Autologous Ossicular Grafts in One-Stage Surgery for Chronic Otitis Media

Generoso T. Abes[1,3], Erasmo Gonzalo DV. Llanes[2,3], Abner C. Chan[2,3] and Romeo L. Villarta, Jr.[2,3]

[1]Professor, [2]Clinical Associate Professor, Department of Otorhinolaryngology, College of Medicine- Philippine General Hospital, University of the Philippines Manila; [3]Philippine National Ear Institute, National Institutes of Health, University of the Philippines Manila

ABSTRACT

Objectives: One hundred thirty-four (134) patients who underwent one-stage surgery for chronic otitis media using autologous ossicular grafts were evaluated to determine functional hearing outcomes.

Method: Records of 134 patients who underwent one-stage surgery for chronic otitis media in an otologic practice at a university tertiary hospital from December 1987 to December 2003 were evaluated.

Results: Approximately 52% were males and 48% were females, with 140 ears evaluated. One hundred sixteen (116, 83%) had primary surgery and 24 (17%) had previous surgeries. Cholesteatoma was seen in 82 (58%), and not in 58 (18%) (with 24 dry ears and 34 discharging ears). Canal-down mastoidectomy was performed in 98 patients (70%) as opposed to 42 (30%) with canal-up procedure. One third (33.86%) had postoperative air-bone gap (ABG) of less than 10 dB while more than 50% of cases had 20 dB or less average postoperative ABG at 0.5, 1, 2 and 4 kHz frequencies. However, about one fourth of cases (27%) had worse mean postoperative ABG. In general, a postoperative ABG of 10 dB was noted more frequently in cases with intact superstructure than those without stapes superstructure across the four frequencies. Most common complications included recurrent ear discharge, epithelial cyst formation, and tympanic membrane graft perforation.

Conclusion: One-stage surgery for chronic otitis media using autologous tissues is a reasonable alternative to accomplish the dual aims of tympanoplasty. The complication rate is low while postoperative hearing results are not markedly different from results obtained with two-stage procedures. Canal-down or canal-up mastoidectomy may both be carried out depending on the nature of the pathology without prejudice to the short term postoperative hearing results. Simplified ossicular connection may be done to connect the stapes with either the malleus or the tympanic membrane graft to improve hearing. Improvements in procedures and techniques should be aimed not only to eradicate disease and improve hearing but also to avoid further injury to the cochlea.

Key Words: chronic otitis media, autologous ossicular graft, one-stage surgery

Introduction

Approximately 60% of patients undergoing surgery for chronic otitis media have perforation with ossicular dysfunction.[1] The severity of the pathology in combination with structural damage in the middle ear and various patient-related factors often dictate the need for restoring ossicular chain function. It remains a challenge for the otologic surgeon to accomplish the dual aims of disease control and hearing improvement in one-stage surgery, particularly in places where two-stage surgery is hardly acceptable due to economic reasons. Biologic materials such as cartilage, mastoid cortical bone and ossicular remnants were found compatible with one-stage surgery even in potentially infected cases.[2] This study reviews the clinical and audiologic outcomes of one-stage surgery for chronic otitis media using autologous mastoid cortical bone and ossicular remnants.

Materials and Methods

Records of all patients who underwent one-stage tympano-mastoidectomy with ossiculoplasty for chronic otitis media performed by the senior author from an otologic practice in a university tertiary hospital from December 1987 to December 2003 were reviewed, where clinical and hearing outcomes were assessed. Patients for revision surgery were included and were noted to have failed tympanoplasty,

residual or recurrence of previous pathology, and primary middle ear reconstructive surgery for non-reconstructed ear. Mean changes in air-bone gap (ABG) in decibels hearing level (HL), ranges and standard deviations were determined. The difference in air bone gap (ABG) before and after surgery was determined (0.5, 1, 2, and 4 kHz) as recommended[5], except that values at 4 kHz were used instead of 3 kHz. The mean change in ABG was computed as mean preoperative ABG minus mean postoperative ABG. Positive values indicate improvement whereas negative values indicate worsened ABG postoperatively. Speech reception thresholds and speech discrimination scores and differences were determined.

