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Endoscopic Transcanal Stapes Surgery: Our Audiological and Surgical Results

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ABSTRACT

The aim of this study is to investigate the intraoperative and postoperative results of endoscopic stapes surgery performed at our institution.

A total of 25 patients with 28 ears (14 right, 14 left ears) who underwent endoscopic stapes surgery between 2018 and 2022 were analysed for postoperative hearing outcomes and surgical complications at the 6-month follow-up.

The average age of the patients was 43.16 years (range, 24-63 years), and 64.0% of the patients were female. The median preoperative air-bone gap decreased from 30.36 dB hearing level (HL) to 18.95 dB HL after surgery ($P < 0.001$). The postoperative air-bone gap was 10 dB or lower in 8 ears (28.6%), 11-20 dB in 10 ears (35.7%), and more than 20 dB in 6 ears (21.4%). Worse hearing outcomes were observed in 4 ears (4.14%). Intraoperative complications included only tympanic membrane ruptures in one patient, which resolved during the initial follow-up. Postoperatively, 10.7% of the subjects complained of changes in taste sensation. One patient developed facial paralysis responsive to steroid treatment one week after surgery.

Endoscopic surgery is particularly suitable for stapedial disorders. Endoscopic stapes surgery is minimally invasive and suitable for surgical training, as surgical anatomy can be easily understood, and both the surgeon and assistant can observe the procedure from the same monitor. The operation should only be performed by experienced surgeons due to the need for single-handed operation and the lack of stereoscopic vision.

Keywords: *Stapes; Stapedectomy; Outcomes; Endoscopic ear surgery*

Endoskopik Transkanal Stapes Cerrahisi: Odyolojik ve Cerrahi Sonuçlarımız

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ÖZ

Araştırmanın amacı, kurumumuzda gerçekleştirilen endoskopik stapes cerrahisinin intraoperatif ve postoperatif sonuçlarını incelemektir. 2018 ile 2022 yılları arasında endoskopik stapes cerrahisi geçiren 25 hasta, 28 kulak (14 sağ, 14 sol kulak) üzerinde yapılan çalışmada postoperatif işitme sonuçları ve cerrahi komplikasyonlar 6 aylık takipte analiz edilmiştir.

Hastaların yaş ortalaması 43.16 yıldı (24-63 yaş aralığı), hastaların %64'ü kadındı. Median preoperatif hava-kemik açıklığı, cerrahiden önce 30.36 dB işitme seviyesindeyken (HL), cerrahiden sonra 18.95 dB HL'ye düştü ($P < 0.001$). Postoperatif hava-kemik açıklığı, 8 kulağın (%28.6) 10 dB veya daha az, 10 kulağın (%35.7) 11-20 dB ve 6 kulağın (%21.4) 20 dB'den fazla olduğu görüldü. Dört kulakta (%4.14) daha kötü işitme sonuçları gözlemlendi. İntraoperatif komplikasyonlar sadece bir hastada timpanik membran yırtıkları içeriyordu ve bu, ilk takipte çözüldü. Postoperatif olarak, katılımcıların %10.7'si tat duyusundaki değişikliklerden şikayet etti. Bir hasta, cerrahiden bir hafta sonra steroid tedavisine yanıt olarak gelişen yüz felci yaşadı.

Endoskopik cerrahi, stapedial bozukluklar için özellikle uygundur. Endoskopik stapes cerrahisi minimal invazivdir ve cerrahi anatomiyi anlamak kolay olduğu için cerrahi eğitim için uygundur; cerrah ve yardımcı aynı monitörden işlemi izleyebilir. Ancak operasyon, tek elle gerçekleştirilmesi ve stereoskopik görüş eksikliği nedeniyle yalnızca deneyimli cerrahlar tarafından gerçekleştirilmelidir.

Anahtar sözcükler: *Stapes; Stapedektomi; Sonuçlar; Endoskopik Kulak Cerrahisi*

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Introduction

Otosclerosis, characterized by bone resorption and sclerotic bone formation in the temporal bone, can result in either conductive or mixed-type hearing loss. It was first described by Valsalva[1].

In 1953, Rosen introduced the original stapes procedure for managing otosclerosis. Since then, various surgical methods, including stapedectomy and stapedotomy, have been described. Traditionally, these surgical procedures have been performed using the operating microscope[2].

