

Otitis media with effusion in adults with patulous Eustachian tube

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Highlight

1. Patients with patulous Eustachian tube (PET) were older, had a shorter duration of disease, and were more likely to develop bilateral otitis media with effusion.
2. Patients with PET were more likely to develop comorbidities of gastroesophageal reflux and allergies.

Abstract

Objective: To study the association between patulous Eustachian tube (PET) and otitis media with effusion (OME) in adults with a history of OME.

Methods: Adult patients with OME (161 adults, 217 ears) were reviewed. Patients with OME were divided into two groups: PET-associated group with a history of PET before onset of OME (29 adults, 45 ears); and non-PET group (132 adults, 172 ears). Comparisons were made between the two groups regarding age, duration of OME, affected side, and type of effusion. Additional comparisons were made regarding the incidence of comorbidities, such as upper respiratory infection, allergies, gastroesophageal reflux, and sniffing.

Results: The incidence of morbidity due to PET in patients with OME (18%, 29/161) was higher than that in the normal population as reported previously (0.01%). Patients in the PET-associated group were older, had a shorter duration of disease, and were more likely to present with OME in bilateral ears than those in the non-PET group. The PET-associated group also showed comorbidities, such as gastroesophageal reflux and allergies.

Conclusions: PET may play an important role in the pathogenesis of adult OME. The prognosis of OME in patients with PET is better than that in those with OME without PET.

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Keywords

Otitis media with effusion (OME), patulous Eustachian tube (PET), comorbidity, gastroesophageal reflux, allergies, upper respiratory infection

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Introduction

Otitis media with effusion (OME) is an accumulation of fluid in the middle ear without acute inflammation or infection.¹ OME may lead to development of adhesive otitis media, tympanic sclerosis, cholesterol granuloma, acquired primary cholesteatoma, and other complications.² The incidence of OME in adults is less prevalent compared with that in children.³ Dilatory dysfunction of the Eustachian tube (ET) plays a major role in the pathogenesis of OME. This dysfunction is the result of inadequate opening or insufficient dilation frequency of the ET required for appropriate aeration of the middle ear.

Patulous Eustachian tube (PET) refers to failure of the ET in maintaining its normal closure state. This results in a chronic dilatory state and permits reflux of sounds and material from the nasopharynx towards the middle ear.⁴ Recent evidence has suggested that PET is also associated with OME. Children with persistent OME have a higher incidence of closure failure of the ET with subsequent evacuation of the middle ear during sniffing, and limited ability to equalize negative pressure compared with children with healthy ears.² Ryding et al.⁵ demonstrated that 13% of young adults with long-standing OME who presented with PET developed this condition as a secondary complication. However, there are several limitations regarding previous studies conducted on OME, including no clinically effective test that can access ET function.^{6,7} Furthermore, whether PET is a cause of OME or whether patients with

OME subsequently develop PET is unknown. The symptoms of patients with PET are usually chronic and progressive. Ward et al.⁸ showed that the mean duration of PET was longer than 5.8 years, while the majority of OME episodes were resolved spontaneously within 3 months.⁹ The diagnostic criteria for PET have now been published and include symptoms, subjective changes in tubal obstruction procedure, and objective findings with regard to research conducted on delayed closure of the ET.¹⁰ In the presence of diffuse symptoms, patients with OME and PET can be distinguished by examination of the tympanic membrane (TM) with medial and lateral excursions during nasal breathing or by tympanometry testing. Therefore, studying the association between the incidence of OME in adults with PET, which is chronic and progressive, is feasible.

In the present study, we report patients with OME with a definite history of PTE and patients with OME without PET. The comorbidities and characteristics of the two groups of these patients were compared.

Materials and methods

Retrospective data of adult patients with OME who visited our clinical center were collected between October 2013 and January 2018. The diagnostic criteria for OME were as follows: type B tympanogram, opacification and/or the presence of an air-fluid level behind the TM as determined by endoscopy or otoscopy,¹¹ main complaints of ear fullness, and hearing

loss with or without tinnitus. The exclusion criteria included the following diseases: nasopharyngeal carcinoma, cleft palate, Down's syndrome, cholesteatoma, and adhesive otitis media.

Patients with PET were identified according to the following criteria: autophony, audible breath sounds, and ear fullness relieved by measures known to cause the ET, such as posture change to the supine/lordotic position and application of pressure to the neck. The diagnosis of PET was definitive when breathing was observed with endoscopy or otoscopy. Patients with the presence of diseases, such as superior semicircular canal dehiscence syndrome, perilymphatic fistula, and acute low-tone sensorineural hearing loss, were excluded.