Surgical Technique

The technique of mastoidectomy as described by Shambaugh and Glasscock[3] and the retro-auricular tympanoplasty techniques of Fisch[4] were adopted with some modifications. Canal wall up mastoidectomy was performed for draining ears without cholesteatoma and in dry ears with ossicular immobility and suspected attic pathology. Cases with cholesteatoma or severe mucosal disease underwent canal down mastoidectomy. The incus or its remnant was disarticulated in all cases of cholesteatoma, granulation tissue or fibrous tissue involving the facial recess, sinus tympani or areas medial to the ossicular structures that could not be accessed if the ossicular structures were intact. Ossicular continuity and mobility were assessed by inspection and palpation. Preservation of remaining viable mucosa was attempted in all cases. Inspection of the eustachian tube orifice was done routinely and any pathology was removed gently with a curette. Meatoplasty was done on all cases which had canal-down mastoidectomy. Palva flap was used in canal-down cases with big mastoid cavities. Autologous temporalis fascia was used as a tympanic membrane (TM) graft in all cases while an autologous incus, malleus remnant or mastoid cortical bone was used as an ossicular graft. The temporalis fascia was harvested intraoperatively and air dried prior to its placement lateral to the fibrous annulus and medial to the malleus handle whenever present or feasible. An autologous incus or malleus remnant was generally used in non-cholesteatoma cases, removed during mastoidectomy and temporarily preserved in normal saline solution. An autologous mastoid cortical graft was used in cases with cholesteatoma or severe mucosal disease or whenever ossicular remnants were not available. An autologous cortical bone was harvested from the posterior portion of the mastoid cortex using an electric drill, mallet and chisel. No silastic sheet or any synthetic material was placed in the middle ear regardless of the extent of pathology. Gelfoam (Pfizer, New York, USA) was used to stabilize the ossicular graft in some cases.

Holding the ossicular graft between the thumb and index finger, free hand remodeling was done using an electric drill with a 1.0 or 1.5 mm diamond burr. The shape and length of the ossicular graft largely depended on the intraoperative assessment of the ossicular defect. The length of the ossicular graft connecting the stapes head and the malleus neck or tympanic membrane graft approximated 4.0 to 5.0 mm. The distance between the stapes footplate and the malleus neck or tympanic membrane graft was about 8.0 to 10.0 mm. In cases with an absent or grossly deformed stapes superstructure, the ossicular graft was placed over the mobile stapes footplate and stabilized by minimal Gelfoam packs. With intact stapes superstructure, an approximately 1.0- to 2.0-mm diameter indentation was created on the ossicular graft and was placed over the stapes head. When the angle between the long axis of the stapes and the malleus handle was less than 15 degrees, the ossicular graft was placed under the malleus neck. If either the malleus-stapes axis angulation was greater than 15 degrees, with an absent malleus, or whenever the connection between the ossicular graft and the stapes was deemed unstable, the ossicular graft was placed under the postero-superior aspect of the tympanic membrane graft. In canal wall up cases, particular attention to avoid contact of the ossicular graft to the posterior bony canal wall was observed. The chorda tympani nerve was placed over the lateral part of the ossicular graft whenever present and feasible. The dissected canal skin, earlier retracted was replaced over the tympanic membrane graft and packed with Gelfoam soaked in antibiotic solution. Small cotton strips impregnated with topical antibiotic ointment was placed lateral to the Gelfoam pack. The posterior incision was closed in layers. Standard mastoid dressing using a two-inch elastic bandage was applied.

The five ossicular connections were: 1) malleus to stapes head (MSH), 2) incus to stapes head (ISH), 3) tympanic membrane graft to stapes head (TMSH), 4) malleus to stapes footplate (MSF), 5) tympanic membrane graft to stapes footplate (TMSF) (Figure 1).

