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REVIEW ARTICLE

Primary tumors and tumor-like lesions of the eustachian tube: a systematic review of an emerging entity

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Abstract Eustachian tube (ET) primary tumors and tumor-like lesions are rare diseases presenting with common ear, nose and throat symptoms. Pathology can range from developmental anomalies to high malignant neoplasms. Hence this review aimed at suggesting a classification and outline relevant aspects of ET primary tumors and tumor-like lesions, describing clinical findings, diagnostic management and therapeutic approaches. MEDLINE, CINAHL, OVIDSP, HIGHWIRE, and GOOGLE databases were searched from inception to July 2011 for relevant studies. Further papers were identified by examining the reference lists of all included. Sixty-five papers met the inclusion criteria, enclosing 78 cases. Case reports are increasing in the past few years. Benign lesions and tumor-like lesions of ET have been reported. Moreover, melanomas, carcinomas, and sarcomas can affect the ET as a primary site.

Keywords Eustachian tube · Skull base · Middle ear · Nasopharynx · Neoplasm

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Introduction

The eustachian tube (ET) is a short but complex hourglass-shaped structure which connects the nasopharynx to the middle ear. In the embryo, ET develops mainly from the endodermal layer of the first pharyngeal pouch, while areas of chondrification arise in the surrounding mesoderm [1]. The cartilaginous two-thirds runs from the torus tubarius through the pharyngeal mucosal space at the level of the sinus of Morgagni. Further, ET crosses the anterior pharyngobasilar fascia in the muscular lacuna between the superior pharyngeal constrictor muscle and basicranium, entering the roof of the posteromedial parapharyngeal space (PPS). This compartment includes vital structures: internal carotid artery (ICA), internal jugular vein, and cranial nerves IX to XII [2, 3]. Before continuing through the isthmus into the bony one-third, or the protympanum, ET cartilage fits into the sphenoid sulcus, lateral to the ICA canal of the skull base. The bony septum between ET and ICA can be dehiscent. Bony ET walls are often pneumatised and some cells may open into the endocranium, which lies as close as few millimeters to the ceiling of the protympanum, and can be involved in the spreading of pathological processes [3, 4].

Eustachian tube has unique features that distinguish its anatomy and function among surrounding structures, e.g. the complex muscular apparatus, the specific distribution of specialized cells, and the production of surfactant [3, 5]. ET histology can explain why ET tumors are different from

other neoplasms of the PPS, which are more often of neurogenic origin [6]. At the level of the nasopharyngeal orifice the lining mucosa presents as a mixture of squamous and respiratory epithelium intercalated by transitional epithelium. The basal layer includes sometimes dark brown pigment positive for melanin, more often in patients of Asian origin [7]. The submucosal layer harbors an extensive lymph network, which drains into either the retropharyngeal nodes medially or the deep cervical nodes laterally [3].

From the isthmus to the tympanic orifice, most of the epithelial cells covering the upper third of ET walls are deemed to be squamous epithelial cells. Indeed, metaplasia of the respiratory epithelium is common following repeated inflammations, the ciliated columnar cells being transformed into squamous cells or goblet cells [8]. The supporting lamina propria has variable thickness and can be divided into three layers: a basal membrane, an inconstant sheet of lymphoid tissue, and a layer of compound tubuloalveolar glands which are more crowded in the cartilaginous portion of ET [1, 8]. The normal presence of mucous glands may distinguish ET mucosa from middle-ear mucosa. In fact, Tos and Caye-Thomasen [9] stated that mucous glands are never a normal component of the middle-ear mucosa, but the expression of an inflammatory disease.

Eustachian tube dysfunction is a common finding in ENT practice, mostly among young patients, usually presenting with otitis media (OM). It is well known that ET obstruction is an important factor leading to OM [3], but Sumi et al. [10] reported that mechanical obstruction of ET nasopharyngeal orifice by PPS benign tumors does not cause invariably OM. Moreover, middle-ear effusions were not seen in tumors that were restricted to ET orifice either with no displacement or with minor displacement of the torus tubarius [11]. With these assumptions, it could be argued that the obstruction of the ET should arise directly from ET to cause OM, as in the case of infiltrating lesions, lesions lying in the lumen or peritubal musculo-cartilaginous anomalies [10].

Despite secondary ET lumen infiltration by nasopharyngeal and PPS malignancies is often reported, primary tumors and tumor-like lesions arising from ET lumen are rarely cited in literature. The first mention of a malignant lesion originating from ET dates back to nineteenth century [12], while benign tumors and pseudo-tumors arising from ET are reported since the introduction of direct nasopharyngoscopy [13], which is actually part of the routine ear nose and throat examination.

Materials and methods

A systematic review of literature was performed using established methodology for systematic reviews [14]. MEDLINE, CINAHL, OVIDSP, and HIGHWIRE databases were searched from inception to July 2011 for relevant studies. Considering that ET primary tumors and tumor-like lesions could be underestimated due to the low incidence, a free GOOGLE search was also performed to identify non-indexed or not peer-reviewed reports. Literature search used the following terms: “eustachian tube”, “auditory tube”, combined with “neoplasm”, “tumor”.

