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The role of endoscopic stapes surgery in difficult oval window niche anatomy

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Abstract

Purpose The surgical treatment of otosclerosis can be challenging in case of anatomical abnormalities or variations of the oval window niche (OWN) area, as in very narrow OWN or in an overhanging facial nerve. The aim of the present study was to explore the role of endoscopic stapes surgery in cases with difficult OWN anatomy.

Methods Patients undergoing endoscopic stapes surgery from 2008 to 2017, which fulfilled the CT scan criteria for a "difficult" anatomical condition, according to the measurements and cut-off values defined in the literature, were retrospectively selected. The intraoperative endoscopic view of the anatomical details and surgical difficulties were analysed through the review of the operative videos. Finally, a statistical analysis of the relationship between endoscopic visualization of anatomical details and radiological measurements was carried out.

Results Eighteen out of 205 patients (8.7%) were included in the study. The 94.4% of patients obtained an optimal endoscopic exposure and visualization of all the anatomical details considered in the study, during each step of stapes surgery. The OWN measurements (width, depth and facial–promontory angle) did not affect significantly the endoscopic surgical exposure of the footplate or any of the other anatomical details.

Conclusions The anatomic features of the oval window area which reduce the visualization in microscopic surgery, did not affect the surgical exposure in endoscopic stapes surgery. Patients having a difficult anatomy of the OWN can be treated safely with the endoscopic approach. In the case of a predicted "difficult anatomy", the endoscopic approach can be considered a viable option.

Keywords Endoscopy · Stapes surgery · Narrow oval window · Anatomy

Introduction

The surgical treatment of otosclerosis can be technically challenging in case of anatomical abnormalities, or in specific situations within the normal anatomy variability range. The anatomy of the oval window (OW) and its relationship with the second portion of the facial nerve and the promontory shows a certain variability [1–5], leading to conditions as the narrow OW niche, deep OW, overhanging facial nerve, or dehiscence of the second portion of the facial nerve covering the OW [6–8]. Those conditions, which can be grouped into the definition of "difficult OW niche anatomy", may induce the surgeon to change the surgical strategy or sometimes to abandon the surgery itself, for minimizing the risk of serious complications.

The preoperative CT scan can detect those anatomical situations and helps the surgeon in predicting an intraoperative difficulty associated with oval window niche (OWN) anatomical variations. Furthermore, the preoperative CT scan is helpful for the differential diagnosis, ruling out inner or middle ear pathologies mimicking otosclerosis, as well as for the detection of other pathology-related difficult conditions such as malleolar ankylosis (or House's syndrome), large otosclerotic foci or round window obliteration. Therefore, although not mandatory, several authors advocate preoperative CT for a better prediction of intraoperative technical difficulties [6–12].

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The endoscopic approach to ear surgery has been shown to have the advantage of a better visualization of the retrotympanum and oval window area compared to classic transcanal microscopic surgery [13, 14]. However, to date, the advantages and limits of the endoscopic ear surgery in the surgical management of otosclerosis have not been fully investigated. In particular, the role of the endoscopic approach in difficult anatomical conditions such as the above mentioned, needs to be elucidated.

The aim of the present study was to explore the role of the endoscopic approach to the treatment of otosclerosis in patients with complex anatomical situations, which have already been recognized in the literature to increase the technical difficulties and the risk of complications.

Methods

The study was designed as a retrospective case series analysis. Records of patients undergoing endoscopic stapes surgery, from 2008 to 2017 at the University Hospital of Modena, Italy (Policlinico di Modena, Azienda Ospedaliero-Universitaria di Modena) were collected on a computerized database. Patients were included in the study if having the preoperative CT scan, intraoperative video recording and age > 18 years. The preoperative CT scans of the patients were analysed in order to select those fulfilling the criteria for a "difficult" anatomical condition. The CT scan-based measures to define a "difficult" anatomical condition were retrieved from the literature [9, 10, 15] (Table 1). In case of different cut-off values reported in previous studies (OWN width), the mean between the minimum and the maximum was used to set the cut-off value (Table 1). As a result, we assumed a difficult oval window niche anatomy if OWN width < 1.1 mm and/or FPA < 42° from CT scan measurements. Given the lack of cut-off values regarding OWN depth in the literature, we did not adopt any OWN depth cut-off among inclusion criteria.

