Endoscopic Stapedectomy: Collective Experience From a Large Australian Center

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Introduction: Endoscopic stapes surgery is a technically demanding procedure that is increasing in popularity. Surgical outcomes and complication rates have been demonstrated to be comparable to traditional microscopic techniques. The surgical outcomes for patients undergoing stapes surgery performed by the Sydney Endoscopic Ear Surgery Research Group are presented.
Study Design: Retrospective review from prospectively gathered database.
Setting: Tertiary referral centers.
Patients: A retrospective case review of patients undergoing endoscopic stapes surgery performed by four surgeons between February 2015 and July 2019 was carried out. Sixty nine patients were identified, and assessed for demographics, functional results, and postoperative complications.
Intervention: Endoscopic stapedotomy.
Main Outcome Measure: Postoperative hearing results.
Results: Sixty eight of 69 patients (98.6%) achieved an airbone gap (ABG) closure of less than 20 dB. Sixty of 69 patients (87%) achieved and ABG closure of less than 10 dB. The average improvement of the ABG over four frequencies achieved was 26.5 dB (range, 0–61). Postoperative complications were infrequent and self-limiting. Six patients experienced dysgeusia without obvious chorda tympani injury, four patients developed short lived vertigo, and two patients experienced tinnitus.
Conclusions: Endoscopically assisted stapes surgery represents a safe alternative to traditional microscopic techniques, with similar morbidity and audiological outcomes.
KeyWords: Endoscopic—Endoscopic ear surgery—Endoscopy—Otoendoscopy—Otosclerosis surgery—Stapedectomy—Stapedotomy—Stapes surgery.

Otol Neurotol **41:**1198–1201, 2020.

OBJECTIVES

Otosclerosis is a hereditary disease causing progressive conductive, mixed, or sensorineiral hearing loss, characterized by abnormal bone remodeling within the otic capsule (1). Fenestration of the oval window as a modality of treatment was first described by Shea (2) in 1956, and since then the procedure has undergone multiple modifications. The operation has traditionally been performed using a microscope, with either a trans-canal or endaural approach. Technological advances however have seen an increase in the use of the endoscope for middle ear procedures (3,4).

Initially primarily used to assess the anatomy, the endoscope is now being used by some surgeons as the primary visulization tool. Despite the drawback of performing a technically difficult operation with one hand, advocates argue that the endoscope allows for better visualization of the stapes and any anatomical anomalies often without the need for an endaural incision, and may allow for some cases to be performed without curettage of the scutum, potentially limiting damage to the chorda tympani nerve (4,5). Furthermore, the endoscopic approach allows for the teaching surgeon to more accurately describe the steps of the procedure to the student. The outcomes for patients undergoing endoscopic stapedotomy performed by the Sydney Endoscopic Ear Surgery (SEES) Research Group are presented.

METHODS

Research board approval was obtained from the local institutional research board. A retrospective case note analysis from a prospectively gathered database was performed for all patients undergoing endoscopic stapedotomy between April 2015 and

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No funding has been received by any author in support of this work.
All authors have read and approved this manuscript and there are no conflicts of interest regarding this publication to declare regarding the publication of this article.
DOI: 10.1097/MAO.0000000000002762

January 2019. All operations were performed by four senior surgeons, all with extensive experience (>100 cases) in endoscopic ear surgery. Records were assessed for patient demographics, surgical technique, prosthesis used, surgical outcomes including closure of air-bone gap (ABG) and any complications.

Inclusion criteria were primary stapedotomy procedures for confirmed fenestral otosclerosis where an endoscope was used for more than 50% of the dissection (Massachusetts Endoscopic Class 2b or 3) (6). Exclusion criteria were: revision cases, those where a duel pathology was present, e.g., malleus head fixation or cases of Massachusetts Class 1 or 2a.

Technique

All patients were operated on under general anesthetia. Typically a 0 degree 3 mm endoscope was used with the light setting at 40%. A tympanomeatal flap was raised endoscopically and the diagnosis of otosclerosis confirmed by inspection of the oval window and palpation of the ossicular chain. Endoscopic assessment was made of the stapes and its relationship to the scutum to determine if curettage was necessary. If an instrument could pass directly to the footplate with a straight trajectory, then the scutum was left intact. If scutal position was less favorable, then it was removed with a handheld curette or microdrill. The chorda tympani was preserved in all cases. Following division of the incudo–stapedial joint, the stapedius tendon and the posterior crus were divided using laser or microscissors, to facilitate down fracture of the stapes superstructure. The distance between the long process of the incus and footplate was measured and then a fenestration was created in the footplate, using either laser, a microdrill, or handheld microperforators. The correctly sized prosthesis was inserted and crimped, then the footplate sealed, using either fat, fascia pieces, or blood. The tympanomeatal flap was replaced and the external auditory canal packed with gelatin foam pieces soaked in ciprofloxacin drops.

