Journal of Otology 13 (2018) 97–100

Contents lists available at ScienceDirect

Journal of Otology

journal homepage: www.journals.elsevier.com/journal-of-otology/

Endoscopic stapedotomy: Merits and demerits

Waleed Moneir, Ahmed Musaad Abd El-fattah*, Eslam Mahmoud, Mohamed Elshaer

Department of Otolaryngology, Faculty of Medicine, Mansoura University, Egypt

ARTICLE INFO

Article history:
Received 9 July 2017
Received in revised form
13 November 2017
Accepted 14 November 2017

Keywords:
Endoscopic stapedotomy
Microscopic stapedotomy
Nasal endoscopes

ABSTRACT

Introduction: Surgical microscopes are still preferred to perform stapes surgery; but the use of the endoscopes would offer much benefits such as good panoramic view and easy accessibility to the oval window niche, the stapes and facial nerve. In this study, we aimed to analyze and compare the outcomes and complications of endoscopic versus microscopic stapes surgery.

Patients and methods: This work was done at the Department of Otorhinolaryngology, Faculty of Medicine, Mansoura University, Egypt, between September 2015 and July 2016. The patients; diagnosed as having otosclerosis and full filled the selection criteria; were randomly divided into 2 groups.

Results: The group A (microscopic group) included 28 patients (aged 19-60 years) and the group B (endoscopic group) included 14 patients (aged 22-56 years). Mean follow-up durations were 4.5 months (1–8.5) in the endoscopic group and 5.5 months (1.5–8) in the microscopic group. The difference in preoperative and postoperative air-bone gap in two groups was statistically significant ($p = 0.031$). But there was no statistical difference for hearing results between two groups and the two techniques have similar audiological outcomes. The main merits of endoscopic stapedotomy are the good quality panoramic image, well identification and visualization of vital structures of the middle ear, minimal handling of chorda tympani nerve if needed with practically no curettage of bony wall.

Conclusions: The present series shows that it is possible to perform stapes surgery using only the 4mm in diameter and 18cm long endoscopes of different angulations, without major difficulties.

This work is conducted in Mansoura University Hospitals, Egypt, to show the advantages and disadvantages of endoscopic stapedotomy in comparison to microscopic stapedotomy. The work described has not been published previously nor under consideration for publication elsewhere. The authors declare that there is no conflict of interest. This study is a part of a master degree thesis submitted by Eslam Mahmoud as partial fulfillment for a master degree. Institutional review board approval, Faculty of Medicine-Mansoura University, was obtained for the study (IRB:MS/15.09.49).

1. Introduction

The stapes surgery is usually performed using either the transcanal or endaural approach. Retroauricular incision is used by some surgeons to evaluate the external auditory canal and middle ear. These approaches are especially used on patients with a narrow or curved external auditory canal. Surgical microscopes are preferred to perform these procedures where they provide good magnification and allow the surgeon to use both of his hands (Böttcher et al., 2009).

Patients who undergo stapes surgery, particularly with the endaural or retroauricular incision, suffer from some complications such as pain, auricular numbness or cosmetic problems. Furthermore, this surgery may become technically difficult with hidden stapes and oval window or narrow external auditory canal. Removal of the scutum may be needed for better exposure of the stapes and oval window, and consequently there is a risk of damage to the chorda tympani. Postoperative taste disorders are encountered in 20–60% of patients after stapes surgery (Böttcher et al., 2009; Miuchi et al.). In addition, subluxation of the ossicular chain may result from removal of the posterior part of the bony canal (Gołabek et al., 2003; Malafronte and Filosa, 2009).

In 2000, Poe (2000) described endoscopic assisted stapedotomy.

* Corresponding author. Department of Otolaryngology, Faculty of Medicine, Mansoura University, Mansoura, Elgomhoria street, Egypt.

E-mail addresses: ahmusaad@hotmail.com, ahmusaad@mans.edu.eg (A.M. Abd El-fattah).

