



Original Article

Preservation of Post Operative Bone Conduction Hearing after Labyrinthine Fistula Repair in Chronic Otitis Media with Cholesteatoma: A Review of 23 Cases

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OBJECTIVE: Labyrinthine fistula can lead to hearing loss, dizziness, and intracranial complications. The management of labyrinthine fistula is controversial, and hearing preservation represents a major challenge. In this study, the authors sought to identify factors related to postoperative bone conduction threshold.

MATERIALS and METHODS: This retrospective study was conducted using the clinical records of 23 cases operated on for chronic otitis media with cholesteatoma from 2004-2011. Symptoms, physical examination findings, fistula test results, pre-/postoperative bone conduction results, and high-resolution temporal bone computed tomography and intraoperative findings were evaluated.

RESULTS: The most common symptom at presentation was hearing disturbance, and the most commonly affected site was the lateral semicircular canal. High-resolution temporal bone computed tomography was found to be much more precise and effective at fistula detection than the fistula test.

CONCLUSION: Postoperative hearing results are not affected by fistula location, size, or number. Complete resection at the site of a cholesteatomatous labyrinthine fistula is the treatment of choice.

KEY WORDS: Labyrinthine fistula, hearing, bone conduction, cholesteatoma

INTRODUCTION

Proliferation of squamous epithelium in the middle ear caused by chronic otitis media with cholesteatoma results in the accumulation of keratinous materials; as a result, complications arise. Complications due to bone destruction include conductive hearing loss caused by the destruction of ossicles, facial nerve palsy, and cerebrospinal fluid leakage due to dural rupture, and labyrinthine fistula. In addition to the complications of cholesteatoma, in cases of transverse fracture, labyrinthine fistula sometimes occurs at temporal bone fractures. Labyrinthine fistula is bony open state of the inner to middle ear caused by bony erosion of semicircular canals and the cochlear ^[1].

Labyrinth fistula caused by cholesteatoma has a frequency of 4-12% ^[1]. In most cases, the fistula is located in horizontal semicircular canals as a complication of cholesteatoma, but it is also encountered in vertical semicircular canals and the cochlear ^[2]. The main symptoms of patients with a labyrinthine fistula are dizziness and hearing loss. If patients with a labyrinthine fistula caused by cholesteatoma are left untreated, intratemporal and intracranial complications such as brain abscess, bacterial meningitis, and labyrinthitis may occur. Accordingly, aggressive treatment is needed in such patients. However, no guidelines have been issued regarding the preservation of hearing when labyrinthine fistula surgery is controversial.

Many researchers have tried to repair a labyrinthine fistula completely at the time of surgery ^[3] and have tried to remove the secondary at the time of surgery to leave part of the cholesteatoma matrix ^[4, 5]. Dornhoffer et al. ^[6] have reported that a transvenous corticosteroid injection just before removal of the cholesteatoma matrix is effective at conserving hearing.

The aim of this study was to identify the factors that affect postoperative bone conduction in labyrinthine fistula patients with chronic otitis media and cholesteatoma with respect to fistula size, number, and location, and to analyse pre- and postoperative bone conduction hearing thresholds.

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Submitted: 27.09.2013 Revision Received: 14.01.2014 Accepted: 01.02.2014

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MATERIALS and METHODS

Patient Selection and Analysis

This retrospective study was conducted on 23 patients diagnosed with labyrinthine fistula due to chronic otitis media with cholesteatoma who underwent fistula repair at a university-based tertiary hospital between 2005 and 2011. The main symptoms were investigated and physical examinations of tympanic membranes, the fistula test, and high-resolution temporal bone computed tomography (CT) were performed at the time of admission. In addition, fistula locations and sizes were determined. Preoperative and postoperative bone conduction testing were performed and the results were analysed with respect to fistula degree and location.

Patients also underwent pure tone hearing testing preoperatively and at 6 months postoperatively. Hearing threshold was defined as the average pure tone threshold at 0.5, 1, 2, and 3 kHz. If the average pure tone threshold increased or decreased by more than 10 dB postoperatively, hearing was deemed to have worsened or improved, respectively.

Operative Procedure

In all cases, surgery was performed using the retroauricular approach under general anaesthesia. Cholesteatoma was removed completely except at fistula sites. According to middle ear status and disease severity, we performed canal wall up or down mastoidectomy. Finally, we removed the cholesteatoma matrix covering the labyrinthine fistula area and closed the fistula site with soft tissue and fascia. The cholesteatoma matrix was removed completely in all cases. If necessary, we carried out ossicular reconstruction.

