



Case Report

EXCLUSIVE TRANSCANAL ENDOSCOPIC REMOVAL OF GLOMUS TYMPANICUM: A STEP-BY-STEP DESCRIPTION OF SURGICAL TECHNIQUE

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ABSTRACT

The purpose of this article is to show step-by-step the exclusive transcanal endoscopic approach to a glomus tympanicum tumour, along with its pre-and post-operative management. Glomus tympanicum is a benign and slow-growing vascular tumour of the middle ear. Staging corresponds to extension within middle ear space and adjacent structures, and it is represented either by Glasscock-Jackson and modified Fisch-Mattox scales. Many strategies have been proposed as treatment options. When surgery is indicated, the evolution of endoscopic ear surgery has allowed an alternative approach to the traditional one. The patient was referred for persistent monolateral pulsatile tinnitus. Computed tomography (CT) scan is essential to define the extension of the lesion in the temporal bone while CT angiography shows its supplying arteries. If the tumour is limited to the middle ear cavity, an exclusive transcanal endoscopic approach is therefore indicated and the patient may be discharged after 24-48 hours after the surgical procedure. Endoscopic excision for small and localized glomus tympanicum tumour represents a safe and effective option with low intra- and post-operative complications.

KEYWORDS: *glomus tympanicum, transcanal endoscopic approach, tumour, middle-ear, endoscopic excision*

INTRODUCTION

Middle ear paraganglioma, also known as glomus tympanicum, is a benign and slow-growing vascular neoplasm arising from the tympanic plexus of Arnold's and Jacobson's nerve onto cochlear promontory (1). It is the most

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common tumour within the tympanic cleft, while is the rarest among its counterparts in other head and neck districts, with the carotid body paraganglioma being the most frequent. All are histologically composed of chief cells and sustentacular cells. Less frequently, a malignant or catecholamine-producing type may be encountered (Fig. 1, 2).

Epidemiologically, glomus tympanicum is more frequent within the female gender, with a bimodal distribution in the late 30s and the early 60s. Clinically a glomus tympanicum often presents with a history of long-term pulsatile tinnitus and auricular fullness, with or without hearing loss (1). Rarely it is associated with bloody otorrhea or neuropathies. In most cases, the diagnosis is incidental. At the otoendoscopic examination, a reddish and bulging tympanic membrane is suggestive of it.

Staging of glomus tympanicum corresponds to the extension within the middle ear space and adjacent structures and it is represented by the Glasscock-Jackson (Table I) and modified Fisch-Mattox scales (Table II) (2). CT- and MRI-scan are very helpful in defining the nature and limits of the lesion while, due to the vascular origin, CT-angiography allows detection of its supplying vascular branches (3).

Therapeutic options may include wait-and-scan policy, external radiotherapy and surgical resection (3, 7). The indications for a conservative approach are non-secreting small tumour (< 1 cm), slow-growing rate, absence of symptoms and older patients with comorbidities precluding major surgery. In these cases, close clinical and radiological follow-up must be planned. External radiotherapy, in terms of conventionally fractionated external beam RT (EBRT) or stereotactic body RT (SBRT), may provide long-term disease control for unresectable growing paragangliomas. Anyway, surgical option is often the preferred method of treatment.

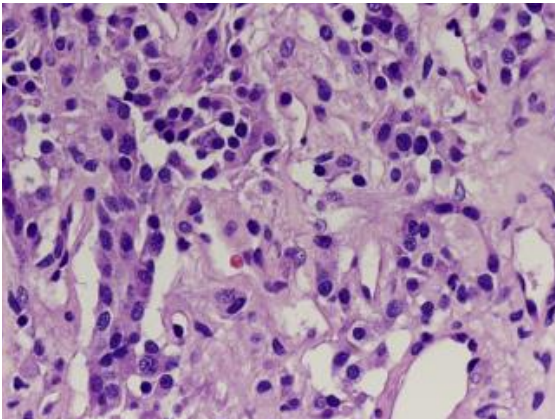


Fig. 1. High-magnification histopathology of paraganglioma. The chief cells are small with basophilic cytoplasm and have round, granular nuclei (Hematoxylin and Eosin stain).