Results

One hundred thirty four (134) patients underwent one-stage tympanoplasty with mastoidectomy from December 1987 to December 2003, ages ranging from five to 61 years (70% were adults from the 21 to 50 year old age group). There were 70 males (52%) and 64 females (48%), with 128 (91%) having one-sided ear surgery, and six (9%) with bilateral ear surgeries. Primary surgery cases were 116 (83%) and revision cases were 24 (17%). The range of postoperative follow-up was two to 168 months, and the average period of clinical outcome evaluation was almost two years (23 months). Audiometric data were available in 110 patients (79%). The average period for hearing evaluation was 52 months (median of six months). About 85% of cases were performed from 1996 to 2004 and more than half during the past five years.

Cholesteatoma was seen in 82 (58%) and not in 58 (18%) (with 24 dry ears and 34 discharging ears). Seventy percent (70%, n = 98) necessitated canal wall down mastoidectomy. Of the 66% (n=92) who had intact stapes superstructure (Figure 2), more than 90% (85/92) necessitated tympanic membrane graft to stapes head ossicular connection (TMSH), five with malleus to stapes head, and two with tympanic membrane to stapes head. Tympanic membrane to stapes footplate connection (TMSF) was done in more than 80%

(40/48) with an absent stapes superstructure while malleus to stapes footplate was done in the remaining cases.

Tympanic membrane graft perforation was more common in cholesteatoma cases (Table 1). Ossicular graft extrusion occurred similarly with or without cholesteatoma. Overall, the most common postoperative complication was recurrently draining mastoid cavity, mostly due to the breakdown of the squamous epithelial lining, fungal infection and inadequate meatal opening. Epithelial cyst formation over the tympanic membrane graft was seen in about 20% of operated ears, one of which developed into a middle ear cholesteatoma on follow–up and necessitated revision surgery. One cholesteatoma case with severe hearing loss preoperatively resulted into a "dead ear." Facial paresis occurred in one case with cholesteatoma, fully recovering after one month. One facial paralysis occurred one week after operation in a 58-year-old female without cholesteatoma. This was attributed to Bell's palsy rather than to surgery and had 90% recovery of facial function after six months. Five patients had dizziness one day after surgery, relieved by intravenous Diazepam 5mg. All cases did not necessitate further anti-dizziness medications. An atrophic tympanic membrane graft plastered to the promontory was found in 8%, mostly in attic cholesteatoma cases. A lateralized TM graft was noted in 5%. Residual cholesteatoma formation (4.9%) noted in the middle ear cavity were found in cases with sinus and attic cholesteatoma. Two cases had revision surgery while the other two were lost to follow-up.

One third (34%) had postoperative ABG less than 10 dB HL while more than 50% had 20 dB HL or less average postoperative air-bone gap (ABG) at 0.5, 1, 2 and 4 kHz frequencies (Table 2). About one fourth of cases (27%) had worse mean postoperative ABG.

Any of the three (MSH, ISH and TMSH) were done in cases with intact stapes superstructure and either MSF or TMSF for those without functional stapes superstructure (Figures 2 and 3). The results for MSH and ISH were combined since they had a similar functional mechanism. In general, a postoperative ABG of 10 dB HL was noted more frequently in cases with intact superstructure than those without stapes superstructure across the four frequencies. The differences in distribution with or without stapes superstructure at each individual frequency were not statistically different, which indicates that not one ossicular connection affected better or worse postoperative ABG at any of the four frequencies. The mean improvement of postoperative ABG of 20 dB HL or less was more frequent among cases with stapes superstructure than those without superstructure but the difference was not statistically significant (p = 0.8). Worse postoperative ABG occurred in both groups, and was not significantly different between groups.

More cases with 20 dB HL or less across 0.5, 1, 2, and 4 kHz (45%, 54%, 58%, 55%, respectively) were obtained with canal-down mastoidectomy than with canal-up cases (38%, 44%, 56%, 50%, respectively). The differences in overall distribution and across each of the four frequencies were not significant. Conversely, there were more cases with worse postoperative ABG among canal-up cases in all four frequencies than canal-down cases, average of 28% and 24%, respectively. There was no significant difference in the overall distribution of cases (p = 0.53). The difference in the improvement of postoperative mean ABG was not clinically significant between the two groups (3 dB HL in canal up and 11 dB HL in canal down cases).