Statistical Analysis

Fisher's exact test and chi square test were used for Group comparisons. *p* values of <0.05 were considered statistically significant.

RESULTS

Medical records of 23 patients were reviewed. There were 10 males and 13 females. The mean patient age at the time of surgery was 55.6 years (range 37–67). The main symptoms at the time of admission were: hearing loss (22/23); ear fullness (14/23); otorrhoea (14/23); headache (2/23); tinnitus (2/23); and facial paralysis (1/23; Figure 1).

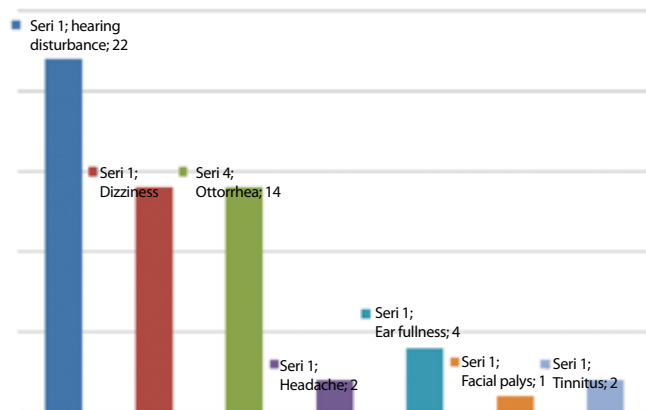


Figure 1. Histogram symptoms

To diagnose labyrinthine fistula, we performed temporal bone CT and the fistula test. The latter test produced positive findings in four of the 23 cases. Of these four, three had a fistula of >2 mm. Temporal bone CT allowed the presence of a fistula to be confirmed in all 23 cases (Table 1). Preoperative bone conduction hearing thresholds were poor and dependent on fistula size. (Pearson's correlation coefficient=0.312, *p*=0.148; Figure 2).

Canal wall down mastoidectomy was performed in 20 cases and canal wall up mastoidectomy in the other three. No postoperative complication or cholesteatoma recurrence was observed after surgery. The mean follow-up period was 16 months (range 3–60 months). The labyrinthine fistula was located in the lateral semicircular canal in 19 cases, in the posterior semicircular canal in 1 case, and in the vestibule in 1 case each. Multiple fistulas were present in the other two cases, involving the lateral and posterior semicircular canals (Figure 3).

The patients that complained of preoperative dizziness all achieved postoperative improvement. Bone conduction hearing threshold improved in only one patient. The fistula was located in the vestibule in this patient. In eight cases, bone conduction threshold was reduced by >10 dB. In the other 14 patients, no bone conduction threshold change was observed after surgery. Two cases were deaf at admission and no hearing improvement occurred after surgery (Table 2). Fistula size (>or<2 mm), location, number, and surgical technique

Table 1. Detection rate of the fistula test for labyrinthine fistula

	Fistula test +	Total -	
Size			
<2 mm	1 (4.3%)	11 (47.8%)	12 (52%)
>2 mm	3 (12.9%)	8 (34.7%)	11 (48%)
Total	4	19	23
Site			
LSCC	4 (17.3%)	17 (73.9%)	21 (91.2%)
Other site	0	2 (8.7%)	2 (8.7%)
Total	4	19	23

LSCC: lateral semicircular canal

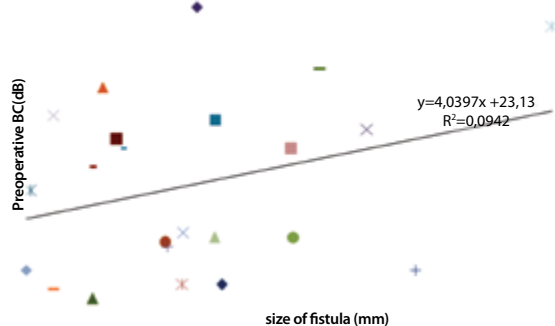


Figure 2. Distribution of preoperative bone conduction

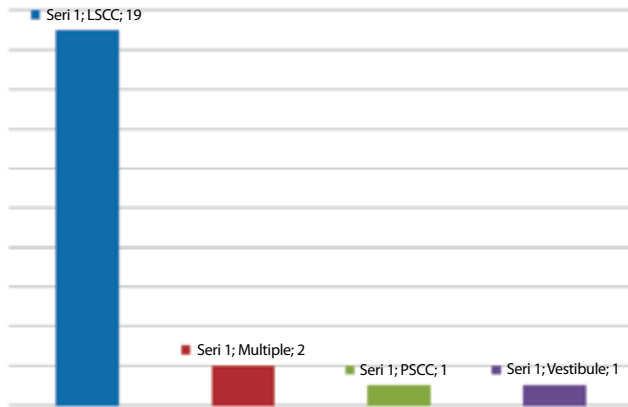


Figure 3. Sites of labyrinthine fistula involvement
LSCC: lateral semicircular canal; PSCC : posterior semicircular canal

