

Canal-Down Tympanoplasty; One-Stage Tympanoplasty with Mastoid Obliteration, for Non-cholesteatomatous Chronic Otitis Media Associated with Osteitis

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We operated on 54 ears using the canal-down procedure consisting of one-stage tympanoplasty with mastoid obliteration for non-cholesteatoma otitis media with lesions in the ossicular chain and compared the results with those of patients treated with the canal-up procedure. Complications, such as mastoid problems, which have been observed in surgery with the simple canal-down procedure, were not observed in operations combining mastoid obliteration. The success rate for our procedure as evaluated by postoperative hearing levels, according to the standards established by the Japan Society of Clinical Otology, Committee on Nomenclature 1987, was 77.4% with tympanoplasty (ceramic P type) with reconstruction of the ossicular chain; 70.6% with reconstructive surgery using T type ceramic; and 50.0% with reconstructive surgery using the patient's own bone. Overall, the success rate was 72.2%. Our procedure seems to be superior to the canal-up procedure with respect to improvement of hearing levels in the treatment of patients with chronic otitis media associated with lesions in the ossicular chain.

Key Words: canal-down, mastoid obliteration, open method, one-stage tympanoplasty

INTRODUCTION

Various procedures have been developed for the surgical treatment of chronic otitis media. The main goals of surgical treatment of chronic otitis are to remove the lesion that prevents healing of the chronically inflamed pneumatized portions of the temporal bone; to accelerate healing of the lesion by the body's natural healing mechanism, and to improve hearing. Tympanoplasty has been divided into two types, the "canal-down" and the "canal-up" procedures, depending on whether or not the mastoid cavity is opened widely to the external ear canal. The external ear canal and the ear drum are both maintained in the normal physiological position with the canal-up procedure, while their positions are changed with the canal-down procedure. The canal-down procedure, developed by Wullstein in 1955, is a classic tympanoplasty which is characterized by wide opening of the mastoid

cavity to the external ear canal. Since it was first described, various modifications of the canal-down procedure have been developed for the treatment of otitis media with cholesteatoma (1, 2, 3, 4). All of these procedures, however, can not prevent postoperative mastoid problems. For this reason, the canal-up procedure, in which the posterior wall of the external ear canal is maintained, is more commonly used (7, 8, 9, 10). We use one-stage tympanoplasty with mastoid obliteration, a modified canal-down procedure, for the treatment of otitis media with cholesteatoma. As reported elsewhere (5, 6), in our canal-down procedure with mastoid obliteration, the skin of the posterior wall of the external ear canal is maintained, the posterior ear canal is reconstructed with the patient's own bone plate and the mastoid cavity is obliterated with the patient's own bone fragments. The same procedure has been used for surgical treatment of non-

cholesteatomatous chronic otitis media. Surgical treatment is performed when lesions in the ossicular chain, particularly at the long process of the incus, and the superstructure of the stapes, are found by high resolution CT scanning (HRCT) and a hearing test. Over the last 5 years we have accumulated data on a sufficient number of cases to evaluate the postoperative course of patients that have undergone surgical treatment of chronic otitis media. In this paper, we describe the canal-down procedure and compare the postoperative course of patients treated with the canal-down procedure to that of patients treated with the original canal-up procedure.

CASES AND POSTOPERATIVE EVALUATION

The cases described here include 51 patients (54 ears), with chronic otitis media with lesions in the ossicular chain without cholesteatoma, who received tympanoplasty according to the canal-down procedure. The patients were followed for more than 5 years postoperatively in the Department of Otolaryngology, School of Medicine, Tokai University, between January 1985 and December 1990. All of these patients had central perforation and hearing impairment of more than 35dB in the air-bone gap. Patients with tympanosclerosis (hearing disturbance due to a sclerotic lesion on the eardrum and on the ossicular chain) and adhesive otitis media (lesions in the ossicular chain due to adherence of the drum) were not included in the study. None of the patients had received prior surgical treatment for chronic otitis media. All patients were tested preoperatively with HRCT for the presence of lesions in the ossicular chain, and in the tympanic and mastoid cavities. The findings and the position of the tympanic membrane were also examined. The height of the tegmen and the positions of the canal facial nerve and canalis semicirculares lateralis, were also determined to exclude patients with cholesteatoma. The control cases were 48 patients who were surgically treated with canal-up tympanoplasty (type III and type IV modification) during a 15-year period from 1975 to 1990. All of these cases of the control group also had central perforation and hearing impairment of more than 35dB in the air-bone gap. All operations using the canal-up or canal-down procedures were performed by one of

two surgeons.

