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Second Ear Surgery for Patients with Bilateral Otosclerosis: Recommended or not?

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Objective: To evaluate the benefits of second side stapes surgery.

Materials and Methods: From 1996 to 2012, a cohort study was conducted on patients with otosclerosis after stapes surgery at a tertiary referral center in Taiwan. Only patients with bilateral otosclerosis were included. Hearing outcomes after the first and second ear surgeries were analysed. Logistic regression analysis was used to control confounding factors of hearing outcomes. We correlated the post-operative AC averages of first- and second-operated ears in patients undergoing bilateral surgeries.

Results: Sixty-four operations were included (48 first and 16 second ear surgeries). There were no differences between first and second ear surgeries regarding the percentages of ears with post-operative ABG ≤10 dB and AC ≤30 dB (P > 0.05). For patients undergoing bilateral surgeries, the probability of symmetric hearing (interaural difference ≤10 dB) after second ear surgery (56%) was higher than that after the first ear surgery (19%, P = 0.028). A positive correlation existed between the post-operative AC averages of the first and second ear surgeries (Rho = 0.479, P = 0.030).

Conclusions: Surgery on the contralateral ear is effective and can be recommended not only because second ear surgery showed comparable hearing outcomes with first one, but also because it provided binaurally symmetric hearing. In particular, for patients with normal or socially serviceable hearing after first ear surgery, the probability of hearing success tended to increase following second ear surgery.

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Introduction

Otosclerosis, a primary focal disease involving the bony labyrinth,[1] is one of the most common causes of acquired conductive hearing loss in adult patients. Caucasians are the most affected race, with the prevalence of clinical otosclerosis 0.3-0.4%.[2,3] The treatment usually involves stapes surgery,[3-5] although an alternative approach of cochlear implantation to deal with hearing loss caused by otosclerosis has been developed.[6] In the past few decades, remarkable advances have been made in surgical techniques and prostheses to improve surgical outcomes.[7-9] The advances in surgical techniques and prostheses mean that stapes surgery is a well-defined, safe and effective treatment option in patients with otosclerosis.[10,11]

About 80% of patients with otosclerosis demonstrate bilateral involvement.[12,13] For patients with bilateral otosclerosis, being able to hear equally well in both ears may be the main expectation of stapes surgery. However, these patients subsequently face the dilemma of whether

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or not to undergo a second ear surgery following the first ear surgery. Concerns over second ear surgery are understandable as it exposes the patients to the risk of adverse consequences for a second time, including immediate or delayed post-operative total hearing and/or vestibular impairments.[12,14,15] In addition, compared with first ear surgery some surgeons have reported that second ear surgery cannot guarantee an equivalent surgical success.[12,13] This may increase the uncertainty of the patients and lead them to question the necessity for second ear surgery. As such, the aim of this study was to evaluate the benefits of second ear surgery and to provide recommendations on whether a second operation should be performed on the other side.

Materials and Methods

Study Design and Patients

The Institutional Review Board of Taipei Veterans General Hospital approved this descriptive, retrospective chart-review study. Written informed consent was obtained from all involved patients. A cohort study was conducted on patients with otosclerosis after stapes surgery, performed between 1996 and 2012 by the same experienced senior surgeon (corresponding author) at a tertiary referral center in Taiwan. The diagnosis of otosclerosis was based on a clinical history of progressive hearing loss, normal otoscopic findings, and conductive or mixed hearing loss evidenced by pure tone audiometry. The absence of a stapes reflex and normal tympanometry were required. The cochlear capsule was evaluated by high-resolution computed tomography to verify the otosclerosis, while the clinical diagnosis was confirmed surgically and pathologically. Ears with revision surgery (n=2), with insufficient audiometric data (n=8), or that were lost to follow-up (n=2) were excluded. Patients with unilateral otosclerosis were also excluded (n=45), and patients with bilateral otosclerosis after unilateral or bilateral stapes surgeries were included (48 patients, 64 ears).