Inclusion criteria were

1. Report of a primary tumor or tumor-like lesion supported by detailed anatomical and histological examination, and preferably by a pictorial assay.
2. Explicit assessment of ET origin. ET boundaries were defined as the limit delineated by the edge of the torus tubarius at the nasopharyngeal orifice and by the bony ridge separating the protympanum from the hypotympanum at the middle-ear opening. Multiple origins were evaluated case by case. Otologic signs and symptoms were considered as possibly suggesting an ET origin in cases of nasopharyngeal or parapharyngeal masses [10, 11].
3. Given that ET tumors and tumor-like lesions are rare, heterogeneous groups of cases are sometimes grouped together for reporting in literature. Therefore, if it could be determined whether it contained relevant cases, the article was included for review and data extracted accordingly.

Secondary involvement of ET, either metastatic or by spread from nasopharynx, middle ear or PPS was considered an exclusion criterion. Infectious granulomas and simple mucosal polyps were also excluded from the review. The searches were not limited by study design or language of publication. Further papers were identified by examining the reference lists of all included articles and hand-searching the relative journals or searching relevant websites. Data were extracted from primary sources only. The review was performed by one author (EM). Older articles have been carefully evaluated because of the difficulty in comparing older medical knowledge with current standards. Among the titles retrieved from the database search, full articles were obtained and reviewed, unless otherwise specified. Discrepancies about inclusion were resolved by mutual consensus among authors.

Results

Sixty-five papers met the inclusion criteria, enclosing 78 cases of tumors and tumor-like lesions of ET. Reports were published from 1888 to 2011. In only one case [15] it has not been possible to obtain the full text article of a relevant

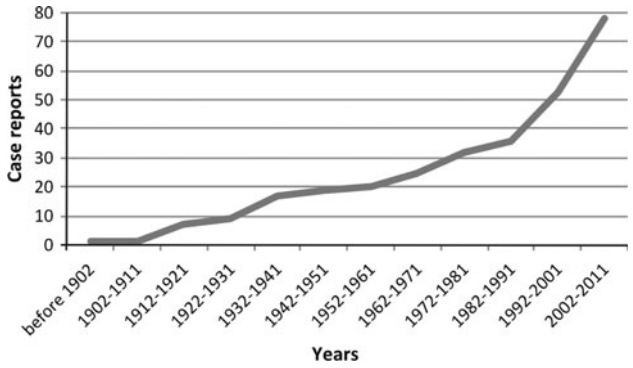

Fig. 1 Cumulative report rate of ET primary tumors and tumor-like lesions

paper, resulting in its exclusion from the review. Report rate of ET primary tumors and tumor-like lesions is increasing in the past few years (Fig. 1); it has doubled since the 1980s. Females and males were overall equally affected (39 females, 37 males, 2 undetermined). Twelve cases of melanotic oncocytic metaplasia (MOM) affecting ET at the nasopharyngeal orifice (online only Table 1) are reported in literature (2 females, 10 males) [16–23]. Average age at diagnosis of MOM is 68 (range 56–81) years. Teratomas and dermoids (or "hairy polyps") were diagnosed in 26 cases (online only Table 2) [24–48]. There were 18 bigerminal, 6 trigerminal, and 2 monogerminal lesions. Twenty patients were females and five were males. The genre was not mentioned in one case. Mean age at diagnosis was 2.9 (range birth–22) years. Chondromas of ET are mentioned in 7 cases (online only Table 3), 5 females and 2 males, with a mean age of 40 (range 14–66) years [49–54].

Eight cases of primary ET melanomas were identified (online only Table 4), affecting 6 females and 2 males, with a mean age of 57 (range 35–75) years [55–61]. ET carcinoma accounts for 18 cases (online only Table 5) [12, 55, 62–73]. Mean age at diagnosis is 51 years (range 31–64), affecting 14 males and 3 females (1 undetermined). Most of these cases are squamous cell carcinomas and affect males, mostly non-keratinising (14 cases, sometimes named transitional cell carcinomas in the past). Four cases are non-squamous cell carcinomas, including a medullary carcinoma [68], one mucoepidermoid carcinoma [73] and two cases of unspecified carcinoma [12, 62]. In one case, polygonal cells were found in association with squamous cell carcinoma [63]. Sarcomas of ET are described in two papers (online only Table 6) [74, 75]. They affected three males with a mean age of 55 (range 44–68) years. Four single cases of different benign ET pathology have been also included (online only Table 7) [76–79]. The entire spectrum of primary pathology of ET is summarized in the Tables (Tables 1, 2, 3, 4).

Table 1 Summary of primary eustachian tube (ET) pathology

Pathology	*N*
Melanin pigmented oncocytic metaplasia	12
Teratoma and dermoid (or "hairy polyps")	
Trigerminal	6
Bigerminal	18
Monogerminal	2
Chondroma	
Chondroma NOS	6
Myxochondroma	1
Melanoma	8
Carcinoma	
Squamous cell carcinoma[a]/Transitional cell carcinoma	14
Medullary carcinoma	1
Mucoepidermoid carcinoma	1
Carcinoma NOS	2
Sarcoma	
Small round cell sarcoma	2
Synovial sarcoma	1
Other	
Foreign body reaction	1
Osteoma	1
Cartilagineous horn	1
Cylindrical cell papilloma	1

NOS not otherwise specified

[a] Associated with polygonal cell carcinoma ($N = 1$)