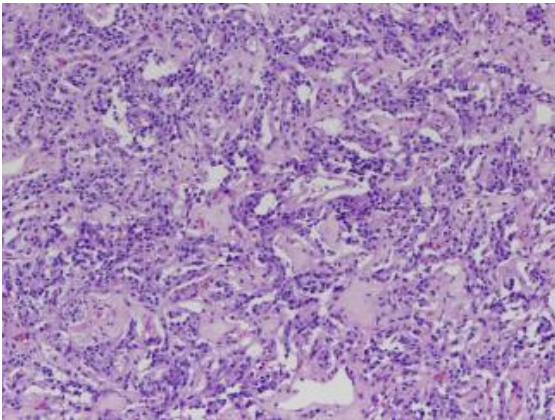


Fig. 2. Low-magnification histopathology of paraganglioma. The Zellballen architecture is visible, along with a richly vascular stroma and focal fibrosis (Hematoxylin and Eosin stain).

Table I. Glasscock-Jackson classification system.

Grade	Definition
1	Tumor margins completely visible on otoscopy
2	Tumor filling the middle ear
3	Tumor filling the middle ear and the mastoid
4	Tumor extending through the tympanic membrane into the external auditory canal

Table II. Modified Fisch-Mattox classification system.

Grade	Definition
A1	Tumor margins completely visible on otoscopy
A2	Tumor margins not completely visible on otoscopy
B1	Tumor filling the middle ear and extending into the hypotympanum or sinus tympani
B2	Tumor filling the middle ear and in the mastoid
B3	Tumor eroding into the carotid canal

Surgical options

Traditionally, most middle ear paragangliomas have been managed with surgical excision and, considering resection, preoperative treatment planning is essential. Firstly, the chosen approach depends on the extent of the tumour within the middle ear and mastoid cavity (1, 2) with the Glasscock-Jackson and modified Fisch-Matttox scales being the most used. Then, the risk of intraoperative blood loss must be estimated: preoperative angiography is mandatory to assess any vessels leading to the lesion, even if in most cases limited to the tympanic cleft embolization is not necessary. Lastly, the need for pharmacological intervention should be considered, to determine whether perioperative α -adrenergic and possibly β -adrenergic blockades are necessary. In this scenario, a transcanal and/or retroauricular microscope-based approach is the traditional technique used to manage this kind of tumour (3-5)..

The transmastoid approach is necessary for tumour extending into the mastoid, into the ear canal or significantly engaging the pro- and hypotympanicum areas. A mastoidectomy is helpful to visualize tumours that extend superiorly into the attic, with an extended posterior tympanotomy in front of tumours extending inferiorly. A modified radical mastoidectomy with or without canal overclosure may be necessary for advanced tumours with external auditory canal erosion. Moreover, even small tumours in patients with very narrow external auditory canal may require postauricular approach. The transcanal microscopic approach is indicated for small tumours limited to the middle ear, even if it is more frequently used in combination with the posterior approach (6, 7).

The rising use of the endoscope in ear surgery introduced a new strategy within the management of this kind of tumour (8, 9, 10). In the beginning, it was just used as a tool to achieve a better visualization of some anatomical details or to explore hidden areas. Then it appeared to be reliable in approaching pathologies of the temporal bone, limited to the middle ear cavity.

Case presentation

A 56-year-old female presented with a history of persistent pulsatile tinnitus limited to the left ear. She did not report any vertigo or other cochleovestibular symptoms. At the otologic examination, the tympanic membrane appeared regular (Fig. 3), while hearing evaluation through pure tone audiometry revealed an ipsilateral air-bone gap of 15 dB (Fig. 4) associated with a type A tympanogram. No stapedial reflex was evoked. A CT scan was then performed, showing a small mass centered in the hypotympanum (Fig. 5A, B) while a CT- angiography showed vascularization from an internal carotid artery vessel in its petrous segment (Fig. 5C). Since the tumour was strictly limited to the pro-/



Fig. 3. Preoperative endoscopic view of left tympanic membrane.

