

## Review Article

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# Permanent eustachian tube dysfunction in cabin crew member: Case report and narrative review

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## Introduction

The Eustachian Tube (ET) is a little structure that permits the communication between nose and middle ear. The ET has a series of functions: pressure equalization and middle ear ventilation, mucociliary clearance and protection from nasopharyngeal reflux and pathogens [1]. Pressure in the middle ear is maintained by the passive and active opening of the ET. When pressure changes, for instance, such as when going to the mountains or diving, we can learn different method to actively open the ET [1,2]. In order to define correctly the Eustachian tube dysfunction, we should refer to failure of the ET to perform any function, but, in truth, we refer to ventilation [2]. The ventilatory dysregulation is defining by clear sign and symptoms including aural fullness and/or abnormal tympanometry [4]. We can divide ETD in 3 subtypes: dilatatory, barochallenge and patulous [5,6]. Patients with Eustachian tube barochallenge (BCETD) show symptoms only when confronted with changes in atmospheric pressure, such as otalgia and/or sense of aural fullness, but also vertigo, acufene or facial palsy, therefore rarely. BCETD is very difficult to diagnose because patient could show normal otoscopic exam at ambient pressure [7]. Therefore we have to consider both the anamnesis and the history of the patient.

## Abstract

Herein we review the current literature on Eustachian Tubal dysfunction (ETD) in patient submitted to different and rapid pressure change. Our review shows that there no data about this kind of pathology in cabin crew member, there only few data for divers. We report a case of a young cabin crew member who developed a permanent ETD after COVID infection and numerous and various therapies. We think that it would be important to introduce other kind of test to evaluate these people before their return to flight in order to reduce the risk of relapse, such as the "seven step test".

There is no agreement on the usefulness of scoring measures, for instance the Eustachian tube dysfunction Questionnaire (ETDQ-7), which some scientist uses to evaluate the symptoms. Nowadays the best therapy is myringotomy with tube placement, but it is inconvenient for aviators and divers who rely on consistent tube patency and who could show tube otorrhea when they are on the ground [8,9]. Here follows a review of the current literature on the different kind of ET dysfunction and, in detail, we focus on BCETD in cabin crew members [11].

## Materials and methods

A review of the relevant international literature has been carried out using the Medline<sup>®</sup> and Embase<sup>®</sup> databases with the following search term: "Eustachian Tube" [All Fields] and ("Dysfunction" [MeSH Terms] or "failure" [MeSH Terms]). Subsequently another search was performed using: (("Eustachian tube" [Title/Abstract] and "airmen" [Title/Abstract] or "pilot" [Title/Abstract]) or "cabin crew" [Title/Abstract]) and ("dysfunction" [Title/Abstract] or "otitis" [Title/Abstract])). References of retrieved articles were scrutinised for additional articles. Articles and book chapters published in English and French were included. Abstracts of all articles and book chapters were screened and selected according to relevance, followed by full reading of the papers.

Furthermore, a literature review for Eustachian Tube Evaluation and treatment was also performed.

### Case report

S. is a cabin crew member in her 40ies, who was flying for about 10 years. About 3 years ago, she had the first episode of barotraumatic otitis media with otalgia and auricular fullness. So, she consulted a specialist to examine her ears and performed several tympanograms, which were type C, that indicates an air depression of the tympanic cavity due to a dysfunction of the ET. After a few months and different kind of therapy, including thermal and cortisone therapy, the tympanogram was, finally, type A and she returned to fly without compensation problem in her ears.

After about 1 year she contracted SARS-COV-19 infection, although she had already been vaccinated. The infection was as a simple upper respiratory tract infection, for which she remains at rest from flight for about 10 days. When healed, she started to fly, but she showed symptoms as barotraumatic otitis again (Figures 1 and 2).

