

## ORIGINAL ARTICLE

### Late Postoperative Hearing Results After Stapedotomy

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**Objective:** Evaluation of long-term postoperative hearing results after stapedotomy

**Study design:** Retrospective analysis of preoperative, early and late (>10 years) postoperative hearing thresholds.

**Setting:** One tertiary referral and teaching hospital

**Patients:** 46 patients with otosclerosis, 31 female and 15 male, mean age 39.6 years at the time of the procedure, mean follow up 14.3 years

**Intervention:** Primary or revision stapedotomy or stapedectomy

**Main outcome measure:** Audiometric data

**Results:** Air-bone gap closure was achieved in all patients, in 70% to a level of less than 10 dB. After years this result remains intact. During follow-up the cochlear function diminished probably due to the otosclerotic process.

**Conclusion:** Stapes surgery is a safe and effective treatment for conductive hearing loss caused by otosclerosis, with a very long lasting beneficial effect.

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In conductive hearing loss caused by otosclerosis stapes, surgery is the generally accepted treatment of choice. Since the introduction of stapes surgery in the 1950's many different approaches have been developed. All modern procedures aim at reconstruction of a functional, mobile ossicular chain and adequate sound transfer at the stapes footplate. In the last two decennia small fenestra stapedotomy has become the most preferred procedure. Concerning the results of these surgical procedures to restore the hearing most of the papers report audiological results directly post-operatively or often with a relatively short follow-up generally varying from six months to two years. Given the fact that the procedure intends to functionally repair the mechanism of the ossicular chain, it is not only interesting to demonstrate the audiological effectiveness of this functional reconstruction, but also whether the reconstructed mechanism remains functional during the patient's

lifetime. In this paper presents the audiometric data of a group of 46 patients who had stapes surgery for otosclerosis 10 to 20 years before. The long-term hearing results are discussed.

#### Patients and methods

We report our results in a group of 83 patients with otosclerosis who were treated with a stapedotomy or stapedectomy procedure between 1983 and 1990. Of this group long term results have been documented in 46 patients. All of these patients were operated using a transcanal technique, by the same surgeon (R.T). Data were gathered in a spreadsheet database, with registration of personalia, primary or revision, type of piston used, type of procedure (stapedotomy or stapedectomy), pre- and postoperative audiometric test results, audiometric test results after ten years or more. The audiometric data consisted of bone and air conduction hearing thresholds in a standard frequency

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range from respectively 250-4000 Hz and 125-8000 Hz. All audiological measurements were performed by certified audiometrists. From these audiometric data the bone conduction and air-bone gap were collected. The AMA scores using the objective techniques for determining the hearing impairment as described in the American Medical Association guides to the evaluation of permanent impairment<sup>[1]</sup> were calculated for the pre and postoperative hearing and the hearing after more than ten years of follow-up. For calculation of descriptive statistics and correlations SPSS 12.01 has been used.

**Patient group:**

The average age of the patients in this subgroup at the time of the procedure was 39.6 years (14.0-67.9). The female:male ratio was 2.3:1. Twenty-six right ears were treated versus 20 left ears. In seven cases the procedure was bilateral. The average age at follow-up was 53.9 yr (24.5-81.2), the average time between the operation and the last audiometric test was 14.3 yrs (10.0-21.1).

**Procedure:**

In 42 cases a stapedotomy procedure was performed. The other four were treated with a stapedectomy. Different types of pistons were used, according to the judgement of the surgeon. The Causse Teflon piston – 0.4 mm was used 30 times; 16 times a Teflon piston – 0.6 mm was inserted. Most of the procedures were the primary surgical treatments of the patients concerned; three stapedotomies were revisions of former procedures.

**Per- and postoperative complications:**

The complication rate was low: One patient suffered from a short period of post-operative vertigo which spontaneously resolved completely, in another patient a dehiscence facial nerve canal was found during the procedure, with no adverse sequelae.

**Results**

For analysing the hearing results the AMA-scores, ABG and handicap the audiometric results were calculated for the frequencies 0.5, 1, 2 and 4 kHz. The average preoperative bone conduction PTA (0.5-1-2-4

kHz) was 21.8 dB with an average air-bone gap (ABG) of 30.2 dB for the same frequencies. Calculating the average hearing impairment using the American Medical Association (AMA) guides to the evaluation of permanent impairment the preoperative impairment was AMA score 216.2 corresponding with a hearing impairment of 43.6% for the ear concerned preoperatively. Postoperatively the bone conduction remain at 19.8 dB with an average ABG of 7.1 dB. In 70% of the patients the postoperative average ABG was 10 dB or lower. The average postoperative AMA score dropped from 43.6 % impairment preoperative to 9.4 % (125.3) postoperatively. The long term follow-up time between the operation and the last audiometric test was 14.3 yrs (10.0-21.1) and the average results showed that the ABG remained stable at 9.3 dB after 10-21.1 years follow-up. The bone conduction however deteriorated to 32.8 dB (AMA 131.2) during the 10-21.1 years postoperatively. The annual rate of cochlear hearing loss, measured by bone conduction pure tone audiometry PTA, was 0.6 dB/year, causing 80% of the rate of overall hearing loss. The annual rate of functional hearing loss is 0.75 dB/year, this is consistent with the very limited progression of the ABG we found, from 7.1 dB postoperatively to 9.3 dB on the long term.