Peer review under responsibility of PLA General Hospital Department of Otolaryngology Head and Neck Surgery.

https://doi.org/10.1016/j.joto.2017.11.002

The use of the endoscope would offer much benefits, such as good panoramic view and easy accessibility to the oval window niche, stapes and facial nerve. Also, with this technique, removal of the scutum and manipulation of the chorda tympani are less frequent. On the other hand, endoscopic ear surgery has some limitations, such as one hand operation and the needed learning curve (Migirov et al., 2011; Kojima et al., 2014).

In this study, we aimed to analyze and compare outcomes and complications of endoscopic stapes surgery versus microscopic stapes surgery.

2. Patients and methods

This study is a comparative analysis of patients with conductive hearing loss who were expected to undergo stapedotomy at the Department of Otorhinolaryngology of Mansoura University Hospitals between September 2015 and July 2016. Institutional Ethics Committee approval for the study was obtained (IRB:MS/15.09.49).

Patients included in this study were those diagnosed with otosclerosis and fulfilled the following criteria: (1) Normal external ear canal; (2) Normal otoscopy; (3) Audiograms showing conductive hearing loss, normal bone-conduction thresholds at 500, 1000, 2000, and 4000 Hz, and absent stapedius reflex; (4) Absent history of past middle ear infection diseases. Patients not fulfilling the inclusion criteria or requiring a revision surgery or surgery on the only hearing ear were excluded.

The patients were randomly divided into 2 groups. Group A included 28 patients who underwent microscopic surgery and group B included 14 patients who underwent endoscopic surgery. Procedures in the endoscopic group were performed by the first author, who is interested and well trained in endoscopic ear surgery; while those in the microscopic group were by the rest of authors, who are experienced in microscopic stapes surgery.

2.1. Procedure

After providing a written informed consent, patients were operated under local anesthesia, and the transcanal approach was the standard approach in both groups.

In the endoscopic group, zero and thirty degree, 4 mm diameter, 18 cm length endoscopes and 3 chips camera were used and held in the left hand of the operating surgeon. All patients assumed the same position usually used for conventional ear surgeries under the microscope. The monitor and video tower was placed in front of the surgeon as for endoscopic nasal surgery. Moreover, the same techniques and instruments used in conventional stapedotomies were applied in these endoscopic procedures.

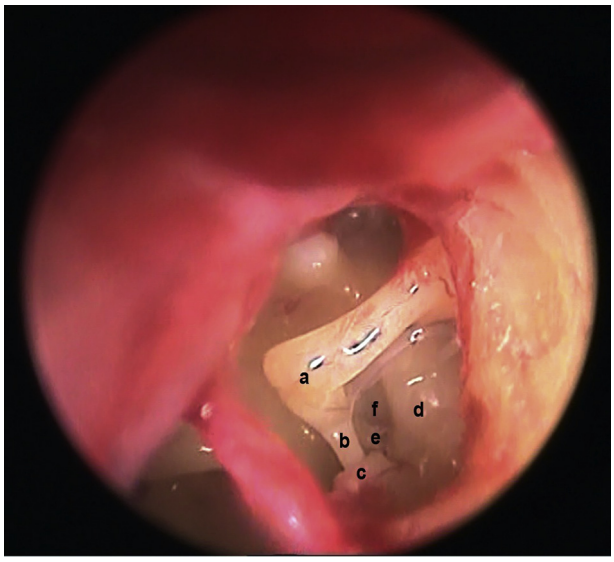

Fig. 1. Endoscopic image through a 0° scope after elevation of the tympanic-meatal flap showing middle ear structures: (a) incudostapedial joint, (b) stapedius tendon, (c) facial nerve, (e) crus of stapes, (f) foot plate of stapes.

