

Canal wall down tympanoplasty surgery with or without ossiculoplasty in cholesteatoma: hearing results

Timpanoplastica aperta con o senza ossiculoplastica nella chirurgia del colesteatoma: risultati funzionali

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Key Words

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Parole chiave

Patologia dell'orecchio • Colesteatoma • Terapia chirurgica • Timpanoplastica • Ossiculoplastica

Summary

Aim of the study was to evaluate the functional results, in two homogeneous groups, for severity of the disease, submitted to canal-wall-down tympanoplasty (TPL CWD), with and without ossiculoplasty. A total of 60 patients who underwent canal-wall-down tympanoplasty for cholesteatoma were evaluated: 31 underwent ossiculoplasty (group A) and 29 classic Wullstein type III and IV operation (group B). Hearing results were evaluated 2 years after surgery according to the AAO-HHS guidelines. Pre-operative audiometrics revealed an air conduction PTA (AC-PTA) of 45.12 dB in group A, and 56.25 dB in group B. Bone conduction PTA (BC-PTA) was 16.86 dB in group A and 26.06 in group B. Two years after surgery, AC-PTA was 42.98 dB in group A and 58.65 dB in group B; BCPTA was 18.79 dB in group A and 25.13 dB in group B. The mean pre-operative ABG was 28.44 dB in group A and 30.14 dB in group B. Two years after surgery, group A showed a mean ABG of 24.06 and group B of 35.54 dB, the difference between the two groups was significant ($p=0.03$). In conclusion, the functional results observed in the present study support the need to reconstruct the ossicular chain in canal-wall-down tympanoplasty, in fact, ossiculoplasty is associated with a better hearing gain than the classic Wullstein operations.

Riassunto

Scopo del nostro è stato quello di valutare i risultati, in due gruppi di pazienti omogenei per gravità della malattia, sottoposti a timpanoplastica aperta (TPL CWD), con e senza ossiculoplastica. Sono stati valutati 60 casi sottoposti a timpanoplastica aperta per colesteatoma, 31 con ossiculoplastica (Gruppo A) e 29 ad intervento tipo II e IV sec. Wullstein (Gruppo B). I risultati funzionali sono stati valutati 2 anni dopo l'intervento secondo le linee-guida dell'AAO-HHS. Nel Gruppo A la soglia audiometrica per via aerea (VA-PTA) prima dell'intervento era 45,12 dB e 56,25 dB nel Gruppo B. A distanza di due anni, il VA-PTA è risultato di 42,98 dB nel Gruppo A e 58,65 dB nel Gruppo B. L'air-bone gap (ABG) nel gruppo con ossiculoplastica era 28,44 dB e 30,14 dB nel Gruppo B. Nel follow-up (2 anni), l'ABG del Gruppo A era di 24,06 e nel Gruppo B di 35,54 dB. La differenza fra i due gruppi era statisticamente significativa ($p=0,03$).

I risultati funzionali ottenuti nel nostro studio sostengono la necessità di ricostruire la catena ossiculare nelle timpanoplastiche aperte, infatti, l'ossiculoplastica è associata ad un miglior recupero uditivo rispetto agli interventi classici sec. Wullstein.

Introduction

Various techniques for cholesteatoma surgery have been developed. Choice of the technique to be used is still a matter of discussion in the international literature. In spite of the variety of procedures, the main objectives of cholesteatoma surgery are the removal of the disease and preservation of a good hearing function. An exhaustive review of the literature on cholesteatoma reveals the fluctuating trend in its treatment^{1,2}: from the first operations of radical mastoidectomy³ to the recent tympanoplasties. Initially, the most diffuse procedure was the canal-wall-up tympanoplasty (CWUT)⁴⁻⁶, now canal-wall-down tympanoplasties (CWDT) are widely performed^{7,8}. Convincing evidence exists that recurrences are reduced in CWDT and the hearing outcome is not sacri-

ficed⁹⁻¹². The indications for an open technique differ according to the different Authors.