CT scan measurements

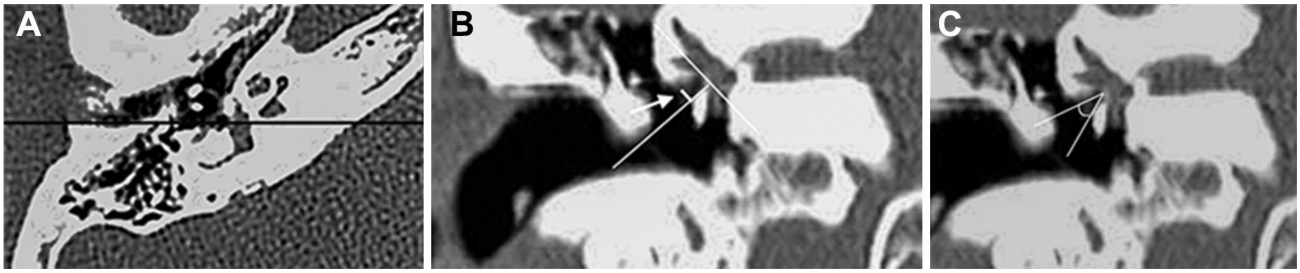
The acquisition of temporal bone images was performed in all included patients with a high-resolution 16-row spiral CT scan (Siemens Healthcare).

The CT scan measurements were conducted with the OsiriX software for iOS (2018 Pixmeo) and were OWN depth, OWN width and facial nerve–promontory angle (FPA) (Fig. 1). As previously described in other studies [9, 10], a line passing on the centre of the footplate on the axial view was the reference for identifying the correct sectional image of the footplate on the coronal view. Then, a line parallel to the main axis of the vestibule in the coronal view, identified the plane of the footplate. Eventually, a line perpendicular to the footplate was drawn from the promontorial margin of the footplate. The oval window width was defined as the distance between the promontory line and the inferior

Table 1 Parameters which defined a difficult oval window niche anatomy in the literature and its prevalence in stapes surgery

Variable	Author (year)	Cut-off	Prevalence (%)
OWN width (narrow oval window niche)	Ayache et al. (1997) [4]	–	12.3
	Lippy (2002) [3]	–	1.1 (requiring promontory drilling)
	Gristwood et al. (2008) [15]	≤ 0.8 mm	5.6
	Ukkola-Pons et al. (2013) [10]	< 1.4 mm	14
	Nemati et al. (2013) [5]	–	10.2
	Inserra et al. (2013) [17]	–	–
	Parra et al. (2017) [9]	≤ 1.1 mm	18
OWN depth (deep oval window niche)	House et al. (2010) [19]	–	–
	Parra et al. (2017) [9]	Not significant parameter	–
OWN angle of exposure (narrow facial–promontory angle)	Parra et al. (2017) [9]	< 42°	6.9
Facial nerve dehiscence (partially or totally covering the OWN)	Cao et al. (1996) [6]	–	6.9
	Ayache et al. (1997) [4]		2.7
	Daniels et al. (2001) [7]		1.2
	Lippy (2002) [3]		–
	Inserra et al. (2013) [17]		17 (of narrow OWN)
	Di Martino et al. (2005) [8]		–
	Parra (2017) [9]		7.9

– No cut-off defining the condition and/or absent prevalence data provided by the author



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margin of the facial nerve, the oval window depth was the distance between the footplate line and the inferior margin of the second portion of the facial nerve. The oval window niche angle (facial–promontory angle) was measured between two lines starting from the centre of the footplate and tangential respectively to the promontory surface and the inferior aspect of the second portion of the facial nerve. The cases with an overhanging facial nerve or a protruding and dehiscent Fallopian canal over the OW, where radiological measurements were impossible (too narrow to be accurately measured) were directly considered as difficult cases. Measurements were blindly performed by two different ear surgeons on CT scans to evaluate the interobserver concordance of the measurements. Final classification into "difficult anatomy" category and subsequent inclusion in the study was applied only to cases with complete agreement between the two observers and fulfilling at least one of the two radiologic criteria (narrow OWN width and narrow FPA).

