

ORIGINAL ARTICLE

Epitympanoplasty with Mastoid Obliteration Technique in Middle Ear Surgery: 12-Year Result

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Objective; The aim of this study was to evaluate the usefulness of epitympanoplasty with mastoid obliteration (EMO). Canal wall down (CWD) mastoidectomy can secure a good surgical field, allowing lesions to be eliminated. However, cavity problems inevitably occur. Canal wall up (CWU) mastoidectomy can avoid cavity problems, but complete removal of lesions is more difficult, and retraction pockets can form. The goal of EMO is to obtain optimal surgical results as in CWD surgery while avoiding cavity problems. Here we introduce the surgical techniques of EMO and discuss the results.

Materials & Methods; A retrospective case review of 401 ears in 398 patients was performed. The EMO technique consists of a simple mastoidectomy, atticotomy, epitympanectomy and epitympanoplasty with mastoid obliteration. The results of 12 years of surgery performed between December 1994 and June 2007 were analyzed and the outcomes of the procedures were evaluated.

Results; Postoperative results from 401 ears were evaluated. The mean age was 42 years, and the mean follow up period was 30 months. There was a 6.2 (7.8 dB hearing gain ($p<0.05$), and the tympanic cavity cholesteatoma recurrence rate was 4.2%. In 0.9 % of cases, there was a residual mastoid cholesteatoma, and these cases underwent revision CWD surgery. There was no attic retraction or retraction pocket formation.

Conclusion; Using EMO techniques, we can eliminate the disadvantages of CWD and CWU mastoidectomy. Cavity problems can be avoided and retraction pocket formation can be prevented. EMO is a useful technique and can be considered before CWD surgery.

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The most effective surgical method for treating middle ear cholesteatoma and chronic otitis media has been debated for decades, especially with regard to differences in efficacy between canal wall down (CWD) and canal wall up (CWU) mastoidectomy^[1,2]. In cholesteatoma surgery, eradication of the cholesteatoma and prevention of disease recurrence are the most important factors^[3]. Postoperative care, including cavity problems and the wearing of hearing aids, also needs to be considered^[3]. The technique of epitympanoplasty with mastoid obliteration (EMO) is aimed at obtaining optimal surgical results as in CWD^[4] surgery while

avoiding cavity problems, to obtain the advantages of both CWD and CWU. This study presents the results of 12 years of EMO surgery with a detailed description of the surgical concept, indications, and technique.

Materials & Methods

In this retrospective case review, we studied 401 ears in 398 patients (194 men and 204 women) who visited the Department of Otorhinolaryngology, Head and Neck Surgery, at Dong-A University Hospital. The surgeries were performed between December 1994 and June 2007.

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The preoperative inclusion criteria for EMO were a cholesteatoma with attic destruction, a sclerotic mastoid with poor Eustachian tube function and an intact posterior canal wall. Other middle ear diseases such as chronic otitis media without cholesteatoma were included, but the latter two criteria were applied equally.

The detailed procedures of the EMO technique consist of a simple mastoidectomy, atticotomy, epitympanectomy and epitympanoplasty with mastoid obliteration. A retroauricular skin incision is made, and a musculoperiosteal flap is elevated. Conchal cartilage is harvested from the auricle using a posterior approach. As much bone chip as possible is harvested from the mastoid cortex using a chisel and hammer. After a simple mastoidectomy, an epitympanectomy is done, removing the scutum and widening the canal. The canal wall is widened as far as possible but ensuring preservation of the posterior wall of the external auditory canal. In most cases, the malleus head and incus are removed. At the end of these steps, the middle ear structures can be visualized via the surgical microscope as much as in a CWD mastoidectomy. After completely removing the attic disease, an epitympanoplasty is done with cartilage chips and slices, reforming the attic and filling it with the cartilage to leave no space for aeration. Temporalis fascia or perichondrium is grafted over the cartilage

graft in the new attic. After the epitympanoplasty, only the mesotympanum and the hypotympanum remain as spaces for air ventilation of the middle ear. The passage between the tympanic cavity and mastoid cavity is blocked with one large cartilage slice, and the mastoid is obliterated with cartilage chips and bone chips, in that order. The periosteal flap is repositioned, and sutures are inserted layer by layer (Figure 1).

The results over 12 years were analyzed, and the outcomes of the procedure were evaluated for hearing results and complications.

