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Effect of stapedotomy on pre-operative tinnitus and its psychosomatic burden

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ABSTRACT

Objective: According to the literature, between 40 and 90% of otosclerosis patients suffering from hearing loss also suffer from tinnitus on the affected side. For a lot of these patients tinnitus represents a handicap that is just as debilitating as the hearing loss itself. The main goal of the surgical treatment of otosclerosis is a significant improvement in hearing loss, but frequent reports of reduced tinnitus after surgery suggest that this can be a positive side effect.
Methods: All patients who underwent stapedotomy were initially included in the study. Retrospectively, the tinnitus questionnaire as compiled by Goebel and Hiller was sent to the patients, and 34 patients (37 ears) replied. The pre- and postoperative cases of tinnitus were divided into compensated and non-compensated tinnitus. In addition the following tinnitus-related factors were evaluated: emotional, cognitive and mental burden; intrusiveness of the tinnitus; hearing problems; somatic ailments; and sleep disturbances.
Results: Over 80% of the patients surveyed suffered from tinnitus pre-operation. The tinnitus disappeared or improved in over 60% of the cases after stapedotomy. In addition, the related factors surveyed also improved appreciably post surgery and reached a significant level in patients with compensated tinnitus.
Conclusion: Besides a significant improvement in hearing loss the intensity and the psychosomatic burden of a pre-operative tinnitus can be reduced by stapedotomy.
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1. Introduction

With an incidence of 1–2% in the white population, otosclerosis is one of the most common causes of acquired hearing loss. In the 18th century, a bony obliteration of the oval window in a deaf patient was first described. Politzer introduced the term "otosclerosis" in 1894, but not until Shea's first stapedectomy in 1956 could the condition be treated successfully with surgery [1,2]. Since then the main goal of surgery for otosclerosis is a significant improvement in hearing. Both the surgical techniques and the prostheses used have changed dramatically since Shea [3–5]. Our preferred procedure is the so-called "Single-Shot"-technique utilizing a CO_2 laser as described by Jovanovic [6,7].

Otosclerosis leads to a pathological increase in bone conversion processes in a region in which conversions normally no longer occur in adults [8,9]. Primary locations for bone conversion processes are firstly the oval window and its surroundings (ca. 90%) and the round window and its surroundings (40%). Less common but also possible are the cochlea, the inner ear canal, the vestibulum and the semicircular canal [10–12]. The main symptom caused by this process is progressive hearing loss, which leads to deafness in 10% of patients. According to the literature attendant symptoms such as vestibular complaints and tinnitus also occur, the former in 40–90% of patients with otosclerosis, the latter in 15–25% [8,13–20]. Thus in otosclerosis both hearing loss and tinnitus can significantly detract from the quality of life and constitute a severe psychological burden for the patient [14].

The pathogenesis of attendant tinnitus is unclear. Studies show the main factor, especially for low-frequency tinnitus, is the mechanically fixed stapedial footplate [13,21]. The toxic metabolite produced by otosclerosis has also been indicated as a possible trigger, as have pathological vascularisation and impaired blood flow in the otosclerotically altered bones. In addition, nerve irritation caused by otosclerotically altered bones has been discussed in connection with the causes of tinnitus [11,12].

The literature features numerous reports of improved tinnitus following stapes surgery [15,22]. It is important to distinguish here between stapedectomy, partial stapedectomy and stapedotomy. According to Gersdorf et al. tinnitus improves very little after a stapedectomy. Stapedotomies and partial stapedectomies on the

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other hand clearly have a positive effect on pre-operative tinnitus, with the former yielding the best results. The operation methods in these cases are of secondary importance. Similar results were achieved with laser stapedotomy, independent of the chosen laser system, and with perforation of the footplate with microdrills [15,23].

In addition to the general tinnitus characteristics regarding frequency and volume as well as subjective disturbance levels, ringing in the ear can be analysed with a sound audiogram [24]. It is also important to evaluate the burden to the patient caused by tinnitus. The tinnitus questionnaire (TF) by Goebel and Hiller is currently considered the best method in Germany for determining the severity of tinnitus. The TF has already been sufficiently evaluated scientifically as a simple and practical tool for everyday hospital use, which provides for a differential assessment of the burden experienced by patients on different levels. A maximum of 84 points can be achieved. Everything from 0 to 46 is a compensated and from 47 to 84 points a non-compensated tinnitus. Non-compensated tinnitus is a permanent mental burden for the patients and there is no possibility of masking the tinnitus. These patients frequently suffer from sleeping disorder, depression and attentiveness disorder [25–29].

The goal of the current study is to evaluate the effects of laser-assisted stapedotomy on pre-existing tinnitus, independent of the frequency, as well as the personal burden of otosclerosis-associated tinnitus.

