

# Transcanal endoscopic treatment of benign middle ear neoplasms

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**Abstract** The application of endoscopic surgery for middle ear pathologies is rapidly increasing. At present, its main application is in the treatment of middle ear cholesteatoma. This report describes the application of this technique as treatment for some benign lesions that may involve the middle ear cleft. A retrospective chart review of six patients who underwent exclusive endoscopic tympanic cavity surgery for benign neoplasms was performed between November 2011 and January 2012. Based on charts, images, and surgical reports, data from the patients were summarized for further consideration. All of the six lesions were in the tympanic cavity without involvement of the mastoid region. An exclusive endoscopic transcanal approach was used in all cases. No patient showed signs or symptoms of pathology recurrence. Endoscopic transcanal excision of benign tympanic cavity neoplasms represents a safe procedure, with minimal morbidity and without external incisions or mastoidectomies.

**Keywords** Middle ear · Benign neoplasms · Transcanal endoscopic approach · Tympano-meatal flap · Paraganglioma · Carcinoid tumor

## Introduction

Endoscopic instrumentation, techniques and knowledge have really improved during the last few years, and we

believe that, in the future, endoscopic surgical techniques will become increasingly important in otologic surgery. Since the introduction of this instrument, the concept of the minimally invasive approach in middle ear surgery is changing. Endoscopic tympanic cavity surgery can offer some advantages compared to the traditional microscopic technique. Regarding middle ear pathology, most of the operations performed by our team during the last 7 years used exclusive endoscopic transcanal approaches [1, 3], avoiding mastoidectomies and external incisions, passing only through the external auditory canal (EAC). Using the microscopic view, these would have required mastoidectomies, superficial soft tissue dissection, and retroauricular incisions.

Currently, the main application of this new technique is in the treatment of cholesteatoma. An exclusive endoscopic approach for this pathology has already been described [2, 3].

Despite the fact that cholesteatoma represents the most frequent lesion occurring in the tympanic cavity, it is not the only disease present in this region. There are quite a variety of benign neoplasms that can be present within the middle ear cleft, such as adenomas, carcinoid tumors, osteomas, hemangiomas and facial nerve neuromas [4].

Just as for cholesteatomas, in the majority of cases reported in the literature, a retroauricular-transcanal approach has been described for small benign tumors limited to the promontory, while a canal wall up or canal wall down mastoidectomy is chosen to treat larger tumors extending into the hypotympanum, the Eustachian tube and/or the tympanic sinus.

The aim of this study is to describe an exclusive endoscopic transcanal approach for different types of benign tympanic cavity tumors and to examine the effective benefit of this approach.

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## Materials and methods

A retrospective chart review of patients who underwent exclusive endoscopic surgery for benign middle ear neoplasms was performed between November 2011 and January 2012. Based on these charts, images, and surgical reports, data from patients included were summarized for further consideration.

### Surgical steps

Two different options of external ear canal management can be used, depending on the extent of the pathology:

- Creation of a tympano-meatal flap to access the tympanic cleft
- Degloving of the tympanic membrane from the external ear canal.

### Tympano-meatal flap

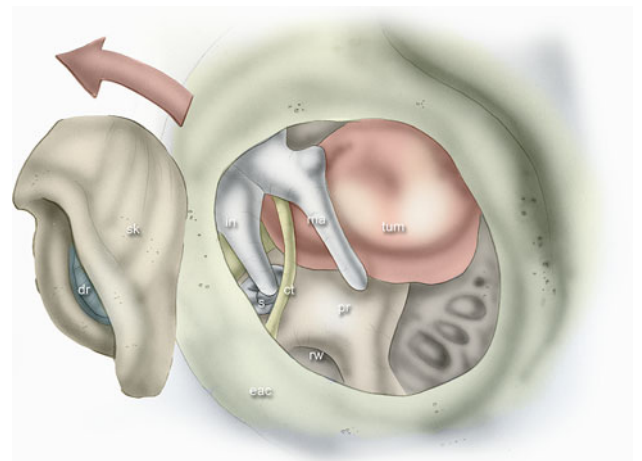
A posterior incision is made in the external auditory canal approximately 1.5 cm from the fibrous annulus using a circular scalpel or Vesalius (the instrument that helps the surgeon to minimize bleeding during this first step). Then a lateral-medial skin dissection is made unsticking the skin of the external ear canal to expose the fibrous annulus. The last phase is performed by reversing the posterior portion of the tympanic membrane anteriorly to visualize and access the tympanic cavity.