Discussion

Benign tumors and tumor-like lesions

Melanotic oncocytic metaplasia

MOM is a benign lesion resulting from the rare occurrence of oncocytic metaplasia together with melanin pigmentation of clusters of seromucinous glands. In the head and neck region MOM occurs more often in the lateral walls of the nasopharynx. Patients are more frequently of Asian origin [16–23]. At a first glance MOM could mimic a malignancy (e.g. mucous melanoma), but although not capsulated, no cellular atypia can be observed at the pathological examination. MOM lesions are small (<1 cm). Once excisional biopsy is taken and benign nature confirmed, no further treatment is required. Thus, few data on treatment and follow-up are available (Tables 2, 3, 4). MOM of ET nasopharyngeal opening can be associated with epistaxis, OM, tinnitus, ear, and throat discomfort of the adult patient, but without a certain causal relationship [16–23]. Similarities between MOM and extra-parotid Warthin's tumor have been noticed [16]. While oncocytes are presumably an age-related by-product, the origin of the

Table 2 Summary of eustachian tube (ET) tumors and tumor-like lesions clinical presentations

	Melanin pigmented oncocytic metaplasia	Teratoma and dermoid	Melanoma	Carcinoma	Sarcoma	Chondroma	Other	Total
Ear symptoms								
Discharging ear (even bloody)		16	2	2			1	21
Bloody otorrhea		2						2
ET obstruction, middle-ear effusion	3	5	2	5		3		18
Ear fullness/ear discomfort	1		3	3		2	1	10
Chronic/recurrent OM		2						2
Sudden deafness			1					1
Hearing impairment	1	1	5	8	2	1	2	20
Ear pain				4	2		2	8
Tinnitus	2		1	4	2	1	2	12
Vertigo						1	1	2
Nose symptoms								
Nasal obstruction or discharge	2			1	2	2		7
Epistaxis	1		2					3
Sleep apnea		1						1
Throat symptoms								
Throat obstruction/discomfort	2	1				3		6
Life- threatening throat obstruction		3						3
Throat bleeding	1			1				2
Vomiting (even bloody)		1						1
Bloody vomiting		1						1
Other symptoms								
Headache				5	1	1		7
Facial nerve palsy			1			1		2
Trigerminal neuralgia				3				3
Other nerves involved				4				4
Neck mass/lymph node swelling			1	2				3
Complex syndrome				5				5

melanin pigment is still controversial, although smoking habits have been advocated. The exact nature of MOM awaits further clarification [23].

Teratomas and dermoids (or "hairy polyps")

Teratomas are rare lesions of embryonic origin, which contain tissues derived from all three germinal layers: endoderm, mesoderm, and ectoderm. Congenital teratomas of the head and neck represent about 5% of all neonatal teratomas, occurring in 1 on 20,000–40,000 live births [80]. The etiology of teratomas is consistently a debatable issue. It seems that teratomas of the head and neck develop from remnants of normal embryologic structures that break off or do not migrate to their original destination, but contain the genetic information to differentiate into their respective end points [80]. Head and neck teratomas are more often benign, although malignant lesions have been described. Malignancy is not equated with the degree of immaturity of the tissue elements. The immature areas are usually in keeping with the immaturity of the host [80]. While there is general agreement about the teratomatous nature of trigerminal lesions, this is not the case of dermoids or "hairy polyps" (D/HPs). D/HPs are lesions composed by derivatives of only two germinal tissues [38, 81–84]. The ectodermal element of D/HPs is confined entirely to their covering of hairy skin, with no ectodermal inclusion cysts within the mesoderm. This differentiates D/HPs from both teratomas and dermoid cysts. D/HPs are by far the most common congenital masses of the oro-nasopharynx and only occur at this site [81]. D/HPs affect females six times more commonly than males while teratomas have equal sex incidence. Differently from teratomas, D/HPs have not been associated with skull base defects; they have no

Table 3 Summary of eustachian tube (ET) tumors and tumor-like lesions: treatment modalities

	Melanin pigmented oncocytic metaplasia	Teratoma and dermoid	Melanoma	Carcinoma	Sarcoma	Chondroma	Other	Total	Average
Surgical treatment									
Mean surgical interventions	1	2.3	1.7	1.5	1	1.3	1		1.4
Maximum number of surgeries	1	4	2	2	1	3	1		2.0
Biopsy		13						13	
Definitive surgery approach									
EAC/mastoid		11				1	1	13	
Transoral		4		2		4		10	
Transnasal	12	1	1				2	16	
Transmaxillar				1	2			3	
Transcervical						1		1	
Transcranial				1		1		2	
Infratemporal			1					1	
Combined approach		9			1			10	
Other treatments									
Radical CT			1					1	
Radical RT			1	10				11	
Neoadjuvant RT			1	1				2	
Adjuvant RT			1	2	1			4	
Combined RT/CT			1	1				2	
None			1	1				2	
Unknown treatment		1	2	3			1	7	

EAC external auditory canal, *CT* chemotherapy, *RT* radiotherapy

Table 4 Summary of eustachian tube (ET) tumors and tumor-like lesions: treatment results

