differences in reported success rates. Other centers reported follow-up visits at 2 and 12 months [23]. Some authors suggested that prolonged surveillance may evaluate surgical outcomes more accurately. Andersen and colleagues [14] showed that graft take-rate was found to be 93.0% at 2 to 6 months but declined to 86.6% at a follow-up period of more than 12 months. A meta-analysis by Tan et al. [5] showed no correlation between success rate and follow-up duration. Aabenhus and associates [23] suggested that results 3 months after tympanoplasty were as valid as results measured 12 months postoperatively hearing. We find the follow-up period of this study satisfactory, as delayed recurrence of tympanic membrane perforation is extremely rare.

This study was limited by its retrospective design, which can introduce selection and information bias. Documentation of perforation size and location was not available. There is some controversy regarding the impact of these variables. While large perforation greater than 50% of the tympanic surface area may be invertedly related to surgical success [5], the location and size of the tympanic membrane defect did not affect the results in long-term observations [24]. Moreover, the sample size was small, especially for patients with secreting ears and positive cultures. This limitation may have affected the results. An additional limitation was a lack of audiometric data, which were available for 45 (44.5%) patients, and without air-bone gap data. Although all patients are requested to undergo a hearing test after surgery, a larger number of postoperative audiograms would indicate the functional change in hearing after surgery better.

CONCLUSIONS

Tympanoplasty success rates and postoperative air threshold differences were not affected by the presence of preoperative active discharge or positive ear cultures. Surgeries should not be postponed due to an infected ear. Further investigation is needed with prospective randomized control trials to determine the relevance of infection prior to tympanoplasty.

Corresponding

Dr. M. Masalha

Dept. of Otolaryngology Head and Neck Surgery, Emek Medical Center, Afula 1834111, Israel

Fax: (972-4) 649-4056

Email: masalha.muhamed@gmail.com

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Never let your sense of morals get in the way of doing what's right.

Isaac Asimov (1920-1992), American writer and professor of biochemistry, known for his works of science fiction and popular science