### Degloving of the tympanic membrane

A circular incision is made in the external auditory canal about 2.5 cm from the fibrous annulus with a circular scalpel or Vesalius. A lateral-medial skin dissection is performed interposing cotton soaked in adrenaline between the skin flap and the underlying bone of the external auditory canal. The dissector is used to leverage on the cotton and push the skin circumferentially to expose the fibrous annulus. By means of a micro-hook, the posterior and superior portions of the annulus are elevated to create the access to the tympanic cleft.

The tympanic dissection continues by detaching the posterior malleolar ligament and dissecting the eardrum from the short process of the malleus and the anterior malleolar ligament until en-bloc removal of the skin together with the eardrum is achieved, preserving the ossicular chain (Fig. 1). The grafts are placed in saline.

One of these two surgical procedures is chosen on the basis of the extent of the disease in the tympanic cavity. Further surgical steps are performed on the same basis.



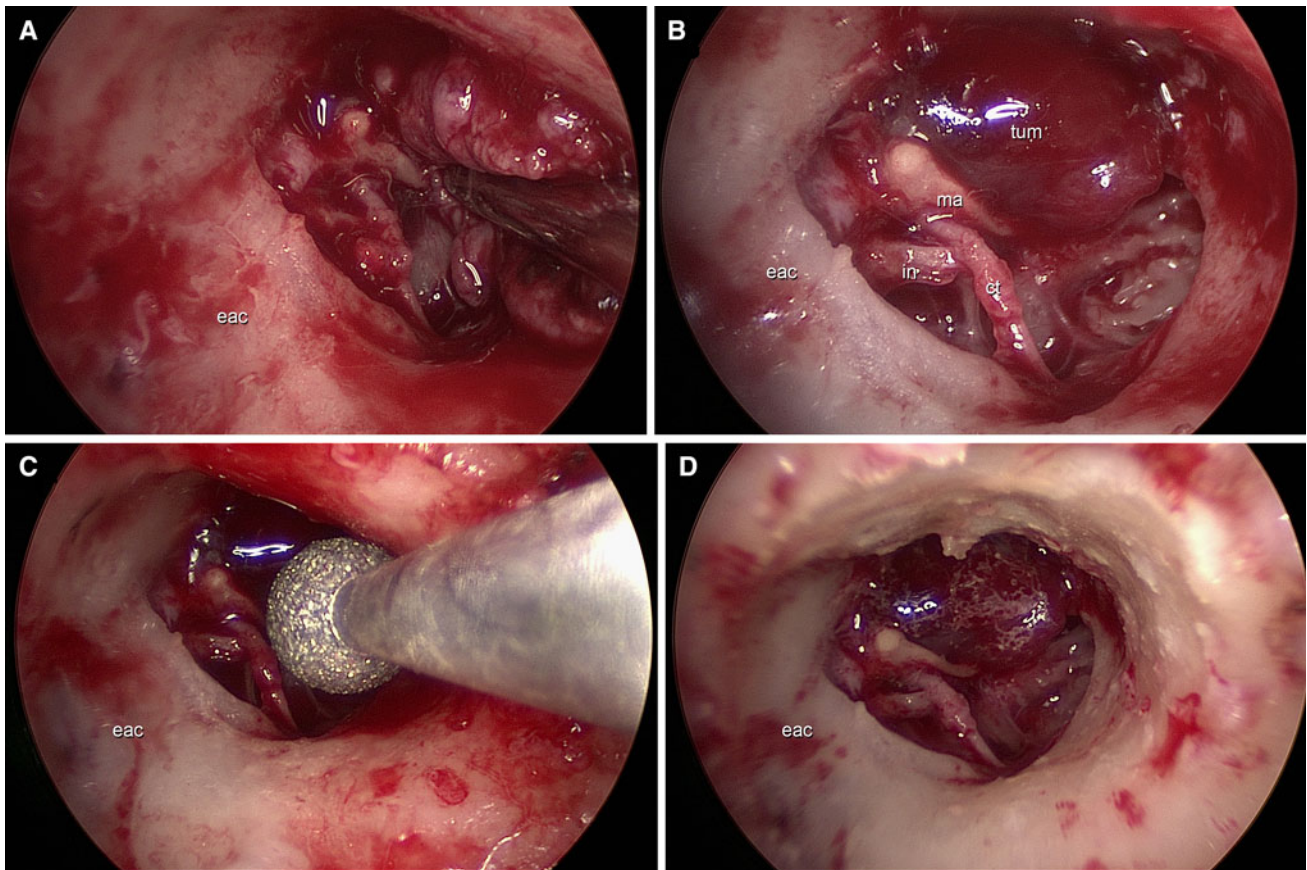
**Fig. 1** Right ear. *Schematic picture* showing the degloving technique. The skin and the ear drum are removed en-bloc from the external auditory canal. This procedure allows the tympanic cleft with the tumor to be visualized. *tum* tumor, *ma* malleus, *pr* promontory, *rw* round window, *ct* chorda tympani, *s* stapes, *in* incus, *eac* external auditory canal, *dr* ear drum, *sk* skin

