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OTOLOGY

Treatment of adhesive otitis media by tympanoplasty combined with fascia grafting catheterization

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Abstract

Purpose The best surgical method for the management of adhesive otitis media is controversial. The aim of the study was to explore the feasibility and effectiveness of tympanoplasty combined with fascia grafting catheterization in the treatment of adhesive otitis media.

Methods This was a retrospective study of patients with adhesive otitis media and who underwent tympanoplasty combined with fascia grafting and catheterization between April 2015 and December 2016 at the Eye-Ear-Nose-Throat Hospital Affiliated to Fudan University. All injured ears were examined by pure tone audiometry at 0.5, 1 and 2 kHz before and at 3 months after operation.

Results Thirty-five patients (35 ears) were followed for 12–44 months. The air-conduction pure tone average was 31.7 ± 12.3 dBnHL. Hearing of 28 patients (80%) was improved to a practical level within 40 dBnHL, but 2 patients (6%) had no change in postoperative hearing. Numbers of patients with spontaneous prolapse, artificial removal of tympanic membrane ventilation tube, and unobstructed in place were 15, 12, and 8, respectively. Twenty-seven patients had perforations left after the prolapse and removal of tympanic membrane ventilation tubes, of which 22 (81%) had perforations healing by themselves. All patients had dry ears after operation, without recurrence. Thirty-three patients (94%) had dry ears within 3 months and only 2 patients (6%) for more than 6 months.

Conclusion Tympanoplasty combined with fascia grafting catheterization is effective in the treatment of adhesive otitis media.

Keywords Tympanoplasty · Fascia grafting · Catheterization · Adhesive otitis media

Introduction

Otitis media is the infection of the middle ear and is characterized by rapid onset of signs and symptoms of inflammation, with ear pain [1, 2]. It mostly affects children < 5 years of age, but nevertheless affect 1.5 per 100 adults of 35–44 years of age and 2.34 per 100 adults of 75–84 years [3]. The main complications of prolonged or recurrent otitis media include tympanic membrane damage and hearing loss [4]. The implantation of tympanostomy tubes is a common procedure for cases of persistent middle ear fluid, frequent ear infection, and infections resistant to antibiotics [1, 2].

Adhesive otitis media is a chronic form of otitis media and occurs when a thin retracted eardrum becomes sucked into the middle ear space and becomes stuck there, with adhesions among structures [5, 6]. Many patients with adhesive otitis media develop recurrent adhesive tympanum, which makes adhesive otitis media a difficult condition faced by otologists. Air-filled tympanic cavity after operation is a sign of successful operation for adhesive otitis media. Eustachian tube dysfunction is the main cause of adhesive tympanum [7, 8], leading to the absence of within the tympanic cavity and the invagination of the tympanic membrane forms a new adhesion.

The management of adhesive otitis media is challenging. Elmorsy et al. [9] suggested to fill the tympanic cavity with a silicone film to prevent postoperative adhesive tympanum; no postoperative adhesion was found after 1 year of

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follow-up, but this method could not solve the problem of ventilation of the tympanic cavity. Elluru et al. [10] investigated cases of chronic otitis media with Eustachian tube obstruction; they placed T-shaped tubes in the tympanic ring and the anterior wall of the external auditory canal when tympanoplasty was performed, and they observed a good curative effect. In 2016, Larem et al. [5] performed tympanoplasty to treat adhesive otitis media using tragus cartilage combined with tympanic membrane ventilation tube; the patients were followed up for 3 years, and good results were achieved.

Nevertheless, the most appropriate surgical approach in terms of balancing the efficacy and morbidity remains controversial. In this study, we propose tympanoplasty combined with fascia grafting catheterization for the treatment of otitis media with adhesive tympanum. The results could indicate a novel method for the management of this condition, at least in selected patients.

Methods

Study design and patients

This was a retrospective study of patients with adhesive otitis media and who underwent tympanoplasty combined with fascia grafting and catheterization between April 2015 and December 2016 at the Department of Otolaryngology of the Eye-Ear-Nose-Throat Hospital. This study was approved by the ethics committee of our university.

The patients with obvious lesion in the nasal cavity and nasopharynx found during preoperative endoscopic sinus examination were excluded.