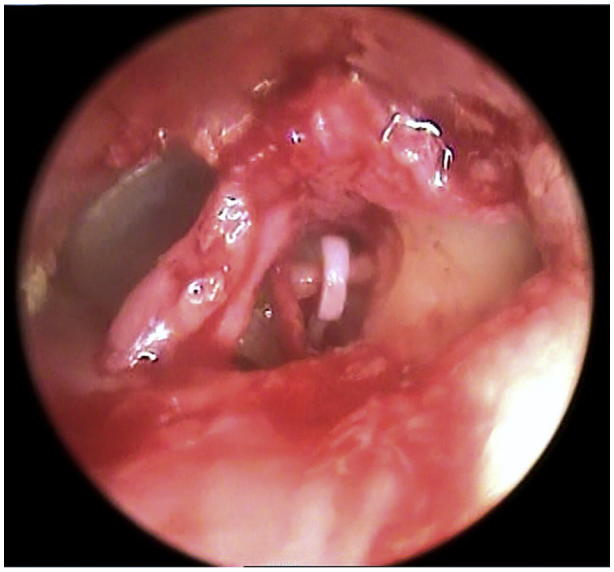

Fig. 2. Endoscopic view (30° endoscope) of a Teflon prosthesis in place.

Hearing was subjectively assessed by the surgeon at the end of every surgery to preliminarily evaluate success of operation. Patients were admitted for 1–2 days and all post–operative medications and precautions were followed. Patients were discharged and a followed–up at 2 weeks and 1 month. Audiogram was usually done at 4–6 weeks while wound healing was assessed.

Clinical notes on important surgery steps to be analyzed included:

(1) Identification of the following middle ear structures (Fig. 1) on the monitor: incudo-stapedial joint, stapes tendon, pyramid, foot-plate and crura of stapes.
(2) If mobilization of the chorda tympani was needed or not.
(3) If curetting/drilling the postero-superior bony canal wall was needed or not.
(4) The way of fracturing the crura under vision.
(5) Fenestration of the foot-plate.
(6) Placement and stabilization of the piston prosthesis (Fig. 2).

Surgery time, in minutes from incision to reposition of flap, was noted. Any complication was recorded and post–op audiograms at an average of 1 month were analyzed.

2.2. Audiological evaluation

Pure tone audiometry was carried out in all patients pre and post-operatively using a 2 channel audiometer (Interacoustics AC40, diagnostic audiometer, Denmark) and immittancemetry using an Interacoustics 235 (Denmark). Air conduction (via supra-aural headphones) and bone conduction (via a bone vibrator) thresholds were measured at 500, 1000, 2000, and 4000 Hz, and the mean (±SD) air-bone gap was noted. The tests were performed in a locally made sound treated room.

Table 1
Postoperative ABG results.

ABG (Post)	Group A	Group B	
Grade A 0–10 dB	16 (57%)	10 (71.4%)	**(success)**
Grade B 11–20 dB	9 (32%)	3 (21.4%)	**(improvement)**
Grade C 21–30 dB	2 (7%)	1(7%)	**(failure)**
Grade D > 30 dB	1(3.6%)	0 (0%)	**(failure)**

3. Results

In microscopic stapedotomy, mobilization of the chorda tympani and curetting of the postero-superior bony canal wall was almost mandatory to visualize the incudo-stapedial joint, stapedius tendon, pyramid, stapes foot-plate and crura after elevation of tympanomeatal flap. Fenestration of the stapes footplate with a perforator was performed while preserving the stapedius tendon and keeping the stapes suprastructure intact for fear of a floating footplate or dislocation of the incus. Teflon piston (0.6 mm in diameter and 4.5 mm in length) was the most suitable prosthesis used in all cases. Lastly, the surgeon cut the stapedius tendon, separated the incudo-stapedial joint, fractured/removed the stapes suprastructure.