Once the tympanic cleft and tumoral mass are exposed, circumferential drilling of the external auditory canal and the edges of the bony annulus is performed to extend the direct view of the tympanic cavity at the level of the pro-tympanic region and the hypotympanum, so that the tumor margins are well visualized (Fig. 2). The same procedure is used at the attic level if necessary. Moreover, the circumferential drilling of the external auditory canal allows the creation of a larger surgical space to help realize endoscopic tumor removal more easily. This procedure also allows a second surgeon to help during the surgical maneuvers.

Then the extent of the neoplasm is considered in relation to the ossicular chain, with the purpose of identifying possible chain interruptions. This evaluation requires a 0° endoscope and, if necessary, a 45° instrument can be employed to expose the epitympanic and isthmic region.

If the lesion presents a lateral extension with respect to the ossicles, chain preservation is attempted. A medial extension of the tumor relative to the ossicles makes chain removal mandatory for radical excision of the tumor.

Tumor dissection is performed via coarctation of the mass using bipolar micro-pliers. In the case of very large neoplasms, this procedure usually begins from the lateral face of the mass and allows the attachment site of the tumor on the tympanic cavity to be found by identifying the neoplastic peduncle. During this phase, the surgeon must carefully avoid possible damage to the facial nerve (second tract), considering that a dehiscence of the facial nerve represents quite a strong possibility in the case of a neoplasm extending into the tympanic cavity. Thus, to avoid heat damage to the facial nerve, it is recommended to perform



**Fig. 2** Clinical case: carcinoid tumor of the right ear. Panel **a** the ear drum degloving is performed. Panel **b** the tumor is visualized in the tympanic cavity. Panels **c** and **d** circumferential drilling of the

external auditory canal is performed to expose the medial region of the tympanic cleft and the tumor margins. *eac* external auditory canal, *tum* tumor, *ma* malleus, *in* incus, *ct* chorda tympani

the dissection with traditional instruments using cotton soaked with saline to maintain a clean surgical field.

Once the mass has been removed, endoscopic exploration must be carefully performed in the tympanic cavity and along the bony margins where the tumor is attached. In fact, for certain histological varieties, it is possible to find infiltration of tumor fragments inside the bone.

Here, extensive, deep drilling of the bony tissue is absolutely necessary to obtain a radical surgery. This procedure minimizes the risk of recurrence that is always possible in the case of carcinoid tumors of the tympanic cavity (Fig. 3).

In the case of extensive drilling of the protympanic and intra-tubaric region, a silastic lamina is placed between the tubaric area and the promontory.

In the case of the degloving technique, if possible, the eardrum is repositioned by hooking the malleus handle after creating an eyelet. If necessary, a temporal muscle fascia is placed as a reinforcement. The skin of the auditory canal is repositioned laying it on top of the external auditory canal and the new tympanic membrane. Fragments of gelfoam (Gelita Medical) are placed in the external

auditory canal to maintain stable grafts. Laying down a silastic (Medtronic Xomed) lamina can be a useful tool/solution to avoid possible stenosis of the auditory canal.

