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Stapedotomy in a residency training program

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Abstract

Introduction: The major objective of a stapedotomy is the restoration of hearing. In training centers, the hearing results obtained by resident physicians are lower than those achieved by more experienced surgeons. An analysis of the surgical results obtained by resident physicians is essential to identification of the deficiencies in the learning process. **Objective:** To analyze the postoperative hearing results obtained by otosclerosis patients who underwent stapedotomy performed by surgeons in a residency program. **Methods:** The pre- and postoperative audiometric results were evaluated in a retrospective study of 98 otosclerosis patients who underwent stapedotomy from January 2000 to December 2010. **Results:** The distribution of patients according to the postoperative results was as follows: 68.4% of the patients achieved a postoperative gap of less than or equal to 10 dB, and 91.8% of the patients achieved a postoperative gap of less than or equal to 20 dB. Three (3.1%) patients had profound sensorineural hearing loss after the procedure. **Conclusions:** An improvement in surgical outcomes of doctors in training is essential for the continuation of training for stapes surgery during medical residency.

Keywords: otosclerosis, stapes surgery, training.

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INTRODUCTION

Otosclerosis is a temporal bone disorder that is one of the most common causes of acquired hearing loss. Histologically, it consists of a modification in bone remodeling in the otic capsule. A usual and initial manifestation is conductive hearing loss, frequently bilateral, caused by stapes footplate fixation. It is an autosomal dominant disease with incomplete penetrance, and it affects approximately 1% of the population globally being more prevalent in Caucasians, young adults and females[1]. The treatment consists of the restoration of hearing by the use of hearing aids (HA) or by otologic microsurgery (stapedectomy or stapedotomy)[2].

Surgical treatment is preferred by many otorhinolaryngologists, and stapedotomy is widely used in the treatment of otosclerosis[3]. The surgeon performs a microfenestra through the stapes footplate and replaces the stapes superstructure with a prosthesis. This procedure requires remarkable skill and ability[4,5], and the results vary according to the experience of the physician. Expert surgeons obtain the best results and achieve a success rate above 90%, with less than 1% sensorineural hearing loss (SNHL)[3]. The success rates as high as these are not reached in most training centers[6-11]. Because stapedotomy is elective surgery, in which the major objective is hearing improvement, some authors question the training in stapes surgery during medical residency[6,11,12].

Few studies have evaluated stapes surgery training. An analysis of the results obtained by surgical residents is important for the identification of deficiencies in the training process. The teaching methodology could be optimized, and the performance of each resident could be improved. This study aims to analyze the hearing results obtained by patients with otosclerosis who underwent stapes surgery performed by residents at the University Hospital of Brasilia (HUB).

METHODS

This study is a retrospective analysis of the medical records of the patients with otosclerosis who underwent stapedotomy from January 2000 to December 2010 at the University Hospital of Brasilia (HUB). The treatment received by all the patients was primary stapedotomy, and the clinical and surgical data were complete, including the pre-and postoperative audiological records. The patients had no malformations of the ossicular chain or other otological diseases that could simulate otosclerosis. The data regarding revisional stapedotomy and stapedectomies (total or partial) and the data from insufficient medical records were excluded from the analysis.

Pure tone audiometry and speech discrimination testing were obtained pre- and postoperatively. The speech discrimination testing was performed to evaluate the speech reception threshold (SRT). The pre- and postoperative audiograms were performed at frequencies from 0.5 to 8 kHz in air conduction and from 0.5 to 4 KHz in bone conduction, including frequency at 3 kHz. The preoperative audiograms were performed up to 1 month before surgery, whereas the postoperative audiograms were performed from 1 month to 2 years after surgery.

The auditory threshold was calculated using the average of 0.5, 1, 2 and 3 kHz frequencies, according to the Committee on Hearing and Equilibrium guidelines for the evaluation of conductive hearing loss. The air-bone gaps were calculated based on the difference between the mean air conduction thresholds and the mean bone conduction thresholds for the identical frequencies. The difference between the pre- and postoperative air-bone gaps at 0.5, 1, 2, and 3 KHz determined the closure of the air-bone gap. These values might vary from negative (worsening after treatment) to positive (improvement after treatment)[13]. The patients were divided into the following four groups according to the postoperative results: (1) the patients with a smaller gap or equal to 10 dB (considered a markedly positive result after stapedotomy), (2) the patients with a gap less than or equal to 20 dB, (3) the patients with a gap less than or equal to 30 dB, (4) and the patients with a gap greater than 30 dB.