The mean SRT for preoperative canal-up and canal-down mastoidectomy were 56 and 59 dB HL, respectively,

Table 1. Postoperative complications (n=140)

Complications	With cholesteatoma		Without cholesteatoma		Total	
	No.	%	No.	%	No.	%
Tympanic membrane graft perforation	7	5	2	1.4	8	6.4
Ossicular graft extrusion	1	1.2	1	1.7	2	2.9
CN VII injury	1	1.2	1	1.7	2	2.9
Dizziness	3	3.6	2	3.4	5	7.0
"Dead ear"	1	1.2	0	0	1	1.45
Lateralized TM graft	3	3.6	1	1.7	4	5.3
Atropic TM graft	4	4.9	2	3.4	6	8.3
Absent ossicular graft	3	3.6	1	1.7	4	5.3
Recurrent cholesteatoma	4	4.9	0	0	4	4.9
Epithelial cyst over TM graft	6	7.3	6	10.34	12	17.64
Recurrent discharge from mastoid cavity	21	25.60	0	0	21	25.60
Total	54		16		69	

Table 2. Distribution of postoperative pure tone average air-bone gap change, (n=110).

Air bone gap (db HL) change	No.	Percentage	Cumulative percentage
10db or less	39	35.4	35.4
11-20	19	17.3	52.7
>20db	22	20	72.7
Worse	30	27.3	100
Total	110		

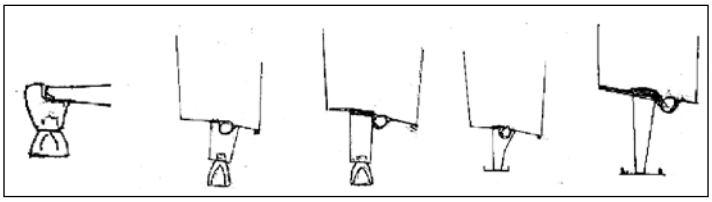
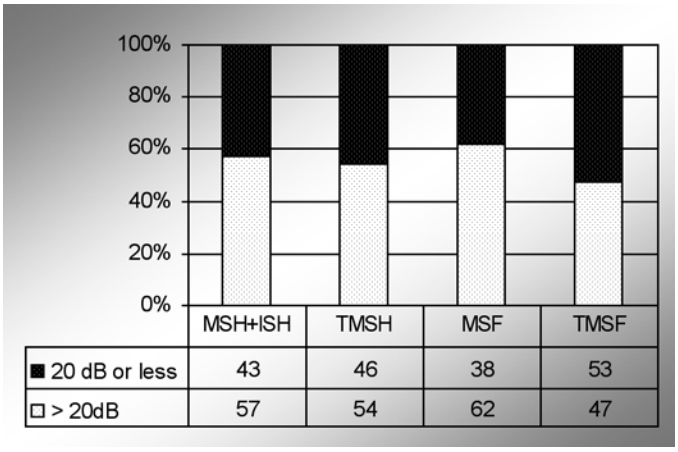


Figure 1. Types of ossicular reconstruction techniques, A – incus to stapes head (ISH), B – malleus to stapes head (MSH), C – tympanic membrane to stapes head (TMSH), D – malleus to stapes footplate (MSF), E – tympanic membrane to stapes footplate (TMSF).

improving to 50 and 49 dB HL, 20 dB HL higher than the mean pure tone thresholds at 0.5, 1 and 2 kHz frequencies. These values were about 10 dB HL higher than what is expected among cases with conductive hearing loss. It should be noted that the variability in mean values of both groups were wide and may account for these discrepancies.