Surgery

After general anesthesia, the patients were placed in the supine position with the ears facing upward. On the basis of thorough removal of the tympanic lesions, the integrity of the mucosa of tympanic cavity was protected as much as possible and the ossicular chain was reconstructed. During the operation, the pathological tissues in the tympanic cavity and mastoid process were removed under the microscope. After the temporalis fascia was harvested, let it dry naturally in the air for about 20 min. Then a hole was made in the fascia and a silicone T-shaped ventilation tube was inserted through the fascia (Figs. 1, 2). Then we used the temporalis fascia with ventilation tube to reconstruct the tympanic membrane (Figs. 3, 4). Gelfoam was used for fixing the fascia and the ventilation tube at both sides of the fascia (Fig. 5). A chlortetracycline gauze was placed in the outer segment of the external auricular canal. All patients were operated by one experienced chief physician.

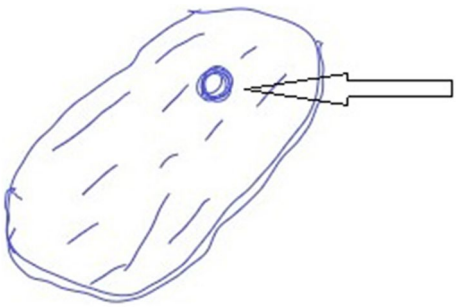

Fig. 1 Making a hole in the anterior portion of the fascia, and let it dry naturally in the air for about 20 min

Postoperative follow-up

All patients were followed up at the outpatient clinic. At 1 month after operation, the gelatin sponge in the external

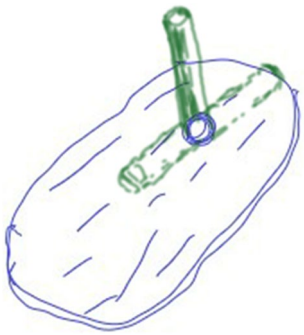

Fig. 2 A silicone T-shaped ventilation tube was inserted through the fascia

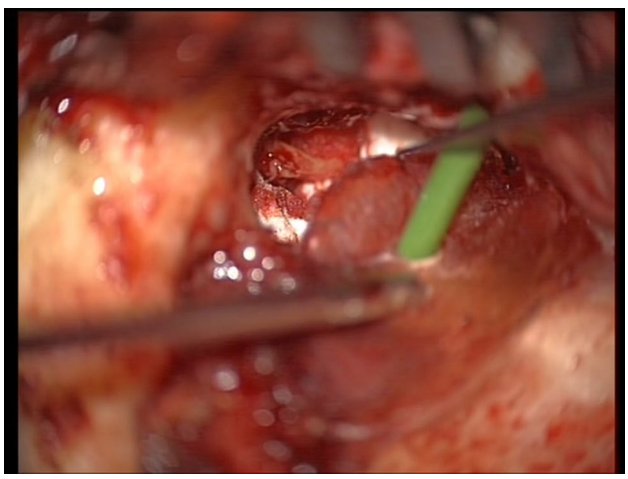

Fig. 3 The temporalis fascia with ventilation tube were laid together to reconstruct the tympanic membrane