Intraoperative parameters

The visualization of the footplate area obtained with a 3 mm – 0° endoscope, used in routine endoscopic stapes surgery, was judged by the revision of the surgical videos recorded from 2008 to 2017. The parameters that were observed and recorded from the surgical videos were: (1) the need for bone removal from the scutum for exposure of the stapes and visualization of the 2° and 3° portion of the facial nerve; (2) the visualization of both anterior and posterior crus; (3) the visualization of the entire footplate margins; (4) the direct visualization of the tip of the drill over the footplate during the platinotomy; (5) the complete visualization of the platinotomy hole during stapes prosthesis positioning; (6) the calibre of the prosthesis; (7) the need for intraoperative surgical strategy change.

Surgical technique

All the patients undergoing endoscopic stapes surgery were operated in general anaesthesia by two senior surgeons. The transcanal endoscopic approach was performed using a 3 mm outer diameter, 15 cm length, 0° operating rigid endoscope (Karl Storz, Tuttlingen, Germany). A modified Rosen incision in the posterior wall of the EAC from 5 to 12 o'clock was performed to create a tympano-meatal flap limited to expose the OW area. The tympano-meatal flap was then elevated to gain the access to the middle ear cleft, preserving the attachment of the tympanic membrane to the malleus. The OW region was thoroughly explored and the relationship among the stapes, promontory and the tympanic tract of the facial nerve was defined. When necessary, a limited atticotomy was performed using a bone curette to widen the operative space lateral to the incudo-stapedial joint. Then, depending on the difficulties deriving from the anatomical condition, two surgical strategies were used before placing the prosthesis:

- Same surgical steps as in classic microscopic stapedotomy technique [2] (disarticulation of the incudo-stapedial joint, stapedial tendon sectioning, posterior crus drilling, anterior crus drilling or fracture and exposure of the footplate for stapedotomy).
- Partial reversal of surgical steps (a modification of reversal surgical steps described by Fisch [2]): sectioning of the stapedial tendon, drilling of the posterior crus of the stapes and exposure of the footplate for stapedotomy, before disarticulating the incudo-stapedial joint and fracturing the anterior crus.

In both situations once an optimal vision of the OW was gained, platinotomy was performed maintaining direct endoscopic vision of the platina, by using a Skeeter drill

(Medtronic, Jacksonville, USA) with a diamond burr. A platinum/polytetrafluoroethylene prosthesis (Spiggle & Theis, Overath, Germany) was inserted into the platinotomy hole and the hook was crimped on the long process of the incus using specific forceps. Gelfoam soaked with blood was put around the prosthesis, the tympanomeatal flap was put back at its original position and the EAC was packed with other Gelfoam pledgets.

Statistical analysis

Statistical analysis was conducted with IBM SPSS Statistics Version 19.0. Descriptive analysis is reported in Table 2. The association between the radiological measurements and the intraoperative details were tested with the two sample *T* test. The association between a narrow FPA, narrow OW width and the intraoperative details were tested with the Chi-square test or Fisher's exact test when appropriate. Patients with difficult OWN anatomy receiving endoscopic revision stapes surgery after microscopic surgery were analysed separately from the primary stapes surgery group, due to the variable situation of the stapes superstructure (absent/present) and footplate (stapedectomy/stapedotomy) in revision surgery.

Interobserver concordance of the OWN width and FPA measurements on CT were calculated with the *K* Cohen's test. Concordance among observers was assumed when the value of the measure included the patient in the same category (narrow vs normal).

Statistical significance was set <0.05 with a 95% confidence interval.

