

## AEROTITIS MEDIA

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**Abstract:** *Aerotitis media (otitic barotrauma, barotitis) is an acute or chronic pathological condition caused by the pressure difference between the ambient air and that of the middle ear. It is the most common otitic disorder among flying personnel today. Under normal conditions this equilibrium is dependent on Eustachian tube function. During ascent, the air expand in all facial structures including the middle ear. Because of excessive pressure on the tympanic cavity, middle ear pressure equalizes and the tympanic membrane snaps or "clicks" into its normal position. During descent from altitude, when the atmospheric pressure increases, a totally different effect is produced. At the moment, Eustachian tube dysfunction (ETD) do not have a consensual treatment. The peculiarities of anatomy and physiology of this structure can be the cause. This paper shows the history of medical efforts in aerotitis, with the corresponding moments of success or disappointment.*

**Key Words:** *Aerotitis media, Surgery, ENT.*

### 1. INTRODUCTION

Various symptoms and disease states have been attributed to abnormal obstruction of the ET, also called ET dysfunction (ETD), including aural fullness, tinnitus, serous otitis media, tympanic membrane retraction, and cholesteatoma.

The effective treatment of these common disorders has challenged otolaryngologists for centuries, and continues to consume substantial resources. Recent advances in endoscopic techniques have brought a renewed interest in the ET as a surgical target. Although several new surgical procedures have been proposed, the ideal treatment for ETD remains to be determined. Prior to the availability of nasal endoscopy, a variety of attempts were made at surgical treatment of ETD, most of which were ultimately in vain. In seeking to develop new techniques, it is often instructive to consider the past history. Therefore, in this article we review the history of ET surgery, with a focus toward identifying factors that may have promoted or hindered successful outcomes .

### 2. ANATOMY

One of the earliest descriptions of the pharyngotympanic tube was made in the fourth century BC by Aristotle, who believed that it carried echoes from the ear to the heart.

The Italian anatomist Bartolomeus Eustachius, who is credited with recording the first work to deal exclusively with the ear, accurately described the course and relations of this structure in 1562. Writing in *Epistola de Auditus Organis*, he divided it into bony and cartilaginous parts lined with a mucous membrane. In 1683, Duverney corrected an age-old misconception by proposing that this structure served as the channel through which the air of the middle ear was renewed, rather than an avenue for hearing or respiration.

The name of Eustachius was ascribed to the structure in 1704 by Antonio Valsalva, who discovered the muscular attachments at the pharyngeal orifice.

Valsalva believed the ET was a conduit for expelling pus in cases of otitis media, for which purpose he developed the maneuver that bears his name.

Three hundred years of investigation has enhanced our understanding of ET anatomy. The ET has a reported length of 31 mm to 38 mm, of which approximately the medial two-thirds is lined with fibrocartilage and the lateral one-third is within the temporal bone. Three-dimensional modeling has demonstrated an hourglass-like central constriction, referred to as the isthmus, near the junction of these segments, which may be as narrow as 0.65 mm<sup>2</sup> cross-sectional area.

The cartilaginous portion is obliquely angled and is composed of anterior and posterior laminae. The anterior lamina provides an insertion for the tensor veli palatini muscle approximately 12 to 20 mm deep to the pharyngeal orifice. The result is a valve-like region which, assisted by other peritubal muscles, produces a coordinated sequence of dilation that has four distinct phases. Abnormal closure of this valve is believed to underlie the majority of cases of ETD.(fig1)

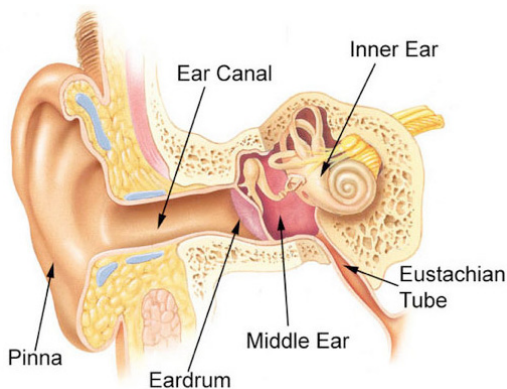


Fig 1 Eustachian tube - anatomy

### 3. IRRIGATION AND INSUFFLATION

In 1724 Guyot performed the first surgical intervention on the ET by oral approach utilizing a curved surgical tool across the soft palate.