	Melanin pigmented oncocytic metaplasia	Teratoma and dermoid	Melanoma	Carcinoma	Sarcoma	Chondroma	Other	Total	Average
Follow up									
Mean (months)	36	22.8	14.2	16.1	23.7	56	12		25.8
Undetermined	11	13	3	5		4	3	39	
Outcome									
Remission	12	15	3	4	1	2	1	38	
Recurrence		1		1				2	
Persistence				1		1		2	
Progression			2	7	2			11	
Undetermined		11	3	6		4	3	27	

malignant potential and do not show progressive growth. D/HPs are usually single but the occasional report of bilateral D/HPs support the theory of a developmental malformation. There is a gross similarity of D/HPs with fetal auricles, which normally develop from the first and second branchial arches. This arrangement was never found in true teratomas. D/HPs of the nasopharynx are consistent with the persistence of the nasopharyngeal membrane. There is also an association between D/HPs and cleft palate, probably secondary to the polyp separating the palatal shelves and preventing their closure [81]. Delides et al. [82] hypothesized that these bigerminal lesions are true teratomas since they found that they arise in different loci that lack any embryological connection. Two cases of

monodermal lesions have been included [39, 48]. Discharging ear for months or even years, sometimes bloody, is the most common clinical presentation of these lesions (Table 2). OM without perforation of the tympanic membrane and signs of ET dysfunction has also been reported. Respiratory distress has been described in cases of nasopharyngeal and ET lesions; it can be present at birth, being sometimes life threatening [30, 32, 37, 45, 80]. Needle aspiration has been recommended for decompressing cystic components and to analyze fluid for glucose to rule out an encephalocele. Fine-needle aspiration can also be useful for making a tissue diagnosis [80]. Teratomas and D/HPs of ET are benign in their histology, but in view of the documented occurrence of immature as well as frankly malignant elements in other head and neck teratomas, and the high degree of morbidity by virtue of their size and location, a prudent approach to the definitive treatment of ET teratomas would include complete surgical excision (Table 3) [80, 85]. Surgery yields an excellent prognosis, as these tumors are often encapsulated or pseudoencapsulated and not infiltrating, which facilitates dissection of the teratoma from surrounding tissue structures [80]. Surgical approach can be attempted through external auditory canal, transmastoid, transnasal, or transoral route. An average of 2,3 surgical interventions is required. Recurrence of the tumor is rare [80, 85]. Routine follow-up is a necessary part of the management (Table 4). Increased serum alpha-fetoprotein (AFP) levels has been proposed as a reliable indicator of disease activity or recurrence of teratomas, bearing in mind that AFP levels can be quite high in the first months of life and also display a wider range of variability than they do after the first year [80].

Chondromas

Benign tumors such as extracranial chondromas of the lateral walls of the pharynx are attributed to ET cartilage when not invading the intracranial space [49–54]. These lesions are usually easily removed surgically and do not recur; however, they can coexist with malignant lesions (Tables 2, 3, 4). In case of ascertained benign lesions, depending on their extension, pieces can be left untouched in proximity of dangerous structures, e.g. cavernous sinus [54].

Malignancies

Melanomas

Melanomas are neural crest-derived neoplasms. Although mucous melanomas (MM) account for only 1.3% of all melanomas, head and neck region is the most common site of origin (55%) [86]. The growing interest on mucosal melanoma of the head and neck is witnessed by the introduction of a dedicated chapter in the last edition of the TNM cancer staging system manual [87]. The clinical presentation of ET MM is variegate, mimicking more common conditions: ear fullness, hearing impairment (even sudden deafness), tinnitus, epistaxis, discharging ear (even bloody otorrhea) and signs of loco-regional involvement, such as facial nerve palsy and neck lymph node swelling are reported (Table 2). Symptoms last for months or years before diagnosis [55–61]. The histologic diagnosis of MM may not be straightforward, especially for amelanotic neoplasms, which may be confused with carcinomas, sarcomas, and others. The differential diagnosis may be narrowed by the application of immunohistochemical staining with melanocytic cell markers (S-100 protein, HMB-45, Melan-A) [86]. The extent of the primary tumor is a major factor determining outcome in patients with MM. In the TNM system, stage III is directly assigned to the presence of MM even limited to the mucosa [87], reflecting the aggressiveness of MM, the challenge of an early recognition, the unsatisfactory evaluation of the effective extension at diagnosis and the poor prognosis. Considering that maximum dimension of ET MM at diagnosis ranges from 10 to 35 mm, it should be noted that tumor thickness greater than 5 mm was found to be an independent predictor of outcome in head and neck MM. Skull base, lower cranial nerves (IX, X, XI, XII), masticator space, carotid artery, prevertebral space, and mediastinal structures can be involved in advanced stages [87]. Complete and wide resection of the tumor with clear margins is the preferred treatment, requiring skull base surgery skills. Unfortunately, local control is not a strong predictor of enhanced survival [86, 87]. Postoperative radiotherapy is recommended by many authors [88]. Follow-up was reported in only five cases of ET MM (average 14 months, range from 8 to 24 months), revealing three cases of complete remission and two cases of progression [55–61].

Carcinomas

Reporting a case of ET carcinoma, Kim et al. [73] speculated that a primary origin from the ET is acceptable because of tumors arising from the ET may protrude in the nasopharynx or extend into the middle ear, while primary tumors of the middle ear tend to invade preferentially the temporal bone and the external auditory canal. Although ascending invasion by the tumor from a primary site in the nasopharynx may be considered, spread into the ET is known to be limited by its cartilaginous tract and by the pharyngobasilar fascia [73]. The first mention of a malignant lesion arising from ET dates back to 1888 [12]. The patient died from intracranial invasion by a malignancy