SURGICAL PROCEDURE

The surgical procedure used for non-cholesteatoma is one-stage tympanoplasty with mastoid obliteration, a canal down procedure. In this procedure, the mastoid cavity is opened by resecting the bone of the posterior and superior walls of the external ear canal. The skin of the posterior superior wall of the external ear canal is maintained. The mastoid cavity, antrum and epitympanum are opened. After cleaning of the lesions, changes in the ossicular chain, particularly at the long process of the incus and the superstructure of the stapes, are carefully observed. While protecting the chorda tympani, the incus is removed by separating from the the lesions around the stapes, followed by removal of the malleus head with a nipper. The tendon of the tensor tympani muscle is also cut. The lesions are cleaned by removing the granulation starting from the epitympanum toward the tympanic cavity, followed by removal of the granulation around the stapes and cleaning of the middle ear cavity lesions while keeping the epithelium of the tympanic membrane intact. After confirmation that the opening of the eustachian tube to the tympanic cavity and the passage of eustachian tube are secured, the eardrum is reconstructed by closing the perforation underlying it with the fascia. The ossicular chain is reconstructed using a ceramic ossicular prosthesis (Apaceram, Pentax, Tokyo) or the patient's own bones, including the incus. Such surgery is performed with consideration given to the superstructure of the stapes and improvement of the hearing capability. In all operations performed after 1988, a ceramic prosthesis was used to reconstruct the ossicular chain. As shown in Figure 1, when the superstructure of the stapes could be utilized, we performed modified Type III tympanoplasty using the P-type ceramic. When the superstructure of the stapes could not be used, we performed modified Type IV tympanoplasty using the T-type ceramic. Details of reconstruction of the ossicular chain are summarized in Table 1. After reconstruction of the ossicular chain, the posterior and superior walls of the external ear canal are reconstructed with the bone plate. The bone fragments from the mastoid cortical

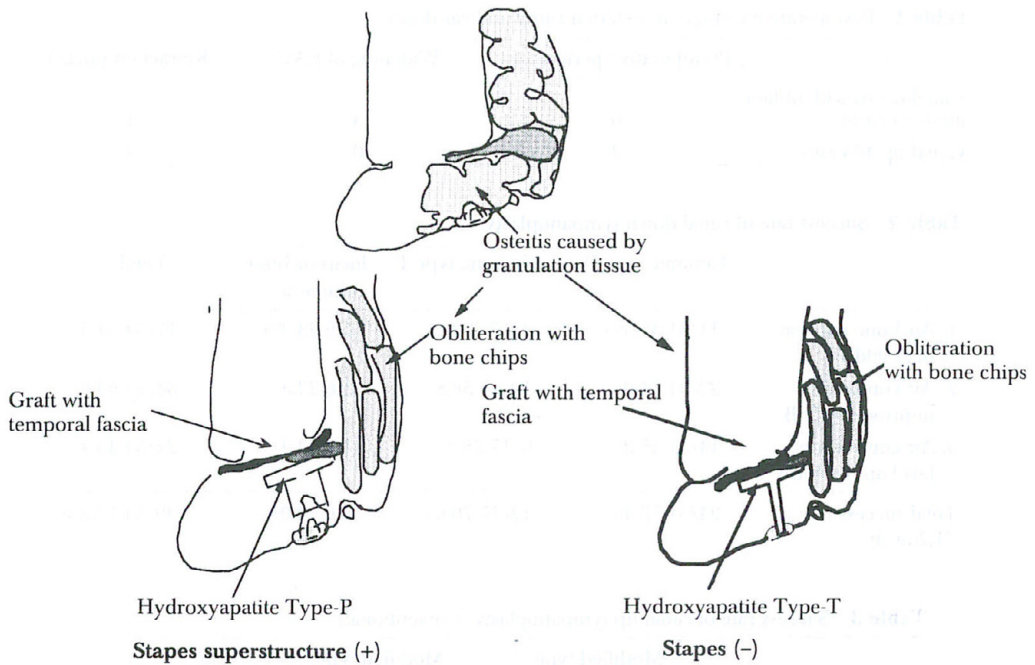


Fig. 1 Operation method in chronic otitis media with osteitis

bone are used for obliteration of the mastoid cavity with consideration given to pneumatization of the postoperative mastoid cavity. The bone fragments are laid as shown in Figure. 2 Throughout the surgery, particular attention is paid to preserve the skin of the external ear canal and keep the tympanic membrane intact except for the perforation area of the tympanic membrane.

RESULTS

Table 1 summarizes the postoperative evaluation of 51 patients (54 ears), who were followed for over five years prior to December 1996. There was no single case of postoperative perforation of the tympanic membrane among patients who were treated with the canal-down procedure. However, three patients had widening of the external ear canal, and one had formation of a retraction pocket in the epitympanum. Among the patients treated with the canal-up procedure, there were two cases of postoperative perforation and one case of formation of a retraction pocket in the epitympanum. However, all ears operated on remained dry after surgery.