Compared to traditional microscopic approaches for middle ear surgery, endoscopic ear surgery (EES) is advocated for its distinct advantages, such as enhanced visualization and access, reduced postoperative pain, expanded experience in surgical education, and the diminished need for cutting the chorda tympani nerve[3,4].

The endoscopic approach, especially in stapes surgery, offers several advantages such as better visualization of the stapes and footplate, reduced bony canal removal, and prevention of endaural incision[5,6]. With these advancements, endoscopic stapes surgery provides similar auditory outcomes when compared to the microscopic technique[2,7].

Additionally, Sproat et al. reported a reduced likelihood of chorda tympani nerve damage, similar procedure durations, and postoperative audiological results between endoscopic and microscopic groups, with endoscopic patients experiencing less postoperative pain[8].

Despite the mentioned advantages, the use of endoscopy in surgery is limited by the fact that it requires the surgeon to operate with one hand while holding the endoscope. Additionally, theoretically, due to the two-dimensional nature of the endoscopic image, it does not provide depth perception. However, this limitation can be overcome by manipulating the endoscope to create a sense of spatial configuration between structures[7].

With the increasing availability of training courses in endoscopic ear surgery, surgical experiences have been globally shared, and endoscopic approaches have become a widespread option worldwide[9]. The purpose of this study is to investigate the intraoperative and postoperative outcomes of endoscopic stapes surgery performed at our institution.

Material And Methods

Population

This study was conducted on patients who presented with complaints of hearing loss to the Ear Nose Throat Clinic of Sivas Republic University between 2018 and 2022. These patients were initially suspected of having otosclerosis based on their medical history, physical examination, audiological, and radiological evaluations. The definitive diagnosis of otosclerosis was established, and surgical treatment was performed by our team. All parameters to be evaluated in the study were accessible from the patient records.

Pure Tone Audiometric Evaluation

Pure tone audiometric evaluations were conducted using the Interacoustics Clinic Audiometry device, AC-40 model (Interacoustics, Assen, Denmark). Audiological assessments were performed before the initiation of treatment and one year after the treatment. Pure tone averages for preoperative and one-year postoperative assessments were recorded. In the audiometric evaluation, air conduction pure-tone thresholds were examined at 250, 500, 1000, 2000, 4000, and 6000 Hz, while bone conduction pure-tone thresholds were examined at 500, 1000, 2000, 4000, and 6000 Hz.

Hearing levels were classified according to the indicator chart provided in Katz's Handbook of Clinical Audiology. Accordingly, patients hearing loss was categorized as follows: mild between 25-40 dB, moderate between 41-56 dB, moderately severe between 57-70 dB, severe between 71-90 dB, and profound for values above 91 dB, indicating severe hearing loss.

In addition to age, gender, and other demographic information, the evaluation of pure-tone threshold averages and air-bone gap (ABG) values was based on the preoperative and postoperative audiometric assessments of patients. The effect of the endoscopic stapedectomy technique on current hearing was determined by classifying the results (ABG<10 dB, ABG<20 dB).

Written and verbal consent was obtained from all volunteers included in the study, and those who agreed to participate were included.

Inclusion criteria for the study required that the cases had undergone surgical treatment with the endoscopic stapedectomy technique, had not used fluoride for medical purposes, and had no

pathologies other than otosclerosis detected during routine Ear Nose Throat examinations.

Surgical Procedure

Endoscopic stapes surgery (EES) was performed under general anesthesia with a transcanal approach in a hypotensive condition. For this surgical procedure, 0-degree endoscope tips with a length of 18 cm and a diameter of 2.7 mm, along with a high-resolution camera system (Karl Storz, Tuttlingen, Germany), were used. After intubation and sterilization, following the infiltration of a local anesthetic (20 mg/mL of lidocaine + 0.0125 mg/mL of epinephrine HCl) to reduce bleeding, a superior and inferior timpanomeatal flap elevation was performed approximately 7-8 mm lateral to the annulus. Care was taken to avoid damage to the chorda tympani while entering the middle ear.

Adequate bone curettage was performed from the scutum to ensure full visibility of the stapes and tendon and to allow for sufficient manipulation. The mobility of the ossicular system in the middle ear was assessed, along with the stability of the stapes footplate or movement of the incudomalleolar joint. The course of the facial nerve and the condition of other middle ear structures were also examined.