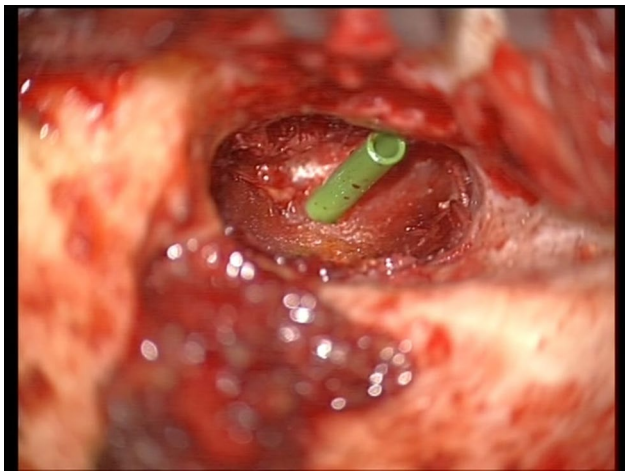

Fig. 4 The temporalis fascia with ventilation tube were laid well in good shape

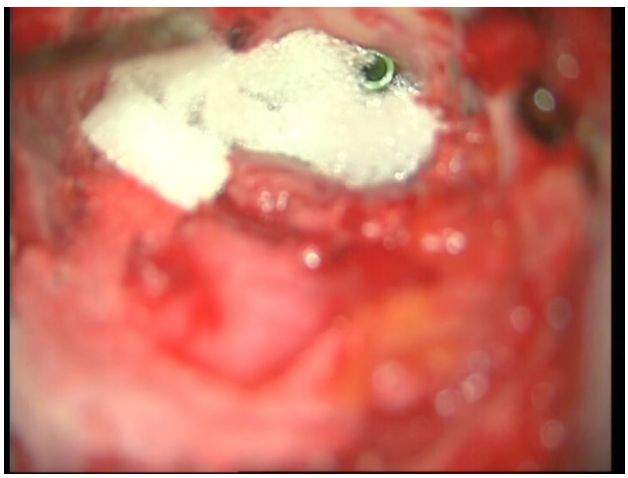

Fig. 5 Gelfoam was used for fixing the fascia and the ventilation tube

auditory canal was removed and the condition of the tympanic membrane ventilation tube was observed. Starting at 1 month after operation, the patients were asked to pinch their nose and blow, so that air could enter the tympanic cavity. After 6 months of follow-up, if the tympanic cavity was filled with air, the tympanic membrane ventilation tube was removed.

Observation indicators

Pure tone audiometry was performed within 1 week before operation and 3 months after operation. The air-conduction pure tone average (PTA) at 0.5, 1, and 2 kHz before and after operation was recorded. The dry ear duration, distribution of air–bone gap (ABG), conditions of tympanic membrane healing, and tympanic membrane ventilation tube were observed.

Statistical analysis

SPSS 19.0 (IBM, Armonk, NY, USA) was used for statistical analysis. Continuous variables were expressed as mean ± standard deviation (SD) or median (range), and compared using paired *t* test or the Wilcoxon test, as appropriate based on the Kolmogorov–Smirnov test. Categorical variables were expressed as frequency (percentage) and analyzed using the Chi square test. $P < 0.05$ was considered statistically significant.

Results

Baseline characteristics of the patients

A total of 35 patients (35 ears) were included. There were 20 males and 15 females. Median age was 43.4 years (range 8–64 years). The duration of disease was 0.5–60 years, with a median of 11.4 years. The preoperative air-conduction PTA of the 35 cases was 57.5 ± 14.5 dBnHL and the bone-conduction PTA was within 20 dBnHL. ABGs of all cases were more than 20 dBnHL (Table 1).

Postoperative hearing

All the patients were followed for 12–44 months. The air-conduction PTA before and after operation was 57.5 ± 14.5 dBnHL and 31.7 ± 12.2 dBnHL, respectively. The hearing improvement was 25.8 ± 18.6 dBnHL ($P < 0.01$) (Table 2). Hearing levels of 28 patients (80%) were improved to a practical level within 40 dBnHL, 5 patients (14%) increased by 10–20 dBnHL, and 2 (6%) had no change in postoperative hearing. Numbers of patients whose ABG at 0.5, 1, and 2 kHz decreased to < 20 dBnHL were 25, 32, and 34, respectively (Table 3).

Table 1 Baseline characteristics of the patients

Characteristic	Patients ($n = 35$)
Age (years), median (range)	43.4 (8–64)
Male, *n* (%)	20 (57)
Duration of disease (years), median (range)	11.4 (0.5–60)
Air-conduction PTA (dBHL), mean ± SD	57.5 ± 14.5

PTA pure tone average, *SD* standard deviation

Table 2 Air-conduction PTA before and after operation

Air-conduction PTA (dBHL), mean ± SD	Total ($n=35$)	Eustachian tube obstruction ($n=15$)	Adhesive tympanum ($n=20$)
Before operation	57.5 ± 14.5	57.9 ± 14.7	57.2 ± 14.7
After operation	31.7 ± 12.2*	31.7 ± 13.1*	31.5 ± 11.7*
Hearing improvement	25.8 ± 18.6	26.2 ± 13.9	25.7 ± 13.2

PTA pure tone average, *SD* standard deviation

*$P<0.01$ vs. before operation

Postoperative tympanic membrane and ventilation tube conditions

The numbers of patients with spontaneous prolapse, artificial removal of the tympanic membrane ventilation tube, and unobstructed tube in place were 15, 12, and 8, respectively. Of the 12 patients whose tympanic membrane ventilation tubes were artificially removed, 2 patients asked to remove the tubes. Their conscious hearing was improved significantly and the air could enter the ear. During follow-up, surgeons believed that the tympanic cavity had been filled with air in eight patients and hearing was improved significantly and so their tubes were removed. At 1 month after operation, no ventilation tube obstruction was found, but at the 2-month follow-up, ventilation tubes in two patients were removed because of mucus plug without ventilation. Four patients had tympanic membrane invagination 2–3 months after the removal of the tympanic membrane ventilation tube, so tympanic membrane catheterization was performed again. To avoid the recurrence of tympanic membrane invagination after extubation, the tube was not removed.