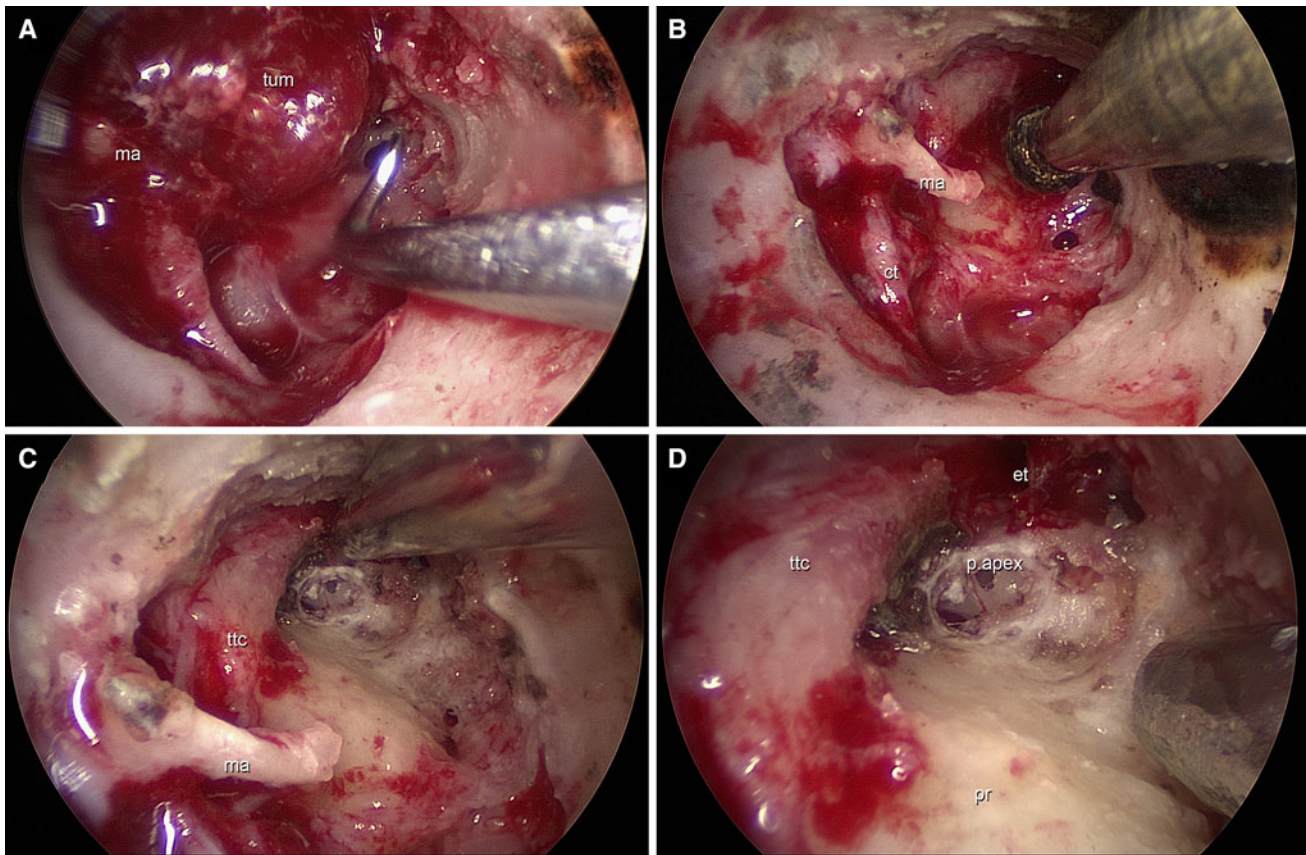
## Results

Six patients, operated between September 2010 and November 2011 were included in the study (Table 1). There were three males and three females and their mean age was 50.16 years ( $\pm 12.2$  SD). Four tumors were on the right side and two on the left side. These included three tympanic paragangliomas, two carcinoid tumors and one osteoma.

Concerning tumor extent, the protympanic space was involved in 4/6 (66.6 %) cases, and the retrotympenic space and hypotympanic space were completely involved in 2/6 (33.3 %) cases. A medial infiltration of the ossicular chain was observed in two tumors.

