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Different approach for surgery of stapes: Comparison microscopic and endoscopic approach

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ABSTRACT

Objective: This study aimed to discuss the different surgical approach, functional hearing results, which are applied to patients operated with a diagnosis of otosclerosis in our clinic.
Methods: This study includes 92 ears of 84 patients who were operated with the diagnosis of otosclerosis. Air bone gap was calculated before and after the operation in all patients. In addition, endoscopic and microscopic methods can be compared and statistically tested whether there is a difference in air bone gap averages and surgical success. Of the 92 ears operated, 56 were right (61%) and 36 were left (39%). Otosclerosis was detected bilaterally in 61 patients (73%) and unilaterally (27%) in 23 patients. The duration of follow-up ranges from 6 month to ten years, on average 28 months.
Results: In the microscopic operation group, the air pathway measurement was mean 55.58 dB preoperatively and mean 38.42 dB postoperatively, with a mean decrease of 17.16 dB determined. The decrease between the preoperative and postoperative air pathway values was determined to be statistically significant (t:7.20, $p < 0.001$). In the microscopic operation group, the air-bone gap value was mean 30.50 dB preoperatively and fell by 15.90 dB to 14.60 dB postoperatively. In the endoscopic group, the air-bone gap value was mean 32.32 dB preoperatively and fell by 13.51 dB to 18.81 dB postoperatively.
Conclusions: Stapes surgery is a successful method with high success rate and low complication rates in the treatment of otosclerosis. The success rate of endoscopic and microscopic stapes surgery is similar. However, endoscopic stapes surgery is specific and difficult otological surgery that must be performed by surgeons specialised on this subject.

1. Introduction

Otosclerosis is an idiopathic disease of the otic capsule which progresses with stapes fixation related to new bone formation. The pathology may not always progress to the stapes base and may be limited to the anterior part of the oval window and in this case the disease progresses silently. Previous studies have shown that patients with a silent course that can be determined histopathologically are seen 10-fold more than patients with clinical otosclerosis [1].

Although there are options such as surgical treatment, medical and hearing aid use in the treatment of otosclerosis, the most common method is stapes surgery. Stapedectomy and stapedotomy options are available in this surgery, and both are widely used.

The main instrument in stapes surgery is the microscope, and it can be used frequently in this surgery in endoscopes, the usage area of which has increased in recent years. Visualization of the middle ear is better in the endoscopic method, and the necessity of using one hand is seen as a serious disadvantage for stapes surgery. The results after endoscopic and microscopic stapes surgery are similar [2–4].

In this study, we aimed to compare the endoscopic and microscopic stapes surgeries performed in the last 10 years in terms of complication rates and hearing gains.

2. Material - method

The study included the separate hearing results at 0,5,1,2,4 khz of 92 ears of 84 patients who were operated on for a diagnosis of otosclerosis between 2010 and 2020. Ethics committee of the approval was obtained at the beginning of the study (no: 11.2.2021-E.2375.). The patients underwent a full Ear, Nose and Throat (ENT) physical examination, pure

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tone audiometry, speaking audiometry, tympanometry, and acoustic reflex tests. Pure tone audiometry tests were applied at 0,5, 1,2,4 khz pre and postoperatively and the air and bone conduction values were recorded.

The air-bone gap was calculated in all patients before and after the operation. The operations applied endoscopically and with the microscopic method were compared, and whether or not there was a difference in the air-bone gap and operation success was evaluated statistically. Any postoperative complications that developed in the patients were recorded.

All patients were operated on by the same surgeon using a microscope (Opmi Vario S88; Carl Zeiss) endoscopic system (Karl Storz, Tuttlingen, Germany, 4.0 mm, 16.0 cm).

To reduce bleeding during the operation, infiltration anaesthesia was applied as a mixture of 1% lidocaine and 1/100,000 adrenalin to the posterior wall of the outer ear pathway. Following a classic Rosen incision, the posterior wall was thinned with a curette to expose the stapes base. In all cases, first the base was pierced then the stapes tendon was cut and the procedure was applied to remove the stapes suprastructure.

The stapedotomy procedure was applied to the two-thirds posterior section of the stapes base, opening a window of mean 0.6-0.8 mm in diameter and using a teflon prosthesis 0.6 mm in diameter. Revision surgery was applied to 12 cases; eight from our clinic and four from another centre. For patients with strong complaints of dizziness, antivertiginous treatment was applied as necessary.