Surgical Procedure

The surgery was performed using an endaural procedure under general anesthesia to avoid any slight movement from a patient at an important moment, causing postoperative serious complications, such as sensorineural hearing loss.[4,16] The tympano-meatal flap was elevated, and after separating the incudo-stapedial joint and removing the stapes arch, a fenestra 0.7 mm in diameter was created at the junction of the posterior one-third and anterior two-thirds of the footplate, using diamond mills driven by a microdrill. Before 2007, all of the ears were operated on using a conventional manual-crimping piston (Schuknecht stainless steel wire Teflon piston). In 2007, the new “heat-crimping” Nitinol piston (SMart™ Piston, Gyrus ENT, Bartlett, TN, USA) was introduced in the study hospital, and after that all of the ears were randomly assigned for either conventional manual crimping or heat crimping. A piston (4.0 to 4.5 mm in length and 0.4 to 0.6 mm in diameter) was inserted into a 0.7-mm hole on the footplate. The piston wire loop was then crimped to the long process of the incus. The details of this surgical procedure have been reported previously.[10]

Audiometric Assessment

The American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) guidelines were followed.[17] Data on pre- and post-operative pure-tone average and air-bone gap (ABG) were compiled, and the mean thresholds were determined at 0.5, 1, 2, and 3 kHz. When the threshold at 3 kHz was not available, the average of the thresholds at 2 kHz and 4 kHz was estimated according to the new and revised reporting guidelines from the Committee on Hearing and Equilibrium[18]. The ABG was calculated using air conduction (AC) and bone conduction (BC) thresholds recorded on the same audiogram.

The medical records of all patients were analyzed for the last otologic and audiologic examinations. Data were collected on gender, side of ear, age of surgery, order of operated ear, piston type (conventional vs. Nitinol), and pre- and post-operative audiograms. Normal hearing was defined as an AC ≤30 dB (socially serviceable hearing), and symmetrical hearing defined as an interaural difference in AC ≤ 10 dB between bilateral ears. In accordance with different outcome variables in the literature, the variables used to evaluate the post-operative hearing outcomes were the percentages of ears with ABG ≤10 dB,[10,12,13,18] ABG ≤20 dB[12,19] and AC ≤30 dB.[12]

Based on data from the literature, on clinical expertise, and on available information from routine clinical practice, the potential confounding factors of hearing outcomes selected for analysis were order of operation, surgery on both sides, piston type, bilaterality, sex, affected side and pre-operative ABG, AC, and BC.

Statistical Methodology

The Mann-Whitney U test was used for non-parametric statistics to compare first and second ear surgeries in age, follow-up duration, and pre- and post-operative AC, BC and ABG. A paired samples *t*-test was used to determine the significant differences between pre- and post-operative AC, BC and ABG between first and second ear surgeries. Pearson's chi-square test or Fisher's exact test was used when analyzing both groups regarding categorical variables. Multivariate logistic regression analysis was used to control potential confounding factors of hearing outcomes, including order of operated ear (1st or 2nd ear), surgery on both sides (yes or no), piston type (classic or Nitinol), sex (male or female), affected side (right or left), pre-operative AC ≤50 dB (yes or no), pre-operative BC ≤30 dB (yes or no), and pre-operative ABG ≤30 dB (yes or no). Spearman rank correlation was used to correlate the post-operative AC averages of first- and second-operated ears in patients who underwent bilateral stapes surgeries. All of the statistical analyses were performed using a commercially available software package, SPSS, version 17.0 (SPSS, Inc., Chicago, IL, USA), and $P<0.05$ was considered statistically significant.

Results

Sixty-four operations in 48 patients were included. Among these 48 patients, 16 (33%) underwent surgery on both ears. The mean age of the total cohort was 38.45±11.62 years (range, 14-62 years), and the mean follow-up period was 18.44±15.09 months (range, 3-61 months). Of the 64 operated ears, 27% (17 ears) were in male patients, and 73% (47 ears) were in female patients; 41% (26 ears) were left ears, and 59% (38 ears) were right ears. Introduction of the Nitinol piston in 2007 resulted in 30% (19/64 ears) of the surgical procedures being performed using this prosthesis. There were no major or long-term complications in this series of patients such as total deafness or complete loss of vestibular function.

Both first- and second-operated ears had significantly better post-operative AC and ABG averages than pre-operative AC and ABG averages (all $P < 0.05$, Table 1). There was no significant deterioration in mean BC after surgery (both $P > 0.05$). There were no significant differences between the two groups regarding demographic characteristics, pre-operative and post-operative hearing results (all $P > 0.05$, Table 2). Multivariate logistic regression analysis did not reveal any statistically significant correlations between hearing outcomes and potential confounding factors (all $P > 0.05$, Table 3).