All grafted fasciae survived normally. Twenty-seven patients (15 cases of spontaneous prolapse and 12 cases of artificial removal) had perforations left after the prolapse and removal of tympanic membrane ventilation tubes, of whom 22 cases (81%) had perforations healing by themselves and 5 (19%) still had small perforations of < 2 mm in diameter. No adhesion or invagination of the tympanic membrane was found after operation.

Dry ear after operation

After operation, dry ear occurred in all injured ears, without any recurrence. Among the 35 patients, 33 (94%) had dry ears within 3 months and only 2 patients (6%) had dry ears for more than 6 months (Fig. 6).

Table 3 ABG distribution after operation

ABG (dBHL), *n* (%)	All ($n=35$)			Eustachian tube obstruction ($n=15$)			Adhesive tympanum ($n=20$)		
	0.5 kHz	1 kHz	2 kHz	0.5 kHz	1 kHz	2 kHz	0.5 kHz	1 kHz	2 kHz
0–10	17 (49)	25 (71)	26 (74)	8 (53)	12 (80)	11 (73)	9 (45)	13 (65)	15 (75)
11–20	8 (23)	7 (20)	8 (23)	2 (13)	1 (7)	4 (27)	6 (30)	6 (30)	4 (20)
21–30	7 (20)	3 (9)	1 (3)	3 (20)	2 (13)	0	4 (20)	1 (5)	1 (5)
> 30	3 (9)	0	0	2 (13)	0	0	1 (5)	0	0

ABG air–bone gap

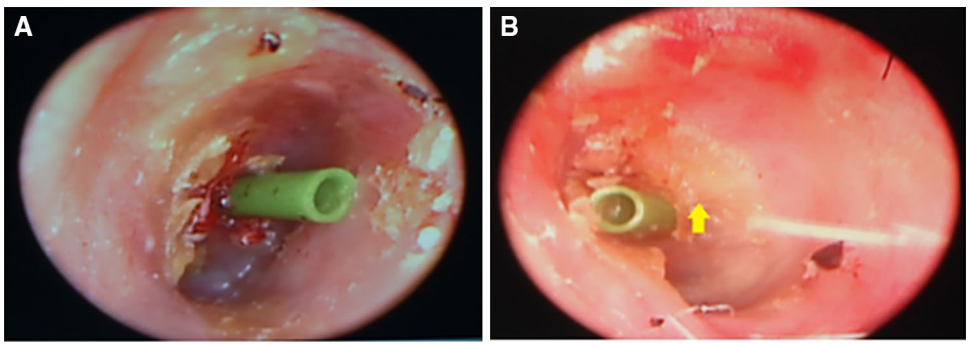

Fig. 6 Postoperative ear conditions. **a** At 1 month after operation, the T-shaped ventilation tube was unobstructed, the tympanic membrane was well formed, the tympanic membrane was slightly thick and with local swelling, and the surface was crusted. The conditions in the tympanic cavity could not be seen at this time. **b** At 3 months after operation, the tympanic membrane was well formed and the T-shaped ventilation tube was unobstructed. The yellow arrow indicates that the cartilage placed on the bone surface could be seen through the tympanic membrane. The tympanic cavity was dry and filled with air

Discussion

The best surgical method for the management of adhesive otitis media is controversial. Therefore, this study aimed to explore the feasibility and effectiveness of tympanoplasty combined with fascia grafting catheterization in the treatment of adhesive otitis media. The results suggest that tympanoplasty combined with fascia grafting catheterization is effective in the treatment of adhesive otitis media. Tympanic membrane ventilation tube placed at the same time did not prolong the dry ear time and cause postoperative recurrence.

The Eustachian tube is not only a necessary channel to maintain the pressure of the middle ear, but also a channel for draining tympanic effusion into the nasopharynx and the normal tympanic cavity requires its normal functions [11]. Eustachian tube dysfunction leads to the imbalance of the middle ear pressure system and the tympanic cavity acquires a negative pressure state, affecting the growth of the tympanic membrane and resulting in invagination and adhesion of the tympanic membrane under negative pressure in the middle ear [12, 13]. In addition, good Eustachian tube function can enhance middle ear ventilation, which can optimize the performance of postoperative tympanic membrane to achieve the normal amplification mechanism of the middle ear and improve hearing [14]. Some scholars suggested that staging surgery or cartilage tympanoplasty should be performed to avoid the effect of tympanic membrane invagination and adhesion caused by negative pressure of tympanic cavity after operation [15–18]. Nevertheless, although there is no tympanic membrane perforation left by staging surgery, patients need to have good compliance, otherwise they would lose the opportunity for timely reoperation, and staging surgery also greatly increases the economic burden of the patients. Zahnert et al. [16] reported that when the thickness of the cartilage is < 0.5 mm, it has the same acoustic characteristics as the tympanic membrane. Nevertheless, whether cartilage still has good tension resistance after trimming and thinning, as well as trimming scars and creases, have not been proven theoretically. Indeed, excessive cartilage thickness might affect the acoustic characteristics of the tympanic membrane. In the present study, air-conduction PTA (postoperative speech frequency hearing at 0.5, 1, and 2 kHz) in all patients was 31.7 ± 12.3 dBnHL after operation. The hearing level was increased by 25.8 ± 18.6 dBnHL in comparison with baseline, which was similar to or even more obvious than in previous studies [10, 15–19]. Moreover, 80% of the postoperative hearing was improved to a practical level within 40 dBnHL. Therefore, tympanoplasty combined with fascia grafting catheterization has obvious advantages in improving postoperative hearing and avoiding reoperation.