Seventeen years later the nasal approach of the ET was depicted in by Archibald Cleland. His successors described in detail, based on cadaveric study, the process of catheterization and tympanic irrigation to expel the “excrementous matter” in the middle ear.

Topical application of adrenalin and silver compounds to the pharyngeal orifice was also occasionally employed.

Itard was the first physician who presented the ET tubular medical device for insufflation as a manner of therapy for otitis. Cases of otitis that did not respond to catheterization, irrigation or insufflation were subjected to more forceful measures. A variety of bougies and dilators were developed by French and German otologists to promote patency of the ET. These instruments were typically made of catgut, whale bone or semiprecious metals. Kramer described the transnasal insertion of a catgut bougie into the ET, which would be left in place to be removed by the patient several hours later. “The massage of the mucosa and musculature” of the ET and “its stimulating effect both on the circulation and on the peripheral nerve endings” were cited as favorable benefits of serial dilation. Metallic bougies were also developed that could conduct a mild galvanic current, which was believed to enhance this salutary effect on the ET tissues.

### 4. FAVORING THE EAR

Prior to the 19th century, the primary interest of otologic surgeons was acute intervention for suppurative mastoiditis.

A new era for otology arrived when, in 1800, Sir Astley Cooper performed the first deliberate myringotomy for the remedy of deafness. Cooper suggested that this new surgical procedure was a viable treatment option for “deafness that arises from an obstruction of the Eustachian tube.”

Step by step, the acceptance of myringotomy had all but forced ET catheterization into obsolescence. Nineteenth century interventions of the ET were predominantly transtympanic. The radical mastoidectomy procedure, so common in the preantibiotic era, was often considered incomplete without transtympanic obliteration of the ET to prevent the passage of infectious matter from the pharynx. Meanwhile, the function of the ET continued to inspire debate. Muller stated that the ET was continuously open; Toynbee claimed it was closed except in the act of swallowing. In any case, the intent of all interventions was the restoration of a static state: either open to permit aeration or closed to bar the entry of infection.

The nature of the ET as dynamic organ remained entirely unappreciated. Surgical incisions of the pharyngeal ET were rarely considered during the latter 19th century.

One observer of the day, drawing a parallel to general surgery, noted that “no one has attempted to extend the treatment of strictures by incision to stenosis of the Eustachian tube.”

In the 20th century, the lay and medical presses were dominated by reports of nonsurgical “reconstruction” of the ET for the cure of deafness using only an unaided finger, although these claims were ultimately refuted.

At least one description exists from this time of transoral surgical closure of the ET at the pharyngeal orifice. In the operation described by Thomas Halsted, an endoluminal incision was carried to the bony isthmus, after which the mucosa was stripped medially to completely denude the cartilaginous ET and produce fibrotic atresia. This was considered only as a salvage technique, and, with rare exception, surgery of the pharyngeal ET remained unpracticed until late in the 20th century.

## 5. STATIC STRUCTURE

Tympanoplasty was an other successful step of this kind of treatment. Zollner described the technique for passing a silk thread through the ET during tympanoplasty to permit delayed packing removal. Later, he implanted a cannula that could allow middle ear insufflation and preserve ET patency through tamponade. However, no proposal for valvular control was made, and the method was tested only on cadavers.

A limited number of operations were performed, and late extrusion of the tube was typical in tympanomaxillary shunt. Local radiotherapy was also applied to produce direct mucosal irradiation in an effort to reduce ET inflammation.