In our experience, we perform a CWDT in the presence of a dead ear, severe neurosensorial hearing loss, large canal wall erosion, bilateral cholesteatoma, poor general conditions, advanced age, unreliable follow-up and unfavourable intra-operative conditions (large labyrinthine and/or cochlear fistula(e), contracted mastoid, far-advanced sigmoid sinus and/or very low-lying tegmen plate, osseous eustachian tube stenosis). Biologic and synthetic materials can be used to reconstruct the ossicular chain and restore the transmission of sound. Homologous ossicles are the first choice material in ossiculoplasty, however, they are not always available¹³⁻¹⁶. In the absence of autologous ossicles, several biological (homologous costal cartilage, cortical mastoid bone, homologous ossicles) or syn-

thetic (plastipore, hydroxyapatite, gold, titanium and others) prostheses can be used. Apart from the material, the ideal ossicular prosthesis should be manageable, versatile, biocompatible and stable over time. In CWDT, the type of reconstruction depends upon the ossicular chain conditions. In the presence of superstructure of the stapes with a mobile footplate, the transmission of sound can be achieved by placing the fascia graft directly on the stapes capitulum or interposing a prosthesis between the graft and the stapes. When the superstructure of the stapes is missing, a fascia graft can be applied directly on the footplate, protecting the round window and obtaining a small middle ear cleft, or a total prosthesis can be interposed between the graft and the footplate. Even if use of the CWDT is widespread, today, few papers have reported results of hearing¹⁷⁻²⁰.

In the present study, functional results of two groups of cholesteatoma patients who underwent CWDT have been compared. In the first group, a classic Wullstein type III or IV tympanoplasty was performed, while in the second group, a prosthesis was interposed between the graft and the stapes or its footplate.

Patients and Methods

From January 1992 to December 2000, 466 patients were operated upon for chronic otitis media with cholesteatoma. The inclusion criteria for this study, were: 1. clinical and histological diagnosis of cholesteatoma; 2. no previous otologic surgery; 3. one-stage CWDT procedure. Based on these criteria, 237 patients with an incomplete clinical history or submitted to radical mastoidectomy or staged tympanoplasty (CWDT or CWUT) were excluded. Furthermore, 169 patients not having 2 years' follow-up were also excluded. The study was, therefore, performed on 60 patients. Ossiculoplasty was performed in 31 patients (group A), whereas the fascia graft was applied directly on the superstructure of the stapes or its footplate in 29 (group B). The choice to reconstruct the ossicular chain was random and based on the surgeon's preference.

Group A consisted of 31 patients (17 male, 14 female), mean age 42.6 years.

Of these patients, 28 had an intact superstructure of the stapes. The ossicular chain was reconstructed in 14 cases with remodelled and transposed incus, in 14 cases with autologous cartilage (tragal or chonchal cartilage), in 1 case with a plastipore prosthesis, in another case with plastipore and autologous cartilage and in one case with transposed incus and autologous cartilage. In all cases, the prosthesis was placed between the newly built tympanic membrane and the stapes or footplate, in none of these cases was the malleus handle employed to stabilize the prosthesis. Group B consisted of 29 patients (13 male, 16 female)

(mean age 44.8 years). In this group, 25 patients had an intact stapes and 4 patients, only the footplate. In all cases, the fascia graft was placed directly on the stapes or footplate.

The functional results were evaluated according to the guidelines of the Committee on Hearing and Equilibrium of the American Academy of Otolaryngology Head and Neck Surgery (AAO-HNS)²¹. Pure-tone average (PTA) was calculated as the mean of 0.5, 1, 2 and 3 KHz thresholds. The 3 KHz threshold, which was not always available, was obtained as the mean of 2 and 4 KHz. Air-bone gaps (ABG) were calculated from air conduction (AC) and bone conduction (BC) thresholds determined in each study. Post-operative hearing gain was calculated from PTA before the operation and at the last follow-up examination.

Statistical analysis of the results was performed with Student t test and χ^2 test. Significance was set at $p < 0.05$.