Postoperative hearing levels are summarized

in Tables 2 and 3. These evaluations were performed using the standard evaluation method established by the Japan Society of Clinical Otology, Committee on Nomenclature 1987. According to this evaluation method, the following criteria are set: the air-bone gap is closed to 20 dB or less, the postoperative air conduction hearing gain is higher by more than 15 dB, and the postoperative air conduction hearing level is within 40 dB. The success rate was obtained by calculating the percentage of cases in which at least one of these criteria is satisfied. As seen in the tables, the success rate of type III-modified tympanoplasty using ceramic P was 77.4%, that of type IV-modified tympanoplasty using ceramic T was 70.6%, that of the ossicular chain reconstruction surgery using the patient's own bone was 50.0%. In controls consisting of 48 ears surgically treated with the canal-up procedure, the success rate of type III-modified tympanoplasty was 53.8% (21/39 ears). The success rate of type IV-modified tympanoplasty was 44.4% (4/9 ears). The success rate of all patients treated with the canal-up procedure was 52.1%. There was no significant statistical difference in the success rate for all cases. However, if we compare the

Table 1 Postoperative changes in external canal and ear drum

	Postoperative perforation	Widening of EAC	Retraction pocket
Canal-down with obliteration 54 cases	0	3	1
Canal-up 48 cases	2	0	2

Table 2 Success rate of canal-down tympanoplasty

	Ceramic type P	Ceramic type T	Incus or bone columera	Total
1. Air-bone gap less than 20dB	11/31 35.5%	4/17 23.5%	2/6 33.3%	17/54 31.5%
2. Air conduction improved >15dB	22/31 71.0	10/17 58.8	2/6 33.3	34/54 63.0
3. Air conduction level above 40dB	14/31 45.2	6/17 35.3	2/6 33.3	22/54 40.7
Total success rate (1,2 or 3)	24/31 77.4%	12/17 70.6%	3/6 50.0%	39/54 72.2%

Table 3 Success rate of canal-up tympanoplasty (conventional)

	Modified type III; stapes (+)	Modified type IV; stapes (-)	Total
1. Air-bone gap less than 20dB	15/39 38.5%	1/9 11.1%	16/48 33.3%
2. Air conduction improve >15dB	9/39 23.1	2/9 22.2	11/48 22.9
3. Air conduction level above 40dB	19/39 48.7	4/9 44.4	23/48 47.9
Total success rate (1, 2 or 3)	21/39 53.8%	4/9 44.4%	25/48 52.1%

success rate between the canal-up and the canal-down procedures focusing on cases in which the improvement of air conduction was higher than 15dB, the canal-down procedure showed a statistically significant ($p < 0.01$) improvement in hearing levels.

DISCUSSION

Since 1970, tympanoplasty with mastoid obliteration has been used as a secondary surgical treatment for patients previously treated with the canal-down procedure for otitis media with cholesteatoma causing a large mastoid cavity (10). We have applied one-stage tympanoplasty with mastoid obliteration using various filling materials such as muscle flap and bone pate. However, the surgical outcome, when these materials were used, was not satisfactory; with the muscle flap there was a tendency to cause widening of the external ear

canal, while the use of bone pate increased the frequency of infection. Therefore, we currently use the patient's own bone fragments as filling material (5, 6). Since the simple canal-down procedure causes various mastoid problems, in all patients with chronic otitis media, regardless of the presence or absence of cholesteatoma, obliteration of the mastoid cavity must be performed when the canal-down procedure is used.

Since 1985, we have used one-stage tympanoplasty with mastoid obliteration as a modified canal-down procedure. In this procedure, the bones of the posterior and superior walls of the external ear canal are removed in patients with non-cholesteatoma chronic otitis media associated with lesions in the ossicular chain. In our procedure, we maintain the skin of the external ear canal even though we remove the external ear canal bones and the mastoid cavi-

ty is filled with the patient's own bone fragments obtained from the temporal bone.

The major advantage of the canal-down procedure is better visibility of the surgical area, which is maintained during the surgery when compared with the canal-up procedure. Granulation can be removed completely and reconstruction of the ossicular chain is easy to perform. As shown in our results, if we keep the skin of the external ear canal intact, even after the removal of the bone of the external ear canal, the cavity formed by the removal of the bone in the external ear canal can be filled with bone fragments obtained from the patient's own temporal bone. In addition, this procedure allows wide visibility which makes it easy to remove granulation, reduces the risk of infection, and prevents perforation of the tympanic membrane. The recovery of hearing levels after our canal-down surgery, in which reconstruction of the ossicular chain using artificial materials can be performed with clear visibility, is excellent, with a success rate of over 70% (Table 2). The formation of a postoperative retraction pocket seems to be the result of blockage between the tympanic cavity and the epitympanum, as confirmed by HRCT. For this reason, it is important to maintain a ventilation space between the eustachian tube orifice and mastoid cavity when the mastoid cavity is obliterated. For patients with chronic

otitis media with a lesion in the ossicular chain without cholesteatoma, one-stage tympanoplasty with mastoid obliteration is useful because lesions of the pneumatized portions of the middle ear can be effectively and safely removed under excellent visibility.

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