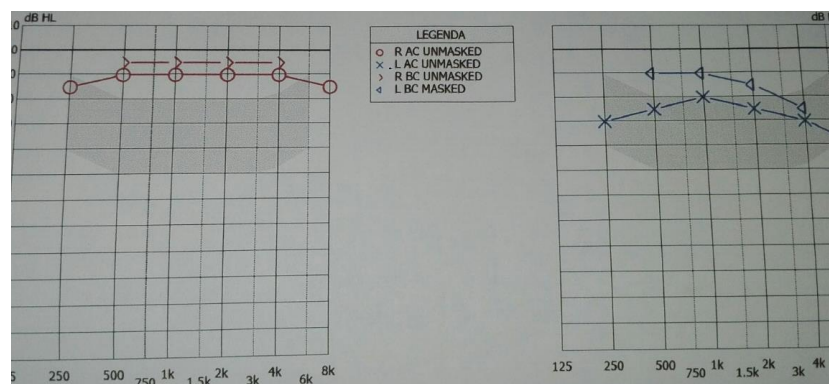


Fig. 4. Preoperative pure tone audiometry

hypo-tympanum, it was classified as Modified Fisch-Mattox Class A and as a Glasscock-Jackson Class 1. As previously mentioned, for a small, localized glomus tympanicum tumour a transcanal endoscopic resection was indicated.

SURGICAL TECHNIQUE

Surgical anatomy

The introduction of endoscope in ear surgery allowed a more detailed description of the middle ear anatomy since many subspaces can be easily explored.

Protympanic space

The protympanic area represents the most anterior portion of the middle ear cavity. It communicates superiorly with the anterior epitympanic space, through the tensor fold, and inferiorly with the hypotympanum, while posteriorly it continues into the mesotympanum. Medially, the lateral wall of the vertical carotid artery and the Eustachian tube orifice are found, while laterally it is bounded by the mandibular fossa.

Hypotympanic space

The hypotympanic area represents the most inferior portion of the middle ear cavity. It communicates superiorly with the mesotympanum, to the protympanum through the protinculus bone ridge and to the retrotympanum through the finiculus bone ridge. It houses the jugular bulb, whose height determines this subsite's volume.

Mesotympanic space

The mesotympanic space is the area one can explore through the external auditory canal. In detail, it is delimited from the tympanic membrane laterally and the promontory area (the bone covering the cochlea) medially. It contains a malleus handle, the long process of incus, the incudostapedial joint and the stapes superstructure.

Epitympanic space

The epitympanic space is the most superior part of the middle ear cavity, which communicates posteriorly with the mastoid cavity through the antrum and inferiorly with the mesotympanum through the epitympanic diaphragm. Anteriorly the tensor fold is found, superiorly the tegmen tympani (which separates the eardrum from the middle cranial fossa), medially the sovrageniculate fossa and laterally the scutum and the pars flaccida. It can be divided into an anterior and posterior portion by the cog, a bone ridge lying from the tegmen to the cochleariform process, where the tensor tympani muscle is attached.



Fig. 5. Paraganglioma of the left middle ear involving the hypotympanum. A. Axial view of non-contrasted CT-scan; B. Coronal view of non-contrasted CT-scan; C. Preoperative angiography showing a small vessel originating before the petrous segment of ICA.

This space is occupied mostly by the ossicular chain (head of malleus, body, and short process of incus) and its ligaments, while medially lies the tympanic tract of facial nerve.

Retrotympanic space

The retrotympanic space is the most posterior area of the middle ear cavity. It communicates anteriorly with the mesotympanum and inferiorly with the hypotympanum through the finiculus. It can be divided into a superior and inferior portion by the subiculum bony ridge lying from the round window to the styloid eminence. Moreover, it can be divided into a medial and lateral portion by the tympanic tract of the facial nerve. An important structure is the pyramidal eminence, from which the stapes muscle arises, representing the lateral border of the sinus tympani.

Operating room

The procedure is performed under general anaesthesia with the patient in the supine position and his head extended and turned about 45° toward the opposite side of the involved ear. The video equipment is placed in front of the surgeon and the instruments' trolley and scrub nurse are positioned at the head of the patient. Endoscopes 4 mm in diameter and 18 cm in length, with angulation of 0° and 45°, are used, connected to a high-definition monitor (Karl Storz, Germany) (6). A facial nerve intraoperative monitoring system is carried out using NIM-Response 3.0 (Medtronic Xomed Inc., Jacksonville), with intramuscular electrodes inserted to capture the responses of orbicularis oculi and mentalis muscles.