Results

The preoperative diagnoses were 335 cases of chronic otitis media with cholesteatoma (83.5%), 37 cases of adhesive otitis media (9.2%), 26 cases of chronic otitis media without cholesteatoma (6.5%), and three cases of cholesterol granuloma (0.8%). Among these, 69 cases were revision cases. Before EMO, the patients had undergone CWU surgery. The mean age of the group was 42 years, ranging from 12 to 67 years. The mean follow-up period was 30 months, ranging from six to 141 months.

Postoperative hearing results were analyzed in 184 ears. The type of ossiculoplasty is summarized in Table 1. Among the tympanoplasty categories, 159 tympanization (tympanoplasty type 0) cases did not undergo a second-stage operation for ossiculoplasty.

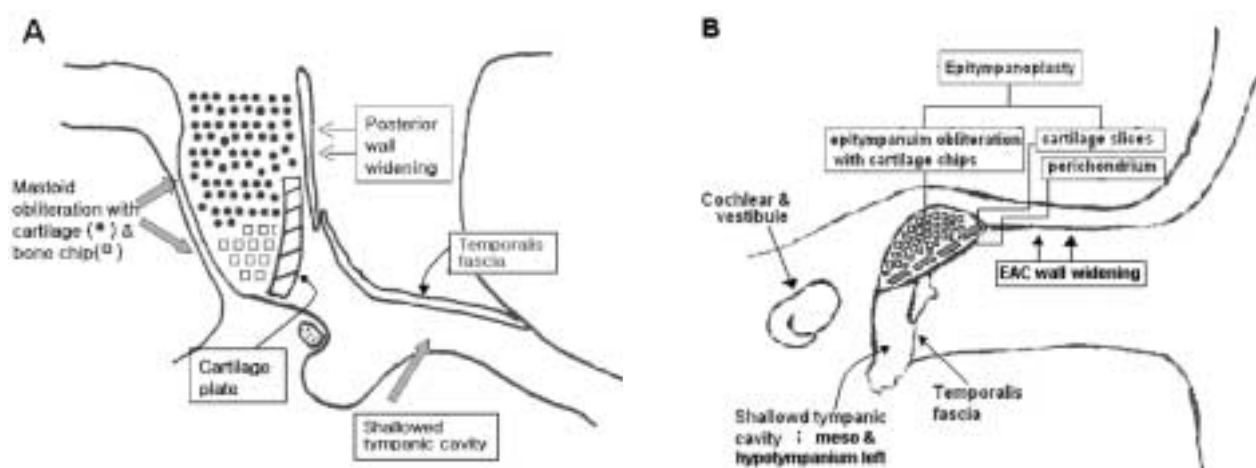


Figure 1. Postoperative cross sectional drawing of EMO : A) axial view, B)coronal view.

In A, posterior EAC wall is drilled and EAC is widened. After tympanomastoid block with cartilage plate, mastoid is obliterated with inner cartilage and outer bone chip. In B, epitympanum is obliterated with cartilage chips after epitympanectomy, and then outer surface is covered with cartilage slices and perichondrium, completing epitympanoplasty.

Table 1. Type of ossiculoplasty

Type	Cases
Tympanoplasty type I	15 (8.0 %)
Short collumerization	125(66.8%)
Autologous incus	30(16.0%)
Hydroxyapatite PORP	95(50.8%)
Long collumerization	44(23.5%)
Autologous incus	3(1.6%)
Hydroxyapatite TORP	41(21.9%)
Fitted incus	2(1.1%)
Tympanoplasty type IV	1(0.5%)
Total	187(100%)

Most of these patients already had severe sensorineural hearing loss, so a second-stage ossiculoplasty had little role in hearing improvement. These patients were excluded from the hearing data analysis.

The majority of patients had mixed hearing loss: preoperative air conduction was 52.6 ± 15.36 dB, and preoperative bone conduction was 20.4 ± 23.16 dB. Postoperative bone conduction was nearly same as the preoperative one. Postoperative air conduction was 46.4 ± 14.32 dB, a gain of 6.2 ± 7.8 dB ($p < 0.05$). This is not a very good result with regard to hearing, but in most cases, the preoperative disease was severe with ossicular chain disruption, cholesteatoma matrix around the stapes and mixed hearing loss. Therefore, disease control becomes the primary goal of the surgery, not restoration of hearing.