originating from the nasopharyngeal orifice of ET and Rosenmüller fossa. The clinical features of this case gave the name to the Negri–Jacod syndrome, consistent with unilateral headache, tinnitus, trigerminal neuralgia, paralysis of the III, IV, VI cranial nerves, ptosis, and proptosis. The diagnosis and treatment of the first published cases of ET carcinomas may have an anecdotal role only. Unilateral ear-related symptoms affecting adult patients should arouse the suspicion of malignant pathology of the ET. In fact, ET carcinoma may present with the gradual onset of common symptoms such as persistent ET or nasal obstruction, ear fullness, tinnitus, pain, deafness, epistaxis, and headache [55, 62, 63, 65–68, 72, 73]. Locoregional involvement may be already evident at presentation, including cranial nerve infiltration [12, 64, 68, 72], metastatic neck swelling [69, 71], bleeding from uncommon sites [70]. Disease often progresses to intracranial invasion (Table 2) [55, 62, 64, 68, 69]. Overlying mucosa may be apparently spared, with only slight signs of inflammation, being the growth mainly submucosal [55]. Radiotherapy has been proposed since the first half of the twentieth century, obtaining sometimes complete remissions [67, 72, 73]. The first surgical approach was attempted by Jacod [66]. It entailed the complete transmaxillary resection of ET [66]. In 1948, Passe [71] performed the excision of a squamous cell carcinoma of the ET by means of soft palate splitting and partial hard palate removal. The contemporary concurrent radio-chemotherapy schema used by Kim et al. [73], including hyperfractionated irradiation (daily 240 Gray bis in die/7440 Gray total/62 fractions) on the right ear and ET and bleomycin, epirubicin, and cisplatin chemotherapy protocol for three times at intervals of 2 weeks yielded to complete remission at 2-years' follow-up in one case of mucoepidermoid carcinoma of the ET. Intensity-modulated radiotherapy (IMRT), which enables radiotherapy to be targeted more accurately, has recently become available [89]. IMRT may be also considered for the treatment of ET carcinomas. However, considering the small sample size and the difficult interpretations of older papers, it is still not possible to determine an optimal standard of management of ET carcinomas.

Sarcomas

Sarcomas of ET have been reported since 1901 [90]. However, no histologic details were provided for that case, so it was excluded from the present review. The two cases of small round cell sarcoma reported by Jacod in 1915 were treated by means of surgical removal through a transmaxillary approach (Table 3) [74]. The cases reported by Jacod [64, 66] can be probably better described as transitional cell carcinomas. In fact the term "reticular cell sarcoma" may be obsolete. The contemporary endoscopic approach followed by adjuvant irradiation yielded to a complete remission at 5 years of follow-up in a case of synovial sarcoma of ET [75].

Single reports

Single cases of primary osteoma [76], cartilaginous horn [77], and cylindrical cell papilloma [79] of ET have been reported. Granulomatous lesions can affect ET following surgical treatment of patulous ET resulting in hyatrogenic foreign body granuloma [78].

Imaging studies

Clinical examination, including routine direct endoscopic examination of the nasopharynx, can provide information on ET nasopharyngeal orifice, e.g. enlargement, drainage from ET, on mucosal involvement, and on local tumor extension. It, however, cannot determine deep extension of the tumor in case of malignancies, such as skull base erosion and intracranial spread [89]. The modern micro-endoscopy technique of ET lumen and middle ear using 2.5–0.8 mm fiberscopes is still developing [91]. Contrast medium injection in the lumen of ET had been used in the past to enhance the poor information that can be obtained from simple X-ray visualization of ET space-occupying lesions [92]. Ultrasound diagnosis of pedicled lesions possibly obstructing airways can sometimes be available prenatally. Ultrasound examination of teratomas generally shows mixed echogenicity, with areas of semicystic, and solid components [80]. Although specific literature on ET imaging is lacking, it is well known that CT is the most reliable imaging tool for the evaluation of middle ear, temporal bone, and bony portion of ET. However, CT usually cannot detect ET lumen details. CT is useful in identifying the paranasopharyngeal extension, the perineural spread and the involvement of the skull base. MR is superior than CT for displaying soft tissues and for differentiating tumors from normal tissues. MR can demonstrate ET structures including cartilage, muscles, adipose tissues, and prove essential information prior to surgery [92]. CT and/or MRI is of importance not only to aid in surgical planning, but also to determine skull erosion or intracranial involvement [80]. The morphological assessment of ET by means of MR has been reported mostly on anatomical specimens: the examination of ET in the living subject for clinical purposes still requires more experience and technical developments [92]. MR can display lymph node metastases and bone marrow infiltration [89]. Staging requires appropriate imaging to rule out distant metastases [56, 57, 60]. Carotid arteriography or selective digital subtraction angiography can be requested to evaluate carotid artery involvement [53, 54, 56]. Positron emission

tomography (PET) is more sensitive than CT and MR at detecting residual and recurrent tumors in the head and neck region, and it has been sometimes requested also for the evaluation of ET lesions [60, 78, 89]. Cross-sectional imaging displays precisely the primary tumor extent. This has proven to enable radiotherapy treatment to be administered more accurately and effectively in adjacent regions [89].

Conclusion

Eustachian tube primary tumors and tumor-like lesions presents with common ENT symptoms such as unilateral ET dysfunction, middle-ear effusion, chronic otorrhea, epistaxis, and upper airway obstruction. The first cases have been reported since the last decades of the nineteenth century. Actually, older reports have an anecdotal value, but new cases are published increasingly often in the past few years. The cause of this increment is open to speculation. Underneath pathology can range from developmental anomalies to high malignant neoplasms, possibly involving ICA and basal foramina. Differential diagnosis may be challenging, and these conditions can be misdiagnosed for months or years. Imaging studies of ET may be elusive. Surgical approach may be extremely difficult and several operations and combined approaches may be required. Reports on ET primary lesions are encouraged in view of their peculiar features. Considering the challenges of rare disease management, ET primary tumors and tumor-like lesions should not remain a neglected entity.