In four cases, it was necessary to perform an expanded transcanal access while in two cases, a simple tympanomeatal flap was sufficient to manage the surgery. In all





**Fig. 3** Clinical case: carcinoid tumor of the right ear. Panel **a** after the coarctation of the mass, a curved instrument is used to remove the tumor and to evaluate the nature of the neoplasm's attachment on the medial tympanic wall. Panels **b** and **d** a diamond cutter is used to remove the bone where the tumor was adherent; in this case, the

tumoral attachment was under the canal of the tensor tympani muscle close to the Eustachian tube. The drilling of this area allows to open the cellularity of the petrous apex. *tum* tumor, *ma* malleus, *ct* chorda tympani, *pr* promontory, *ttc* tensor tympani canal, *p.apex*, petrous apex, *et* Eustachian tube

cases, the neoplastic lesions were completely removed with an exclusive endoscopic approach. A bipolarization was used to reduce neoplasm dimensions in four cases (three paragangliomas and one carcinoid tumor) while the exclusive use of a sharp dissection was necessary in two patients (one osteoma and one carcinoid tumor). The ossicular chain was preserved in four patients while in one case, it had to be sacrificed to complete the surgery and in another patient, it was almost totally eroded because of the pathology. After 1 year, one patient developed a cholesteatoma of the external ear canal and had to be operated a second time.

## Discussion

The exposure and visualization of the entire middle ear space are sometimes difficult using only microscopic vision. With recent advances in minimally invasive surgery, the use of the endoscope has led to new treatment options for tympanic cavity pathologies [2, 3]. Moreover, the anatomy of the

middle ear is particularly complex and the endoscopic approach represents an improvement regarding the anatomic concepts of this region because it guarantees round-the-corner views of some hidden areas such as the sinus tympani, facial recess, anterior epitympanic spaces, attic, hypotympanum and protympanum (Fig. 4) [3].

In addition, concerning the physiopathology of middle ear disease, endoscopic middle ear surgery may help in this purpose, allowing the surgeon to examine behind corners without radically changing middle ear anatomy, and thus completely explore all ventilation pathways [5].

Many authors have described the results of the endoscopic approach in cholesteatoma surgery [2, 3, 6] listing some important advantages. For example, it can be helpful in checking for the presence of residual disease in the tympanic cleft when microscopic observation and straight vision are insufficient. The objection of “the number of hands” using during endoscopic ear surgery is very frequent and constantly present. Present authors could say that, just as it happens in endoscopic nasal surgery, the use of one hand (while the other one holds the endoscope)

**Table 1** Clinical summary of patients

	Sex	Age	Side	Symptoms	Histological type	Intratympanic extent	Tumor class <sup>a</sup>	Surgical notes	Results	Follow-up (months)
Patient n1	F	33	Right	Tinnitus, conductive hearing loss	PGL	Epitympanic space, sinus tympani, protympanic space, Eustachian tube, round window	B1	Tympanic-meatal degloving	No symptoms, loss of hearing	9
Patient n2	F	56	Left	Tinnitus, ear fullness	PGL	Hypotympanic space, ossicular chain	B1	Tympanic-meatal degloving	No symptoms, improvement of hearing	18
Patient n3	M	67	Left	Conductive hearing loss	PGL	Ossicular chain (malleus) and promontory space	A1	Tympano-meatal flap	No symptoms, no hearing modification	5
Patient n4	M	35	Right	Conductive hearing loss	MEA-ND	Ossicular chain (incus and malleus erosion), protympanic space	–	Tympanic-meatal degloving	Tinnitus before temporomandibular articulation movements; no hearing modification	6
Patient n5	M	57	Right	Conductive hearing loss	MEA-ND	Eustachian tube and protympanic space	–	Tympanic-meatal degloving	No symptoms, no hearing modification	8
Patient n6	F	53	Right	Conductive hearing loss	Osteoma	Mesotympanic space, epitympanic anterior space	–	Tympano-meatal flap	Loss of taste in the anterior tongue, jaw pain, improvement of hearing	5