There were 83 complications in 76 patients (19%). Postoperative wound infections and otorrhea were controlled within a few months after surgery using

outpatient clinic-based dressings and oral antibiotics. The remaining complication rate was 11.2%. Residual tympanic cavity cholesteatoma was detected in 17 cases, all of which were treated in the outpatient clinic with a simple endaural procedure. In four cases, there was residual mastoid cholesteatoma, and all of these patients underwent CWD revision surgery (Table 2). Overall treatment flow chart is shown in Figure 2.

Postoperative temporal bone computed tomography (TBCTs) were taken in several cases. In the TBCTs, the reconstructed epitympanum is seen to have soft tissue density with formation of a shallow tympanic cavity (Figure 3). The scutum is absent, and the attic is filled with cartilage, leaving no space for a retraction pocket. In the picture of postoperative tympanic membrane, the reconstructed epitympanum is seen with no attic resorption or retraction pocket formation (Figure 4). In early surgeries, we used chopped cartilage only, which caused no problems but gave a coarse appearance. We now cover the cartilage chips with thin cartilage slices to give a smooth surface.

Table 2. Postoperative complications.

Postoperative complications	Cases
Postoperative infection (wound infection & otorrhea)	33(8.2%)
Tympanic cavity residual cholesteatoma	17(4.2%)
Hydroxyapatite ossicular prosthesis protrusion	9(2.2%)
Tympanic membrane perforation	20(4.9%)
Mastoid cavity residual cholesteatoma	4(0.9%)
Total	83(20.6%)

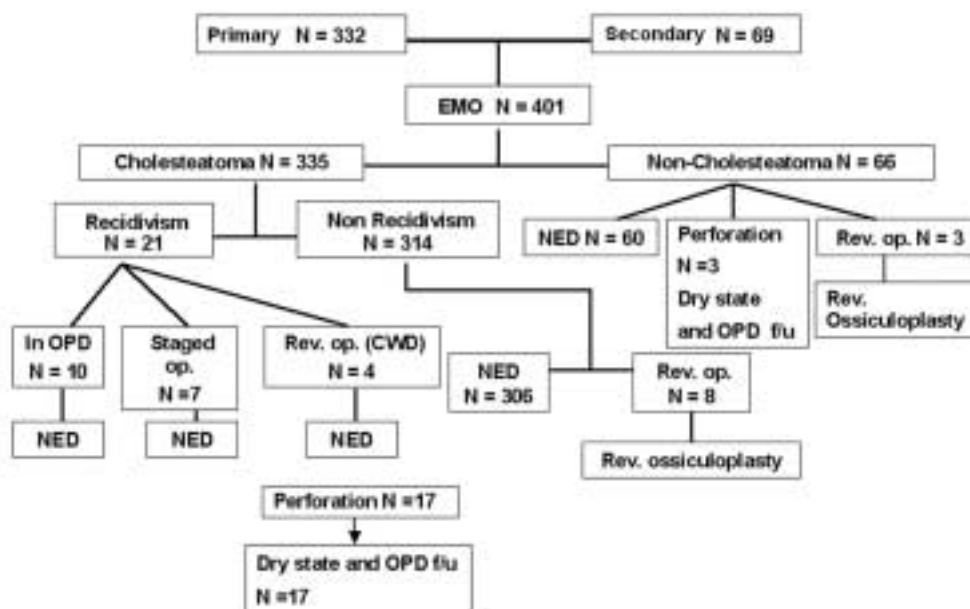


Figure 2. Treatment of postoperative complications: Total recidivism cases were 21 cases. Tympanic cavity residual cholesteatoma was detected in 17 cases and 10 cases were treated in the out patient clinic. The other 7 cases were detected during the subsequent staged operation and treated without any further problems. 4 cases of mastoid remnant cholesteatoma underwent a revision canal wall down mastoidectomy operation. There were a total of 20 cases with tympanic membrane perforation. All were treated in the outpatient clinic. *N*: number; *Primary N*: patients who underwent first operation; *Secondary N*: patients who underwent revision operation; *CWD N*: patients who had previously underwent canal wall up mastoidectomy, and underwent revision surgery at this time; *EMO*: epitympanoplasty and mastoid obliteration; *Rev*: revision; *Op*: operation; *f/u*: follow up; *NED*: no evidence of disease; *CWD*: canal wall down mastoidectomy; *OPD*: out patient department