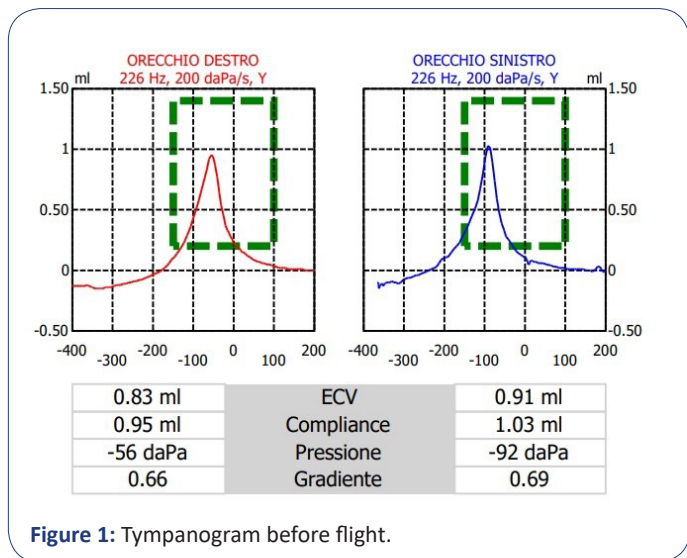


Figure 1: Tympanogram before flight.

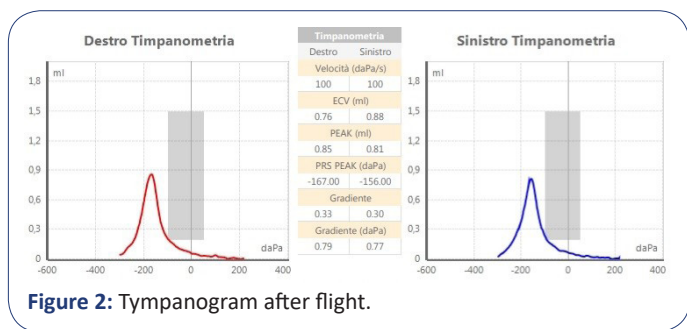


Figure 2: Tympanogram after flight.

She reported otalgia and auricular fullness, the ENT specialist diagnosed an otitis media with ears drums retracted and type C tympanogram. Therefore she had thermal treatments, tubal ventilation therapy with Otovent© and with insufflations of salsobromiodic vapors in order to resume flying, but every time she flied symptoms appeared again. Every time she flew, in the last two years, she experienced the same symptomatological and impedance measurement situation. For the purposes of excluding any other possible cause of tubal dysfunction, she also had a gnathological evaluation that excluded pathologies

concerning the temporomandibular joint, that could affect the opening of the tubes. Besides, she also had an endoscopic evaluation which excluded pathologies affecting the nasal cavities that could prevent correct tubal ventilation. Each further exam was perfect, so we could exclude any other pathologies that could explain her auricular symptoms. Luckily, she had no vertigo problems, but only audiological symptoms as ETD manifestation except for hearing loss (Figure 3).

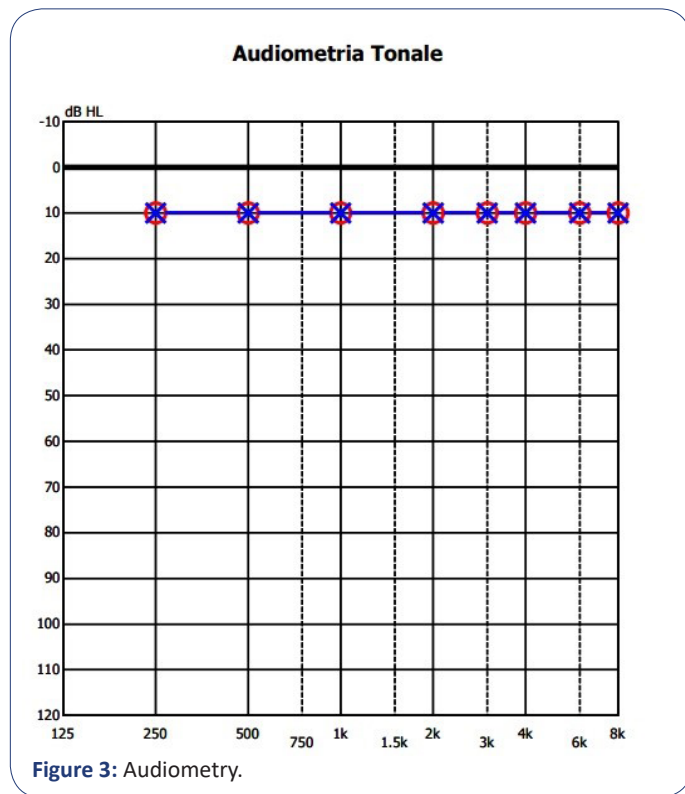


Figure 3: Audiometry.