We further evaluated the outcome associations of the first and second ear surgeries in patients who underwent surgery on both ears (32 surgeries on 16 patients, Table 4). An interaural difference of AC ≤10 dB was achieved in only 19% of the cases after the first ear surgery, and in 56% after the second ear procedure ($P = 0.028$, Table 4). The operated ear became the better hearing ear in 94% of the cases after the first ear surgery, and in 44% of the cases after the second ear surgery ($P = 0.002$). Moreover, we found that among the ears with hearing success

Table 1. Pre- and post-operative hearing results for the first and second operated ears

Type	Ears (n=64)	AC average (dB)			BC average (dB)			ABG average (dB)		
		Pre-OP	Post-OP	p	Pre-OP	Post-OP	p	Pre-OP	Post-OP	p
1st ear	48	54.77±13.12	35.55±13.35	<0.001	25.53±10.38	27.34±12.19	0.079	29.56±9.35	8.12±7.45	<0.001
2nd ear	16	53.60±14.26	41.23±15.54	0.001	28.66±12.02	30.16±12.90	0.315	25.79±6.91	11.67±7.95	<0.001

AC = air conduction hearing level; BC = bone conduction hearing level; ABG = air-bone gap; Pre-OP = pre-operative; Post-OP = post-operative; dB = decibel.

(ABG ≤10 dB) after first surgery, 42.9% (6 of 14 ears) were found to have hearing success in the contralateral ear. Among the ears without hearing success after first surgery, 50% (1 of 2 ears) were found to have hearing success in the contralateral ear (P = 1.000). In addition, we also found a significant positive correlation between the post-operative AC averages of the first and second ear surgeries (*Rho* = 0.479, P = 0.030, Figure 1).

Discussion

Most patients with otosclerosis have bilateral disease, as seen in our series (52% of the patients had otosclerosis).[12,13] For patients with bilateral otosclerosis, an important dilemma arises following the first ear surgery of whether a second operation should be performed on the other side. The major concern about second ear surgery arises mainly from the risk of potentially devastating and unpredictable complications, such as permanent vestibular dysfunction and total deafness. In particular, bilateral stapes surgery exposes the patient to the risk of adverse consequences twice,[15] and it is this that has driven the opinion against a second ear surgery.[12,14]

A review of the literature showed that controversy still exists over surgery on the contralateral ear. Some studies have shown that the improvement in hearing may be less prominent in the second-operated ear than in the first-operated ear,[12,13] while others have shown that satisfactory hearing outcomes can be obtained in second ear surgery.[20,21] One of the possible explanations for these inconsistent findings may be that only a few studies have compared the pre-operative status and controlled the potential confounding factors of hearing outcomes before comparing the efficacy of hearing outcomes of first and second ear surgeries.

Table 2. Comparison of patient characteristics and audiometric results between the Nitinol and conventional piston groups

Factors	1st ear (n=48)	2nd ear (n=16)	p
Mean follow-up in months (SD)	19.19 (15.96)	16.19 (12.26)	0.666
Mean age in years (SD)	38.19 (11.89)	39.25 (11.127)	0.664
Piston type			1.000
Classic, n (%)	34 (70.8)	11 (68.8)	
Nitinol, n (%)	14 (29.2)	5 (31.3)	
Sex			0.525
Male, n (%)	14 (29.2)	3 (18.8)	
Female, n (%)	34 (70.8)	13 (81.3)	
Pre-OP hearing status			
AC average (SD), dB	54.77 (13.13)	53.60 (14.26)	0.932
BC average (SD), dB	25.53 (10.38)	28.66 (12.02)	0.494
ABG average (SD), dB	29.56 (9.36)	25.79 (6.92)	0.211
AC ≤50dB, n (%)	20 (41.7%)	20 (43.8%)	0.884
BC ≤30dB, n (%)	37 (77.1%)	10 (62.5%)	0.329
ABG ≤30dB, n (%)	29 (60.4%)	11 (68.8%)	0.551
Post-OP hearing outcomes			
AC average (SD), dB	35.55 (13.35)	41.23 (15.54)	0.101
BC average (SD), dB	27.34 (12.19)	30.16 (12.90)	0.433
ABG average (SD), dB	8.12 (7.45)	10.67 (7.95)	0.254
AC ≤30 dB, n (%)	22 (45.8)	5 (31.3)	0.306
ABG ≤10 dB, n (%)	34 (70.8)	7 (43.8)	0.051
ABG ≤20 dB, n (%)	44 (91.7)	14 (87.5)	0.635

Pre-OP = pre-operative; Post-OP = post-operative; AC = air conduction; BC = bone conduction; ABG = air-bone gap; SD = standard deviation; dB = decibel.