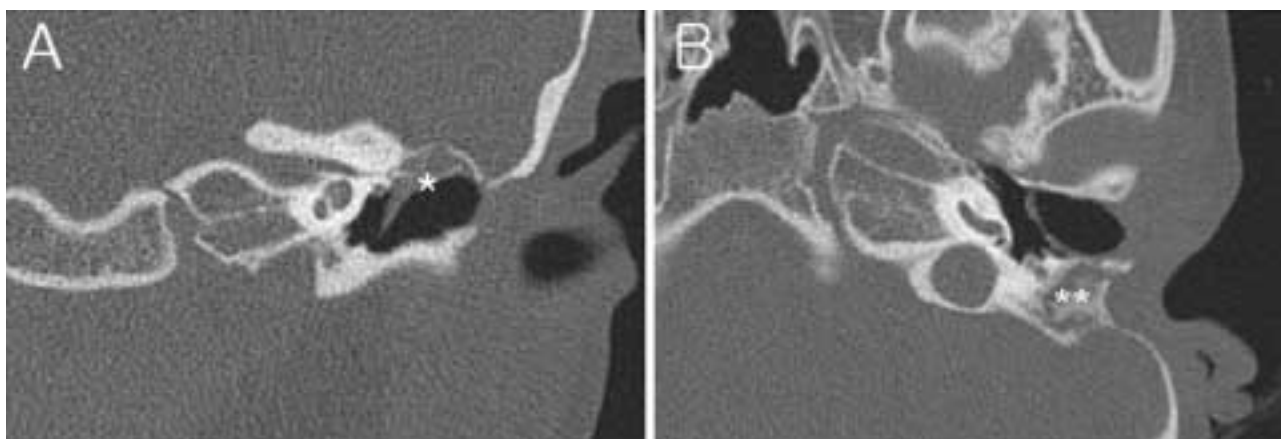


Figure 3. Postoperative TBCTs: A) axial view & B) coronal view. The reconstructed epitympanum (*) is seen to have soft tissue density, and a shallow tympanic cavity has been formed. Obliterated mastoid (**) is seen with a soft tissue density with inner cartilage and outer bone chip.

Discussion

Optimal surgical treatment for managing cholesteatoma has remained in dispute for a very long time. There are many articles comparing the advantages and disadvantages of CWU and CWD

mastoidectomy procedures for addressing middle ear pathology^[1,2]. Previously, CWD surgery has been the gold standard in cholesteatoma surgery^[3,4]. CWD surgery is better for complete eradication of the disease, and the recurrence rate is lower than for CWU

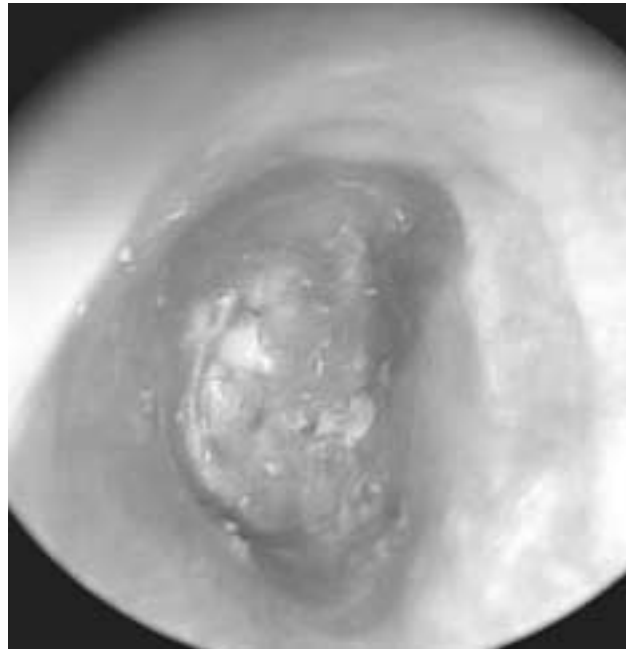


Figure 4. Postoperative right TM photos taken at 9 months postoperatively. Epitympanoplasty was done with cartilage chips and slices. Big cartilage slices are used to cover the outer surface of the attic, making smooth appearance.

surgery^[2]. However, because of problems with the CWD technique, the CWU technique is often used. By using CWU surgery, issues such as cavity problems, bowl infections, difficulties with postoperative fitting of hearing aids and precautions around water to prevent dizziness from stimulation of the semicircular canal can be solved. However, the recurrence rate of cholesteatoma is much higher. Therefore, a variety of methods have been developed to make up for the weak points of each technique.^[5-8,10-12]