2. Materials and methods

53 patients had a stapedotomy between January 2008 and February 2010 in our Hospital. Upon request to the Ethics Commission no official approval for this study was needed. The patient survey was conducted retrospectively using the tinnitus questionnaire by Goebel and Hiller. From the total score of the questionnaire, a global severity degree is determined ranging from slight to average to severe to very severe. Up to a total score of 46 the tinnitus is defined as compensated and from 47 as non-compensated. The compensated tinnitus can be divided in "slight tinnitus" (0–30 points) and "moderate tinnitus" (31–46 points). The non-compensated tinnitus can be divided in "severe tinnitus" (47–59 points) and "very severe tinnitus" (60–84 points). The 52 questionnaire items of the TF are additionally divided into definable problem areas representing typical attendant and resultant symptoms. These six subcategories are: 1. emotional burden, 2. cognitive burden, 3. intrusiveness of the tinnitus, 4. hearing loss, 5. sleep disturbances, and 6. somatic ailments. The categories of "emotional burden" and "cognitive burden" are assigned to the area "psychological burden" [25–29].

The questionnaire and a reminding letter 6 weeks later were sent by mail to all of the 53 patients. The rate of return was over 64%; 34 patients (13 men and 21 women, average age 42.9) were included in the study. Using Goebel and Hiller's tinnitus questionnaire, the pre- and post-operative tinnitus was categorized as compensated or non-compensated. The tinnitus questionnaire by Goebel and Hiller permits a differentiated assessment of tinnitus-induced difficulties experienced on various levels. The total score is used to determine a global degree of severity and impact. Furthermore the questionnaire addresses the following tinnitus-related problem areas: emotional (EM) and cognitive (Co) burden; psychological burden; intrusiveness (InTi); acute hearing problems (Aku); sleep disturbances (SI); and somatic ailments. These subcategories are also evaluated.

The procedure is performed entering through the ear with a relief cut as in Heermann in general anaesthesia. The dissection of the stapedius tendon and of the posterior limb was achieved with multiple single shots with the CO_2 laser (output power 2 W, pulse length 50 ms). The creation of an approximately 600 μm perforation in the stapes footplate was also done with the CO_2 laser and the "Single-Shot"-technique (output power 20 W, pulse length 50 ms), corresponding to Jovanovic's description [6,7].

Next the prostheses were inserted according to the manufacturer's guidelines. K-Pistons or Soft-CliP-Pistons were used. At the end of the procedure silicon strips were inserted as well as a tamponade in the ear canal for one week.

On the first day post-op, every patient was subjected to a bone conduction test. After the removal of both the strips and the tamponade 7 days post-operative, an audiometric exam was carried out. Additionally, 6 weeks after the OP, a second audiometric exam took place in our hospital.

The statistical analysis of our results was done with Excel and SPSS 17.0. The data was examined for normal distribution with the help of the Shapiro–Wilk tests. The assumption of normal distribution for all examined values was rejected so that instead of the *t*-tests, the Wilcoxon signed rank test was used.

3. Results

Over 80% of the patients interviewed suffered before the operation from tinnitus in addition to having hearing loss in the ipsilateral ear (28 patients). Only 5 patients had non-compensated tinnitus, the remaining 23 had compensated tinnitus. 61% of the patients suffering from pre-operative tinnitus reported an improvement in or eradication of the tinnitus after the stapedotomy. The total TF score for patients with compensated tinnitus improved significantly (Fig. 1). Patients with non-compensated tinnitus did show a reduction in the score following the operation, without however reaching a significance level of $p = 0.05$. The scores in the subcategories of the tinnitus questionnaire also improved after the stapedotomy. The result was highly significant in every category in patients with compensated tinnitus, while in patients with non-compensated tinnitus no significant level was reached. Only one patient reported a new occurrence of tinnitus after the operation, but this was no longer reported 6 weeks later at the second check.

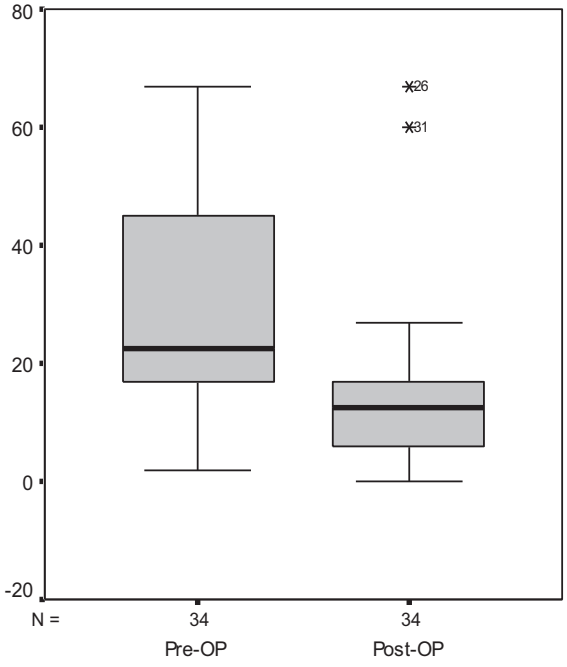

Fig. 1. Total score of tinnitus questionnaire (TF) developed by Goebel and Hiller pre- and post-operatively. Box plot with median and quartiles.

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