

PREVALENCE OF TRAUMATIC TYMPANIC MEMBRANE PERFORATION IN PATIENTS WITH A PATULOUS EUSTACHIAN TUBE

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ABSTRACT

Background: With respect to physical relations in force and pressure, we hypothesized that the prevalence of traumatic tympanic membrane perforation in patients with a patulous Eustachian tube is greater than normal, because in Eustachian tube patency, the internal air pressure of the middle ear will not increase after compression, subsequent to trauma. Therefore the force upon the tympanic membrane may cause it to perforate easier.

Methods: In this study we evaluated 45 patients with traumatic tympanic membrane perforation. After otoscopy, modified inflation-deflation test was performed to determine the opening, closing, and residual pressure of the Eustachian tube.

Results: Approximately 60 percent had a patulous Eustachian tube, 27% had poor Eustachian tube function and 13% had normal Eustachian tube function.

Conclusion: It appears that patients with a patulous Eustachian tube are probably at high risk for traumatic tympanic membrane perforation.

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Keywords: Patulous Eustachian Tube, Traumatic Tympanic Membrane Perforation.

INTRODUCTION

Since the Eustachian tube bellows are usually collapsed and open only on swallowing or yawing, some people have an Eustachian tube that seems permanently open and in the extreme form of this abnormality (the hyper-patent Eustachian tube) is open even at rest.¹ Various inflammatory mediators are capable of affecting the tube patency.² The percentage of people with a permanently open Eustachian tube is not known, but has been estimated at about 0.5 percent of the entire population.¹ Based on physical rules, we hypothesized that patients with a patulous Eustachian tube are highly at risk for traumatic tympanic membrane (TM) perforation in comparison with normal persons. Trauma acts as a strong force that tends to push a column of air through the ear

canal, and compresses the middle ear space. Therefore, the air molecules in the middle ear are forced into a smaller volume and increase the inside pressure of the middle ear. This at once reminds us of Boyle's law ($P_1 V_1 = P_2 V_2$), where P_1 and V_1 are the pressure and volume, respectively, in one case, and P_2 and V_2 are the values in another.³ On the basis of the relation $F = (P_2 - P_1)A$, where F is the total force (against TM), A is the area of TM which is involved, and the resultant value of P_2 and P_1 is the pressure acting on a surface (TM), where P_2 is the air pressure in the external auditory canal and P_1 is middle ear pressure during trauma.

Increased middle ear pressure (P_1) subsequent to a trauma reduces the resultant P_2 and P_1 ($P_2 - P_1$) and also reduces the force upon the TM in normal cases. Therefore their tympanic membrane will not be perforated as easy as patients with a patent Eustachian tube. In these patients, after trauma, the middle ear pressure will not

increase and also the force against the TM will not decrease because of the fact that this abnormality permits air to flow readily from the ear into the nasopharynx and connect it to the atmosphere. The purpose of the present study is to demonstrate this theory with clinical experience.

PATIENTS AND METHODS

In this study, data were collected from 15 patients (during a period of 7 months in the year 2001) and 30 patients (during May-July, 2005) with traumatic tympanic membrane perforation in Audiology and ENT Clinics of Shahid Beheshti Medical Sciences University Hospitals (Loghman and Taleghani). After taking an otologic history for each case and otoscopy, the Eustachian tube function test was perforated. Since our patients had a nonintact tympanic membrane, we used the pump manometer system of the electroacoustic impedance bridge (AZ7) to perform the modified inflation-deflation Eustachian tube function (ETF) test,^{4,5} in order to assess passive and active functioning of the Eustachian tube and determine its opening pressure (OP), closing pressure (CP), and residual pressure.^{6,7} The mean opening pressure for apparently normal subjects with a traumatic perforation and negative otologic history is 330 mm H₂O (+70mm H₂O). A very low opening pressure (e.g., less than 100mm H₂O) would indicate a semi-patulous Eustachian tube.⁸ Inability to maintain even a modest positive pressure within the middle ear would be consistent with a

patulous tube. Complete equilibrium of applied negative pressure by swallowing is usually associated with normal function, but partial equilibrium or even failure to reduce any applied negative pressure may or may not be considered abnormal,⁹ because all swallowing does not necessarily open the Eustachian tube.¹⁰ However we considered the latter condition as a poor ETF.