After confirming the stability of the stapes footplate, it was separated from the incudostapedial joint, and the stapes tendon was cut. The anterior and posterior crura were fractured to remove the stapes superstructure. A hole was carefully drilled in the footplate using a Microdrill to accommodate the piston. After that, a Teflon piston was hung on the long process of the incus, and the motion system was ensured. In selected cases for piston stability, bone cement was used on the incus and piston, and a fat graft was used around the piston to support it and prevent perilymph leakage. The motion system was checked, and the piston was laid over the tympanomeatal flap to prevent flap lateralization, supported with gel foam. Patients were discharged on the second day postoperatively after head elevation and received ear drops containing ciprofloxacin following external ear canal cleaning one week later. The first audiological evaluation after surgery was performed at 4-6 weeks. Additionally, audiological evaluations were repeated at 6 months and 1 year postoperatively.

Statistical Analysis

For the evaluation of the data obtained in the study, the SPSS (SPSS Inc., Chicago, IL) 23.0 software program was used. Complementary statistics such as arithmetic mean, standard deviation, median, and minimum-maximum values were used for data evaluation. The normality assumption was checked using the Kolmogorov-Smirnov or Shapiro-Wilk test. Parametric tests were used for values that met the normality assumptions, while non-parametric tests were used for values that did not meet the normality assumptions.

The relationship between two variables was examined using Pearson correlation and Spearman rank correlation. Chi-square analyses were used for categorical qualitative variables. A significance level of $p < 0.005$ was considered statistically significant.

Result

A total of 28 ears from 25 patients were included in the study, with 64% (n=16) being female and 36% (n=9) male. The average age of the patients was 43.16±11.44 years (ranging from 24 to 63 years). The average age of female patients was 44.00±11.23 years (ranging from 26 to 63 years), while the average age of male patients was 41.67±12.35 years (ranging from 24 to 58 years). There was no significant difference in age between females and males. Fourteen patients were operated on the right ear, and 14 patients on the left ear.

Changes in both air conduction and bone conduction were found to be statistically significant before and after surgery (Table-1).

Table 1. Changes in air conduction and bone conduction before and after surgery

	Mean	Std.Deviation	Minimum	Maximum	p
AC Pre-Op	54.0714	10.4027	33	80	0.001
AC Post-Op	38.6071	20.4565	10	90	
BC Pre-Op	23.5714	10.1267	12	52	0.010
BC Post-Op	20.0357	15.2352	5	65	

The patients' preoperative and six-month postoperative bone conduction thresholds, air-bone gap, and average postoperative air-bone gap improvement have significantly improved (Table-2).

Table 2. Preoperative and Six-Month Postoperative Bone Conduction Thresholds, Air-Bone Gap, and Average Postoperative Air-Bone Gap Improvement in Patients.

	BC	ABG	ABG.Gain
Preop	23,57±10,13 (12-52)	30,36±7,58 (13-47)	-
Postop	20,04±15,24 (5-65)	18,93±9,5 (5-40)	11,43±11,56 (-12-33)
p	0,01	<0,001	-

The results of the air-bone gap show a significant improvement compared to the preoperative levels ($p < 0.001$). The postoperative air-bone gap was 10 dB or lower in 8 ears (28.6%), 11-20 dB in 10 ears (35.7%), and more than 20 dB in 6 ears (21.4%). Worse hearing outcomes were observed in 4 ears (4.14%) (Figure 1).

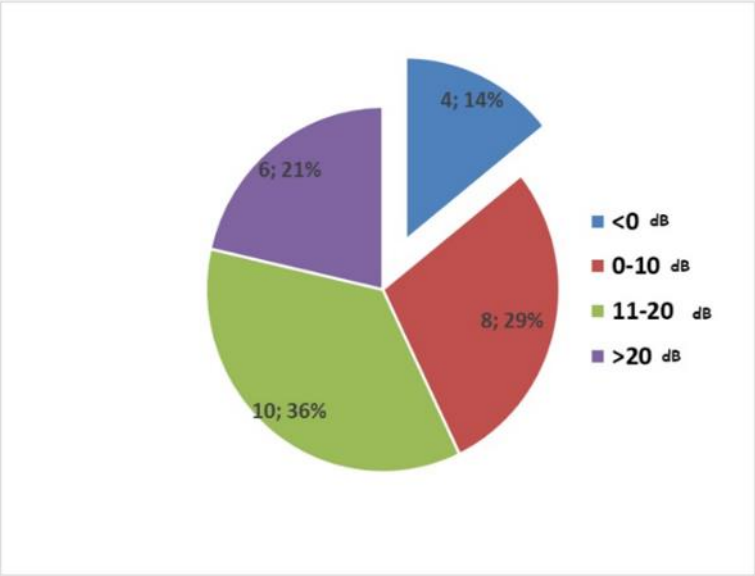

Figure1. Rate of change in the air-bone gap.