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References

1. Gulya AJ (2007) Anatomy of the temporal bone with surgical implications. Informa Healthcare, New York
2. Maheshwar AA, Pensak ML, Kim EY, Keller JT (2004) Roof of the parapharyngeal space: defining its boundaries and clinical implications. Ann Otol Rhinol Laryngol 113:283–288
3. Bluestone CD (2005) Anatomy. Eustachian tube. In: Bluestone CD (ed) Eustachian tube: structure, function, role in otitis media. BC Decker, Hamilton, pp 25–44
4. Djerić D, Savić D (1985) Anatomical variations and relations of the bony portion of the eustachian tube. Acta Otolaryngol 99:543–550
5. Bluestone CD (2005) Physiology. Physiology of the eustachian tube within its system. In: Bluestone CD (ed) Eustachian tube: structure, function, role in otitis media. BC Decker, Hamilton, pp 51–62
6. Chijiwa H, Mihoki T, Shin B, Sakamoto K, Umeno H, Nakashima T (2009) Clinical study of parapharyngeal space tumours. J Laryngol Otol Suppl 31:100–103
7. Ali MY (1965) Histology of the human nasopharyngeal mucosa. J Anat 99:657–672
8. Hiraide F, Inouye T (1983) The fine surface view of the human adult eustachian tube. J Laryngol Otol 97:149–157
9. Tos M, Caye-Thomasen P (2002) Mucous glands in the middle ear—what is known and what is not. ORL J Otorhinolaryngol Relat Spec 64:86–94
10. Sumi T, Tsunoda A, Shirakura S, Kishimoto S (2007) Mechanical obstruction of the eustachian tube by the benign tumor of the parapharyngeal space does not cause otitis media with effusion. Otol Neurotol 28:1072–1075
11. King AD, Kew J, Tong M et al (1999) Magnetic resonance imaging of the eustachian tube in nasopharyngeal carcinoma: correlation of patterns of spread with middle ear effusion. Am J Otol 20:69–73
12. Negri S (1935) La sindrome di Silvio Negri. Storia d'un tumore della base del cranio. Cenni sulla malattia del Comm. Mons. Bernardo Raineri. Reperto necroscopico. Riv Oto Neuro Oftal 12:515–522
13. Holmes E (1911) Examination and treatment of the eustachian tubes by the aid of the naso-pharyngoscope. Ann Otol Rhinol Laryngol 20:29–42
14. Centre for Reviews and Dissemination, University of York. Systematic reviews: CRD's guidance for undertaking reviews in health care. York: York Publishing Services Ltd. 2009
15. Dunlap AM (1938) Malignancy of the nasopharynx and eustachian tube. Chin Med J 53:68–71
16. Griffiths AP, Dekker P (1991) Oncocytic metaplasia of the nasopharynx or extra-parotid Warthin's tumour? J Clin Pathol 44:1030–1032
17. Shek TW, Luk IS, Nicholls JM, Fok KO (1995) Melanotic oncocytic metaplasia of the nasopharynx. Histopathology 26:273–275
18. Hirakawa E, Miki H, Ohmori M, Kobayashi S, Haba R, Nagai Y (1999) Melanin pigmented oncocytic metaplasia of the nasopharynx. Virchows Arch 434:455–457
19. Xue WC, Hui YZ (1999) Melanotic oncocytic metaplasia of the nasopharynx. Histopathology 35:481–482
20. Sakaki M, Shek TW, Hirokawa M et al (2004) Melanotic oncocytic metaplasia of the nasopharynx: a report of seven cases and review of the literature. Virchows Arch 444:345–349
21. Lui PC, Chan AB, Chan KF, Choi CH, Tse GM (2004) Melanocytic and non-melanocytic oncocytic metaplasia of the nasopharynx. Pathology 36:504–505
22. Takano K, Sato J, Shirasaki H, Yamazaki N, Hoki K, Himi T (2004) Melanin pigmented oncocytic metaplasia of the nasopharynx. Auris Nasus Larynx 31:161–163
23. Kondo T, Mori K, Oka S, Morinaka S (2010) Melanotic oncocytic metaplasia of the nasopharynx as a benign mimicker of malignant melanoma: a case report. Diagn Pathol 5:5
24. Henke K (1924) Ein Beitrag zur Kenntis kongenitaler Mittelohrgeschwulste. Z Hals-Nasen-Ohren-Heilkunde 10:377–382
25. Navratil J (1965) Teratome der Paukenhohle und der Tuba Eustachi. Acta Otolaryngol (Stock) 60:360–366
26. Pirodda E (1965) Dysontogenetic dermoid of the eustachian tube. J Laryngol Otol 79:546–553
27. Eichel BS, Hallberg OE (1966) Hamartoma of the middle ear and eustachian tube. Report of a case. Laryngoscope 76:1810–1815
28. Münker G (1972) Akzessorische Ohrmuschel in der Ohrtrompete. Z Laryngol Rhinol 51:175–178
29. Karduck A, Schulz P (1973) Choristom mit Ausgang vom Paukennahen Anteil der Ohrtrompete. HNO 21:190–194