Audiometric data

Pure tone audiograms were carried out pre and post-operatively for all the patients included in the study. The last post-operative follow-up audiogram was included if fulfilling the AAO-HNS guidelines [16]. The bone-conduction (BC) and air-conduction (AC) threshold were calculated as the average for 0.5–1–2 and 4 kHz. The air–bone gap (ABG) was reported as the four-tone pure-tone average for air conduction minus the four-tone pure-tone average for bone conduction at 0.5–1–2 and 4 kHz. Additionally, pre-operative minus post-operative pure-tone bone conduction at 1–2 and 4 kHz was calculated for measurement of the overclosure or sensorineural damage. Sensorineural damage was defined as a reduction in BC > 20 dBHL.

Results

Interrater reliability of the measurements performed on the stapes surgery patients before the inclusion in the study resulted substantial to very good for FPA (κ 0.82) and OWN width (κ 0.75). Three cases out of 205 were excluded from the study because they obtained different anatomical classification (normal vs difficult) by the two blind observers.

Eighteen cases out of 205 (8.7%) endoscopic stapes surgeries fulfilled all the criteria and were included in the study. Of those, 12 underwent primary stapes surgery and 6 revision stapes surgery. Patients were male in 6 (33.3%) and female in 12 (66.7%). The mean age of patients included in the study was 49.3 years (range 34–60).

In the group of primary stapes surgery (12 cases), the mean oval window width was 1.04 mm (range 0.77–1.26), mean OWN depth was 2.1 mm (range 1.70–2.77) and mean OWN angle was 37.1 (range 29–49). Within that group, three patients met the narrow OWN criteria, three the narrow FPA criteria and six cases met both. The revision stapes surgery group (6 cases) had a mean OWN width of 1.01 mm (range 0.94–1.32), mean depth of 1.84 mm (range 1.50–2.25) and mean FPA of 39.8° (range 33–43). Of those, three cases met the narrow OWN criteria, one case the narrow FPA and two cases both conditions.

All the patients of the revision group presented with a persistent conductive hearing loss after the first operation. In three cases the surgical procedure was interrupted by the previous surgeon, in one before performing the removal of the superstructure and in the other two before performing the platinotomy. The other three cases had a dislocation of

Table 2 Oval window niche measurements

Variable	Cut-off	Measurements within the included patients Mean (range)	Frequency *N* (%)
OWN width	< 1.1 mm	1.02 mm (0.77–1.09)	13/205 (6.3)
FPA	< 42°	37.1 (29–40)	11/205 (5.3)
OWN depth	–	2.1 mm (1.70–2.77)	–
Facial nerve dehiscence covering the OWN	Facial nerve dehiscence and OWN width < 1.1 mm	–	2/205 (0.9)

OWN oval window niche, *FPA* facial–promontory angle, *Cut-off* cut-off of CT scan measurements of the OWN adopted from the revision of the literature, *Frequency* frequency of patients fulfilling the cut-off criteria (either isolated or in association with the other criteria) among the whole study population the prosthesis with partial erosion of the long process of the incus and obliterated platinotomy hole.

In both groups none of the patients complained post-operative vertigo, facial nerve dysfunction or post-operative dysgeusia.

The auditory outcomes are reported in Table 3. The mean follow-up was of 12.3 months (range 6–22). The 91.7% of primary stapes surgery and the 83.3% of revision surgery cases obtained a post-operative air–bone gap < 20 dB HL. None of the patients had sensorineural damage or persistent conductive hearing loss (ABG > 30 dB HL).

Relationship between intraoperative details and CT scan measurements

The descriptive data regarding intraoperative details and their relationship with the CT scan measurements, for the primary and revision stapes surgery groups are listed in Table 4. We did not find any significant association between the measurements (OWN width, FPA and OWN depth) and a poor endoscopic visualization of the listed details. Only one case of the revision group, having a dehiscent overhanging facial nerve with complete obliteration of the OWN (Fig. 2), failed to obtain the complete visualization of footplate margins and required a change in the surgical strategy (promontory drilling).