Table 3. Control of potential confounding factors using multivariate analysis

Factors	ABG ≤10 dB (%)			ABG ≤20 dB (%)		
	n (%)	OR (95% CI)	p	n (%)	OR (95% CI)	p
Order of Operated Ear			0.054			0.223
1st ear (n=48)	34 (70.8)	7.41 (0.96-56.63)		44 (91.7)	11.15 (0.23-541.5)	
2nd ear (n=16)	7 (43.8)	1 (Ref)		14 (87.5)	1 (Ref)	
Surgery on both sides			0.185			0.567
Yes (n=32)	21 (65.6)	3.27 (0.56-18.87)		29 (90.6)	2.20 (0.14-32.41)	
No (n=32)	20 (62.5)	1 (Ref)		29 (90.6)	1 (Ref)	
Piston type			0.094			0.998
Classic (n=45)	26 (57.8)	1 (Ref)		39 (86.7)	1 (Ref)	
Nitinol (n=19)	15 (78.9)	3.23 (0.82-12.70)		19 (100.0)	3.58 (0.01-1.00)	
Sex			0.874			0.521
Male (n=17)	10 (58.8)	1 (Ref)		15 (88.2)	1 (Ref)	
Female (n=47)	31 (66.0)	1.11 (0.30-4.13)		43 (91.5)	2.02 (0.23-17.15)	
Affected side						0.320
Right (n=38)	27 (71.1)	1.56 (0.39-6.13)	0.525	34 (89.5)	1 (Ref)	
Left (n=26)	14 (53.8)	1 (Ref)		24 (92.3)	4.71 (0.22-99.84)	
Pre-OP AC ≤50 dB			0.425			0. 630
Yes (n=27)	16 (59.3)	1 (Ref)		24 (88.9)	1 (Ref)	
No (n=37)	25 (67.6)	2.08 (0.34-12.57)		34 (91.9)	2.40 (0.06-85.54)	
Pre-OP BC ≤30 dB			0.821			0.417
Yes (n=47)	29 (61.7)	1 (Ref)		42 (89.4)	1 (Ref)	
No (n=17)	12 (70.6)	1.23 (0.20-7.59)		16 (94.1)	5.09 (0.10-259.4)	
Pre-OP ABG ≤30 dB			0.413			0.352
Yes (n=40)	27 (67.5)	1.98 (0.38-10.16)		36 (90.0)	1 (Ref)	
No (n=24)	14 (58.3)	1 (Ref)		22 (91.7)	5.82 (0.14-238.1)	

Pre-OP = pre-operative; post-OP = post-operative; AC = air conduction hearing level; CI = confidence interval; OR = odds ratio.

Table 4. Outcome associations of the first and second surgeries in patients with surgeries on both ears (16 patients)

Variables	1st ear surgery	2nd ear surgery	p
Interaural difference in AC ≤10 dB			0.028
Yes, n (%)	3 (19)	9 (56)	
No, n (%)	13 (81)	7 (44)	
Better hearing ear			0.002
Operated ear, n (%)	15 (94)	7 (44) *	
Non-operated ear, n (%)	1 (6)	9 (56)	

AC = air conduction.

* Operated ear in the second ear surgery was the non-operated ear in the first ear surgery.