In this study, we examined a hybrid of CWD and CWU surgeries with slightly more similarity to the CWU technique. The most encouraging result was the low recurrence rate. Of 401 ears, there were 332 ears with cholesteatoma, and the recurrence rate was 6.3% (21 cases). Among these, there were four cases of residual mastoid cholesteatoma. These occurred only in the early years of using this surgical technique and are clustered in the five years from 1994, when we started to use the epitympanoplasty and mastoid obliteration technique. The mastoid obliteration technique cannot be used in cases where complete intraoperative removal of a mastoid cholesteatoma is questionable^[10,13,14]. No further

mastoid remnant cholesteatoma was discovered after these early cases, which could be attributed to trial and error or imperfections in performing the technique initially. If we exclude those four cases, the total recurrence rate is reduced to 5.1%.

For successful cholesteatoma surgery, complete removal of the disease is important to prevent recurrence, as is prevention of retraction pocket formation in the attic^[6,8,15]. Our technique of epitympanoplasty and mastoid obliteration has strong advantages in both regards.

The most serious disadvantage of CWU surgery is limitation of the surgical view, which makes it difficult to remove the cholesteatoma completely^[3,4,7]. The sinus tympani, lateral epitympanum, stapes footplate and other sites are critical points to check for any remaining cholesteatoma^[3,7]. Meticulous elimination of the cholesteatoma matrix is essential, and an adequate surgical view is essential for viewing every important area in the tympanic cavity and mastoid cavity. In our technique, we performed an epitympanectomy and widened the posterior canal wall. With this method, nearly the same surgical field can be obtained as in

CWD surgery. Therefore, complete removal of the cholesteatoma is possible, and cavity problems can be avoided.

To treat attic destruction, we used epitympanectomy and epitympanoplasty. The epitympanectomy is needed to obtain a broad surgical view, and in the reconstruction of the attic, we obliterated the epitympanum with cartilage. Scutum reconstruction with the formation of a new aerated attic can also be used^[3,7].

Postoperative attic retraction pockets are a critical issue because of the possibility of their progression to recurrent cholesteatoma^[5,6,8,11,15]. Retraction pockets can be caused by negative pressure in the middle ear and mastoid cavity, and in cases with stenotic Eustachian tubes, retraction pocket formation happens more frequently; however, obliteration of the attic can eliminate these potential spaces. We used epitympanoplasty in order to obliterate the potential space for retraction pocket formation in the attic. At the same time, the mastoid is obliterated to prevent negative pressure in the mastoid. We obliterated the attic with small cartilage chips, trimmed the outer surface of the obliterated attic, making it smooth with a covering of larger cartilage slices, and then covered the raw surface with perichondrium-steps that together make up the epitympanoplasty. There was no postoperative formation of a retraction pocket in 401 ears.

There is continuous gas exchange and gas absorption in the mastoid mucosa, and continuous air ventilation is maintained via patent Eustachian tubes. However, in most cases of cholesteatoma or chronic otitis media, Eustachian tube function tends to be poor, and negative pressure may result from increased nitrogen absorption across the diseased mastoid mucosa^[5,16]. To prevent this, exenteration of the mastoid mucosa is important in the rehabilitation of a poorly aerated ear. However, with poor Eustachian tube function, exenteration of the mastoid mucosa is not sufficient to prevent mastoid negative pressure and to prevent retraction pocket formation^[5,8]. Mastoid obliteration

can further reduce the air burden of the stenotic Eustachian tube and reduce the risk of negative pressure formation^[5,11-14].

A normal mastoid cavity acts as an air reservoir^[5,16]. After mastoid obliteration, abrupt rises or falls in air pressure can cause trauma in the middle ear. However, with poor Eustachian tube function, the pressure change ranges observed in the middle ear cavity are narrow compared with the ranges observed with patent Eustachian tubes. Therefore, poor Eustachian tube function is an important preoperative consideration in epitympanoplasty and mastoid obliteration.

A variety of materials have been used for mastoid obliteration^[9,10,13,14]. When beginning to use epitympanoplasty and mastoid obliteration in 1994, we used abdominal fat as the obliterating material. However, fat tends to be absorbed over time, producing postauricular dimpling. Therefore, we currently use cartilage and bone chips harvested from the auricular cartilage and temporal cortical bone respectively. The cartilage is used in the inner portion first, then the bone chips are used over the cartilage to completely fill the mastoid cavity.