Discussion

The endoscope permits a superb vision of the mesotympanum and an optimal visualization of the retrotympanic area [13, 14]. The visualization of the second portion of the facial nerve, the second genu, the posterior and subpyramidal recesses, the OW and the round window area have been showed to be easily explored with a 0° or 45° endoscope after the tympano-meatal flap elevation. In stapes surgery the complete visualization of the OW area and the possibility of changing the angle of view of the oval window area by simply moving the 0° endoscope or by switching to angled endoscopes (30° or 45°), may represent an additional advantage in unfavourable anatomical conditions with poor footplate visualization (Fig. 3), which have been proven to increase the technical difficulty and the risk of complications in traditional microscopic approaches.

The preoperative radiological assessment before stapes surgery, although not mandatory, is recommended by several authors for both the differential diagnosis and the preoperative identification of surgical difficulties [9–12]. In particular, the width and depth of the OWN, the angle of exposure of the OW between the facial nerve and the promontory, the presence of an overhanging facial nerve or a dehiscent second portion of the intratympanic facial nerve can be radiologically predicted in most of cases [9–11]. In our study, we observed that radiological measurements might be reliably conducted by otologic surgeons with a high interobserver concordance, supporting results of other studies [10].

The incidence of a narrow OWN has been reported from 5.6 to 18% according with different definitions and measures. A distance between the inferior aspect of the second portion of the facial nerve and the promontory inferior to 0.8 [15]–1.4 mm [10] have been classified as narrow OWN. Our cut-off resulting from the mean between other studies was consistent with the findings of a recent study by Parra et al. [9].

The intraoperative technical difficulty of microscopic stapes surgery has been correlated to the width of the OWN measured on the CT scan by several authors [3–5, 9, 10, 15,

Table 3 Hearing results

Mean data	Primary surgery PTA (SD)	Revision surgery PTA (SD)
Pre-op BC	25.8 (9.2)	32.2 (8.5)
Post-op BC	20.3 (7.7)	23.1 (4.4)
Pre-op ABG	26.5 (12.1)	39.3 (12.1)
Post-op ABG	7.4 (3.8)	2.8 (3.5)
ABG category	*N* (%)	*N* (%)
< 10	7 (58.3)	3 (50)
11–20	4 (33.3)	2 (33.3)
21–30	1 (8.3)	1 (16.7)
> 30	0 (–)	0 (–)

Pre- and post-operative hearing data are reported in dBHL

Pre-op and post-op BC mean pre-operative and post-operative bone conducted threshold, *Pre-op and post-op ABG* mean preoperative and post-operative air-bone gap, *SD* standard deviation, *N* number of patients, *ABG category* Post-operative PTA (500–1000–2000–3000 Hz) air–bone gap (ABG) results reported in dBHL

Table 4 Relationship between measurements and intraoperative details

	Narrow OWN	Narrow FPA	Both	Total *N* (%)	*p*
Epitympanotomy					
Primary stapes surgery	3/3	2/3	6/6	11/12 (91.7)	0.45
Revision surgery	0/3	0/1	0/2	0/6 (0)	–
Anterior crus					
Primary stapes surgery	3/3	3/3	5/6	11/12 (91.7)	0.30
Revision surgery[a]	2/2	–	–	2/2 (100)	–
Footplate margins	6/6	4/4	7/8	17/18 (94.4)	0.17
Tip of the drill	5/6	4/4	7/8	16/18 (88.8)	0.46
Platinotomy hole	6/6	4/4	8/8	18/18 (100)	–
Partial reversal technique					
Primary stapes surgery	3/3	2/3	3/6	6/12 (50)	0.19
Revision surgery[a]	2/2	–	–	2/2 (100)	–
Promontory drilling	0/6	0/4	1/8	1/18 (5.5)	0.21
Prosthesis calibre					
Primary stapes surgery					0.25
0.4 mm	0	0	0	0	
0.5 mm	1/3	2/3	3/6	6/12 (50)	
0.6 mm	2/3	1/3	3/6	6/12 (50)	
Revision surgery					0.71
0.4 mm	0	0	0	0	
0.5 mm	1/3	1/1	1/2	3/6 (50)	
0.6 mm	2/3	0/1	1/2	3/6 (50)	