Finally, in the last year she took a freediving course to learn new tympanic decompression techniques to implement her skill in Valsalva Manoeuvre.

In addition to the tympanograms, on the last flight, she also filled out the ETDS-7 questionnaire pre, during and post flight, that indicated an ET dysfunction with a mean score of 6.5 during the flight and 5 after flight.

Nowadays, S. is no longer fit to fly because she has developed a chronic Eustachian tubal dysfunction (ETD) which does not allow her to compensate in a constantly way (Figure 4).

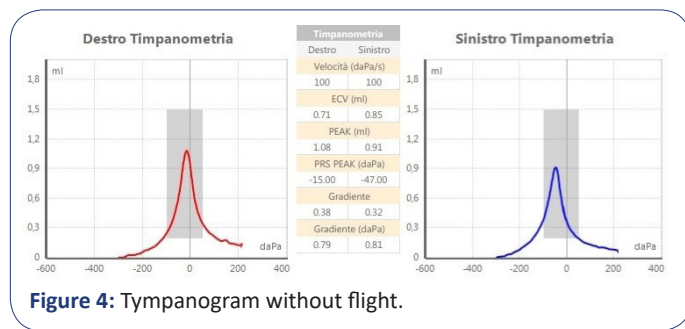


Figure 4: Tympanogram without flight.

In fact the ETD symptoms disappear only after about 4 days since the last flight. She has not developed hearing loss, vertigo or colesteatoma, but she usually experience fullness also in little pressure variation such as in high-speed train, for instance.

**Baro-challenged eustachian tube dysfunction:** The Baro-challenged Eustachian Tube Dysfunction (BCETD) is typically based on a circumstance in which sudden changes in atmospheric pressure can cause a dysfunction of Eustachian Tube [11]. The stress imposed on the mucosal surfaces of the Eustachian tube by repetitive equalization maneuvers from the increased or decreased atmospheric pressure leads to localized inflammation and mucosal edema [12].

Occurrence is greater in children, but approximately 1% of the adult population is diagnosed with ETD, even if there is no data about the prevalence of BCETD and of BCETD in plane crew members [13]. Some risk factors may be cleft palate disorders, Kartagener syndrome, rhinosinusitis, gastro-oesophageal reflux disease, smoke and each pathology that could damage mucociliary clearance or cause mucosal inflammation. This inflammation affects the ability for subsequent attempts at opening and clearance [4,5-14].

Specifically, deep-sea diver or high altitudes workers, such as plane cabin crew members, are generally people who can experience baro-challenge-induced ETD [13,14]. The evaluation should include otoscopy, tympanogram, nasopharyngeal endoscopy, audiological tests. ETD questionnaire (ETDQ-7) should be administered in order to estimate the subjective symptoms. It consists of 7 separate questions, scoring between 1 (no problem) and 7 (severe problem). An average overall score of more than 2.0 indicates the presence of ETD [15].

Usually, the BCETD does not have a typical otoscopic examination, mostly in children, but a major episode can cause ear effusion and hemotympanum. Besides, possible complications include glue ear (otitis media with effusion), eardrum retraction (atelectasis of the middle ear), and chronic otitis media, coalescentoma too [16].

The treatment is, obviously, connected to the cause of the dysfunction, we can distinguish treatment in acute situation and in chronic situation. Acute ET is treated with applying oral or topical decongestants in order to reduce mucosal edema and local tissue hyperemia, improving Eustachian tube patency. The most common medications are oral corticosteroid and local both in nose, to reach the nasopharynx, and on the ear drum. Instead, in chronic situation, where there is no certain cause, the use of auto-inflation devices for reopening the Eustachian tube by raising the pressure in the nose has shown favorable results for correcting middle ear pressure and fluid clearance. Another therapy is the tympanostomy with tube insertion or the tube balloon dilatation [8-10].