RESULTS

Demographics

Sixty nine patients were included in the study. The mean age was 50 years (range, 22–75 yr). Surgery was performed on 34 left ears and 35 right ears. Thirty two patients were women, 37 men.

The postoperative audiogram was performed on average at 3 months (range, 1–12 mo).

Surgical Technique

Endoscopic Grade

Thirty nine (57%) of operations were performed entirely endoscopically (Massachusetts Endoscopic Grading Class 3) (6). Therefore the remaining 30 (43%) required a microscope to be used to complete part of procedure, although the endoscope was used for more than 50% (Massachusetts Endoscopic Grading Class 2B). The reasons for switching to the microscope included narrow ear canals requiring canalplasty, or for better visualization of the footplate. The use of the microscope was not dependant on experience, i.e., there was no apparent relation to learning curve in respect to switching to the microscope.

Scutal Removal

Sixteen (23.1%) patients were able to have successful stapedotomy procedures without the need for scutum curettage.

Laser Use

Fifty eight (84.0%) cases used a KTP laser to divide the stapedius tendon and posterior crus plus fenestrate the footplate.

Choice of Piston

Medtronic Big Easy piston (Medtronic, MN) was used in 40 (58.0%) and Grace Medical ''Eclipse'' nitinol piston (Grace Medical, TN) was used in the remainder 29 (42.0%) patients. Reflecting this, the prosthesis was manually crimped onto the incus in 43 (62.3%) patients and crimped utilizing the laser in 26 (37.7%) patients.

Footplate Seal

A blood patch was used in 23 (33.3%) patients, a fat or fascia plug in 45 (65.2%) patients, and tragal perichondrium in 1 patient (1.5%).

Air-Bone Gap

Table 1 shows average air conduction and bone conduction thresholds for patients separated into endoscopic grading Class 2b and 3. The average air-bone gap closure achieved for the two groups was similar; 4 dBHL for Class 2b and 7 dBHL for Class 3. All but one patient (98.6%) had their ABG closed to less than 20 dBHL across four frequencies (0.5, 1, 2, and 3 kHz). The remaining patient had an ABG of 23 dBHL (see Table 2).

Complications

Dysguesia

Six (8.7%) patients developed dysguesia postoperatively, with no obvious damage to the chorda tympani during the procedure. The risk ratio for postoperative

TABLE 1. *Average air conduction and bone conduction thresholds and air-bone gap with 95% confidence intervals for patients undergoing endoscopic stapedotomy*

	Preoperative (Class 2b, n = 30)	Postoperative (Class 2b)	Preoperative (Class 3, n = 39)	Postoperative (Class 3)
Air conduction average (dBHL)	57 (±5.1)	24 (±3.4)	57 (±5.8)	31 (±4.7)
Bone conduction average (dBHL)	22 (±3.5)	20 (±4.5)	27 (±4.5)	25 (±4.3)
Air-bone gap average (dBHL)	35 (±3.9)	4 (±1.46)	30 (±2.8)	7 (±1.8)

TABLE 2. *Postoperative closure of air-bone gap*

Postoperative Air-Bone Gap (dBHL)	Patients
0–10	60 (87.0%)
11–20	8 (11.6%)
>20	1 (1.4%)

TABLE 3. *Postoperative dysguesia in relation to scutum curettage*

	Dysguesia	No Dysguesia	Total
Scutal curettage	2	51	53 (76.8)
No scutal curettage	4	12	16 (23.2)
Total (%)	6 (8.7)	63 (91.3)	69
Odds ratio (OR)	0.12		
Risk ratio (RR)	0.15		

dysguesia in patients who had scutal curettage compared with patients who did not have scutal curettage was 0.15 (Table 3).

Vertigo

Four (5.8%) patients developed transient vertigo, all of which had resolved spontaneously within 2 weeks.

Perforation

Three (4.3%) patients had an iatrogenic tympanic membrane perforation, which was repaired at the time of surgery with an underlay fascial graft. All had healed at the subsequent follow up.