Narrow OWN patients with oval window niche width < 1.1 mm, *Narrow FPA* patients with facial–promontory angle < 42°, *Both* patients with both narrow OWN and narrow FPA, *Epitympanotomy* need for bone removal from the scutum to expose the stapes and visualize the 2° and 3° portion of the facial nerve (for the revision cases, need for enlargement of the epitympanotomy performed during previous surgery), *Anterior crus* visualization of the anterior crus, *Footplate margins* visualization of the entire footplate margins, *Tip of the drill* direct visualization of the tip of the drill during the platinotomy, while seeing the footplate margins and facial nerve, *Platinotomy hole* proper visualization of the platinotomy hole during the positioning of the prosthesis, *Prosthesis calibre* the calibre of the piston

[a]Condition valid only for 2 out of the 6 revision surgery cases

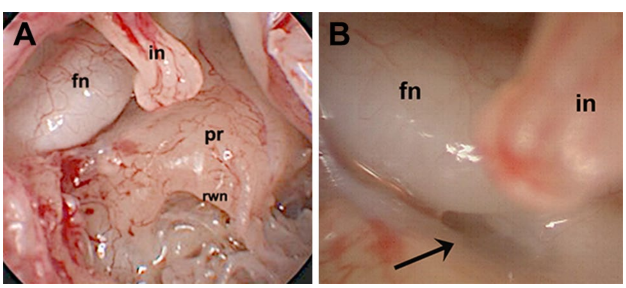

Fig. 2 Clinical case: right ear; stapedotomy procedure. **a** Identification of a facial nerve prolapses with a 0° endoscope. The oval window is covered by the VII cranial nerve. **b** Magnification of the oval window region with the 45° optic. A small amount of the stapes footplate is detectable. *fn* facial nerve, *in* incus, *pr* promontory region, *rwn* round window niche. The black arrow indicates the stapes footplate

17, 18]. The depth, on the contrary has not been consistently demonstrated to be associated to technical difficulties during the microscopic surgery [9, 19], and did not exist in the literature any cut-off value to define a deep footplate. In our study, we did not observe any correlation between the OWN depth and poor endoscopic visualization of any of the intraoperative details. Parra et al. recently identified a statistically significant association between the technical difficulty perceived by experienced stapes surgeons and either a CT measured width of the OW inferior to 1.1 mm, or a view angle of the footplate (facial–promontory angle) less than 42 degrees [9]. Furthermore, other studies had showed that the risk of surgical complications increases with the technical difficulty encountered by the surgeon [9, 17, 18]. Therefore, the surgeon might expect an increased risk of surgical complications when measuring a narrow OWN on the preoperative CT scan.

In our series, adopting a cut-off for OWN width of 1.1 mm and the FPA inferior to 42 degrees, we observed a