2.1. Statistical analysis

Data obtained in the study were analyzed statistically using IBM SPSS vn. 20.0 software (IBM Corporation, Armonk, NY, USA). Both descriptive and analytical statistics were calculated. In the comparisons of the pre and postoperative variables, the Paired *t*-test was applied. A value of $p < 0.05$ was accepted as statistically significant.

3. Results

The patients comprised 44 (52%) males and 40 (48%) females with a mean age of 33 years (range, 26-56 years) and mean follow-up period of 28 months (range, 6 month-10 years). Of the 92 ears operated, 56 were right (61%) and 36 were left (39%). Otosclerosis was detected bilaterally in 61 patients (73%) and unilaterally (27%) in 23 patients. The operations on the 92 ears were performed endoscopically in 48 (52%) cases and microscopically in 44 (48%). In the microscopic operation group, the air pathway measurement was mean 55.58 dB preoperatively and mean 38.42 dB postoperatively, with a mean decrease of 17.16 dB determined.

The decrease between the preoperative and postoperative air pathway values was determined to be statistically significant (t:7.20, $p < 0.001$). The preoperative air pathway and bone pathway hearing threshold mean values and the postoperative air pathway and bone pathway mean values are shown in Table 1.

A statistically significant difference was determined between the microscopic and endoscopic operations in respect of the air-bone gap values measured pre and postoperatively (microscopic group, t:7.77, p:0.000; endoscopic group, t:2.74, p:0.023) (Table 1). In the microscopic group, the air-bone gap value was mean 30.50 dB preoperatively and fell by 15.90 dB to 14.60 dB postoperatively. In the endoscopic group, the air-bone gap value was mean 32.32 dB preoperatively and fell by 13.51 dB to 18.81 dB postoperatively.

The pure tone audiogram results of the patients examined in the postoperative period were analyzed in terms of air-bone gap closure values. Air bone gap value improved by an average of 12.40 dB in 31 of 44 ears in the microscopic group, while this average value was calculated as 18.56 dB in 13 ears. When this evaluation was made for the endoscopic group, 29 of 48 ears had a mean closure of 13.24 dB, while this value was 19.80 dB in 19 patients.

The air-bone gap distribution of the patients according to the Denoyelle et al. [5] classification is shown in Table 2. According to this, the operation results of the patients were separated into 4 groups as very good, good, acceptable, and failure. When the functional success criteria was taken as ≤20 dB (very good and good), 75% of patients applied with the microscopic group and 64% in the endoscopic group were determined as successful.

Postoperative complications were determined as temporary vertigo in 37 patients, sensorineural hearing loss in 2 patients, damage to the chorda tympani in 8 and perforation of the tympanic membrane in 2. Revision surgery was applied to 12 patients, four of whom had been operated on in another centre. In the eight patient from our own clinic, the stapes base was cleaned of granulation tissue and the prosthesis was replaced, but no effective improvement was obtained in hearing. In the other patients from an external centre, the prosthesis was replaced and the air-bone gap was seen to improve to 20 dB.

4. Discussion

Since Shea first described modern stapedectomy in 1956, stapes surgery with the microscopic method has maintained its popularity until today. The increasing use of endoscopic system for the last 30 years has also found a place in stapes surgery and otologist studies have done many studies on this subject. It is stated that the use of endoscope or microscope in stapes surgery does not make a difference in terms of functional results. However, there are situations where these two methods are limited as well as advantageous situations. The use of microscope may be insufficient in visualizing the middle ear, especially in people with narrow external auditory canal, and endoscope may be more advantageous in these patients. The use of one hand in the endoscopic method, the two-dimensional image and the insufficient depth of the image are the limitations of this method [6,7].

There are many studies comparing endoscopic and microscopic methods in stapes surgery. The main idea in these studies is that the two methods are not superior to each other in terms of hearing gains, but the endoscopic method requires less scutum curettage, less injury to the chorda tympani nerve, and less tympanic membrane perforations, making this method preferable. In addition, it has been argued that

Table 1
Pre and postoperative distribution of the air-bone gap values.