Not statistically significant

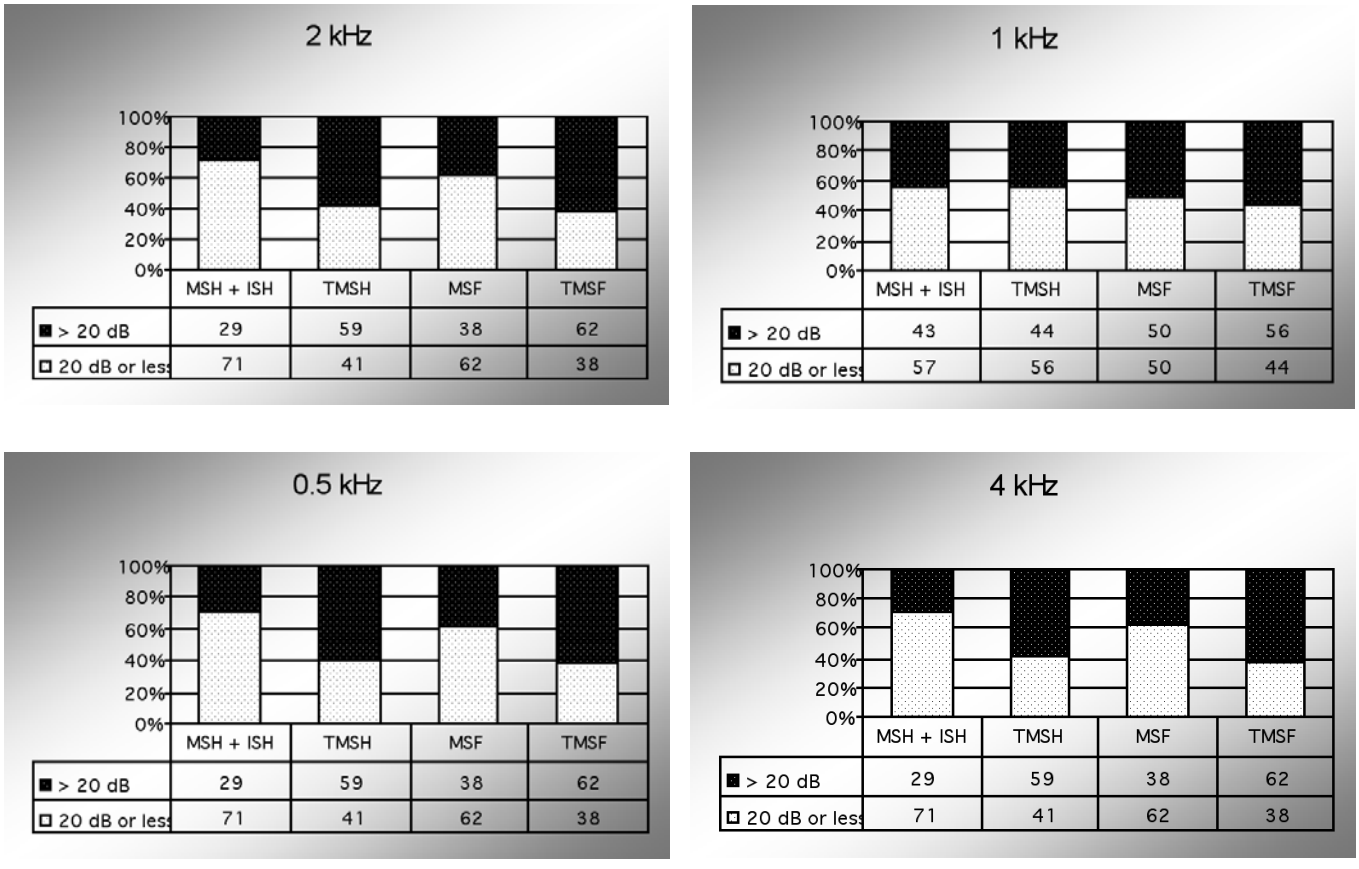
Figure 2. Postoperative PTA-ABG of patients according to type of ossicular connection, intact (MSH+ISH, n=7, TMSH, n=61) and absent stapes superstructure (MSF, n=8, TMSF, n=34).