Worse hearing outcomes occurred in some patients due to the following reasons:

One patient who underwent surgery on the right ear had a reoperation one year after the initial procedure due to erosion of the prosthesis on the incus neck.

Two patients required reoperation because the prosthesis became dislodged.

Surgery was canceled for one patient who was planned for surgery on the left ear due to an extremely narrow external auditory canal that would not allow passage of the endoscope.

In one patient where the facial nerve was exposed, facial paralysis responsive to steroid treatment developed one week after surgery. In one patient, a perforation of approximately 2x1 mm in the tympanic membrane was closed during surgery using a fat graft harvested from the earlobe, and the postoperative examination showed an intact tympanic membrane. Three patients reported a disturbance in their sense of taste. No patient experienced severe vertigo.

Discussion

Stapes surgery is the gold standard treatment for otosclerosis. Initially, this surgery was performed using a microscope. However, as endoscopic ear surgery became popular among otologists, literature reviews have revealed an increasing number of studies each year, and the amount of data that can be gathered about EES procedures is growing[10].

The first results related to EES were published by Tarabichi in 1999, and they observed a postoperative decrease of <10 dB in ABG in 85% of cases[11]. In the 2000s, due to strong criticism from the otological community and very few published studies on EES, there were almost no results reported. However, in the decade from 2010 to 2020, new studies began to emerge. In 2016, a study by Daeshi et al.[12] reported a <20 dB decrease in ABG in 94% of cases and a <10 dB decrease in 58% of cases. Another study by Hunter et al.[13] showed a 90% reduction in ABG <20 dB. Naik et al. reported outcomes from their series of 20 EES cases, where 55% of patients achieved complete closure of the air-bone gap, 30% had mild conductive hearing loss (up to 20 dB), and 2 cases had mixed hearing loss (BC up to 30 dB and air-bone gap up to 20 dB). They also mentioned a case where a patient initially experienced improvement in hearing after surgery but developed a moderate conductive hearing loss of 35 dB at the 10th week due to adhesions[14]. In our study, we obtained better hearing results with an 86% improvement in ABG. Among these ears, the postoperative air-bone gap was 10 dB or lower in 8 ears (28.6%), 11-20 dB in 10 ears (35.7%), and more than 20 dB in 6 ears (21.4%). In the 4 ears who did not achieve the desired hearing outcome, one had erosion of the prosthesis on the incus neck one year after surgery, two had dislodgement of the prosthesis, and one had worse hearing due to an extremely narrow external auditory canal that would not allow the passage of the endoscope.

In the initial follow-up, postoperative dysgeusia was recorded in 10.7% of patients, a range that falls between 0% to 61.9% as reported for traditional microscopic stapes surgery[15,16]. High rates of postoperative dysgeusia have been noted with minimal chorda tympani nerve manipulation, which is common in endoscopic stapes surgery[17]. Additionally, it is important to note that being close to the light source during surgery can potentially affect the chorda tympani nerve[18]. However, the impact of light intensity on the sense of taste has not yet been researched. Interestingly, the extent of chorda tympani nerve damage does not always align with the degree of changes in taste sensation, as only 50% of patients with chorda tympani nerve sectioning reported alterations in taste sensation[16]. Late facial nerve palsy (House-Brackmann grade 3) occurred in one of the patients one week after surgery. In this patient, there was facial nerve dehiscence. No damage was inflicted on the facial nerve during surgery, and the temporary facial paralysis improved within 1 month after medical. The use of bone cement to stabilize the piston and incus was considered a possible risk factor. Timpanic membrane perforation, as reported by Jacob B. Hunter and colleagues, occurred in approximately 8% of cases. In our case series, only one patient experienced a perforation of approximately 2x1 mm in size during the surgery. This perforation was closed with a fat graft taken from the earlobe during the operation, and postoperatively, the tympanic membrane was found to be intact[18].