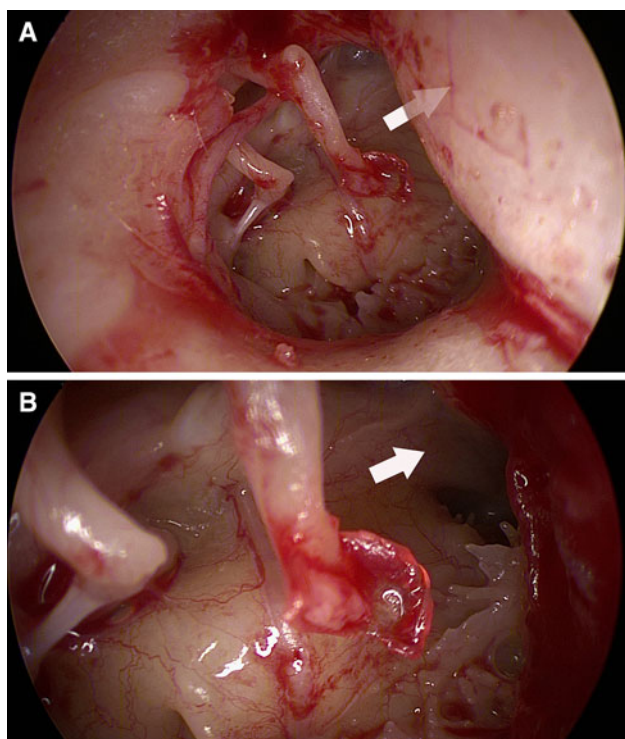
PGL middle ear paraganglioma, MEA-ND middle ear carcinoid tumor

<sup>a</sup> Based on the modified Fisch and Mattox classification [7]

suffices for the purpose of all steps, since after the ear canal skin has been removed, bleeding markedly reduces during operation into tympanic cavity. Only in some rare cases, a third hand could help holding suction, or forceps to stretch some structures, or to facilitate dissection. The microscope allows a two-hand dissection, but the price to pay is the necessity to perform external incisions and mastoidectomies, as well as the loss of the minimal invasivity. For sure endoscopic surgery has some disadvantages, such as dirtening of the tip with frequent necessity of cleansing, and increased time for some surgical steps, but in the final balance present authors are convinced about a very favourable advantages/disadvantages ratio.

Different types of benign neoplasm occur in the tympanic cavity. Paraganglioma tympanicum (also known as glomus tympanicum) represents the most frequent, but adenomas, carcinoid tumors, osteomas, hemangiomas and facial nerve neuromas can also occur in this region [4]. Despite the fact that they are quite rare entities, these lesions can sometimes involve the middle ear requiring a differential diagnosis with cholesteatoma. For this reason, it is important to understand their clinical and radiological features.

Temporal bone paragangliomas are classified into four categories (Class A, B, C and D) according to their location and extent based on high-resolution computed tomography (HRCT) examination [7]. They can also extend into the mastoid, can occlude the Eustachian tube, or can protrude through the tympanic membrane into the external auditory canal [4]. Concerning the possible treatment options, although radiotherapy has been advocated by some authors as a therapeutic option [8, 9] in advanced cases, the majority of authors agree that radiotherapy should only be recommended [4, 10, 11] for patients in whom there are serious contraindications to surgery and in the most advanced stages, while in the vast majority of cases and in the early stages (A and B), surgery remains the gold standard to treat these pathologies. The surgical approaches depend on the involvement of some particular regions within the middle ear. A stapedectomy-type transcanal approach has been described for all cases in which the tumor is limited to the middle ear cleft with clearly visible margins [4, 12–15]. The postauricular extended facial recess approach and/or infratympanic extended facial recess approach is usually used when the tumor involves the mastoid and extends into the hypotympanum [12–15].



**Fig. 4** Right ear, endoscopic 0° view (*white arrow* indicates hidden areas). Panel **a** The middle ear medial aspect visualized by external auditory canal. Panel **b** the protympanic space visualized only by closing the endoscope to the surgical field

Carcinoid tumors can also rarely occur within the tympanic cavity [16]. Regarding carcinoid tumors, surgical treatment is required. Some authors suggest a transcanal tympanotomy if the lesion is small and confined to the middle ear cleft [17]. If the lesion fills most of the middle ear, a facial recess approach mastoidectomy is recommended [18, 19]. After the excision, no adjuvant treatment is necessary [18, 20], but the patients should be followed closely for possible local recurrent disease [17].

