G Model
ANL-1961; No. of Pages 5
ARTICLE IN PRESS
Auris Nasus Larynx xxx (2015) xxx–xxx
Contents lists available at ScienceDirect
Auris Nasus Larynx
journal homepage: www.elsevier.com/locate/anl

Factors affecting postoperative outcome in otosclerosis patients: Predictive role of audiological and clinical features

Mayuko Kishimoto [a], Hiromi Ueda [a,*], Yasue Uchida [a], Michihiko Sone [b]

[a] Department of Otorhinolaryngology, Aichi Medical University School of Medicine, Aichi, Japan
[b] Department of Otorhinolaryngology, Nagoya University School of Medicine, Nagoya, Japan

ARTICLE INFO

Article history:
Received 10 October 2014
Accepted 18 March 2015
Available online xxx

Keywords:
Otosclerosis
Postoperative air-bone gap
Multivariate regression analysis
Factor

ABSTRACT

Objective: Factors affecting postoperative hearing results of patients with otosclerosis were analyzed.
Methods: Included were 191 patients with otosclerosis in whom 234 primary stapes surgeries were performed from August 1991 to December 2011 by one surgeon in three tertiary hospitals. Evaluation of factors affecting postoperative hearing thresholds at individual frequencies were performed by logistic regression analysis.
Results: Closure of the air-bone gap (ABG) after surgery was good at 2 kHz, but poor at 4 kHz and frequencies under 1 kHz. In addition, improvement at 8 kHz was worse than that at any other frequency. Multivariate logistic regression analysis by the stepwise method showed that under the mean preoperative ABG (odds ratio [OR] = 2.42), unilaterality (OR = 2.53) and male sex (OR = 2.65) were significantly better prognostic factors at 250 Hz. At 500 Hz, under mean preoperative ABG (OR = 2.56) was the significantly better factor. No significant factors were found at 1 kHz. Cochlear otosclerosis (OR = 3.57) was a significantly worse prognostic factor at 2 kHz. Under mean preoperative ABG (OR = 2.82) and younger age (OR = 1.03) were significantly better prognostic factors at 4 kHz. At 8 kHz, worse preoperative air conduction threshold (OR = 1.96) was a significantly better prognostic factor.
Conclusion: Preoperative ABG, preoperative air conduction threshold, cochlear otosclerosis, male sex, laterality and age were significant prognostic factors for postoperative hearing outcome in otosclerosis patients. Especially, preoperative ABG was a significant prognostic factor at multiple frequencies. We suppose that patients with larger preoperative ABG have some other otosclerotic lesions outside the oval window niche.

1. Introduction

The incidence of patients with clinical otosclerosis is considered to be smaller in Japan than that in Western countries [1]. However, the number of patients with otosclerosis has increased recently, and there has been a corresponding increase in the number of patients who have undergone stapes surgery [2]. As an operation for patients with otosclerosis, stapes surgery in which the stapes is removed partially (or totally) and an artificial prosthesis is used in the reconstruction of the ossicular chain has been the standard since first reported by Shea [3]. Since his report, the stapes surgery technique has been modified in various ways, for example, stapedectomy or stapedotomy, use of a laser or diamond drill, and with various prosthesis. Postoperative hearing results after stapes surgery are generally good, but cases with less than optimal results still exist [4]. We believe the ultimate goal for postoperative hearing outcome is that after surgery, all patients acquire closure of the postoperative air-bone gap (ABG) within 10 dB without postoperative bone conduction deterioration at all frequencies. Without doubt, the technique of the surgeon is the most important factor in postoperative hearing improvement. However, reports on other factors affecting postoperative hearing outcome are conflicting [4–7]. One group of authors [8] reported that ABG after surgery was good at 2 kHz and 4 kHz but was poor at 8 kHz and at frequencies below 1 kHz. They also pointed out the significant influence of the size of the fenestra of the stapes footplate and the preoperative ABG.

* Corresponding author at: Department of Otorhinolaryngology, Aichi Medical University School of Medicine, 1-1 Yazakokarimata, Nagakute, Aichi 480-1195, Japan. Tel.: +81 561 62 3311; fax: +81 561 63 3403.
E-mail address: uehiromi@aichi-med-u.ac.jp (H. Ueda).

http://dx.doi.org/10.1016/j.anl.2015.03.001
0385-8146/

In this study, we retrospectively investigated the audiological and clinical features of patients with otosclerosis operated on by one surgeon and analyzed the factors affecting postoperative hearing results in the short term by multivariate logistic regression analysis.

2. Materials and methods

From August 1991 through December 2011, 234 ears of 191 patients with otosclerosis underwent stapes surgery performed by a single surgeon at Nagoya University Hospital and Japanese Red Cross Nagoya Daiichi Hospital, Nagoya, Japan, or Aichi Medical University Hospital, Nagakute City, Japan. We excluded the patients who underwent stapes mobilization (4 ears) and who showed deterioration of greater than 10 dB in postoperative bone conduction (BC) thresholds at speech frequencies (2 ears). Of the patients, 80 (34.2%) were men and 154 (65.8%) were women.