30. Desnos J, Martin A (1974) Association d'une surdité génétique et d'une hypoacousie de transmission par dysembryome pharyngotympanique. Ann Otolaryngol Chir Cervicofac 91:411–416
31. Arcand P, Abela A (1985) Dermoid cyst of the eustachian tube. Otolaryngology 14:187–191
32. Nicklaus PJ, Forte V, Thorner PS (1991) Hairy polyp of the eustachian tube. J Otolaryngol 20:254–257
33. Vrabec JT, Schwaber MK (1992) Dermoid tumor of the middle ear. Case report and literature review. Am J Otol 13:580–581
34. Boedts D, Moerman M, Marquet J (1992) A hairy polyp of the middle ear and mastoid cavity. Acta Otorhinolaryngol Belg 46:397–400
35. Forrest AW, Carr SJ, Beckenham EJ (1993) A middle ear teratoma causing acute airway obstruction. Int J Pediatr Otorhinolaryngol 25:183–189
36. Kolias SS, Ball WS, Prenger EC, Myers CM (1995) Dermoid of the eustachian tube: CT and MRI findings with histologic correlation. Am J Neuroradiol 16:663–668
37. Morisseau-Durand MP, Roman S, Triglia JM, Manac'h Y (1996) Le tératome de l'oreille moyenne. A propos de 4 nouvelles observations. Ann Otolaryngol Chir Cervicofac 113:362–366
38. Ruah CB, Cohen D, Sadé J (1999) Eustachian tube teratoma and its terminological correctness. J Laryngol Otol 113:271–274
39. Sichel JY, Dano I, Halperin D, Chisin R (1999) Dermoid cyst of the eustachian tube. Int J Pediatr Otorhinolaryngol 48:77–81
40. Gourin CG, Sofferman RA (1999) Dermoid of the eustachian tube. Otolaryngol Head Neck Surg 120:772–775
41. Wasinwong Y, Chaipasithikul S, Kanchanapitak P (2003) Eustachian tube mature teratoma. Otolaryngol Head Neck Surg 128:589–591
42. Roh JL (2004) Transoral endoscopic resection of a nasopharyngeal hairy polyp. Int J Pediatr Otorhinolaryngol 68:1087–1090
43. Baek SJ, Kim SC, Kim DI, Chung MH (2005) Radiology quiz case 3: hairy (dermoid) cyst originating from the eustachian tube. Arch Otolaryngol Head Neck Surg 131(823):826–827
44. Walker P (2008) Dilated eustachian tube orifice after endoscopic removal of hairy polyp. Otolaryngol Head Neck Surg 139:162–163
45. Agrawal N, Kanabar D, Morrison GA (2009) Combined transoral and nasendoscopic resection of an eustachian tube hairy polyp causing neonatal respiratory distress. Am J Otolaryngol 30:343–346
46. Chen M, Sun P, Liu W, Liu S, Zhang Y (2011) Eustachian tube mature teratoma. Int J Pediatr Otorhinolaryngol Extra 6:20–22
47. Wang JL, Hou ZH, Chen L, Yuan J, Yang SM (2011) Combined application of oto-endoscopes and nasal endoscopes for resection of dermoid tumor in eustachian tube. Acta Otolaryngol 131:221–224
48. Sim MW, Stewart TA, Snissarenko EP, Xu HX (2011) Congenital cholesteatoma involving the eustachian tube. Int J Pediatr Otorhinolaryngol 75:600–602
49. Drennowa KA (1930) Chondrom des seitlichen Tubenwulstes des Nasenrachenraumes. Monatschrift Ohren 64:74–77
50. Yates AL (1935) Myxochondroma of the nasopharynx. Proc R Soc Med 29:190
51. Kishore K (1967) Chondroma of naso-pharynx. J Laryngol Otol 81:93–97
52. Rao A (1956) A case of chondroma of the nasopharynx. J Laryngol Otol 70:371–373
53. Ikeda K, Kikuta N, Sasaki Y, Kusakari J, Hozawa K, Kawase T (1987) Extracranial chondroma of the skull base. Arch Otorhinolaryngol 243:424–428
54. Sichel JY, Monteil JP, Elidan J (1994) Skull base chondroma of extracranial origin. Head Neck 16:578–581
55. Handrock M, Roggendorf W, Schüssler U (1980) Zur Differentialdiagnose des chronischen Paukenergusses. HNO 28:19–24
56. Lai CC, Tsay SH, Ho CY (2001) Malignant melanoma of the eustachian tube. J Laryngol Otol 115:567–569
57. Racic G, Kurtovic D, Roje Z, Tomic S, Dogas Z (2004) Primary mucosal melanoma of the eustachian tube. Eur Arch Otorhinolaryngol 261:139–142
58. Baek SJ, Song MH, Lim BJ, Lee WS (2006) Mucosal melanoma arising in the eustachian tube. J Laryngol Otol 120:E17
59. Tywończuk-Szulc M, Kibiłda B (2007) Przypadek czerniaka złośliwego trąbki słuchowej. Otolaryngol Pol 61:335–338
60. Tanaka H, Kohno A, Gomi N, Matsueda K, Mitani H, Kawabata K, Yamamoto N (2008) Malignant mucosal melanoma of the eustachian tube. Radiat Med 26:305–308
61. Yang BT, Wang ZC, Xian JF, Chen QH (2009) MR imaging features of primary mucosal melanoma of the eustachian tube: report of 2 cases. AJNR Am J Neuroradiol 30:431–433
62. Procter PC (1912) Two cases of new growth involving the eustachian tube. Boston Med Surg J 166:96–97
63. Patterson N (1913) Post-nasal tumour. Proc R Soc Med 6:55–56
64. Jacod M (1921) Sur la propagation intracranienne des sarcomes de la trompe d'Eustache: syndrome du carrefour petro-sphenoidal; paralyse des 2, 3, 4, 5 et 6 pairs craniennes. Rev Neurol 28:33–38
65. Jacod M (1936) Reticulosarcoma of the eustachian tube; roentgenography and exeresis by the transmaxillary route of the opposite side with partial resection of the nasal septum. Ann Otolaryngol 6:215–222
66. Charleux MK, Feulliade G, Levy A (1935) Unilateral paralysis of cranial nerves caused by epithelioma of the eustachian tube. Lyon Med J 155:399
67. Schumaker PW (1940) Primary carcinoma of the eustachian tube. Ann Otol Rhinol Laryngol 49:1058
68. Brownell DH (1940) Primary carcinoma of the eustachian tube. Ann Otol Rhinol Laryngol 59:551–555
69. Stewart HL, Lieber MM (1940) Squamous cell carcinoma of the eustachian tube. Arch Pathol 30:518–532
70. Lawson LJ (1943) Primary carcinoma of the Eustachian tube: a study of evidence of its occurrence. In: Mundt GH (ed) Chicago Laryngological and Otological Society. Soc Trans 37(6):890–893
71. Passe ERG (1948) Primary carcinoma of the eustachian tube. J Laryngol Otol 62:314–315
72. Facer GW, Piepgras DG, Weiland LH, Mokri B (1980) Unusual causes of unilateral serous otitis media. Laryngoscope 90:1305–1312
73. Kim YH, Chae SW, Jung HH (2003) Mucoepidermoid carcinoma arising from the eustachian tube and middle ear. J Laryngol Otol 117:202–204
74. Jacod M (1914) Sur les sarcomes de la trompe d'eustache cartilagineuse. Bulletins et mémoires de la société française d'otologie, de laryngologie et de rinologie 30:365–375
75. Lin HC, Friedman M, Kuo FY, Huang HY (2009) Synovial sarcoma of the eustachian tube. Head Neck 31:1245–1248
76. Hildyard VH, Compere WE Jr (1959) Osteoma of the eustachian tube. Laryngoscope 69:1524–1527
77. Hirokawa RH, Scher DA, Yanagisawa E (2001) Unusual cartilaginous lesion of the torus tubarius as a cause of otalgia. Ear Nose Throat J 80:136–137
78. Kirsch CF, Suh JD, Lufkin RB, Canalis RF (2007) False-positive positron-emission tomography-CT of a Teflon granuloma in the parapharyngeal space occurring after treatment for a patulous eustachian tube. AJNR Am J Neuroradiol 28:1371–1372
79. Chrysovergis A, Paschalidis J, Michaels L, Bibas A (2011) Nasopharyngeal cylindrical cell papilloma. J Laryngol Otol 125:86–88
80. April MM, Ward RF, Garelick JM (1998) Diagnosis, management and follow-up of congenital head and neck teratomas. Laryngoscope 108:1398–1401