Table 2. Relationships between changes of bone conduction and fistula size, location, and number and operation type

	Fistula test	Total		
	+	-		
Fistula size	>2 mm	7	4	p=1.000
	≤2 mm	7	5	
Fistula location	LSCC	12	9	p=0.0502
	Other	2	0	
Fistula number	Single	14	7	p=0.142
	Multiple	0	2	
Operation type	CWU	1	2	p=0.538
	CWD	16	4	
Closed cavity		2	1	
Open cavity		13	7	

LSCC: Lateral semicircular canal; CWU: Canal wall up mastoidectomy; CWD: Canal wall down mastoidectomy

were not found to significantly affect postoperative bone conduction threshold (Table 2).

DISCUSSION

Cholesteatoma should be treated aggressively in chronic otitis media with cholesteatoma, because of the possibility of serious complications such as labyrinthine fistula and facial nerve paralysis induced by bone destruction or ossicular chain erosion. Fortunately, the incidences of such complications have been reduced by early treatment and the use of antibiotics, but it should be noted that labyrinthine fistula may occur without symptoms. Many studies have been conducted on the frequency of labyrinthine fistula caused by cholesteatoma, and although findings differ, reported frequencies of are ~7% for patients with chronic otitis media with cholesteatoma [7].

According to previous research, 70-80% of labyrinthine fistulas caused by cholesteatoma are located in the horizontal semicircular canal [5,8], and the frequencies of fistula in the superior and posterior

semicircular canals are both around 5% [9]. Quaranta et al. [10] found that most fistulas occurred in the horizontal semicircular canal, with prevalences in the superior and posterior semicircular canals of 6% and 2%, respectively, and that fistulas of the promontory and oval window occurred with prevalences of 6.9% and 7.7%, respectively. Furthermore, fistulas of the oval window or promontory have been reported to be poor prognostic factors for bone conduction hearing after surgery.

The fistula test can be performed easily on an outpatient basis, but its diagnostic sensitivity is only 30-60%; thus, its findings are inadequate to confirm diagnosis [2]. On the other hand, temporal bone CT has an overall sensitivity of 75%, and if the thickness of CT is less than 1 mm, its sensitivity exceeds 90% [11]. In the present study, only four positive fistula test results were obtained among the 23 patients (17.4%), but a fistula was confirmed by temporal bone CT in all patients.

Labyrinthine fistulas are classified by size and depth of invasion [10]. Size is defined as the diameter of bone erosion, and it has been reported that if the size of a fistula is less than 2 mm, the possibility of a damaged membranous labyrinth is low, because the cholesteatoma matrix is limited to the region of bone destruction [7]. On the other hand, Palva et al. and Quaranta et al. [10,12] found that the prognosis of labyrinthine fistula was correlated with invasion depth rather than fistula size. Dornhoffer et al. [6] classified labyrinthine fistulas by cholesteatoma penetration depth, and reported that range and depth of labyrinth penetration were associated with the preservation of post-operative bone conduction hearing. Subsequently, several researchers used this taxonomy to examine treatment results. Because this was a small retrospective study, we did not analyse the penetration depth. Nevertheless, our findings substantively concur with those of previous studies.

No treatment guidelines for labyrinthine fistula have been established. Thus, the issue remains controversial. There are two major treatment plans. The first involves closing the fistula with soft tissues by removing the cholesteatoma completely [4] and the second involves leaving only the portion covering the stoma at the primary operation, and closing the fistula and removing overlying residual cholesteatoma matrix at the secondary surgery [1]. Both methods are designed to prevent the deterioration of sensorineural hearing loss, but no consensus has been reached as to which method better preserves hearing.

Recent studies have shown that complete removal of the cholesteatoma matrix and fistula closure effectively control disease and preserve hearing [13,15]. According to these studies, if the matrix is left over the fistula site, the risk of labyrinthitis increases and sensorineural hearing loss or deafness may occur. Accordingly, in these studies, it was recommended that cholesteatoma be removed as completely possible during the primary operation. On the other hand, other authors have different opinions, and have recommended that surgeons should consider the staged operation when multiple fistulas are present, when fistulas are large, or when adhesion is severe. They also found that leaving the cholesteatoma matrix in situ did not induce sensorineural hearing loss or other complications [9,16]. In the present study, complete cholesteatoma removal and fistula repair were undertaken during the primary surgery.