SURGICAL STEPS

Tympano-meatal flap elevation

The ear is prepared and sterilized by filling the external auditory canal (EAC) with iodine solution. After proper infiltration of EAC skin with mixture of mepivacaine 2% and epinephrine, a posterior incision from the 5 o'clock to the 12 o'clock position is made approximately 0.5/1 cm from the fibrous annulus using a circular scalpel (4, 10). Usually, a previous tattooing of the incision with cautery has been made to help the surgeon to minimize bleeding during this first step (5). A lateral to medial skin dissection is then made detaching the tympanomeatal flap from the underlying bone using cottonoids soaked in epinephrine to avoid excessive bleeding. An otologic microhook usually allows to raise the fibrous annulus and gain access to the middle ear. The tympanomeatal flap is lastly dissected from the malleus and transposed and flattened onto the anterior surface of EAC (Fig. 6).

Tympanic cavity exploration

Once the tympanic cleft and tumoural mass are exposed, the tympanic cavity is explored (10) with both a 0° and 45° endoscope, to assess the extension of the lesion as well as its relationship with the facial nerve and the ossicular chain. Indeed, if the lesion presents with a medial extension relative to the ossicles, chain removal may be necessary to obtain a radical excision of the tumour. However, the well-known endoscopic ability to "look behind the corner" makes this scenario less frequent, as described in the present case.



Fig. 6. Tympanic flap elevation from external auditory canal infiltration to its dissection from malleus handle.

Tympanic cavity exploration reveals a vascularized lesion consistent with a tympanic glomus type A located at the inferior aspect of the protympanic region bordering with the hypotympanum (Fig. 7). Delicate bone removal of hypotympanic cells is performed utilizing the Pieszosurgery to extend the view so that the tumour margins are well visualized. The ossicular chain appeared intact so there was no need to interrupt it. The bone covering the facial nerve did not seem dehiscent and anyway far from the vascular lesion.

Glomus tympanicum cauterization

Cautery of this type of tumour is mandatory before dissection (10). Hence, coarctation of the mass as well as cauterization of blood vessels supplying the tumour is performed using bipolar micro-pliers (Fig. 8).

Tumour dissection and management of eventual bleeding

The dissection is carefully performed with gentle instruments, using a microhook, bone curette and otologic suction (10) (Fig. 9). Cottonoids soaked with saline/diluted epinephrine solution were used to maintain a clean surgical field and achieve adequate hemostasis, which can be refined with bipolar micro-pliers.

Drilling of tumour attachment

Once the mass has been removed, endoscopic exploration must be carefully performed in the tympanic cavity and along the bony margins where the tumour is attached. Deep drilling of the bony tissue underlying tumour bed is absolutely mandatory to obtain a radical surgery (10). This procedure minimizes the risk of recurrence, which is possible in front of tumours arising from paraganglia (Fig. 10).

Revision of haemostasis and closure

At the end of the procedure, further exploration of the tympanic cavity is done to check for possible bleeding spots, which are eventually cauterized with bipolar pliers or cottonoids soaked with diluted epinephrine (Fig. 11). Sometimes, absorbable homeostatic products (e.g., Tabotamp Fibrillar) are left in the surgical field. Moreover, the integrity of the facial nerve through intraoperative nerve stimulation, of the ossicular chain by gentle pressure, and of the tympanic membrane are checked. Lastly, the tympanomeatal flap, eventually repaired with a myringoplasty if damaged, is returned to its original position. No histological examination has been requested due to piecemeal dissection and intraoperative appearance.

Absorbable haemostatic gelatin sponges (Spongostan) are left in the external auditory canal to guarantee proper healing of tympanomeatal flap (10).

Peri- and postoperative assessment

The patient was discharged after 24 hours without complications. An audiometry test was not performed at the discharge as no manipulation

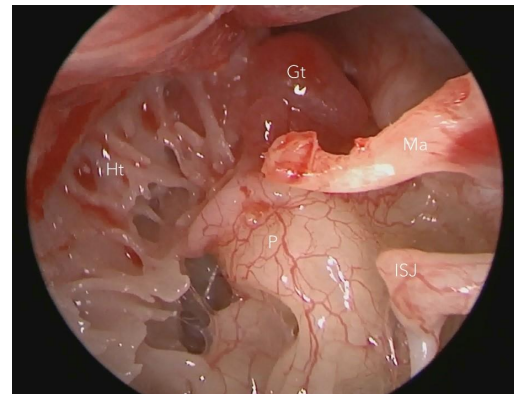


Fig. 7. Tympanic cavity exploration reveals a vascular lesion consistent with a glomus tympanicum located in the protympanum. Gt: glomus tympanicum; Ma: malleus; ISJ: incudo-stapedial joint; P: promontorium; Ht: hypotympanum.