Discussion

When the surgical option for chronic otitis media is limited to a one-stage procedure, the major aim is to establish a "safe" ear. Without an accompanying reconstructive procedure, the postoperative hearing results are disappointing.[6] The results show one-stage procedure need not be aimed at disease eradication alone. In more than 50% of cases, satisfactory hearing results with air-bone gap of 20 dB HL or less may be achieved with one-stage tympano-mastoidectomy even if the case mix includes patients with or without cholesteatoma, with or without discharge. The results obtained with one-stage procedure were not markedly different from those with staged procedure as previously reported.[7-10]

Autografts are good ossicular materials with low extrusion rate and good long term survival rate even in cholesteatoma cases.[11-13] The low perforation rate, ossicular graft extrusion rate and cholesteatoma recurrence rate validate these findings. Cholesteatoma recurrence rate was less than 5%, similar to other studies[14]. Better exposure and disease removal associated with canal-down mastoidectomy may explain these favorable results.[14]

The presence of the stapes superstructure favored chances of hearing improvement, similar to previous reports[7,10] due to better stability of the ossicular connection. Comparable hearing results were obtained with TMSH and



Not statistically significant

Figure 3. Postoperative PTA-ABG at 0.5, 1, 2, and 4 kHz of patients according to type of ossicular connection, intact (MSH+ISH, n=7, TMSH, n=61) and absent stapes superstructure (MSF, n=8, TMSF, n=34).

TMSF ossicular connection, indicating that the tympanic membrane graft may be used as a reasonable alternative whenever the angle between the malleus long process and stapes is deemed unstable. It must be noted that assignment of patients to either malleus to stapes (MSH or MSF) or tympanic graft to stapes connection (TMSH or TMSF) was done intraoperatively depending on the angular orientation of the malleus handle to the stapes head or footplate. The comparison made in this study was not meant to establish the equivalence of one technique with the other but to emphasize the point that the tympanic membrane to stapes connection may be considered as an option whenever the malleus to stapes connection is deemed unstable intraoperatively.

Hearing improvement may be obtained either with canal-up or canal-down tympano-mastoidectomy. Our experience showed that there were more cases who obtained postoperative ABG 20 dB or less with canal-down mastoidectomy, contrary to the opinion of other authors.[9] We can only hypothesize that the canal-down procedure provided better control of variables relevant to hearing improvement such as better elimination of pathology particularly in cholesteatoma cases, wider access needed for reconstruction, and wider exposure for proper placement of the ossicular graft. One of the reported changes in hearing results associated with canal-down procedures is the loss of the natural acoustic resonance resulting from loss of the ear canal and the enhancement of resonance higher than 1.5 kHz.[9] Our results concurred with these observations notably with greater improvement in mean postoperative ABG at 2 and 4 kHz than at 0.5 and 1 kHz frequencies. Since the results were reported as mean values of postoperative ABG, we must take note that these observed improvements may not be due to postoperative improvement in air conduction but may also be due to worsening of postoperative bone conduction.

All cases were performed by a single surgeon, removing the variability attributed to different surgeons. The cases were done over a 16-year period, with the tendency to find better results among cases done later than in earlier years of surgery due to improvement along the learning curve. While it is customary to analyze hearing results based on pure tone audiogram, there is no universal agreement on how best to summarize hearing results[5]. Conclusions derived from these results are limited and not essentially applicable for individual patients.

Conclusion

One-stage surgery for chronic otitis media using autologous tissues is a reasonable alternative to accomplish the dual aims of tympanoplasty. The complication rate is low while postoperative hearing results are not markedly different from results obtained with two-stage procedures. Canal-down or canal-up mastoidectomy may both be carried out depending on the nature of the pathology without prejudice to the short term postoperative hearing results. Simplified ossicular connection may be done to connect the stapes with either the malleus or the tympanic membrane graft to improve hearing. Improvements in procedures and techniques should be aimed not only to eradicate disease and improve hearing but also to avoid further injury to the cochlea.

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