	Mean	CI	SD	MD	Paired *t*-test	p
Microscopic approach						
Pre -postoperative						
Air-bone gap ($n = 44$)	30.50-14.60	11.79-19.99	14.73	2.04	7.77	0.000
Endoscopic approach						
Pre -postoperative						
Air-bone gap ($n = 48$)	32.32-18.81	2.38-24.63	15.55	4.91	2.74	0.023

CI: confidence interval %95.
SD: Standard deviation.
MD: Mean difference.

Table 2
Classification of the postoperative air-bone gap of the microscopic and endoscopic approach.

Air-bone gap (db)	Microscopic		Endoscopic	
	No of patients	%	No of patients	%
0-10 (very good)	25	57	26	54
11-20 (good)	8	18	5	10
21-30 (acceptable)	5	11	12	25
>30 (failure)	6	14	5	11

endoscopic stapes surgery is technically easy to perform, safe and advantageous in terms of middle ear visualization. The disadvantages are the lack of binocular vision, the need for one-handed operation, and the high learning curve.

In the study of Gülsen et al. microscopic and endoscopic stapes surgery were compared in terms of functional results and complication rates. As a result of this study, the authors reported that endoscopic stapes surgery is a minimally invasive method, there is no difference in functional results, and fewer complications are seen in the endoscopic method [8,9].

The success of the operation applied is evaluated most often by closure of the air-bone gap. In this study, the patients were classified in four groups according to the Denoyelle et al. [5] classification as very good, good, acceptable and failure. The functional success criteria was accepted as a reduction in air-bone gap to $\leq$20 dB. The results of those operated on with the microscopic technique were very good in 57% of cases, good in 18%, acceptable in 11%, and failure in 14%. The results of the endoscopic group were 54% very good, 10% good, 25% acceptable, and 11% failure.

Functional success was obtained at the rate of 71% in the microscopic technique group and 60% in the endoscopic group. Although not at a statistically significant level, the lower success in the endoscopic technique was thought to be due to the use of the endoscopy technique being relatively new in otosclerosis surgery and therefore we are still at the start of the learning curve. It is thought that similar rates will be obtained as endoscopic experience increases.

Although the results of otosclerosis surgery are pleasing, serious complications may be encountered both intra-operatively and post-operatively. Spandow et al. [10] reported complications associated with otosclerosis surgery as damage to the chorda tympani nerve in 2 cases, tympanic membrane perforation in 1 case and total hearing loss in 1 case. Berliner et al. [11] reported floating base in 2 patients, base fracture in 2, perilymph leakage in 1, vertigo in 9, granuloma in 1, and total hearing loss in 3. Different studies in literature have reported different complication rates. The most feared complication in stapes surgery is total hearing loss. This hearing loss may be due to reasons associated with the trauma of surgery such as overuse of the curette, too much traumatic work and leakage of blood to the inner ear. There has been reported to be an increased risk of sensorineural hearing loss in obliterative otosclerosis, revision surgery, patients who develop perilymph gusher, and in cases who develop endolymphatic hydrops [12].

In our study, severe sensorineural hearing loss developed in 2 patients. In addition, vertigo was found in 37 patients in the postoperative period, chorda tympani nerve injury in eight patients, and tympan membrane perforation in 2 patients. Of the patients with postoperative vertigo, 17 patients underwent stapes surgery using the microscopic method, while 20 of them were patients who underwent endoscopic surgery. Two of the patients with sensorineural hearing loss were in the patient group with endoscopic method. 3 of the patients with chorda tympani injury were operated with endoscopic method and 5 of them were operated with microscopic method. Of the 2 patients with tympanic membrane perforation, 1 was in the endoscopic group and 1 was in the microscopic group stapes surgery is a successful method with high success rates and low complication rates in the treatment of otosclerosis. To be able to avoid serious complications that can develop during stapes surgery, the need for experience and careful surgery applied with patience must not be forgotten. It can be considered that as endoscopy becomes more widespread in otological surgery and experience increases, complication rates will fall and satisfactory surgical results will be obtained.

As a result of this study, in which we shared our 10 years of experience in stapes surgery with different surgical approaches, we think that the surgical approach used does not make any difference in the results of stapes surgery, and that the most important factor that can affect the results is the experience of the surgeon. It is also extremely important that patients' expectations are well known before surgery and informing patients in detail will enable patients to evaluate all the possibilities and the physician to make the correct indication.

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CRediT authorship contribution statement

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Declaration of competing interest

The authors declared no conflict of interest.

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