We recommended surgery for the patients with greater than 20 dB in preoperative ABG at speech frequencies. The surgical method was the same as described previously [9]. The surgeon (H.U.), the approach (transcanal), and the atticotomy with a chisel were the same for all patients. In our early surgical period up to 1999, the order of manipulation at surgery was as follows. First, a control hole was made in the stapes footplate to prevent the footplate from floating. Then the suprastructure of the stapes was removed. Next, a small fenestra of 0.8 mm was made using a Fisch's manual microperforator (stapedotomy). Finally, a 0.6-mm-thick Schuknecht-type Teflon wire piston (GYRUS, USA) was inserted into the footplate opening and crimped onto the incus. Small pieces of connective tissue were placed around the piston and sealed with fibrin glue when either one half or all (stapedectomy) of the footplate was removed. In our later surgical period, from 1999 onwards, the reversal steps technique devised by Fisch [10] was mainly performed. First, a small fenestra of 0.8 mm was made, and a Teflon wire piston was inserted and crimped onto the incus. Then, the suprastructure of the stapes was removed. Following the introduction of this method, we could perform stapedotomy in many patients and prevent some complications such as a floating footplate [9]. However, in patients with a narrow oval niche, the stapes suprastructure was removed first. In some of the surgeries, a KTP laser or CO_2 laser was used to cut the posterior crus and make a small fenestra. After 2007, a whole Teflon piston (GYRUS, USA) was mainly used instead of a wire piston.

2.1. Statistical analysis

We used the univariate logistic and multivariate regression analysis (stepwise method) to predict which factors would affect the postoperative hearing results, which were evaluated at 3–12 months after surgery. We judged success when closure of the postoperative ABG was within 10 dB at 250 Hz, 500 Hz, 1 kHz, 2 kHz and 4 kHz, respectively, and when improvement of postoperative air conduction (AC) was above 10 dB at 8 kHz. We choose success (yes vs no) as the criterion variable. The predictive variables included in the logistic regression analysis were sex (male vs female), patient age, side (right vs left), laterality (bilateral vs unilateral), size of the fenestra (stapedotomy vs stapedectomy), order of removal of the stapes suprastructure (before prosthesis insertion vs after prosthesis insertion), prosthesis (wire piston vs piston), cochlear otosclerosis (otosclerotic foci identified beyond the oval window niche by computed tomography [CT] imaging, yes vs no), laser use (yes vs no), preoperative ABG (under mean value at 250 Hz, 500 Hz, 1 kHz, 2 kHz and 4 kHz, yes vs no) and preoperative AC thresholds (under mean value at 8 kHz, yes vs no). At first, we performed univariate analysis using these variables. From the results of univariate analysis, we selected factors with a P value within 0.2 and performed multivariate logistic regression analysis by the stepwise method. A value of $P < 0.05$ was considered to indicate statistical significance. The analyses were performed with StatFlex version 6 statistical software (Artech Co., Osaka, Japan).

3. Results

Demographic and clinical characteristics of the patients and the 234 ears are shown in Table 1. Stapedotomy (small hole in the stapes footplate) was performed in 151 ears (64.5%). Stapedectomy (half or complete removal of the stapes footplate) was performed in 83 ears (35.5%). Removal of the stapes suprastructure before prosthesis insertion was performed in 131 ears (56.0%), whereas that after prosthesis insertion was performed in 103 ears (44.0%). Cochlear otosclerosis in which otosclerotic foci were identified beyond the oval window niche by CT imaging was detected in 18 ears (7.7%). CO_2 or KTP laser was used in only 15 ears (6.4%).

Preoperative ABG (at 250 Hz, 500 Hz, 1 kHz, 2 kHz 4 kHz) and AC threshold at 8 kHz are shown in Table 2. Preoperative ABG and AC thresholds were maximum at 250 Hz and minimum at 2 kHz, as were their respective mean values. Fig. 1 shows the mean preoperative and postoperative air and bone conduction threshold for all surgical ears. Closure of the ABG after surgery was good at 2 kHz but poor at 4 kHz and at frequencies lower than 1 kHz.

Table 1
Demographic and clinical characteristics of the 234 ears.

Characteristic	No. (%)
Sex	
Male	80 (34.2)
Female	154 (65.8)
Age (years)	
Mean (range)	45.4 (10–75)
Side	
Right	134 (57.3)
Left	100 (42.7)
Laterality	
Bilateral	167 (71.4)
Unilateral	67 (28.6)
Size of fenestra	
Stapedotomy	151 (64.5)
Stapedectomy	83 (35.5)
Removal of stapes suprastructure	
Before insertion	131 (56.0)
After insertion	103 (44.0)
Prosthesis	
Wire piston	184 (78.6)
Piston	50 (21.4)
Cochlear otosclerosis	
Yes	18 (7.7)
No	216 (92.3)
Laser use	
Yes	15 (6.4)
No	219 (93.6)

Table 2
Preoperative ABG and AC threshold (8 kHz) in the 234 ears.

Frequency	Minimum (dB)	Maximum (dB)	Mean (dB)	S.D. (dB)
250 Hz	25	85	51.5	11.5
500 Hz	15	75	42.0	10.9
1 kHz	10	70	34.3	10.8
2 kHz	−5	55	20.7	10.9
4 kHz	−5	65	21.1	11.9
8 kHz	10	Out of range	56.5	23.4

Abbreviations: ABG, air-bone gap; AC, air conduction; S.D., standard deviation. Mean and S.D. values at 8 kHz in 15 ears were excluded as being out of range.