According to the diagnostic criteria, patients with OME were divided into the two following groups: the PET-associated group with a medical history of PET before development of OME (45 ears in 29 patients); and the non-PET group (172 ears in 132 patients). All patients in the two groups received conservative treatment to accelerate mucosal drainage and were subsequently subjected to puncture of the TM. Specimens of middle ear effusion were obtained by aspiration of fine needles. Certain patients underwent ET exercise with the Valsalva maneuver.

Comparisons of age, duration of OME, affected side, and types of effusion (serous or mucoid) were made between the PET-associated group and the non-PET group. Additionally, according to the patient's medical records, comorbidities, such as upper respiratory infection (URI), allergies, gastroesophageal reflux, and frequency of sniffing, were compared between the two groups.

The data were analyzed with IBM SPSS 24.0 (IBM Corp., Armonk, NY, USA). Statistical analysis of the results was performed using the t-test and χ^2 test. A p value less than 0.05 was considered statistically significant.

The study received ethical approval by the ethics committee of the Affiliated Hospital of Qingdao University. Informed consent was obtained from all participants before initiation of the study.

Results

Clinical manifestations of PET-associated OME and non-PET associated OME

A total of 161 adult patients with OME (217 ears) were studied. The demographics of the PET-associated and non-PET groups are shown in Table 1. The mean age of patients in the PET-associated group was

Table 1. Characteristics of the PET-associated group and non-PET group.

Characteristics	PET-associated group	Non-PET group	t value	χ^2 value	p value
Age (years)	51.42 ± 14.27	38.49 ± 21.70	3.064		<0.01
Duration of OME (days)	13.37 ± 7.92	31.53 ± 11.48	8.096		<0.001
Sex (male/total)	14/29 (48.28%)	70/132 (53.03%)		0.215	0.643
Sides (bilateral/total)	16/29 (55.17%)	40/132 (30.30%)		6.483	0.011
Type of effusion (mucous/total)	3/29 (10.34%)	53/132 (40.15%)		9.312	0.002

Values are mean ± standard deviation or n (%).

PET: patulous Eustachian tube; OME: otitis media with effusion.

significantly older than that in the non-PET group (t-test, $p < 0.01$). The duration of OME in the non-PET group was significantly longer than that of the non-PET group (t-test, $P < 0.001$). There was no significant difference in sex between the PET-associated and non-PET groups (χ^2 test). The bilateral occurrence of OME in the PET-associated group was higher than that of the non-PET group (χ^2 test, $p = 0.011$). Mucous secretion was significantly more common in the non-PET group than in the PET-associated group (χ^2 test, $p = 0.002$), while serous secretion was more common in the PET-associated group.

Comorbidities of the PET-associated and non-PET groups

Comorbidities of the PET-associated group and the non-PET group are shown in Table 2. Sniffing occurred significantly more often in the PET-associated group than in the non-PET group (χ^2 test, $p < 0.001$). The rates of comorbidities of allergies and gastroesophageal reflux were significantly higher in the PET-associated group than in the non-PET group (χ^2 test, both $p < 0.05$). However, there was no significant difference in the comorbidity of URI between the two groups.

Discussion

The ET is a complex anatomical structure that connects the middle ear to the nasopharynx. The ET usually dilates during swallowing or yawning with contraction of the tensor veli palatini, which is the most important muscle in the cartilaginous portion of the ET that can open the ET.¹² The functions of the ET are as follows: 1) pressure equalization and ventilation of the middle ear; 2) mucosal clearance of secretions from the middle ear; and 3) protection of the middle ear from noise, and from pathogens and secretions in the nasopharynx.^{2,13} The tensor veli palatini muscle is the dilator of the ET, and its muscular over-activation predisposes people to PET.⁸ According to a previous study, the morbidity of PET was estimated as 0.01% in the normal population.¹⁴ In the present study, the incidence of morbidity due to PET in patients with OME was 18% (29/161), which is higher than that previously found in the normal population.

The ET acts by maintaining pressure equalization and ventilation of the middle ear. Dilatory ET dysfunction may be due to negative pressure in the middle ear cleft.¹⁵ Although the etiology of OME is believed to be multifactorial, ET dysfunction is thought to be one of the most important reasons responsible for development of

Table 2. Comorbidities of OME with PET or without PET.