The surgeries were performed by third-year otorhinolaryngology residents of the HUB, which is associated with the University of Brasilia. The residents were consistently under the supervision of an otological surgeon. The following steps outline the surgical technique: (1) local or general anesthesia, (2) infiltration of the external auditory canal with lidocaine with epinephrine (1:100,000), (3) incisions at 6 and 12 hours, 1 cm from the tympanic annulus, and uniting them later, (4) raising of the annulus and tympanic membrane with preservation of the chorda tympani nerve if possible, (5) palpation of the ossicular chain to evaluate the mobility, (5) curettage of the posterior-superior bony ridge for perfect visualization of the stapes footplate on the oval window, incus-stapes joint, tympanic branch of the facial nerve, pyramidal process and stapedial ligament, (6) measurement of the height of the prosthesis from the stapes footplate and the incus long process; (7) manual fenestration of the stapes footplate, (8) disarticulation of the joint connecting the *incus* to the *stapes*;(9) fracture and removal of the stapes superstructure; (10) positioning of the prosthesis, (11) placement of the fat originating from the earlobe around the fenestra and the prosthesis, (12) repositioning the tympanic-meatal flap; (13) placement of Gelfoam® in the ear canal; and (13) operative wound care[4,5].

The data were statistically analyzed using SPSS 22.0 for Mac. Student's *t* test was used to compare the means of the continuous variables. A value of $p < 0.05$ was considered statistically significant. The National Committee of Ethics in Research approved this study, under protocol number 616.750.

RESULTS

A total of 153 medical records of patients who underwent stapes surgery were evaluated. After applying the inclusion and exclusion criteria, 98 stapedotomies were enrolled in this study. The mean age was 36.94 ± 11.28 years (14-68 years), and 55 (56.12%) patients were female. No difference was observed between the number of surgeries performed on the left and right sides. The prostheses used were of the following materials: 13 (13.26%) patients received a Teflon prosthesis; 47 (47.96%) received a Teflon-platinum prosthesis and 38 (38.78%) received a titanium prosthesis. Three (3.1%) patients had profound sensorineural hearing loss after the procedure.

The overall mean air-bone gap was 35.12 ± 8.12 dB preoperatively whereas it was 9.98 ± 8.37 dB postoperatively ($p < 0.0001$), with a gain of 25.14 ± 12.01 dB. There was a reduction of the air-bone gap in relation to the average of all the frequencies analyzed before and after surgery (Table 1 and Figures 1 and 2). The mean SRT was 55.97 ± 10.71 dB preoperatively and 29.84 ± 17.56 dB postoperatively ($p < 0.0001$). The distribution of the patients according to the postoperative results showed that 68.4% of the patients achieved a gap less than or equal to 10 dB, and 91.8% achieved a gap less than or equal to 20 dB (Table 2).

DISCUSSION

Third-year medical residents have performed the stapes surgery at the University Hospital of Brasilia. Because the residency training is sequential by year, it has been accepted that the residents would be better able to perform this type of surgery in the last year of training. In the first year, residents perform simple ear surgeries and acquire basic surgical skills with hands-on activities in the temporal bone dissection laboratory. In the second year, the residents make tracking more complex surgeries, continue otological surgery training with anatomical models and begin to perform basic ear surgeries. In the third year, the residents perform advanced otological dissections and begin to perform more complex surgeries. The supervision of an otological surgeon is constant at all stages. This model is similar to the programs of other institutions[6,7].

Table 1. Values of the air-bone gap in relation to the average of the frequencies analyzed before and after surgery (n = 98).

Frequency	Mean ± DP (dB)	Value of *p*
General		
Pre	35.12 ± 8.12	$p < 0.0001$
Post	9.98 ± 8.37	
Gain	25.14 ± 12.01	
500 Hz		
Pre	45.56 ± 10.18	$p < 0.0001$
Post	14.39 ± 11.56	
Gain	31.17 ± 14.94	
1000 Hz		
Pre	38.22 ± 9.48	$p < 0.0001$
Post	10.61 ± 10.12	
Gain	27.61 ± 13.46	
2000 Hz		
Pre	28.31 ± 10.50	$p < 0.0001$
Post	7.09 ± 8.25	
Gain	21.22 ± 12.40	
3000 Hz		
Pre	28.37 ± 10.05	$p < 0.0001$
Post	7.83 ± 10.06	
Gain	20.54 ± 15.68	

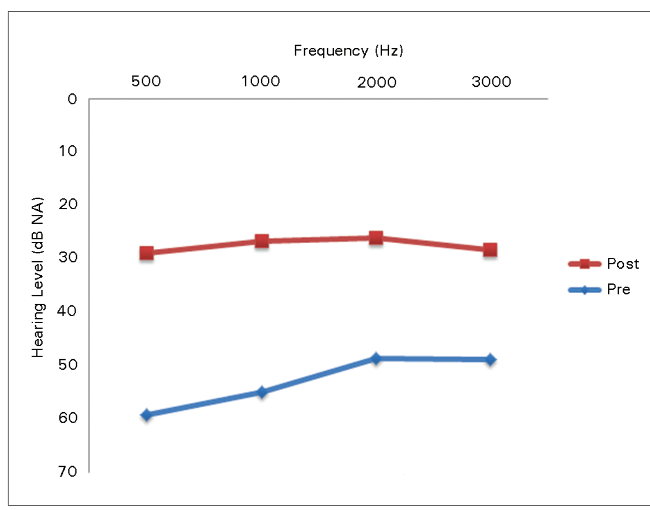

Figure 1. Mean values of air conduction of each frequency analyzed pre-and postoperatively (n = 98).