Results

The mean pre- and post-operative thresholds of air and bone conduction for groups A and B are given in Table I. Statistical analysis showed that 2 years after surgery, the two groups did not differ in terms of AC and BC PTA and at each single frequency.

Mean pre-operative ABG was 28.44 dB in group A and 30.14 dB in group B. Two years after surgery, group A showed a mean ABG of 24.06 and group B of 35.54 dB. Mean ABG improved in group A by 4.38 dB but decreased in group B by 3.40 dB. The difference between the two groups was significant ($p = 0.03$) (Fig. 1). Figure 2 reports the number and the percentage of subjects with mean pre-operative ABG lying within 0-20 dB, 21-40 dB and >40 dB HL before and after the operation, in the two groups. The number of patients with an ABG between 0-20 dB improved after surgery in group A but did not change in group B.

Table I. Air conduction pure tone average (AC PTA), bone conduction pure tone average (BC PTA), air bone gap (ABG) and ABG gain (with standard deviation) before and two years after surgery (\pm SD).

	Group A	Group B
AC PTA pre	45.70 dB (18.73)	56.96 dB (16.29)
AC PTA post	43.37 dB (21.09)	58.65 dB (20.31)
BC PTA pre	15.88 dB (12.64)	24.81 dB (10.18)
BC PTA post	17.59 dB (13.56)	23.88 dB (13.03)
ABG pre	28.48 dB (10.94)	30.14 dB (11.08)
ABG post	24.06 dB (10.67)	33.54 dB (12.90)
ABG Gain	4.38 dB (10.61)	3.40 dB (11.99)

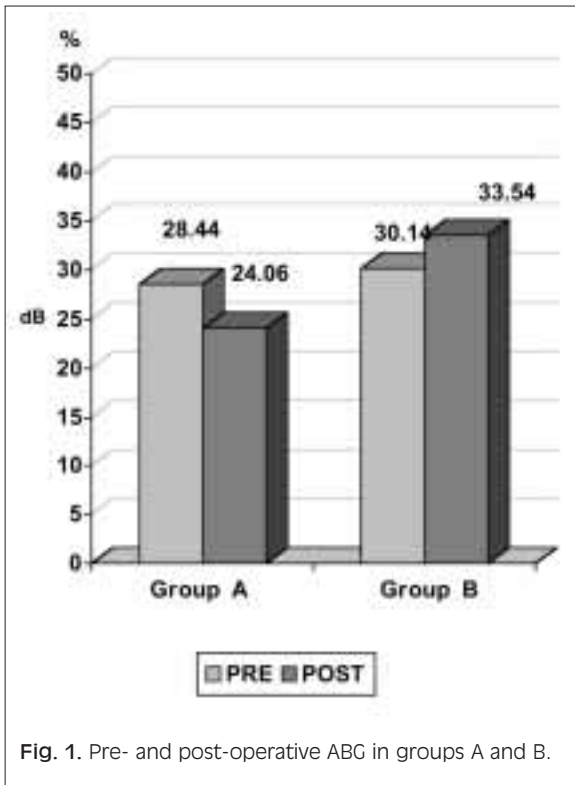


Fig. 1. Pre- and post-operative ABC in groups A and B.

In subjects undergoing ossiculoplasty with autologous cartilage (15/31), the gain was 5.52 dB, whereas in those with remodelled incus (16/31), the gain was 2.92 dB (Table II). The results of hearing in patients of groups A and B, according to the presence or absence of the stapes superstructure, are reported in Table III. The presence of the stapes superstructure does not seem to influence either the pre- or post-operative hearing. However, the number of patients with only the footplate was small.

The mean gain related to the pre-operative ABG revealed that the patients in group A with ABG 0-20 and 21-40 dB showed a significantly higher post-operative improvement than patients in group B ($p < 0.05$) (Table IV).

