# Patulous Eustachian Tube Accompanied by Internal Carotid Artery Anomalies

Case Report

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**Abstract**

Patulous Eustachian tube is a physical disorder in which the normally closed Eustachian tube remains open intermittently. Internal carotid artery (ICA) anomalies accompanied by Eustachian tube anomalies have been described very rarely in the literature. To the best of our knowledge, the presented case is the second case in the literature. In this report, we present a rare case of ICA anomalies accompanied by a bilateral patulous Eustachian tube in a 51-year-old woman.

**Keywords:** Eustachian tube, internal carotid artery, congenital anomalies, computed tomography, otology, case report

## Introduction

The Eustachian tube (ET) is a delicate anatomical structure that connects the middle ear to the nasopharynx. The ET acts as a pressure equalizer and mucus drainer for the middle ear. Patulous Eustachian tube (PET) is a physical disorder in which the normally closed ET remains open intermittently. Internal carotid artery (ICA) anomalies accompanied by PET have been described very rarely in the literature (1, 2). In the presented case, we describe rare ICA anomalies accompanied by a bilateral PET.

## Case Presentation

A 51-year-old female patient presented with a complaint of progressive hearing loss. It was learned from the patient's history that she had received treatment for ear infections and chronic cough at various times. Recently, she had a complaint of a sound coming from both ears while breathing. The patient had no known disease or operation history. Laboratory findings were within normal limits. On the patient's audiogram, conductive hearing loss was detected. There was a type C tympanometry curve in both ears on the tympanogram. On an otoscopic examination, bilateral dry tympanic membranes were detected. Depending on the patient's complaints, high-resolution temporal bone computed tomography (CT) and contrast-enhanced CT-angiographic (CTA) examinations were performed. High-resolution CT of the temporal bone showed prominent and wide ETs connecting both middle ears and nasopharynx (Figures 1a, b). Bilateral mastoid cell complex aerations were not observed. Soft tissue structures compatible with chronic otitis media were observed in

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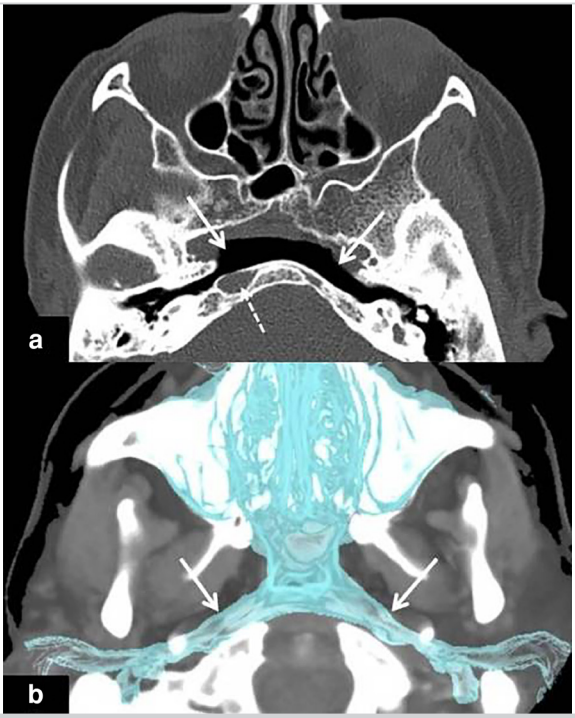


**Figure 1.** a) On the axial unenhanced computed tomography image, both Eustachian tubes are observed to be wider than normal and with a horizontal course (white arrows), and both carotid canals are not observed. In addition, in the clivus localization, a bone defect in which the aberrant internal carotid artery course is noted (dotted white arrow). b) 3D-volume rendering computed tomography fusion image shows patulous Eustachian tubes (white arrows) connecting the nasopharynx and middle ear bilaterally