81. Burns BV, Axon PR, Pahade A (2001) 'Hairy polyp' of the pharynx in association with an ipsilateral branchial sinus: evidence that the 'hairy polyp' is a second branchial arch malformation. J Laryngol Otol 115:145–148
82. Delides A, Sharifi F, Karagianni E, Stasinopoulou A, Helidonis E (2006) Multifocal bigerminal mature teratomas of the head and neck. J Laryngol Otol 120:967–969
83. Ferlito A, Devaney KO (1995) Developmental lesions of the head and neck: terminology and biologic behavior. Ann Otol Rhinol Laryngol 104:913–918
84. Heffner DK, Thompson LD, Schall DG, Anderson V (1996) Pharyngeal dermoids ("hairy polyps") as accessory auricles. Ann Otol Rhinol Laryngol 105:819–824
85. Devaney KO, Rinaldo A, Ferlito A (2005) Teratoma of the middle ear: a real entity or a non-entity? Acta Otolaryngol 125:122–124
86. Medina JE, Ferlito A, Pellitteri PK et al (2003) Current management of mucosal melanoma of the head and neck. J Surg Oncol 83:116–122
87. American Joint Committee on Cancer (AJCC) (2009) Mucosal melanoma of the head and neck. In: Edge SB, Byrd DR, Compton CC, Fritz AG, Greene FL, Trotti A (eds) AJCC cancer staging manual, 7th edn. Springer, New York, pp 97–100
88. Seetharamu N, Ott PA, Pavlick AC (2010) Mucosal melanomas: a case-based review of the literature. Oncologist 15:772–781
89. Wei WI, Kwong DL (2010) Current management strategy of nasopharyngeal carcinoma. Clin Exp Otorhinolaryngol 3:1–12
90. Abbott FC (1901) Case of sarcoma, probably primary, of eustachian tube. Trans Otol Soc UK 2:18–20
91. Di Martino E, Walther LE, Westhofen M (2005) Endoscopic examination of the eustachian tube: a step-by-step approach. Otol Neurotol 26:1112–1117
92. Oshima T, Kikuchi T, Hori Y, Kawase T, Kobayashi T (2008) Magnetic resonance imaging of the eustachian tube cartilage. Acta Otolaryngol 128:510–514