Merchant et al. [20] reported that when the mastoid air cell of the middle ear is < 0.5 cm^3, hearing decreases significantly. Therefore, filling air in the middle ear cavity is necessary to improve postoperative hearing. For the cases of tympanic membrane adhesion and Eustachian tube obstruction, it is difficult to form a air-filled tympanic cavity soon after operation. Hence, fascia grafting catheterization could provide a air-filled tympanic cavity and promote the functional recovery of the tympanic mucous membrane. Sade [8] suggested that the aerodynamics of the middle ear, the integrity of the anatomy of the middle ear, and the biomechanics of the sound transmission function are necessary for maintaining the sound transmission function of the middle ear. When failing to restore the normal aerodynamic function, attempting the protection and reconstruction of sound transmission are practically futile. Tympanic membrane perforation or long-term catheterization is the only possible remedy for injured ears after the removal of lesion and tympanoplasty but without normal aerodynamic function. Therefore, in this study, early tympanoplasty combined with fascia graft catheterization was adopted to restore the normal aerodynamic function of the tympanum as soon as possible.

In the present study, the rate of postoperative spontaneous prolapse of the tympanic membrane ventilation tube was 15/35 (43%). This high rate might be due to the fact that the patients were required to pinch their nose and blow up after operation; with the recovery of the function of the middle ear and the complete survival of the grafted fascia, the ventilatory tubes spontaneously prolapsed. Ventilation tubes were removed in ten patients who felt well and for whom the surgeons thought that postoperative recovery were good and obvious air-filled cavity was seen during follow-up. The ventilation tube was still unobstructed but in place in eight patients, which played an important role in maintaining middle ear cavity filled with air. Five patients had perforations < 2 mm in diameter, which still played the catheterization effect. There was no inflammation in the tympanic cavity anymore and dry ears were obtained. The rate of tube occlusion after operation was 5.7% (2/35), which was significantly lower than the natural tube occlusion rate of tympanic membrane catheterization in secretory otitis media for 1–6 months [21]. Although there was capillary hemorrhage in the surgical cavity, no blockage in the ventilation tube was found 1 month after operation and it might be because the tympanic and mastoid cavities continued to exude tissue fluid, which could prevent the formation of a scab. In two patients, the ventilator tubes were blocked by sticky mucus plugs after dry ears, possibly because there was little exudation and the fluid becomes viscous. Therefore, early blockage of ventilation tube does not happen often, but might occur after dry ears. The tympanic membrane perforations in 22/27 (81%) patients were healed after ventilation tubes were removed or prolapsed, and 5/27 (19%) patients

had perforations < 2 mm in diameter. Although the perforation rate of tympanic membrane in this study was much higher than that of secretory otitis media after catheterization [22], small perforations did not affect the survival of the grafted fascia. The presence of perforations was equivalent to long-term tympanic membrane catheterization effect and maintained the middle ear cavity filled with air. All injured ears were dry after operation, and most patients 33/35 (94%) had dry ears within 3 months. Therefore, tympanoplasty combined with fascia grafting and catheterization did not prolong the dry ear time.

The present study is not without limitations. The sample size was small and from a single center. In addition, the patients were selected and there was no control group. Additional studies are necessary to determine the exact benefits of this approach.

In conclusion, tympanoplasty combined with fascia grafting catheterization is a simple operation with good hearing recovery after operation, mainly because of improved air condition in the tympanic cavity overt the short term. The tympanic membrane ventilation tube placed at the same time would not prolong the dry ear time and cause postoperative recurrence. Therefore, this approach is probably worth promoting.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All the procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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