Tinnitus

Two (2.9%) patients developed postoperative tinnitus, both with a successful audiological outcome (ABG 10 and 4 dBHL).

Other

No patients developed sensorineural hearing loss or developed facial nerve paralysis.

DISCUSSION

Evidence for the efficacy of endoscopic ear surgery is continually increasing, and the technique is becoming more popular due to its ability to provide increased access to middle ear structures through a transcanal approach. Marchioni et al. (7) in 2016 reported on the endoscope's ability to provide surgeons with improved visualization of middle ear structures in situations where previously the patients' anatomy would have made completion of a stapedotomy procedure too difficult if the surgeon was utilizing the microscope alone.

Audiological Outcomes

98.6% of patients had their ABG closed to less than 20 dBHL in this series. This is comparable to a recent microscopic case series by Strömbäck et al. (8) in 2017, who reported an ABG closure rate of less than 10 dBHL in 69% and 11 to 20 dB in 28% of patients. When looking at other published series of endoscopic stapedotomy, the results repeatedly seem to be comparable to microscopic techniques, achieving ABG closure of less than 20 dBHL in 90 to 100% of cases (9–11). A recent meta-analysis by Manna et al. (9) of five published papers comparing microscopic techniques to endoscopic stapedotomies in 283 ears demonstrated a significantly lower incidence of postoperative pain and chorda tympani injury in the endoscopic group, with comparable audiological outcomes and rates of postoperative vertigo.

The hearing results from this cohort are likely subject to selection bias, since the more challenging cases were converted from Class 3/2b to Massachusetts Class 2a therefore, excluding them from this data set.

Complications

The objective outcome for stapes surgery is to improve hearing outcome for patients. As there are non-surgical treatment options with hearing aids, any surgical intervention must not only achieve good audiological outcomes but should have an associated low morbidity. Sensorineural hearing loss (SNHL) is one of the most serious adverse outcomes of this procedure, of which the literature reports a rate of 0.5% (12) utilizing traditional microscopic techniques. Facial nerve paralysis is another potentially devastating consequence of this surgery and this group reported no events of SNHL, or facial paralysis, adding to the evidence that endoscopic stapedotomy is a safe alternative or adjunct to the microscope.

Once again the cohort may have selection bias as the more difficult cases were converted to Class 2a reducing the complication rate.

Chorda Tympani

Although visualization of the footplate due to the wide angled view of the endoscope may be technically easier without removing the scutum, a straight line trajectory is still required when placing the prostheses. For this reason, scutum curettage was still required in nearly two thirds of patients, which is consistent with what other groups have found utilizing this technique (13). Microscopic techniques have published rates of chorda tympani damage of between 5.6 and 23% (14,15) which is similar to those rates found by this group. Other potential complications of curettage such as incus dislocation were not seen.

Previously published endoscopic series have shown chorda tympani injury to be statistically significantly lower than rates seen in microscopic series (9). Even in the six patients who did not require scutum removal, four still experienced dysguesia postoperatively. The risk ratio describes the relative probability of a patient having symptomatic dysguesia following scutal curettage compared with a patient who did not have scutal curettage. A risk ratio of 0.15 seen this series is interesting, as it actually suggests there was a lower probability of dysguesia when the scutum was curettaged, which seems

counterintuitive. In fact, in this series, scutal curettage was associated with an 85% decreased risk of developing postoperative dysguesia. Presumably irritation of the chorda in these cases where the scutum was left intact, occurred from direct mechanical trauma when raising of the tympanomeatal flap, heat transduction from the endoscope, or desiccation during the procedure.

It must be taken into consideration that the operative procedures in this series were all performed by experienced endoscopic ear surgeons. Despite this, the microscope was still used in 43% of cases, and complications were still encountered. The authors would therefore, strongly recommend surgeons become comfortable with other endoscopic procedures before attempting endoscopic stapedotomy. With more study and series publications such as this one, it will be possible to identify cases that are more suitable for the total endoscopic approach, and which should be completed with the aid of the microscope.

CONCLUSION

This group achieved good results with ABG closure, and complication rates were comparable to those seen with traditional microscopic techniques. This study increases the evidence that endoscopic stapes surgery is a viable and safe adjunct to the microscope. The microscope was still required in 43% of cases in experienced endoscopic surgeons' hands. A combined approach can be used for difficult cases, where the endoscope can provide increased visualization of the anatomical structures and preparation of the footplate, then transition to the microscope for prosthesis placement where a two handed technique can be advantageous.

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