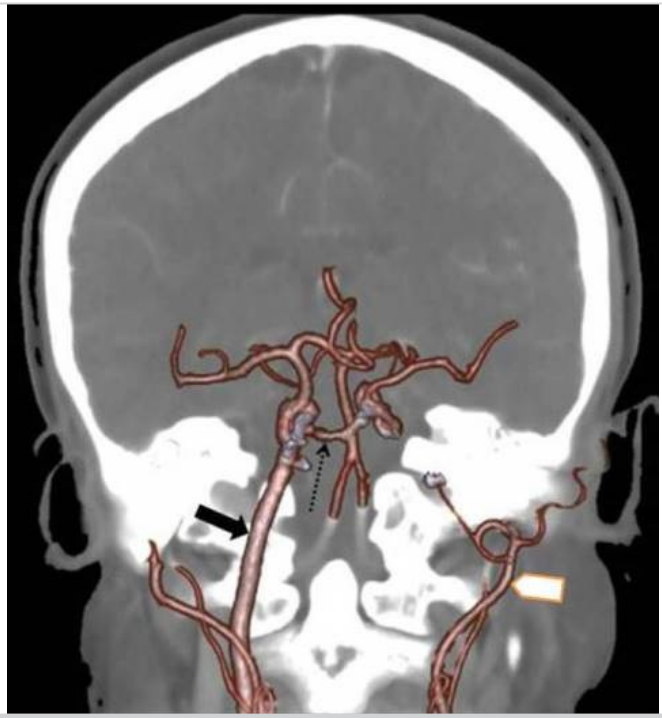

**Figure 2.** On the coronal contrast-enhanced computed tomography-angiographic fusion image, the internal carotid artery on the right is patent (black arrow) and has a tortuous appearance. The internal carotid artery is not observed on the left. The external carotid artery (short white arrow) is seen on the left. Furthermore, the aberrant arterial structure originating from the distal right internal carotid artery and extending to the left (aberrant left internal carotid artery, dotted black arrow) calls attention

bilateral mastoid cells. Both the middle and the inner ear structures were normal. Bilateral carotid channels were not observed. CTA examination revealed that the right ICA was patent. The left ICA was not seen in its normal location. The left ICA continued as a branch emerging from the right ICA at the level of the dorsum sellae and clivus. The right ICA had a tortuous appearance at a distal level. The A1 segment of the left anterior cerebral artery was observed as hypoplasic (Figure 2). No other accompanying vascular pathologies such as aneurysm or dissection were detected on CTA. In light of these findings, the patient was diagnosed with bilateral PET and ICA anomalies. The patient was informed about the present anomalies. Surgical treatment was recommended to the patient, but the patient did not accept surgical treatment. The patient was recommended conservative treatment and advised to gain weight.

An informed consent form was signed by the patient for the publication of this case.

## Discussion

The ETs and the tympanic cavity originate from the first pharyngeal sac. The distal of the first pharyngeal sac forms the primitive tympanic cavity, while the proximal narrows to form the ETs. In case of damage at this stage, the ETs may be enlarged and associated with the tympanic cavity. An abnormal opening of the ET can lead to extreme changes in middle ear pressure and abnormal ossicular movements, resulting in hearing impairment. It may cause recurrent ear infections and chronic otomastoiditis attacks, as in our patient (2-4).

PET was first described by Jago (5) in 1867, not as a defect in embryogenesis, but as acquired in patients with diabetes, extreme weight loss, otitis media, and malignancy. PET can also be seen in patients with Trisomy 13, 18, 21, 22, those with extreme weight loss, those using oral contraceptives, and patients with oculo-auriculo-vertebral spectrum and Klippel-Feil syndrome (1, 3, 4). In 1990, Tolley and Phelps (6) demonstrated the radiological findings of this pathology using CT images.