Comorbidities(%)	PET-associated group (n=29)	Non-PET group (n=132)	χ^2 value	p value
Sniffing	14 (48.28%)	11 (8.33%)	28.919	<0.001
URI	9 (31.03%)	40 (30.30%)	0.006	0.938
Allergies	13 (44.83%)	27 (20.45%)	7.564	0.006
Gastroesophageal reflux	11 (37.93%)	26 (19.70%)	4.466	0.035

PET: patulous Eustachian tube; OME: otitis media with effusion; URI: upper respiratory infection.

Patients with allergies were diagnosed with allergic rhinitis with the Score for Allergic Rhinitis scale and intradermal skin testing.

Patients were diagnosed with gastroesophageal reflux if they had accumulated a score of 8 or more in the Gastroesophageal Reflux Disease Questionnaire scale.

this disease. Dilatory ET dysfunction has been characterized as an important factor in the pathogenesis of OME.^{16,17} Iwano et al.¹⁶ studied ET function in adults with OME using the tubotympano-aerodynamic method, the pressure equilibration test and the inflation-deflation method. These authors showed impairment of active opening function in adult patients with OME.

Negative pressure in the middle ear is considered a major contributing factor in development of OME. Patients with PET-associated OME may have an increased incidence of dilatory dysfunction of the ET and/or negative pressure in the middle ear. In the present study, extreme retraction of the TM was observed during endoscopy or otoscopy in PET-associated OME, which suggested the presence of negative pressure in the middle ear of these patients. However, this finding could not explain whether negative pressure is the reason or the consequence of OME. Cinamon¹⁷ constructed a plastic model of the middle ear and ET to examine its passive and dynamic properties. This author found that ET obstruction via middle ear fluid may cause negative pressure in the middle ear, even in the setting of an otherwise normally functioning ET.

The function of ET during the occurrence of OME with PET is complicated. Patients with PET may develop episodes of dilatory dysfunction of the ET, resulting in OME. A previous study examined the short-term and long-term variability of tubal opening and closing functions in children with OME.⁷ The authors from this previous study concluded that ET opening and closing functions were highly variable in cases of OME, whereas the tubal function test alone showed little value when used as a prognostic tool for individual ears.⁶ A total of 30% of PET cases have retraction of the TM, tympanosclerosis, or even middle ear effusion. Ward et al.⁸ demonstrated that pre-existing dilatory

dysfunction and/or the incidence of chronic middle ear disease were present before development of PET.

Dilatory dysfunction of the ET presents temporarily, while PET is a chronic status. Patients with PET can experience both patulous and dilatory dysfunction of the ET.¹⁸ Ikeda et al.¹⁹ found that the ET may show diverse functions in patients with OME. These authors reported three patients with trigeminal nerve injury during neurosurgical removal of intracranial tumors who initially developed transient OME within a few months following surgery and subsequently developed PET. They speculated that trigeminal nerve damage may alter ET function by two mechanisms as follows. Initially, OME is responsible for impairment of ET opening function, and subsequently, PET results in insufficiency of closure. Therefore, during OME in patients with primary PET, induction of inflammation in the ET or middle ear may temporarily alter the status of PET to cause dilatory ET dysfunction. The present study supports these findings. We observed that following episodes of OME, the symptoms of PET returned in all patients, suggesting that PET was a chronic condition.

Ward et al.⁸ showed that PET often appeared in bilateral ears. In the present study, the incidence of bilateral OME in PET-associated OME was more common than that in non-PET-associated OME. Our study suggested that PET may lead to formation of OME. Patients with OME and PET showed a shorter duration of OME and lower incidence of mucous effusion than did those without PET. These findings indicate that PET-associated OME may be mild or moderate compared with non-PET-associated OME. For patients with PET, an open ET can aid in drainage of effusion and equalization of pressure in the middle ear.²⁰ This condition is required for patients with PET.

The most common cause of OME in adults is acute or chronic URI. URI can result in the temporary incidence of dilatory dysfunction of the ET. In the present study, 31.03% of patients with PET-associated OME and 30.30% of those with non-PET-associated OME showed URI, with no significant difference in rate between the two groups. These data suggest that infection in the ET or middle ear can be a common cause of OME in adults.