All patients who underwent endoscopic surgery experienced mild postoperative dizziness.

Despite the limited number of cases examined in this study, the safety of endoscopic surgery was observed based on the frequency of complications. However, stapes surgery is challenging, and complications can lead to significant sensorineural hearing loss.

Conclusion

Endoscopic surgery, especially for stapedial diseases, is suitable and offers a minimally invasive approach. It is also conducive to surgical education, as surgical anatomy can be easily understood, and both the surgeon and assistant can observe the procedures on the same monitor. However, due to the need for single-handed operation and the lack of stereoscopic vision, it should only be performed by experienced surgeons.

References

1. Karosi T, Sziklai I. Etiopathogenesis of otosclerosis. Eur Arch Otorhinolaryngol. 2010;267(9):1337–1349.

2. Isaacson B, Hunter JB, Rivas A (2018) Endoscopic stapes surgery. Otolaryngol Clin North Am 51(2):415–428. https://doi.org/10.1016/j.otc.2017.11.011

3. Nassiri AM, Yawn RJ, Dedmon MM et al (2018) Primary endoscopic stapes surgery: audiologic and surgical outcomes. Otol Neurotol 39(9):1095–1101. https://doi.org/10.1097/MAO.0000000000001958

4. Iannella G, Marcotullio D, Re M et al (2017) Endoscopic vs microscopic approach in stapes surgery: advantages in the middle ear structures visualization and trainee's point of view. J Int Adv Otol 13(1):14–20. https://doi.org/10.5152/iao.2017.3322

5. Bianconi L, Gazzini L, Laura E, et al. Endoscopic stapedotomy: safety and audiological results in 150 patients. Eur Arch Otorhinolaryngol. 2020;277(1):85–92

6. Vaughan C, Fox R, Jufas N, et al. Endoscopic stapedectomy: collective experience from a large Australian center. Otol Neurotol. 2020;41(9):1198–1201.

7. Hunter JB, Rivas A (2016) Outcomes following endoscopic stapes surgery. Otolaryngol Clin North Am 49(5):1215–1225. https://doi.org/10.1016/j.otc.2016.05.012

8. Sproat R, Yiannakis C, Iyer A (2017) Endoscopic stapes surgery: a comparison with microscopic surgery. Otol Neurotol 38(5):662–666. https://doi.org/10.1097/MAO.0000000000001371.

9. Bartel R, Levorato M, Adroher M et al (2019) Transcanal endoscopic type 1 tympanoplasty in children: cartilage butterfly and fascia temporalis graft. Int J Pediatr Otorhinolaryngol 121:120–122.

10. Bartel, R., Sanz, J.J., Clemente, I. et al. Endoscopic stapes surgery outcomes and complication rates: a systematic review. Eur Arch Otorhinolaryngol 278, 2673–2679 (2021). https://doi.org/10.1007/s00405-020-06388-8

11. Tarabichi M (1999) Endoscopic middle ear surgery. Ann Otol Rhinol Laryngol 108(1):39–46

12. Daneshi A, Jahandideh H (2016) Totally endoscopic stapes surgery without packing: novel technique bringing most comfort to the patients. Eur Arch Otorhinolaryngo 273(3):631–634
13. Hunter JB, O'Connell BP, Rivas A (2016) Endoscopic techniques in tympanoplasty and stapes surgery. Curr Opin Otolaryngol Head Neck Surg 24(5):388–394.
14. Naik, C., & Nemade, S. (2016). Endoscopic stapedotomy: our view point. European Archives of Oto-Rhino-Laryngology, 273, 37-41.
15. Yung M, Smith P, Hausler R, et al. International common otology database: taste disturbance after stapes surgery. Otol Neurotol 2008; 29:661–665.
16. Berling Holm K, Knutsson J, Stromback K, et al. Taste disturbance after stapes surgery: an evaluation of frequency, severity, duration, and quality-of-life. Acta Otolaryngol 2017; 137:39–43
17. Guder E, Bottcher A, Pau HW, et al. Taste function after stapes surgery. Auris Nasus Larynx 2012; 39:562–566
18. Hunter JB, Zuniga MG, Leite J, et al. Surgical and audiologic outcomes in endoscopic stapes surgery across 4 institutions. Otolaryngol Head Neck Surg 2016; 154:1093–1098.