Discussion

Much controversy exists, today, concerning open or closed tympanoplasty in cholesteatoma surgery. CWDTs are associated with a lower risk of recurrence compared to CWUT, where the restoration of the middle ear cleft and mastoid may maintain the conditions responsible for the formation of the cholesteatoma²². There is general agreement that the recurrence rate is higher in CWUT, and a second-stage operation is always necessary^{23,24}.

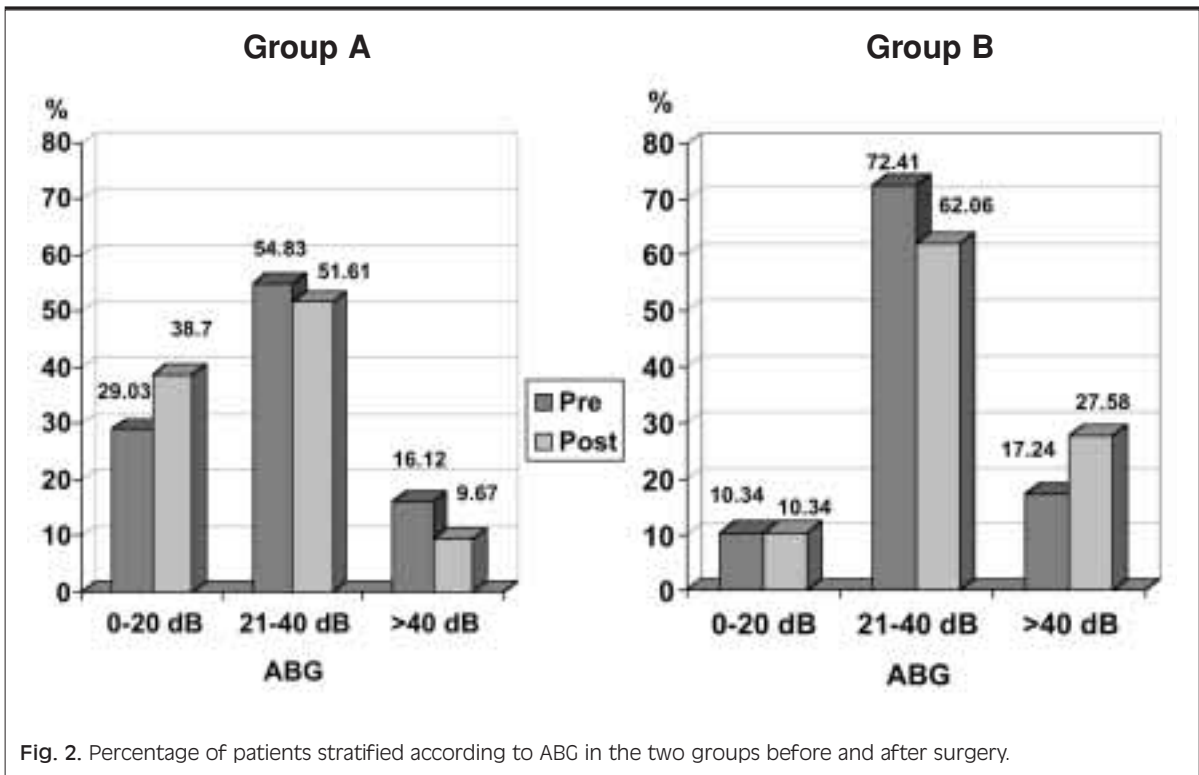


Fig. 2. Percentage of patients stratified according to ABC in the two groups before and after surgery.

Table II. ABG gain obtained in groups A and B. In group A, gains related to the material employed in ossicular chain reconstruction are shown.

	Group A			Group B
	Total	Cartilage	Ossicles	
ABG gain (dB)	4.38	5.52	2.92	-3.40

was greater.

Average post-operative ABG was 24.06 dB in group A and 38.7% of patients had a postoperative ABG between 0 and 20 dB.

Assessment of hearing results was performed according to the AAO-HNS guidelines²¹. Caution should be used in comparing the results of this study with those of other studies on account of the methodological differences in the analysis. The most common approach

Table III. ABG and gain (\pm SD) in groups A and B according to presence or absence of stapes superstructure.