The frequency of sniffing is another important factor required for negative pressure in the middle ears of patients with PET. Certain patients with PET show negative pressure in their nasopharynx, which results in temporary closure of the ET and relief of symptoms, such as autophony. Subsequently, negative pressure in the middle ear cavity is generated.²¹ Habitual sniffing and negative pressure in the middle ear contribute to development of retraction-type middle ear diseases, such as cholesteatomas and adhesive otitis media.²² Falk and Magnuson²³ examined closing failure of the ET in children with OME by direct pressure recording in the nose and in the ears following grommet insertion. These authors demonstrated that the ET was closed in the majority of cases and suggested that sniff-induced negative pressure was directly involved in development of OME. Yaginuma et al.²⁴ further suggested that, in several patients, sniffing, which was provoked by nasal diseases (not caused by PET), played an important role in the pathogenesis of OME by generation of negative nasopharyngeal pressure. This mechanism of action accounts for approximately 10% of pediatric patients with OME. In the present study, sniffing was more frequently observed in patients in the PET-associated group than in those in the non-PET group. The findings suggested that habitual sniffing played an important role in PET-associated OME.

Gastroesophageal reflux and allergies contribute to OME in adults. Sone et al.²⁵ showed that gastroesophageal reflux symptoms were more frequent in adults with idiopathic OME than in those without OME. These authors further demonstrated high levels of pepsinogen in their middle ear effusions and positive reflux symptom index scores in a high number of patients with OME.²⁶ In a study conducted by Hurst,²⁷ patients with OME and chronic draining perforations or tubes were evaluated for the incidence of allergies by intradermal skin testing. All of their patients were atopic. Immunotherapy provided complete resolution of effusion or drainage in 85% of all dysfunctional ears. Allergy-associated cytokines have been proposed to act as the major regulators of middle ear inflammation of chronic OME.²⁸ The present study further showed that gastroesophageal reflux and allergies occurred more often in PET-associated OME than in non-PET-associated OME. We speculate that unlike dilatory dysfunction of the ET, development of PET does not result in OME directly. Adults with PET are susceptible to OME because of their inability to protect the middle ear against inflammation and infection by viruses, bacteria, gastroesophageal reflux, and allergies.

The present study also demonstrated that patients in the PET-associated group were older than those in the non-PET group. This finding suggests that muscle atrophy is more likely to occur in older people. Moreover, younger patients with PET are more sensitive to emerging symptoms of OME that are usually concealed by PET in older patients with OME. In the present study, gastroesophageal reflux, allergies, and URI were found in the PET-associated and non-PET groups. The prevalence of gastroesophageal reflux and allergies in the PET-associated group was higher than that in the non-PET group.

The present study has some limitations. Our results did not exclude the possibility of gastroesophageal reflux, allergies, and URI as incentive factors in the development of PET. Ward et al.⁸ showed a high prevalence of the following symptoms in patients with PET: environmental allergy, laryngopharyngeal reflux, stress, and anxiety. Patients with allergies or stress and anxiety were more likely to present with tonic contraction of their tensor veli palatini muscle as determined by nasopharyngoscopy. To investigate the associations among these factors and between PET and OME, further studies are necessary to compare the different prevalence of allergies and gastroesophageal reflux in patients with OME with or without PET. This investigation is particularly difficult because specific symptoms of OME tend to be concealed by those of PET. Therefore, the diagnosis of PET in patients with OME is not readily distinguished.

Because of the low prevalence and obscure symptoms in patients with OME and PET, OME can be incorrectly identified as being caused by ET dilatory dysfunction. In the present study, auto-inflation of the ears, such as the Valsalva maneuver, appeared to be helpful for recovery of OME in the absence of PET. A recent study indicated that surgical interventions, such as balloon dilation Eustachian tuboplasty²⁹ and laser tuboplasty,³⁰ were performed for dilatory dysfunction of the ET. In Ward et al.'s study,⁸ PET was observed immediately after balloon dilation of the ET. However, if a patient with OME and PET is misdiagnosed with dilatory dysfunction of the ET, interventions may aggravate PET. As a result, accurate diagnosis of the type of ET dysfunction is crucial for appropriate treatment for patients with OME.

In conclusion, PET is associated with morbidity and development of adult OME. PET plays an important role in abnormal dilation of the ET, which permits reverse infection of viruses or bacteria, or

reflux of gastric acid and allergy-associated cytokines. Morbidity of PET in patients with OME is higher than that in the normal population. Patients with PET-associated OME recover earlier than those with OME without PET.

Data availability

The data used to support the findings of the present study are available from the tables.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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