After EMO, the mastoid and epitympanum are obliterated, which gives advantages in postoperative care. There was postoperative tympanic cavity cholesteatoma recurrence in 4.2% of cases (17 cases); however, as the mastoid cavity and attic were already obliterated, tympanic cholesteatoma cannot grow into those spaces. Therefore, even if a cholesteatoma recurs, it is confined to the mesotympanum and hypotympanum, where the surgeon can easily view and manipulate the disease using a transcanal approach in the outpatient department. This can decrease the need for revision surgery for recurrent cholesteatoma and can lower the burden on the surgeon and the patient.

In advanced cholesteatoma, most patients have mixed hearing loss, and a hearing aid is needed for postoperative hearing rehabilitation. A strong advantage of the epitympanoplasty and mastoid

obliteration technique over the CWD mastoidectomy is that postoperative fitting of completely-in-the-canal type hearing aids is possible because the posterior canal wall is preserved.

Conclusion

With the EMO technique, we can make up for the disadvantages of CWD and CWU. After epitympanoplasty and mastoid obliteration, all of the cavity-related problems seen with CWD surgery can be avoided without sacrificing the broad surgical view, and the recurrence rate is lower, as in CWD surgery. In attic cholesteatoma with sclerotic mastoid and poor Eustachian tube function, the epitympanoplasty and mastoid obliteration technique can be considered before CWD surgery.

References

1. Smyth GD. Canal wall for cholesteatoma: up or down? Long-term result. *Am J Otol* 1985; 6:1-2
2. Syms MJ, Luxford WM. Management of cholesteatoma: status of the canal wall. *Laryngoscope*. 2003; 113:443-8
3. Meuser W. The exenterated mastoid: A problem of ear surgery. *Am J Otol* 1985; 6:323-5
4. Hulka GF, McElveen JT Jr. A randomized, blind study of canal wall up versus canal wall down mastoidectomy determining the differences in viewing middle ear anatomy and pathology. *Am J Otol* 1998; 19:574-8.
5. Gantz BJ, Wilkinson EP, Hansen MR. Canal wall reconstruction tympanomastoidectomy with mastoid obliteration. *Laryngoscope* 2005; 115:1743-40.
6. Yanagihara N, Gyo K, Sakai Y, Hinoihara Y. Prevention of recurrence of cholesteatoma in intact canal wall tympanoplasty. *Am J Otol* 1993; 14:590-4.
7. Haginomori S, Takamaki A, Nonaka R, Takenaka H. Residual cholesteatoma: incidence and localization in canal wall down tympanoplasty with soft-wall reconstruction. *Arch Otolaryngol Head Neck Surg*. 2008; 134:652-7.
8. Hinoihara Y, Yanagihara N, Gyo K. Surgical treatment of retraction pocket with bone pate: scutum plasty for cholesteatoma. *Otolaryngol Head Neck Surg* 2005; 133:625-8.
9. Cevat U. Canal wall reconstruction and mastoid obliteration with composite multi-fractured osteoperiosteal flap. *Eur Arch Otorhinolaryngol* 2006; 263:1082-86.
10. Takahashi H, Iwanaga T, Kaieda S, Fukuda T, Kumagami H, Takasaki K, Hasebe S, Funabiki K. Mastoid obliteration combined with soft-wall reconstruction of posterior ear canal. *Eur Arch Otorhinolaryngol*. 2007 Aug; 264:867-71.
11. Mehta RP, Harris JP. Mastoid obliteration. *Otolaryngol Clin N Am* 2006; 39:1129-42.
12. Yung M, Smith P. Mid-temporal pericranial and inferiorly based periosteal flaps in mastoid obliteration. *Otolaryngol Head Neck Surg* 2007; 137:906-12.
13. Dornhoffer JL, Smith J, Richter G, Boeckmann J. Impact on Quality of life after mastoid obliteration *Laryngoscope*. 2008; 118:1427-32.
14. Duckert LG, Makielski KH, Helms J. Management of anterior epitympanic cholesteatoma: expectations after epitympanic approach and canal wall reconstruction. *Otol Neurotol*. 2002; 23(1):8-13
15. Sade J. Treatment of retraction pockets and cholesteatoma. *J Laryngol Otol* 1982; 96:685-704
16. Ars B, Wuyts F, Van de Heyning P, Miled I, Boqers J, Van Marck E. Histomorphometric study of the normal middle ear mucosa. Preliminary results supporting the gas-exchange function in the postero-superior part of the middle ear cleft. *Acta Otolaryngol* 1997; 117:704-7