	Stapes present		Stapes absent	
	Group A	Group B	Group A	Group B
ABG pre (dB)	27.76 (10.94)	30.67 (11.78)	28.66 (10.5)	27.50 (8.42)
ABG post (dB)	23.16 (10.58)	33.67 (13.74)	25.50 (11.60)	32.92 (11.54)
Gain (dB)	4.61 (10.81)	-3dB (12.77)	3.16 (10.9)	-5.42 (11.83)

Table IV. Gain related to pre-operative ABG in groups A and B and statistical significance.

	Gain		p
	Group A	Group B	
ABG pre			
0-20 dB	2.50	1.25	<0.05
21-40 dB	4.33	-4.64	<0.05
>40 dB	5.94	0.83	>0.05

The results of hearing reported in the literature are contrasting. In fact, while some authors reported better results with CWUT^{1,4,25}, others did not find significant differences between CWDT and CWUT^{2,10,11,22,26-29}. In only one paper were better results in CWDT described³⁰.

In CWDT, hearing results depend on the status of the ossicular chain and on the re-establishment of the transmission of sound through a tympano-ossicular system. In this study, we have compared the hearing results of patients submitted to CWDT without ossiculoplasty (classic Wullstein type III and IV) and with ossiculoplasty.

The audiological evaluation was performed two years after surgery in accordance with the AAO-HNS guidelines²¹.

Group A patients compared to group B presented a significant decrease in the pre-operative ABG, an increase in the number of patients with an ABG between 0-20 dB and higher gains when the preoperative ABG

is to report the residual air bone gap that compares pre-operative bone conduction and post-operative air conduction thresholds. However, this approach fails to take into account the Carhart³¹ effect leading to overestimation of ABG closure. Few Authors report the 4 frequencies PTA (0.5, 1, 2 and 4 kHz), while 3 frequencies PTA (0.5, 1 and 2 kHz) or 4 frequencies PTA (0.25, 0.5, 1 and 2 kHz) are often used. Another confounding factor is the staging of the procedure.

In fact, in staged procedure before the second stage, the TM and the stapes or footplate are not connected and the procedure is aimed only at restoration of hearing. Pre II stage ABG are often higher than the pre I stage ABG, where the columella effect of the cholesteatoma is frequent. The absolute gain which can be achieved in single-stage procedures is, therefore, lower than in staged procedures.

Babighian¹⁸ reported the hearing results of single-stage CWDT with ossiculoplasty in cholesteatoma. In his series, the mean post-operative ABG in this group of patients was 25.4 dB. Similar results were obtained by Cook et al.³² in single-stage CWDT with ossiculoplasty. Berenholz et al.³³, in staged CWDT with ossiculoplasty, reported a mean post-operative ABG of 17.8 dB.

The number of patients with a post-operative ABG 0-20 dB ranges between 30 and 69% in the different series³²⁻³⁴, however, the guidelines of the AAO-HNS were followed. Autologous cartilage ossiculoplasty determined a mean gain of 5.52 dB, compared to 2.92 dB obtained by ossicles. Nevertheless, our study-group is not large enough to evaluate the influence of the material used, on the functional result. Therefore,

further studies are necessary to clarify this aspect. In this study, reconstruction of the ossicular chain with a prosthesis determined better results than the classic Wullstein type III and IV operations. Although in group A, the presence of the stapes did not seem to influence the hearing outcome, the small number of cases does not allow us to evaluate whether the presence of the stapes superstructure is associated with better results.

The better results obtained in group A patients, com-

pared to group B, when the ABG was <40 dB are related to the poor gain obtained when ossiculoplasty is not performed and, therefore, the difficulty to maintain the preoperative hearing.

The functional results of this study support the need to reconstruct the ossicular chain in CWDT. In fact, interposition of a prosthesis between the fascia graft and the stapes or its footplate is associated with a better hearing gain than when the classic Wullstein operations are performed.

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