In this study, 68.4% of the patients achieved a postoperative gap less than or equal to 10 dB. This result is in agreement with other studies conducted in training centers in which the surgical success ranged from 48% to 87%[6-11]. An accurate comparison between studies is difficult and was not our goal. There is a wide range of audiological criteria for evaluating surgical success. Most studies are retrospective and

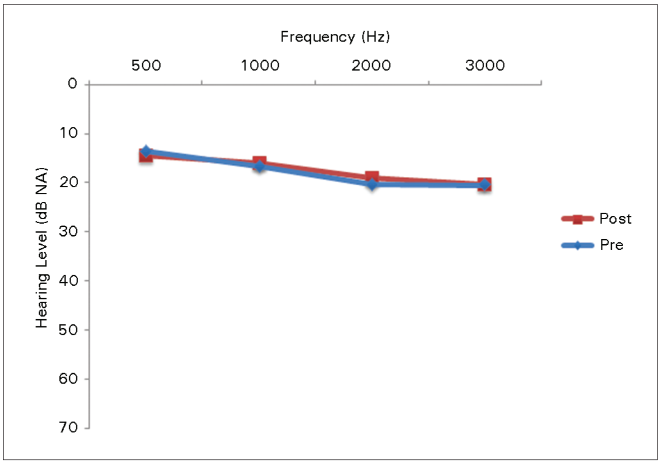

Figure 2. Mean values of bone conduction of each frequency analyzed pre-and postoperatively (n = 98).

Table 2. Distribution of the patients according to the range of the air-bone gap (n = 98).

Air-Bone Gap (dB)	Distribution (%)
General (n=98)	
≤ 10	67 (68.4%)
≤ 20	90 (91.8%)
≤ 30	95 (96.9%)
> 30	3 (3.1%)

are not in perfect agreement for all the parameters of the guidelines of the Committee on Hearing and Equilibrium. However, those studies have been shown that the results obtained in hospitals with resident training programs are inferior to the results achieved by experienced surgeons. Some authors have questioned who should perform stapes surgeries once the primary goal of surgery is to restore hearing[6]. Moreover, even an otologic during its formation will be exposed to lower than optimal results[12,14]. So the question to ask would be where is the deficiency in the learning process and how this could be improved.

The results show that 91.8% of the patients achieved a postoperative gap less than or equal to 20 dB. This results represents a difference of 23.4% between the closure of the air-bone gap to less than or equal to 10 dB and the closure of the gap to less than or equal to 20 dB. Other studies in training institutions present this high discrepancy. Vernick[6] reported 13%, Freitas et al.[7] obtained 15.8%, and Caldart et al.[9] found a difference of 24.56%. This disparity in closure could be inconsequential to technical problems related to the level of experience of the surgeon. The postoperative movement of the prosthesis could impair hearing and affect the audiometric results[6]. Some authors question whether the level of surgical experience refers only to stapes surgery or to ear surgery in general[7]. Mathews et al.[15] reported a closure of the gap equal to 10 dB in 87% of the patients who underwent laser stapedotomy performed by residents. These authors argue that intensive training in the dissection laboratory, more strict supervision and less invasive procedures could shorten the learning curve and improve the performance of medical residents.

The shortening of the learning curve in stapes surgery has been challenging for training institutions. The acquisition and maintenance of surgical skills are related to the number of procedures performed. Hughes[12] and Sargent[14] demonstrated that excellent results are possible by reducing the postoperative gap to less than or equal to 10 dB in more than 90% of the patients after 40 or 50 operations. The learning curve would begin in residency training and continue following residency. Regarding the minimum number of surgeries per year, some authors suggest that a minimum of 8 surgeries per year would be desirable for stapedectomies. Regarding post-surgical deafness, Morrison[16] reports that the rates reach 4% in the first 50 cases, which is reduced to 0.25% in 600 cases. Furthermore, several factors could interfere with the learning curve, such as the innate ability of the surgeon, prior experience, motivation, available technology, task complexity, intraoperative findings, institutional factors and team support[17,18]. The number of patients for the development and maintenance of surgical skills in stapes surgery is limited, and the optimization of learning might be depend on the identification of the susceptibility of each surgeon to these factors.

CONCLUSIONS

An improvement in the surgical outcome is essential for the continuation of the training of surgical residents in stapes surgery. Experience in performing stapes surgery must be acquired during residency training programs, as with other types of otological surgery. Teaching of stapes surgery only for otologist would cause damage to the training of the general otolaryngologist. Optimizing the laboratory training and the daily clinical experience could shorten the learning curve and increase patient safety. In addition, patients should be informed that the success rates of a surgeon with limited experience are lower.

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