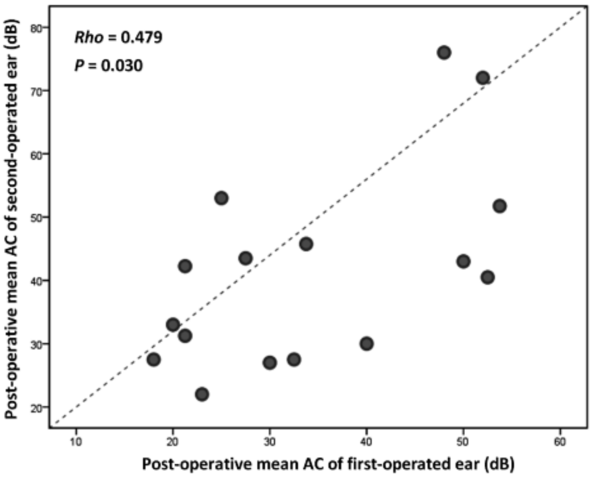

Figure 1. Correlation between the post-operative mean air conduction thresholds (AC) of the first- and second-operated ears in 16 patients who underwent bilateral stapes surgeries. The dashed line indicates a positive correlation. The relationship was significant (Spearman rank correlation coefficient, Rho = 0.479, P = 0.030).

In the present study, under initial comparable pre-operative conditions, second ear surgery showed comparable hearing outcomes with first ear surgery (Table 2). In order to examine the effect of potential confounding factors on treatment outcomes, multivariate logistic regression was used for further analysis. Surprisingly, regardless of which outcome variable was used (post-operative ABG ≤10 dB or ≤20 dB), no correlations were found between hearing outcomes and the confounding factors (all $P > 0.05$). As expected, the order of surgery had no impact on the hearing outcomes, confirming that second ear surgery may provide comparable hearing success in patients with bilateral otosclerosis (Table 3). These results offer valuable information for patients with bilateral otosclerosis who may question whether to undergo a second operation on the contralateral side.

On the other hand, some authors have found that unilateral surgery in patients with bilateral otosclerosis may not be sufficient to provide acceptable and symmetric hearing function,[12,19] emphasizing that unilateral hearing success may not always be beneficial from the perspective of the patient. Binaurally symmetric hearing function is actually more important for patient satisfaction than a technically successful operation on only one ear due to the known benefits of binaural hearing, for example, better sound quality, improved speech understanding and the ability to localize the direction to sound sources.[12,22] An interaural difference in AC ≤10dB between operated and non-operated ears has been used as a criterion of symmetric hearing in several studies.[12,15] In the current study, we observed that second ear surgery was more beneficial in providing binaurally symmetric hearing (Table 4). Our observations are further supported by Kisilevsky et al., who also found that second ear surgery led to more successful symmetrical hearing in patients who underwent bilateral stapes surgeries.[12] The functional benefit of second ear surgery is also reflected by the fact that the probability of better hearing in the non-operated ear after the first surgery was only 6%, but this significantly increased to 44% after the non-operated ear became the second-operated ear (P = 0.002, Table 4). Therefore, we suggest that second-ear surgery is worthwhile in patients with bilateral otosclerosis. Furthermore, a significant positive correlation was found between the hearing thresholds of bilateral ear surgeries (*Rho* = 0.479, P = 0.030, Figure 1). Consequently, second ear surgery is highly recommended for patients with normal or socially serviceable hearing after first ear surgery, as the probability of hearing success tends to increase following second ear surgery.

It seems reasonable to recommend a contralateral ear surgery once a patient has already had a satisfactory air-bone gap closure in the first ear post-operatively. In practice, however, we have faced difficulties in persuading our patients that surgery on the contralateral ear is effective for binaurally symmetric hearing, and that it can be recommended due to the known benefits of binaural hearing as mentioned above. The patients' main concerns over second ear surgery are understandable as it exposes them to the risk of adverse consequences for a second time, including total hearing and/or vestibular impairments. Importantly, even though we tell them that the benefits of contralateral ear surgery outweigh the risk of adverse consequences (i.e., binaurally symmetric hearing is obtainable with a low risk of adverse consequences), they still want to see evidence of this. This is the original idea behind this study, and we hope to provide an evidence-based recommendations rather than an expert opinion. It is our hope that the results of this study will provide clinicians and patients with valuable reference data.

Because patients often have overly optimistic and even false expectations about surgical success, a critical issue worth addressing about stapes surgery is how patients define surgical success. The truth is that the gain in hearing is not usually satisfactory even if technical success is obtained. In the current study, for instance, although an ABG $\leq$ 20 dB was achieved in about 90% of the patients in the first- and second-ear surgeries, less than half of the patients had normal hearing outcomes (Table 2), which often misleads patients into thinking that their hearing is still "abnormal" after surgery. There is therefore a need to emphasize that, despite unfavorable functional hearing results, stapes surgery can delay or even halt the progression of disease.[23] Moreover, hearing gain plays an important role in successful hearing aid fitting, allowing patients to use less powerful hearing aids and solving the problems of acoustical feedback. Through the better use of hearing aids with important discriminatory improvements, patients can be expected to use their hearing aids more successfully compared to patients without surgery .