In 1955, Beck developed a strontium–yttrium bougie for this purpose, and published favorable results for posttreatment ET patency, although long-term effects of this treatment remained speculative.

## 6. DYNAMIC ORGAN

The proliferation of fiberoptic endoscopy in the late 20th century has facilitated study of the nasal cavity and nasopharynx. Enhanced optics and video technology have allowed direct observation of the valve-like function of the ET pharyngeal orifice, and several reports have described the dynamic anatomy of the ET, particularly the contributions of peritubal musculature. Interestingly, endoscopy of the ET lumen has been available since 1976, when first reported by Yamashita. Aside from experimental efforts, however, a practical application for this technology has yet to be described.

Other pathways approach in ET surgical pathology has been presented by Kujawski so called Eustachian tuboplasty and by Metson. Recently, Yanez has demonstrated a laser tuboplasty with notable-term medium results. Although all of the operations described thus far have sought to relieve obstruction of the ET, the disorder known as patulous ET bears brief mention. Patulous ET most commonly presents with autophony, although accurate diagnosis may be challenging. Because patulous ET has only recently been considered a distinct entity, the evolution of its treatment is brief. In 1974, Misurya proposed a procedure to lengthen the tensor veli palatini, which was carried out by release of the muscular tendon from its course around the hamulus. A similar result was attempted through pterygoid hamulotomy.

Transtympanic silicone plugging has been advocated, as has ligation of the pharyngeal orifice and injection of botulinum toxin into the paratubal muscles.

Poe has described the endoscopic placement of a cartilage graft into a submucosal pocket within the tube lumen to restore normal valve competence of the ET. Due to small case numbers, conclusions about the effectiveness of any particular treatment are limited. Having reviewed the historic record, the wide variety of interventions that have been proposed for ETD is apparent. One is reminded of the repertoire of techniques available for tonsillectomy, which exists because an ideal technique remains to be discovered.

The results of each historic procedure have been limited by either the unsuccessful relief of symptoms or the risk of unacceptable adverse effects. Procedures that entailed drilling the bony ET placed the carotid artery at unacceptable risk. Surgical alteration of the peritubal muscles jeopardized normal swallowing function.

The blind insertion of catheters and other surgical instruments may have traumatized the ET lumen mucosa and contributed to scarring and ultimate treatment failure.

Moreover, as with other historic studies of surgical intervention, the reporting of outcomes has rarely been held to rigorous standards. Catheterization sought to address pathology in the middle ear, rather than within the ET itself. Dilation and drilling of the bony ET presumed that stenosis at the narrowest anatomical segment was the site of the lesion. Shunting procedures relied on the supposition that the ET was simply a passive conduit. It is worth noting that although medical therapies for ETD are widely practiced, their effectiveness remains uncertain. Several factors contributing to physiologic obstruction of the ET have been proposed, including allergic rhinitis, sinusitis, adenoiditis, and extraesophageal reflux.

Accordingly, patients diagnosed with ETD have been treated with antihistamines, topical and systemic decongestants, intranasal corticosteroids, antibiotics, mucolytics, and proton pump inhibitors.

Despite anecdotal successes, high-quality data for these measures is lacking. In this light, a reliable surgical therapy would be particularly beneficial. Potential avenues for the future of ET surgery include tubal endoscopy, balloon dilatation, endotubal stenting, and image-guidance technology.

## CONCLUSIONS

Aerotitis media is the most common otitic disorder among flying personnel today. Although ET surgery has a lengthy history, the development of effective interventions is still in its infancy. Historic attempts to irrigate, obliterate, or bypass the ET overlooked the complex physiologic role of this dynamic organ.

Minimally invasive endoscopic techniques are now under investigation, enabled by the armamentarium of the rhinologist. Although the ideal treatment remains speculative, recent advances in the understanding of ET function have brought us closer to the effective management of this common disorder.

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