RESULTS

The percentage of otologic signs including tinnitus, vertigo, hearing loss, otalgia, and effusion for all patients are summarized in Table I.

In the first 15 patients, tinnitus found in 8, vertigo in 7, hearing loss in 13, otalgia in 4 and effusion in three of 15 cases. In the 2 patients who didn't show any hearing loss, the TM had a pinhole perforation. In abnormal patency of the Eustachian tube usually the middle ear remains well ventilated; however, unwanted nasopharyngeal secretions can also traverse the tube, and is probably the most important cause for the presence of effusion in 3 of 15 patients. Modified inflation-deflation test was performed for all 45 patients. The test showed that 12 patients had poor ETF with mean opening pressure of ~350 dapa, closing pressure ~200 dapa and residual pressure ~100 dapa, 6 patients had normal ETF, and 27 patients had a patulous Eustachian tube. The percentage of these three conditions in patients with traumatic TM perforation is shown in Figure 1.

Table I. Percentage of otologic symptoms in patients with traumatic TM perforation (the first 15 patients).

Otologic symptom	Tinnitus	Vertigo	Hearing loss	Otalgia	Effusion
Percentage	53%	46%	80%	26%	20%

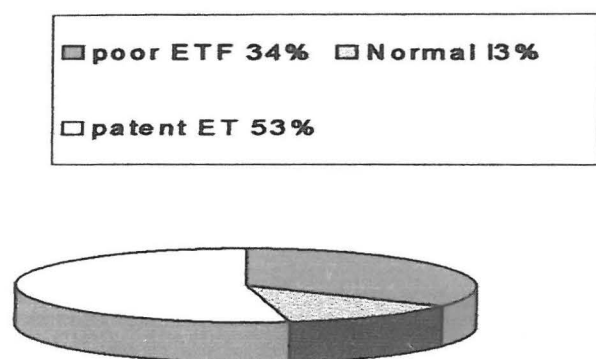


Fig. 1. Percentage of normal, poor and patent Eustachian tube function in 45 patients with traumatic TM perforation.

DISCUSSION

The disorder of hyper-patent Eustachian tube is often unrecognized or misdiagnosed, because of the ambiguous symptom of a 'plugged ear'. But when the patient also complains of autophony and hearing amphoric sounds, a patulous tube should be suspected.¹¹ Most of the Eustachian tubes with sniff-induced otitis media seem to have excessive patency and poor active opening ability, but may not be hyper-compliant or floppy.¹² The patulous or non-closing form is present in 7 percent of all adults.¹³

With respect to physical relations and clinical experiments in this research, it seems that the prevalence of

traumatic TM perforation in patients with a patulous Eustachian tube is probably more than in normal subjects. In addition, according to this fact that the passive Eustachian tube opening pressure of young children is much lower than that of adults, it is probable that young children may be at high risk of traumatic TM perforation in comparison with adults. Mink (1992) reported that pressure changes in the external auditory canal of patients with a patulous Eustachian tube are about one order greater than in normal cases that are able to keep their Eustachian tube open for a prolonged period of time. This occurrence might be caused either by relaxation of the fibers of the TM or by different degrees of opening of the Eustachian tube.^{14,15} Based on the results, probably the other cause of the high prevalence of traumatic TM perforation in patients with a patulous Eustachian tube is due to TM structural changes.

A patulous Eustachian tube is now claimed for prolonged negative pressure in the middle ear that is caused by a sniffing habit.¹⁶ On the basis of the relation $F = (P_2 - P_1)A$, negative middle ear pressure subsequent to sniffing increases the resultant P_2 and P_1 , ($P_2 - P_1$), therefore the force upon the TM after trauma will perforate it more easily than normal cases.

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