The incidence of PET varies between 0.3–6.6%. Patients with a PET often complain of autophony. In addition, tinnitus, which is felt in the form of a sound or humming synchronised with breathing, disturbs the patient. Patients' symptoms are relieved in the supine position or when they bring their head to knee level (1, 2, 4). In a recent study, long-term PET has been shown to be associated with sensorineural

hearing loss. The presence of PET causes pressure changes in the cochlea through abnormal ossicular movement in the middle ear, causing sensorineural hearing loss (7). Our case had conductive hearing loss. We think that this situation is due to ET dysfunction.

Our case can be categorized as agenesis according to the classification of developmental anomalies of the ICA. This is more common on the left side. Congenital ICA agenesis is very rare. Most of the cases are detected incidentally during imaging procedures. Three types of collateral networks have been described in patients with ICA agenesis. The most common type is the fetal form, in which the ipsilateral anterior and middle cerebral arteries are supplied respectively by the normal contralateral ICA via the anterior communicating artery and the basilar artery via the ipsilateral dominant posterior communicating artery. The second collateral type is the adult form, in which the contralateral anterior cerebral artery supplies the ipsilateral anterior and middle cerebral arteries of the affected side via the anterior communicating artery. In the third collateral type, blood flow is obtained from the external carotid system, the contralateral ICA, or some primitive vessels (8, 9).

In literature search, we found that Menyatsoe and Khan (10) described a case with PETs and ICA anomalies with imaging findings like our case. To the best of our knowledge, the presented case is the second case in the literature showing similar characteristics.

One study has shown that the ET/ICA/midline angle varies between 37.7° on average (11). The absence of carotid canals and the presence of abnormal ICAs, as in our case, may lead to a more horizontal orientation of the ETs, resulting in a patulous appearance. The relationship between the ET and the ICA is important during endoscopic surgery for the dysfunction of the ET. The distance from the ICA to the ET varies between men and women. ET-ICA distance is shorter in patients with abnormal aberrant ICA (11).

The diagnosis of a PET is usually made based on suggestive symptoms, physical examination, and audiological findings. However, there is currently no diagnostic gold standard method. Various special tests such as tubomanometry, sonotubometry, and tubotympanic aerodynamics have been developed for PET diagnosis; however, these methods do not provide information about the anatomical structure of the ET. Therefore, radiological methods, especially CT, can be used in diagnosing PET. A disadvantage of the standard CT in these cases is that the patient's symptoms usually disappear when lying in supine position. Therefore, there is a tendency to underdiagnose PET on standard CT scanning in the supine position. In the literature, it has been shown that horizontal cone-beam CT is more successful in the diagnosis of PET in terms of showing the long axis, short axis, cross-sectional area, and total volume of the ET lumen. The main disadvantage of horizontal cone-beam CT is that the soft tissue contrast resolution is lower than that of standard CT (12).

In treatment planning, the etiological factors should be eliminated. In conservative treatment, regaining lost weight, changing head position, and nasal irrigation with saline may be recommended. Surgical treatment options can be applied to symptomatic patients (1, 3, 4).

The presented case is a very rare condition. In cases with PET, craniocervical vascular structures, especially ICAs, should be evaluated radiologically in terms of possible variational conditions and accompanying pathologies. This evaluation will guide the surgeon before interventional invasive procedures in this region.

**Informed Consent:** An informed consent form was signed by the patient for the publication of this case.

**Authorship Contributions**

Surgical and Medical Practices: M.A., M.D., Concept: M.A., N.B., M.D., Design: M.A., N.B., M.D., Data Collection and/or Processing: M.A., N.B., M.D., Analysis and/or Interpretation: M.A., N.B., M.D., Literature Search: M.A., N.B., M.D., Writing: M.A., N.B., M.D.

**Conflict of Interest:** There is no conflict of interest to disclose.

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**Main Points**

- Patulous Eustachian tube (PET) is a physical disorder in which the normally closed ET remains open intermittently.
- Internal carotid artery anomalies accompanied by ET anomalies have been described very rarely in the literature.
- In cases with PETs, craniocervical vascular structures should be evaluated radiologically in terms of possible variational conditions and accompanying pathologies.

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