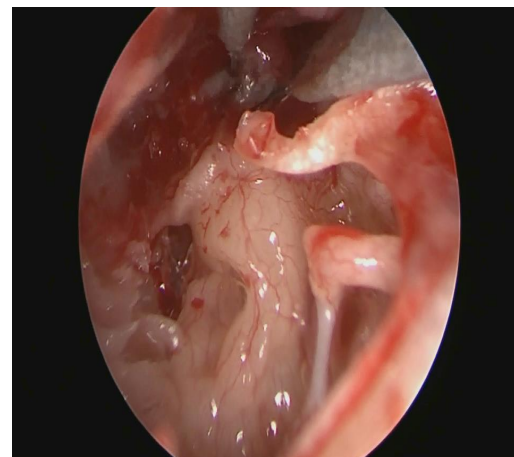


Fig. 8. Cauterization of glomus tympanicum attachment with bipolar forceps.



Fig. 9. Tumor dissection gently performed with the aim of a bone curette.

of the ossicular chain occurred. The post-operative indications included the usage of antibiotic ear drops and avoidance of water into the treated ear and pressure surges for 1-2 months (11-16). In our clinic regular follow-up is maintained, firstly within 2-4 weeks, then with a post-operative audiometric test after 3-6 months and finally annually through a CT scan. The patient complained of homolateral tinnitus but no vertigo. The audiometric examination at 3 months showed a neurosensorial hearing loss of 15 dB, while a one-year CT scan showed no signs of recurrence.

CONCLUSIONS

Surgical excision for glomus tympanicum is the first treatment choice in most cases. The approach is determined by the location and the extension of the lesion, assessed with CT or MR-scan. In the era of minimally invasive treatments, exclusive endoscopic ear surgery can be considered a valid alternative, especially in Glasscock–Jackson type 1 and modified Fisch–Mattox class A tumours. Indeed, this method provides a dynamic and close tumour visualization, leading to a safe, controlled and effective removal without any sutures or canaloplasty, especially if approached by trained surgeons. Thanks to it, this procedure significantly reduces the operating time, and it is even suitable for 24-hour hospital stay.

Declaration of competing interest

The authors have no conflict of interest to declare.

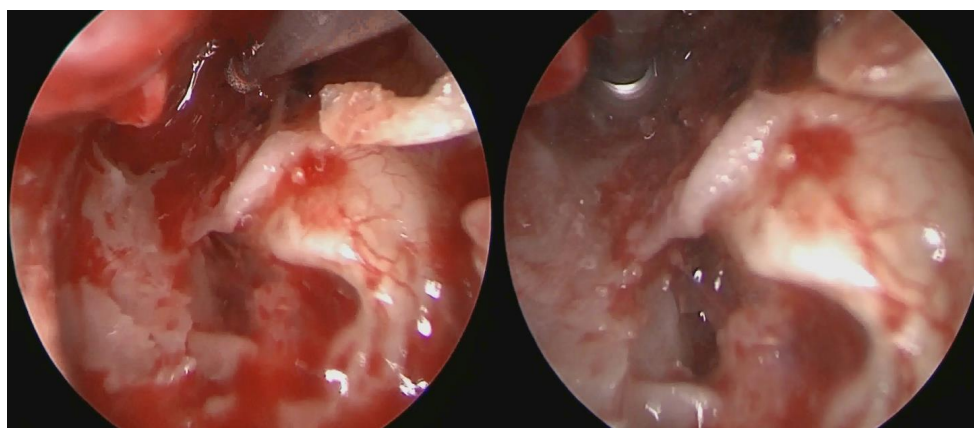


Fig. 10. *Drilling of the protympanic and hypotympanic tumour attachment with the aim of a diamond burr.*



Fig. 11. *Tympanic cavity at the end of surgical procedure of exclusive endoscopic glomus tympanicum excision. The pro- and hypo-tympanic cells are clearly visible as drilled out.*

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