In endoscopic stapedotomy, elevation of the tympanomeatal flap was done from an endomeatal incision, 8 mm lateral to the tympanic annulus either from 12 to 4 o'clock (left ear) or from 8 to 12 o'clock position (right ear), followed by assessment of ossicular chain mobility and visualization of the incudo-stapedial joint, stapedius tendon, pyramid, stapes foot-plate and crura (especially the anterior crus) without mobilizing the chorda tympani or curettint the postero-superior bony canal, except in one case where the last 2 steps were needed. Fenestration the foot-plate and stabilization of the prosthesis were done with comfort in all cases.

Patients were discharged the next day with the usual instructions for similar interventions. The ear cover was removed after 1 week and hearing was roughly evaluated by the tuning fork. Six weeks post-operatively, audiogram was repeated and the air-bone gap (ABG) was determined for 500, 1000, 2000, and 4000 Hz.

ABG was categorized as: grade A = 0–10 dB (success), grade B = 11–20 dB (improvement), grade C = 21–30 dB, and grade D = > 30 dB, where grades C and D were considered as a failure (Table 1).

Table 2
Pre and post-operative AC measurements (dB HL).

Parameter	Pre AC 1000	Post AC 1000	Test of significance
	Median (Min - Max)	Median (Min - Max)	
Group A	50 (35–80)	30 (15–75)	Z = 4.6 P < .0001**
Group B	56.25 (12.04)	29.38 (9.1)	t = 10.2 P < .0001**
Parameter	Pre AC 2000	Post AC 2000	Test of significance
	Mean ± SD	Mean ± SD	
Group A	54.46 (13.6)	36.61(12.9)	t = 11.2 P < .0001**
Group B	53.75 (12.8)	34.06 (10.4)	t = 5.9 P < .0001**
Parameter	Pre AC 500	Post AC 500	Test of significance
	Mean ± SD	Mean ± SD	
Group A	50 (35–75)	30 (15–65)	Z = 4.6 P < .0001**
Group B	37.5 (25–70)	25 (20–50)	Z = 2.6 P = .01

**Highly significant (p < .001).

The mean age was 33 ±11.2 years (ranging from 19 to 60 years) for group A (n = 28) and 33.6± 10.3 years (ranging from 22 to 56 years) for group B (n = 14). The mean follow-up duration was 4.5 months (1.5–8.5 months) in group B and 5.5 months (1.5–8 months) in group A. The mean pre-operative air-bone gap was 30 dB (25–40 dB) in group A and 32.5 dB (25–45 dB) in group B (endoscopic). On the other hand, the mean post-operative air-bone gap was 12.5 dB (0–35 dB) in group A and 10 dB (0–25 dB) in group B. Although the difference between pre- and post-operative air-bone gaps in the two groups was statistically significant (p = .031), there was no statistical difference for overall hearing between the two study groups. The two techniques showed similar audiological outcomes when pre- and postoperative air conduction thresholds (at different frequencies) were compared (Table 2). Mean operation time was 47.3 min in group A and 39.1 min in group B (p = .014).

Tympanomeatal flap tear was encountered in 3 cases with microscopic stapedotomy (2 on left and 1 on right) and in 1 case with endoscopic stapedotomy (right side). The tear healed spontaneously in all 4 cases. Temporary impairment of taste and dysguesia occurred in 7 cases with microscopic stapedotomy (25%) and in 1 case in the endoscopic group (7%), due to manipulations of the chorda tympani. Accidental complete transection of the nerve occurred in 1 case in the microscopic group (3.6%).

Incus subluxation was reported in 3 cases with microscopic stapedotomy (although placement of the prosthesis was successful by supporting the incus with an angled hook), but none in the endoscopic group.

Four patients in the microscopic stapedotmy group and one in the endoscopic stapedotomy group suffered from mild and transient intraoperative vertigo during fenestration of the footplate and placement of the prosthesis. Vertigo was conservatively controlled in all 5 cases.

No post-operative SNHL was recorded in either microscopic or endoscopic stapedotomy cases.

4. Discussion

Although the main advantage of the binocular operating microscope is providing a magnified image with depth perception, its straight line viewing has some limitations in transcanal procedures like stapedotomies, where the visual field becomes limited especially in case of tortuous narrow canals. However, it remains widely used worldwide in performing stapedotomies for its generally satisfactory results.