The merits and demerits of canal wall up or down mastoidectomy are also topics of debate. Palve et al.^[3] suggested that canal wall down mastoidectomy be used for a labyrinthine fistula and Sanna et al.^[4] favoured consideration of canal wall down mastoidectomy for only a hearing ear, for multiple fistulas, and for revision surgery. Smyth et al.^[16] described the efficacy of the canal wall down technique for cholesteatoma with labyrinthine fistula, and found that the recurrence rate of cholesteatoma for the canal wall down technique was lower than that for the canal wall up technique. These authors proposed canal wall down mastoidectomy in cholesteatoma with a complication, such as labyrinthine fistula.

However, Morawski et al.^[20] recommended considering canal wall up mastoidectomy in labyrinthine fistula cases, and concluded that canal wall up or down mastoidectomy should be selected based on considerations of contralateral ear state, pneumatization of the mastoid antrum, and fistula depth and size. Nonetheless, the canal wall up procedure was favoured by these authors, because they found it easier to perform and safer than the canal wall down procedure^[17]. Furthermore, the consensus among recent studies on the topic is that the canal wall up technique should be used if possible, but that if it is impossible to approach pathological tissues or to eliminate the disease completely, canal wall down mastoidectomy should be used^[15]. In the present study, canal wall down mastoidectomy was conducted in 20 cases and canal wall up mastoidectomy in three, and we found no difference between these two Groups in terms of postoperative bone conduction hearing results or complications. In the present study, bone paste, temporalis muscle, fascia, or perichondrium was used for fistula repair, as in other studies^[17].

In previous studies, 12-30% of labyrinthine fistula patients presented in a state of deafness^[5,8]. In the present study, two patients (8.37%) were deaf on admission. Much research has been conducted on hearing decline caused by labyrinthine fistulas and residual hearing after surgery. Furthermore, the authors made it clear that no significant difference in hearing results was found between the complete cholesteatoma matrix removal group and the partial removal group. They concluded that total removal of the cholesteatoma matrix over a fistula did not affect hearing capacity but did reduce the risk of infectious labyrinthitis.

If all cholesteatoma tissue is removed without iatrogenic injury and the fistula is closed with soft tissue at the initial surgery, residual hearing may be preserved. On the other hand, bone conduction hearing may be preserved even when there is a fistula in a horizontal semicircular canal. Kobayashi et al.^[18] reported on the utriculoendolymphatic valve (membrana limitans) between the cochlear and vestibular labyrinth, based on the preservation of bone conduction hearing in cases with a horizontal canal fistula.

Some reports have claimed improvements in bone conduction hearing after surgery. In the present study, this occurred in one case, with a fistula in the vestibular area. In one report, evidence of hearing improvement was found after removal of a cholesteatoma causing labyrinthitis^[19]; in another, sound conduction in the middle ear improved after correction of the Cahart effect^[11].

Others have found that an intraoperative corticosteroid injection aids hearing preservation^[7,15,20]. At the time of operation, surgeons removed all cholesteatoma matrix (except that overlying fistulas), and injected corticosteroid (methyl prednisolone 500 mg, intravenous) 15 minutes prior to treating the fistula site and again 2 days after surgery. The authors reported the effectiveness of intraoperative corticosteroid on bone conduction hearing, but unfortunately, the number of cases was small and the control Group contained patients (diabetes or glaucoma patients) in whom corticosteroid was contraindicated. Evidently, large-scale comparative studies are needed to determine the effect of corticosteroid.

In conclusion, high-resolution temporal bone CT is more effective than the fistula test for identifying fistulas caused by cholesteatoma. In the present study, no significance could be attached to fistula size, location, number, or surgical method with respect to postoperative bone conduction hearing results. In our experience, the removal of all pathological tissues at the primary surgery with fistula closure, regardless of fistula position, size, or degree of penetration, provided an effective means of treating a labyrinthine fistula caused by cholesteatoma. This study is limited by a small cohort size and a short study period. Thus, we suggest that additional studies be conducted to identify factors that affect hearing results.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Institutional Review Board of Gachon University, Gil Medical Center.

Informed Consent: Written informed consent was not obtained due to the retrospective nature of this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - C.H.C.; Design - J.H.L.; Supervision - J.H.L.; Funding - J.H.L.; Materials - H.C.Y.; Data Collection and/or Processing - H.C.Y.; Analysis and/or Interpretation - J.H.A.; Literature Review - Y.W.K.; Writing - C.H.C.; Critical Review - J.H.L.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: This study was supported by a grant from the Gachon University, Gil Medical Center.

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