In spite of the clinical dilemma, i.e., objective success of audiologic results but subjective dissatisfaction with hearing gain in most first- and second-ear surgeries, a second ear surgery can still be recommended to achieve binaurally symmetric hearing (if the first ear surgery is a success) or to increase hearing gain in the contralateral ear for better use of hearing aids (if the first ear surgery fails). Additionally, regardless of whether hearing success in the first ear surgery was achieved or not, the chance of hearing success in the second ear surgery was not significantly different (42.9% vs. 50%, P = 1.000), supporting that a second ear surgery may be recommended even for patients with unsuccessful first ear surgery. On the other hand, hearing aids may be recommended for either successful (binaurally symmetrical hearing if the first ear surgery is a success, or asymmetrical hearing if the first ear surgery fails) or unsuccessful (binaurally asymmetrical hearing if the first ear surgery is a success) second ear surgery in order to more successfully use the hearing aids. For those patients with unsuccessful surgeries on both sides, hearing aids also have a certain significance, not least, to improve hearing.

This gives rise to the question of whether there are effective alternative choices for the management of less successful or unsuccessful primary surgeries in the first or second ears. These choices may include revision surgery, hearing aid use and observation. According to reports in the literature, the percentage of revision cases is only between 2% and 6%.[24] In this study, no patients underwent revision surgeries for unsuccessful post-operative surgical outcomes, which may be due to the small sample size. In our experience, these patients choose to use hearing aids or observation. Therefore, the results in the study may not provide sufficient evidence to make conclusive statements regarding the effectiveness of revision surgery. However, previous studies have shown that although revision stapes surgery is less likely to be successful than the primary operation, it may allow for hearing improvement, thus becoming one of the choices for management of unsuccessful primary surgery.[25,26]

Although speech discrimination is relatively unimpaired in conductive hearing loss, and patients with conductive hearing loss, for example with otosclerosis, may be expected to show good speech discrimination scores with the volume set at their most comfortable level, a comprehensive audiological examination should consist of pure-tone audiometry and speech audiometry. Speech audiometry has become a fundamental tool to evaluate supra-threshold intelligibility and to predict the success of otologic surgery, and, therefore, otologists and patients would like to obtain information about recovery with regards to word recognition ability. For speech recognition tests, speech stimuli should consist of familiar words in that language, and test materials should also be standardized in an experimental setting.[27,28] To date, however, there is lack of clinically evidence-based speech test materials on word discrimination scores in both Mandarin-Chinese and Taiwanese Hokkien, which are the two most widely spoken languages in Taiwan. Neither are there any test materials that have been proven to be reliable diagnostic tools for clinical practice. As a result, speech recognition testing is not routinely applied in patients with otosclerosis in our hospital, thus the available data were not sufficient for analysis in this study.

Another point needed to be brought up is the timing of a second ear surgery. Our previous study have demonstrated that the choice of optimal surgical timing is an important issue for otologists to improve the surgical service delivery and to focus on the patients who need surgery the most. The information on surgical timing may inform patients more explicitly about expected post-operative audiometric results.[23] In this study, the median interval between the first and second ear surgeries in the 16 patients who underwent surgery on both ears was 10.62 months (range, 3-65). However, due to the small number of patients and the inherent bias associated with a retrospective review, this study failed to provide conclusive evidence of the opitimal timing of a second ear surgery. A prospective controlled study should be conducted to establish the guideline for the timing of a second ear surgery.

There are some other possible limitations to this study. First, although the uniformity and consistency offered by a single surgeon performing the otosclerosis surgeries at a single center is a great strength of our study because it reduces the influence of individual surgeons on surgical outcomes, our results may not be directly applicable to other clinics and surgeons because other surgeons may use different techniques and prostheses.[29] Additionally, in the logistic regression analysis, unavoidable selection bias may exist, and some unnoticed confounding factors may not have been included to prove the independent correlations with clinical outcomes.[30] Moreover, the regression analysis results must be interpreted with caution because a correlation does not necessarily mean that a causal relation exists.[31] Furthermore, one of the reasons why we obtained a positive correlation between post-operative AC averages of the first and second ear surgeries may be explained by the bilateral stapes surgeries in the same patient being performed by the same surgeon. Therefore, caution should be taken when discussing the results during patient consultations if the patient will undergo contralateral ear surgery performed by a different surgeon.