Osteomas are rare in the temporal bone and the middle ear is the least common location within the temporal bone [21, 22]. Although osteomas of the tympanic cavity can remain asymptomatic, conductive hearing loss is the most common symptom. In addition, when the Eustachian tube is obstructed, otitis media with effusion may appear [23]. The authors recommend surgical intervention only for symptomatic lesions, and a canal wall up or down mastoidectomy should be performed in these cases (on the basis of the extent of the tumor) [21, 22]. On the other hand, radiotherapy is recommended when a white bony mass is detected behind the tympanic membrane [22].

All of these tumors can be located in the central part of the middle ear cleft or can extend to adjacent regions. On the basis of their extent, different surgical approaches must be planned. In the case of a very limited mass, it may be

easy for the surgeon to observe and control the lesion using only a transcanal approach even microscopically, but these masses can often involve some “hidden regions” of the middle ear. In particular, the protympanic and retrotympanic areas represent sites that are poorly observable in the transcanal microscopic field of vision, and epitympanic and/or hypotympanic involvement can also represent a difficult challenge. In these situations, with an exclusive microscopic management, it is almost impossible to obtain a clear visualization of the neoplasm without a retroauricular-transcanal approach or even a canal wall up/down mastoidectomy.

The tumors reported in our study showed involvement of different middle ear peripheral areas such as the epitympanum, hypotympanum, retrotympanic space, and/or Eustachian tube region. Interestingly, we could perform a total excision of all these lesions avoiding both a retroauricular incision and also canal wall up/down mastoidectomy. On the other hand, it must be noted that this approach is considerably more difficult and technically challenging. Here, an intimate knowledge and experience with the endoscopic anatomy of the tympanic cavity is required.

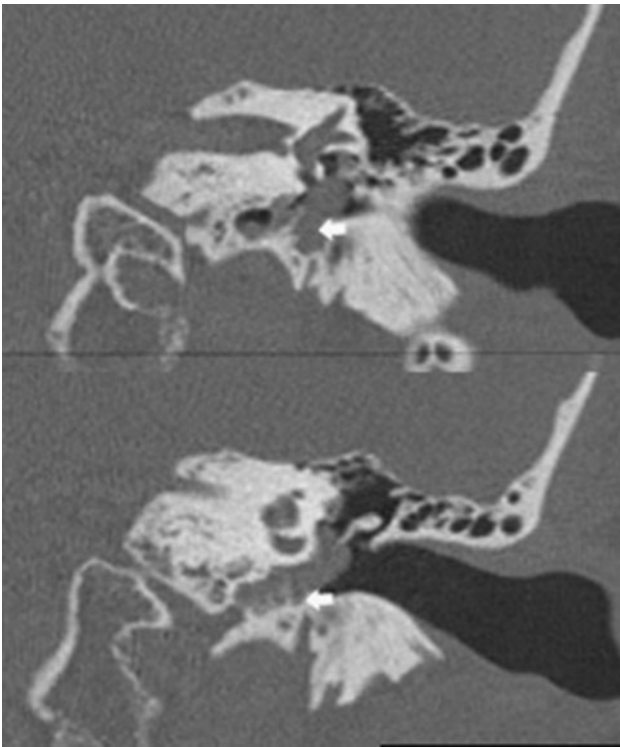
Of the three tympanic paragangliomas, one was type A1 and two were type A2 on the basis of Sanna extension subclassification. Regarding the two larger paragangliomas, the first involved the central middle ear and the hypotympanic region (Fig. 5), while the second reached the tubaric recess anteriorly, the sinus tympani posteriorly, and the epitympanic area superiorly. The A1 paraganglioma, which was a considerably smaller mass, involved only the promontory area and the malleolar handle.

Considering the two carcinoid tumors, the first completely enclosed the ossicular chain, completely occupying the tympanic cleft. After its removal, it was possible to observe the stapes, a residual part of the incus and the malleus handle. The second carcinoid tumor involved the protympanic space extending anteriorly through the peritubaric orifice (Fig. 6). In this case, we found a completely preserved ossicular chain.