Advancement of endoscopy into the otology field was made 15 years ago, although it remains mainly used for diagnostic procedures or as an additive tool to microscopic surgery for better visualization and identification of important structures and hidden areas in the middle ear which are difficult to access (Naik and Sanjana, 2016). Surgeons often find it difficult to handle traditional otoendoscopes (i.e. 6–10 cm length and 2.7 mm diameter) during middle ear surgeries because of interference with the free movement of the other hand holding the instruments. On the other hand, the view offered by nasal endoscopes (18 cm in length and 4 mm in diameter) is larger and more panoramic. In addition, they allow the other hand to handle the instruments more efficiently (Sajjadi, 2013).

Although otoendoscopes have been recommended by a number of authors, in this study the whole procedure was done by using a nasal endoscope with 0° or 30° angles. There were no obstacles in manipulating the endoscope and instruments.

Curetting or drilling of the postero-superior canal wall is routinely needed for better exposure of the pyramid, stapes tendon and suprastructure. Consequently, this can potentially cause unwanted trauma to the chorda tympani resulting in taste

disturbances. Also, postero-superior retraction pockets may occur later from excessive curettage (Sarkar et al., 2013). In our study, we found that after elevation of the tympanomeatal flap, the incudo-stapedial joint, stapes suprastructure and stapedial tendon could be easily visualized by just advancing the endoscope toward the middle ear while tilting it. The endoscope offered the best help during this stage of the entire procedure. Minimal removal of the postero-superior meatal wall was sometimes needed for appropriate fenestration of the footplate and insertion of the prosthesis.

With the microscope, the highest degree of magnification is needed to visualize the footplate area and to fracture the crura. Yet, in many instances the anterior crus of the stapes cannot be seen by the surgeon, which would result in trying to remove the suprastructure blindly (Kojima et al., 2014).

Nogueira Júnior and others, in 2011 (Nogueira Júnior et al., 2011),stated that a better view of the anterior crus was provided by the endoscope which would enhance fracturing under direct visualization and avoid blind maneuvers, thus bringing chances to fracture the foot plate into nil. In this series good visualization of both crura was achieved in all of the cases which allowed performing safe fracturing and removal of suprastructure. Moreover, when a higher magnification was needed, advancement of the endoscope was done to get a better picture on the monitor.

Other studies show that there is no statistically significant difference between endoscopic and microscopic stapedotomy with regard to the postoperative air-bone gap. Furthermore, they show that full endoscopic stapes surgery is technically feasible, safe and promising, and that the main advantage is virtually excellent vision. On the other hand, the disadvantages are lack of stereoscopic vision, having to work with only one hand, and the learning curve. Also, some of the main favorable outcomes in endoscopic stapes surgery are lower rates of chorda tympani injury and tympanic perforation in comparison with microscopic stapes surgery (Migirov and Wolf, 2013; Daneshi and Jahandideh, 2016; Surmelioglu et al., 2016; Sproat et al., 2017). In this study, regarding post–operative hearing improvement, the results were satisfactory. Posterior air bone gap of 0–10 dB was reported in about 71% of our endoscopic cases and 57% of our microscopic cases, while air bone gap between 10 and 20 dB was reported in about 21% of our endoscopic cases and 32% of microscopic cases.

In spite of the previously reported results in this series which are similar to findings in other studies in the literature, the main shortage of this study is the small number of patients and multiple surgeons performing the procedures. But, the authors believe that this work highlights important issues regarding the possible application of endoscopic stapes surgery with optimistic preliminary results. There is a requirement for further studies with larger sample sizes and longer follow-up periods to fully gauge the safety and effectiveness of this technique.