Conclusions

The results of this study have important treatment implications, and may provide valuable pre-operative evidence for patients with bilateral otosclerosis regarding expected hearing outcomes when making the decision of whether or not to accept an intervention on the contralateral ear. Surgery on the second diseased ear was shown to be highly effective and can be recommended because the chance of surgical success is comparable in both ears. Moreover, second ear surgery is worthwhile because it offers a higher chance of binaurally symmetrical hearing, which may be the main expectation of the patients from stapes surgery. Importantly, a statistically significant positive correlation between hearing thresholds of bilateral ear surgeries implied that second ear surgery has a beneficial effect on increasing the chance of hearing success for patients with normal or socially serviceable hearing after first ear surgery.

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Addendum: Missed Abstract in Vol 9 Suppl. 1

Lecture (4) by Paul R. Kileny

THE CLINICAL UTILITY OF ELECTROCOCHLEOGRAPHY (ECOCHG) IN THE DIAGNOSIS AND SURGICAL MANAGEMENT OF SUPERIOR SEMICIRCULAR CANAL DEHISCENCE (SSCD)

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Electrocochleography (EcochG) is often used in the evaluation of episodic vertigo, and abnormal findings are commonly associated with endolymphatic hydrops. Work carried out by our group has shown that an abnormal EcochG is also a reliable diagnostic indicator for superior semicircular canal dehiscence. We theorize that the presence of a third window exposing the membraneous labyrinth to intracranial pressure alters cochlear hydrodynamics in such a fashion as to simulate hydrops, due to pressure alterations within the cochlea. This presentation will review our diagnostic protocol in patients suspected to present with SSCD, including our electrocochleographic technique, criteria, and findings in a series of patients with documented SSCD. Data will be presented on 40 adult patients with confirmed SSCD who underwent tympanic EcochG as part of a diagnostic or preoperative evaluation that also included vestibular-evoked myogenic potentials (VEMPs). Patients also underwent audiometric testing, and high-resolution temporal bone computed tomography reformatted to optimally view the superior semicircular canal. EcochG demonstrated 89% sensitivity and 70% specificity for SSCD. The mean SP/AP ratio among ears with SSCD was significantly higher than that among unaffected ears (0.62 versus 0.29). The presentation will also include a report on our most recent series of 26 patients presenting with clinical and computed tomographic evidence of SSCD, who underwent intraoperative EcochG during superior canal occlusion via middle fossa approach (20 patients) and transmastoid approach (six patients). Most of these patients also had postoperative EcochG testing in the outpatient setting. The main outcome measure was the summating potential (SP) to action potential (AP) ratio, as measured by EcochG, and alterations in SP/AP during canal exposure and occlusion. The EcochG was obtained in identical fashion intraoperatively, and in the outpatient setting using a hydrogel-tipped tympanic membrane surface electrode, placed under oto-microscopic visualization onto the tympanic membrane surface. We used alternating polarity clicks as stimuli, and our criterion was 0.40 or less for a normal SP/AP ratio. The mean SP/AP ratio among ears with SSCD was significantly higher than that among unaffected ears. During occlusion procedures, the SP/AP increased upon exposure of the canal lumen. After occlusion, the SP/AP dropped below the intraoperative baseline in most cases. All patients experienced symptomatic improvement. All patients who underwent postoperative EcochG obtained one to three months after SSCD repair, presented with a normalized SP/AP of 0.4 or less. In a few cases, the SP/AP was reduced after canal occlusion, but became elevated again prior to closing. In all those cases, a postoperative evaluation showed a normalized SP/AP ratio. These findings expand the differential diagnosis of abnormal EcochG. In conjunction with clinical findings, an abnormal EcochG supports a clinical diagnosis of SSCD. Intraoperative EcochG facilitates dehiscence documentation and allows the surgeon to confirm satisfactory canal occlusion. Like the other abnormal findings and symptoms associated with SSCD the EcochG, normalizes after surgical correction.