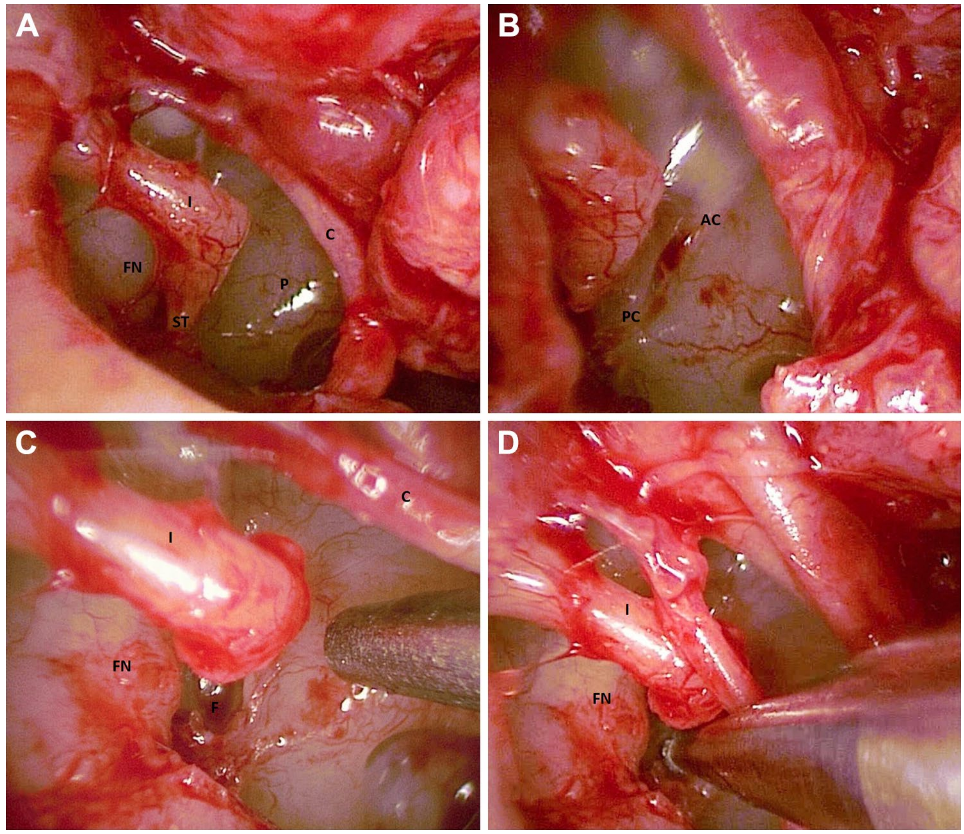

Fig. 3 Clinical case of narrow OWN (0.9 mm width): right ear. **a** Evaluation of the stapes from the EAC showing a facial nerve overhang. **b** The anterior and posterior crura as well as the posterior and anterior margins of the footplate are visualized with the 0° endoscope entering the tympanic cavity with the endoscope in an antero–inferior position. **c** Inferior and superior margins of the footplate can be visualized with the 0° endoscope after stapes crus removal. **d** Panoramic view of the footplate margins, facial nerve and the tip of the drill while performing platinotomy hole. *ST* stapedial tendon, *P* promontory region, *I* incus, *FN* facial nerve, *C* chorda tympani, *F* stapes footplate, *AC and PC* anterior crus and posterior crus

prevalence of a narrow OWN in 8.5%, which was slightly inferior to the mean value of the literature (Table 1).

Our findings showed that the endoscopic approach with a 3 mm – 0° endoscope permits a complete view of the footplate margins, in all the cases of our series with a difficult anatomy due to a narrow OWN, limited FPA or both. The visualization of the anterior crus, when laterally covered by the facial nerve prominence, was possible in all cases but one moving the endoscope in an anterior and inferior position. However, the complete visualization of the margins of the footplate and of the second portion of the facial nerve permitted to perform the platinotomy hole in posterior–central position in nearly all cases. Only one case having an overhanging facial nerve completely covering the OWN failed to obtain the complete endoscopic visualization of the footplate margins and required a not-centred platinotomy hole through a promontory drilling technique (Fig. 2).

Furthermore, in all cases but one it was possible to have a complete visual control of the tip of the drill during the platinotomy. The panoramic view provided by the endoscope which includes the whole footplate, the tip of the drill and the second portion of the facial nerve at the same time, may be difficult in a narrow OWN or in a reduced angle of exposure with the microscopic technique [9]. In addition, the use of the laser, when an overhanging or dehiscent facial nerve is present, can be risky. The endoscope in those cases provides a good visual control, helping the surgeon in such difficult conditions, during the platinotomy step.

A partial reversed sequence of the surgical steps was possible in 7 cases. The angle of view provided by the endoscope, permitted to adopt that surgical strategy, which added the safety of having a platinotomy hole before performing the anterior crus fracture [3, 18], which is particularly useful in case of footplate fracture or floating stapes.

We observed that the prominence of the second portion of the facial nerve affected the visualization of the footplate less than we expected in our difficult anatomy case series. The angle of view of the footplate in those cases, from anterior to posterior and inferior to superior, permitted always to visualize the whole footplate margins after the removal of the stapes superstructure (Figs. 3, 4).

The hearing results of our series (Table 4) were comparable to the regular stapedotomy hearing outcomes reported in the literature [20, 21]. There were no cases of postoperative changes of the preoperative bone conduction threshold, confirming the safety and efficacy of the endoscopic guided technique. In addition, it is noteworthy the absence of dysgeusia and postoperative complications in our difficult OWN anatomy series, which support the advantages of the endoscopic approach reported in other studies of the literature [20].