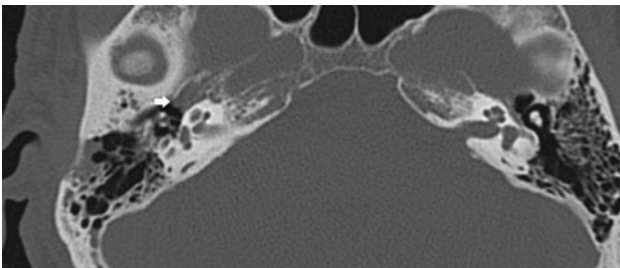
Concerning the osteoma, it was present as a rough and irregular mass extending medially to the malleus handle, between the mesotympanic space and epitympanic area. The chain was normal but presented a low mobility.

As mentioned above, to treat all lesions, a circular incision was made at the level of the external auditory canal about 3 cm from the annulus. In four cases, degloving of the external auditory skin was performed with successive enlargement of the bone annulus, to obtain a better view of the tympanic cavity. This procedure allowed us to improve visualization of the retrotympanic, protympanic, hypotympanic or attic spaces for the larger tumors involving these hidden areas. Moreover, in this way, it was





**Fig. 5** CT shows a tympanic paraganglioma that involves the hypotympanic region (*white arrow*)



**Fig. 6** CT shows the presence of a tumoral mass that extends anteriorly to the Eustachian tube orifice (*white arrow*)

possible to create a wider surgical space and allow a second operator to participate during the surgery.

In our opinion, this method was useful, in particular, to remove the larger carcinoid tumor that extended deeply into the Eustachian tube. In fact after this enlargement, we could completely visualize even the intra-tubaric space and remove all residual neoplastic fragments. However, this step was not necessary for the two smaller lesions whose margins could be easily visualized using the 180° tympanic-meatal flap technique.

The dissection of five neoplastic tissues (apart from the middle ear osteoma) was performed by coarctation of the tumor with a bipolar micro-forceps. This was important to reduce the dimensions of the masses and also to avoid possible bleeding. Nevertheless, for one paraganglioma, it

was necessary to use a CO<sub>2</sub> laser (Sharplan) because of significant bleeding. For the larger neoplasms, we preferred to cauterize the tissue before the lateral aspect of the mass. In fact, with this device, it was possible to check the attachment site of the tumor on the tympanic cavity identifying the neoplastic pedicle. During this phase, it was very important to carefully visualize the second facial tract to avoid any damage from heat.

Once the tumors had been removed, we drilled carefully and deeply into the bone layer above the adhesion area to avoid possible recurrence. In fact, for certain histological varieties, it is possible to identify infiltration of tumoral fragments inside the bone. For this reason, it is indispensable to carry out extensive, deep drilling of the bony tissue to obtain a radical surgery. This procedure minimizes the risk of recurrence that is always possible in the case of carcinoid tumors.

After this, we performed a careful endoscopic exploration of the tympanic cavity: for the two larger tumors, we had to use a 45° angled endoscope to carefully check in some hidden areas such as the peri-tubaric space and tympanic sinus. In all cases, no residual pathological material was found.

In all patients, we achieved total preservation of the facial nerve and no patient complained of facial dysfunctions after surgery. This was possible because the endoscopic approach guarantees clear control of the entire facial tympanic tract during the procedure for every area the surgeon is exploring.

Concerning the ossicular chain, it was necessary to sacrifice it (apart from the stapes) for the larger paraganglioma. In this case, chain removal was necessary to remove the superior portion of the tumor that involved the epitympanic region. For the two carcinoid tumors, we chose to maintain the ossicular chain in both cases (although one patient presented erosion of the ossicular chain) because, in our opinion, its removal was not necessary to avoid any recurrence.

## Conclusion

On the basis of our recent experience, exclusive endoscopic middle ear surgery could be considered as a valid alternative to the classic microscopic technique in many cases of benign tympanic cavity neoplasms. Even in the cases where the microscopic approach is needed, the endoscopic technique can be used during some steps as a complementary method and in the final check at the end of the surgical procedure.

**Conflict of interest** None.

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