## Discussion

To date, in civil aviation only pilots assigned to people or goods transportation are subject to impedance testing to evaluate tubal function [17]. On the other hand, in the military field all personnel belonging to the flight crew are subject to all the checks before they allowed to start their flying activity and during all their working life. In the civil sphere, European legislation states that further checks for cabin crew members and amateur pilots are arranged only in case of a previous pathology or ear block self-assessment [17]. But we have to consider that a self-evaluation could lead to misdiagnosis because the tube dysfunction is a typical reason for disqualification from flight for them.

The moments of greatest pressure variations inside the middle ear with the need to open the Eustachian tube are landing

and take-off, in which all the people present on the aircraft are forced to implement compensation procedures to balance pressure, a mechanism that does not occur always automatically [18]. During take-off the pressure in the cabin is reduced and it cause a bulge outward of the tympanic membrane, the air trapped in the middle ear forcefully opens the ET balancing the pressure; equally on landing the air inside the middle ear is reduced in volume causing an inward bulge of the tympanic membrane [18,19]. These variations in the position of the tympanic membrane are perceived as painful by the patient who reports hearing loss, autophony and auricular fullness. In the event that it is not possible to rebalance the pressure in the middle ear, it is possible that a barotrauma would develop, the manifestation of which can range from otalgia to perforation, vertigo, otorrhagia [20]. In some people who are more ET trained this mechanism may be simpler and more spontaneous, so a swallow can suffice. For others, instead, it is necessary to perform the Valsalva Maneuver or wait for landing for a spontaneous normalization of blood pressure to occur. In the light of these characteristics, it is essential to diagnose ETD in the cabin crew members as, compared to a standard passenger, a person flight crew is subject to multiple landings/takeoffs during the same day (they can have as much as 4 landings and 4 take-offs) and, sometimes, they do not have a recovery day between one working day and another. The problem in civil aviation lies precisely in self-diagnosis since a pilot or cabin crew with ear blocks is declared unfit to fly until resolved: then the patient may be induced to lie and overlook the first signs of an ETD. Nowadays, there are no studies regarding ETD prevalence in air pilots or other cabin crew members.

A study about 42 military aviators says that is very difficult to obtain a precise estimation of ETD in Aviators, because that none evaluation of ET function can be performed during the dynamic changes of atmospheric pressure occurring during the flight [21]. Therefore, to assert that an ETD is present and to evaluate the probability of barotitis during flight, the dynamic function of ET patency should be tested with specific tests during simulated flights as in a pressure chamber [22,23]. A study of 335 military pilots carried out to evaluate the Eustachian Tube functionality in hypobaric chamber has shown that some of them had barotitis even if their otoscopic evaluation and tympanogram were normal [24]. This situation could be related to a very slight obstruction of the tube lumen due to focal inflammation not detectable by either otoscopy or tympanometry. Another study on divers shows that a nine-step inflation/deflation test has a high accuracy as a predictor of middle ear barotrauma [25].

## Conclusions

Herein we present a case of tubal deficit in a patient constantly exposed to rapid pressure variations at least 8 times a day in a theoretically controlled pressure environment. A narrative review of the literature does not currently report studies about this kind of continuous and repeated pressure stimulation. Therefore, it is our opinion that further studies should be conducted to define if there is a maximum daily activity threshold or if it is necessary to insert a specific post-tubal retraining after an acute deficit, such as infectious otitis, upper respiratory tract infection, etc. Furthermore, this case suggests that, probably, it is not enough to perform a pre-flight tympanogram to define the restoration of tubal activity, perhaps we should evaluate about inserting tubomanometry or nine-step inflation/deflation test as a flight test at least for people who have had functionality problems.

## Declarations

**Conflict of interest statement:** The authors declare no conflict of interest.

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