**Table 1.** Summary data of the hearing results of stapes surgery preoperative, postoperative and after long-term follow-up.

		Average score 46 patients
Pre-op	ABG (dB)	30.2
	AMA	216.2
	% handicap	43.6
Post-op	ABG (dB)	7.1
	AMA	125.3
	% handicap	9.4
<b>Follow-up 10-21.1 yr</b>	ABG (dB)	9.3
	AMA	168.4
	% handicap	25.2

Analysis of these data by looking at correlations showed that a high pre-operative AMA score is positively correlated with a low postoperative AMA

(pearson correlation coefficient 0.464,  $p < 0.01$ ) and with the long term AMA score (0.585,  $p < 0.01$ ). The pre-operative ABG shows no significant correlations with any of the outcome variables. Age is positively correlated with the long term AMA score and long term handicap (0.425 and 0.445,  $p < 0.01$ ). We found no significant relation between, type of procedure or piston type and any of the outcome variables. This study showed that the reconstruction with a stapes prosthesis in otosclerosis remains stable after more than ten years follow-up and that the cochlear function diminished during the same follow-up time.

### Discussion

Only a few studies so far have reported about results of surgical procedures for treatment of otosclerosis after 10 years or more<sup>[2-5]</sup>. In 2002 House et al presented data from a retrospective review of prospectively collected audiometric data, concerning 209 ears in 145 patients<sup>[5]</sup>. All procedures were performed by the same surgeon. The results stapedectomies were compared with those of stapedotomies, with a follow-up of respectively 11 and 6 years per group. No significant differences in outcome of the two procedures were found.

In all procedures Teflon pistons with a diameter between 0.4 and 0.6 mm were used, according to the judgement of the surgeon. The average improvement of conductive PTA was 20 dB. During the observed time span the average PTA deteriorated 8 dB, the bone-conduction thresholds decreased with an average rate of 0.9 dB per year. These figures are in line with our long-term observations in the present study. Aarnisalo et al described in 2003 the audiometric results of 142 patients with otosclerosis<sup>[7]</sup>. These authors compared a group of patients treated with stapedectomy with a group of patients treated with a stapedotomy procedure. No significant difference was found between the two groups in improvement of hearing. The average air-bone gap closure direct postoperatively was 18.5 dB in patients treated with a stapedectomy, and 20.5 dB in patients treated with a stapedotomy. Follow up showed that on average hearing of the patients had deteriorated with a rate of

0.9 dB/year. Also a tendency toward enlargement of the air bone gap as a function of time was shown.

After twenty years both groups had an average ABG of 11.6dB. In this study 10% of the patients underwent revision surgery during the 20 year follow-up period.

Vincent et.al. studied 180 patients with a follow-up data of 10 years or longer<sup>[8]</sup>. Of this group 82 cases had audiologic data available. In the paper, among many other data, the audiological results of this group at 10 years postoperatively were described. The rate of successful ABG closure to 10 dB or less was 98.8% at 1 yr postoperatively, and 96.7% after 10 years. The average four frequency BC thresholds deteriorated only slightly over the recorded period, from 23.3 dB at one year to 25.2 dB at 10 years. The rate of deterioration was calculated per age group. The annual deterioration in AC threshold ranged from 0.15 to 0.66 dB, BC thresholds deteriorated with 0.19 to 0.55 dB/yr. In both AC and BC thresholds deterioration was faster in older age groups. In this paper we report audiometric results of stapes surgery in or patients with a follow-up longer than ten years. In all patients in our study a significant air-bone gap closure, the main goal of stapes surgery, was achieved, to a level of 10 dB or less. Age, grade of otosclerosis and air-bone gap at the time of surgery had no significant effect on the achieved level of closure of the air-bone gap. Regardless of procedure and piston type the air-bone gap closure remained intact even after more than ten to twenty years of follow-up. In our series no revision was performed. This means that the reconstruction of the ossicular chain by means of a stapes piston is stable and can last a life time. The hearing deterioration in our patient population during this long follow-up must be explained by cochlear degeneration, caused by either presbycusis alone or summation effect of presbycusis and cochlear otosclerosis. This finding is consistent with deterioration in patients with otosclerosis after stapes surgery as found in the literature. In our opinion it is important to inform our patients about these long-term phenomena also in the preoperative informed consent. More studies are needed to predict the possible cochlear hearing deterioration after long time follow-up of patients with otosclerosis after stapes surgery.

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