Readers should always be aware of the needed learning curve before getting into such endoscopic procedures. The experience with the use of microscopes and solid knowledge of middle ear anatomy, in addition to necessary surgical skills, are mandatory. This conclusion goes with the statement by Lanella and Magluilo (2016) i.e. audiological outcomes achieved by endoscopic surgery were similar to those obtained through a microscopic approach. However, initially longer operative time and a learning curve are the principal grounds that may discourage most ear-surgeons from commencing endoscopic stapes surgery.

5. Conclusions

These preliminary case series results highlight that it is feasible to perform stapedotomies with 0° and 30° nasal endoscopes (4 mm, 18 cm) with great comfort. The main merits are good quality panoramic viewing, adequate identification and visualization of vital structures of the middle ear, and minimal manipulation of the chorda tympani nerve, if ever needed, with practically no need for curettage of bony wall. The demerits are mainly single handed operation and lack of depth in vision, which can be overcome by high power magnified image on monitor.

References

Böttcher, E., Pau, A., H., W., et al., 2009. Taste disturbance after stapessurgery–clinical and experimental study. Acta Otolaryngol. (Suppl.562), 71–78.

Daneshi, A., Jahandideh, H., 2016. Totally endoscopic stapes surgery without packing: novel technique bringing most comfort to the patients. Eur. Arch. Oto-Rhino-Laryngol. 273 (3), 631–634.

Gołabek, W., Szymanski, M., Siwiec, H., et al., 2003. Incussubluxation and luxation during stapedectomy. Ann. Univ. Mariae. Curie. Sklodowska. Med 58, 302–305.

Kojima, H., Komori, M., Chikazawa, S., et al., 2014. Comparison between endoscopic and microscopic stapes surgery. Laryngoscope 124, 266–271.

Lanella, G., Magluilo, G., 2016. Endoscopic versus microscopic approach in stapes surgery: are operative times and learning curve important before making the choice? Otol. Neurotol. 37 (9), 1350–1357.

Malafronte, G., Filosa, B., 2009. Fisch's reversal steps stapedotomy: when to useit? Otol. Neurotol. 30, 1128–1130.

Migirov, L., Wolf, M., 2013. Endoscopic transcanal stapedotomy: how I do it. Eur. Arch. Oto-Rhino-Laryngol. 270 (4), 1547–1549.

Migirov, L., Shapira, Y., Horowitz, Z., et al., 2011. Exclusiveendoscopic ear-surgeryforacquiredcholesteatoma: priliminary results. Otol. Neurotol. 32, 433–436.

Miuchi,S., Sakagami,M., Tsuzuki,K. Guder2.Taste function after stapessurgery.Auris Nasus Larynx.39:562–566.

Naik, C., Sanjana, N., 2016. Endoscopic stapedotomy: our view point. Europ Arch Otorhinolaryngol 273 (1), 37–41.

Nogueira Júnior, J.F., Martins, M.J., Aguiar, C.V., et al., 2011. Fully endoscopic stapes surgery (stapedotomy): technique and preliminary results. Braz J Otorhinolaryngol 77 (6), 721–727.

Poe, D.S., 2000. Laser-assisted endoscopic stapedectomy: a prospective study. Laryngoscope 110 (Pt2Suppl.95), 1–37.

Sajjadi, H., 2013. Endoscopic middle ear and mastoid surgery for cholesteatoma. Iran JOtorhinolaryngol 25 (2), 63–70.

Sarkar, S., Banerjee, S., Chakravarty, S., et al., 2013. Endoscopic stapes surgery: our experience in thirty two patients. Clin. Otolaryngol. 38 (2), 157–160.

Sproat, R., Yiannakis, C., Layer, A., 2017. Endoscopic stapes surgery: a comparison with microscopic surgery. Otol. Neurotol. 38 (5), 662–666.

Surmelioglu, O., Ozdemir, S., Tarkan, O., et al., 2016. Endoscopic versus microscopic stapes surgery. pii: S0385–8146(16)30201-2 Auris Nasus Larynx 22. https://doi.org/10.1016/j.anl.2016.07.001 ([Epub ahead of print]).