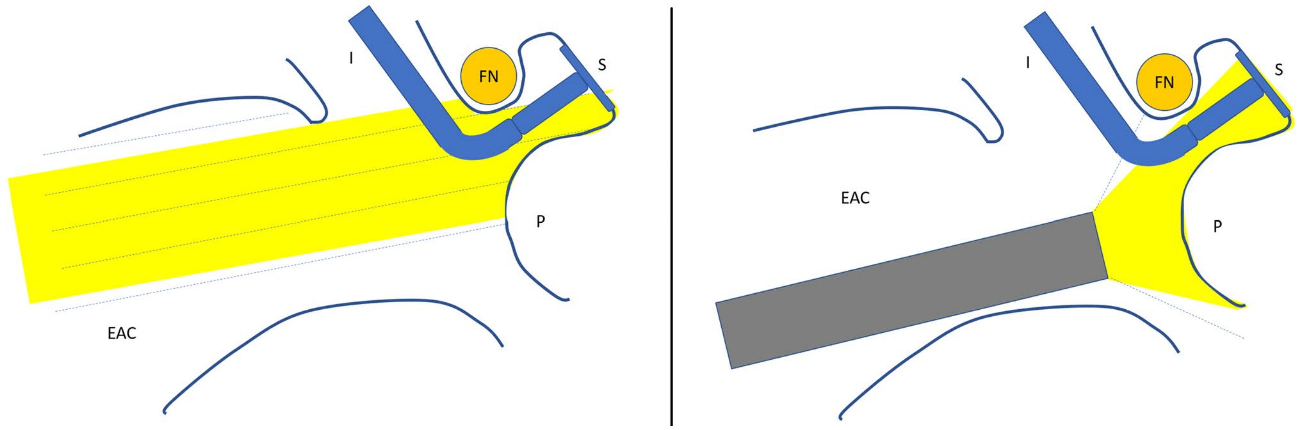

Fig. 4 Schematic diagram (coronal view repeating a CT scan) of the surgical exposure of the footplate in case of a narrow OWN with microscope (**a**) and endoscope 0 degree (**b**). *I* incus, *S* stapes, *P* promontory, *EAC* external auditory canal

The limits of the present study were the retrospective design and the lack of a microscopic control analysis of the same cases. However, we included in our study six cases of endoscopic stapes revision surgery with difficult OW anatomy, conducted after failure of microscopic stapedotomy (persistent conductive hearing loss). We observed in three of them, a dislocation of the prosthesis and an obliterated platinotomy hole, condition which may be interpreted as the result of a poor visualization of the footplate with an incomplete or improper footplate perforation or the selection of the wrong prosthesis length. In the other two cases the procedure was interrupted by the previous surgeon due to the difficult anatomical situation (very narrow OWN) before the removal of the crura. In all but one of those revision cases, the endoscopic visualization of the footplate and tip of the drill was complete during the platinotomy step. The check of the correct positioning of the prosthesis into the platinotomy hole, avoiding any friction with the promontory or facial nerve canal was possible in all cases. Those findings, although limited to a small number of cases, give support the hypothesis of a better visualization with the endoscope of a narrow OWN compared to the microscopic approach.

Conclusions

In the difficult anatomical situations of the oval window area, which have been proven to reduce the footplate exposure in microscopic stapes surgery, the endoscopic approach provided an optimal visualization and showed to be feasible, safe and effective. Although a proper surgical experience is required for managing those uncommon "difficult anatomy" cases both in the microscopic and endoscopic approaches, the latter permit an easy and panoramic exposure of the stapes superstructure and footplate margins, which can help the surgeon in performing stapes surgery. The endoscopic approach to stapes surgery can be considered a viable option in case of a predicted difficult oval window niche anatomy.

Compliance with ethical standards

Conflict of interest All the authors approved the manuscript. The authors have no financial disclosures or conflict of interest.

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