Original Article

Association of Endoscopic Eustachian Tube Grading with Tympanic Membrane Mobility and Tympanometric Patterns in Middle Ear Disease

Dhivyanka M[1], Visali M G A[2], Praveen R[3], P. Ilangovan[4]

[1]Final Year Postgraduate, Department of ENT, A.C.S Medical College and Hospital, Poonamallee High Road (Chennai–Bengaluru Highway, NH4), Velappanchavadi, Chennai, Tamil Nadu, India. [2]A.C.S Medical College and Hospital, Poonamallee High Road (Chennai–Bengaluru Highway, NH4), Velappanchavadi, Chennai, Tamil Nadu, India. [3]Assistant Professor, Department of ENT, A.C.S Medical College and Hospital, Poonamallee High Road (Chennai–Bengaluru Highway, NH4), Velappanchavadi, Chennai, Tamil Nadu, India. [4]Professor and Head, Department of ENT, A.C.S Medical College and Hospital, Poonamallee High Road (Chennai–Bengaluru Highway, NH4), Chennai, Tamil Nadu, India.

Abstract

Background: Eustachian tube dysfunction (ETD) is a key factor in the development and persistence of inflammatory middle ear disease. However, the relationship between endoscopic anatomical grading of the Eustachian tube opening (ETO) and objective functional parameters remains insufficiently characterised. The objective is to evaluate the association between endoscopic grading of the Eustachian tube opening and tympanic membrane mobility, and to correlate these findings with impedance audiometry and middle ear clearance function. **Material and Methods:** This hospital-based observational study was conducted in a tertiary care centre from 2024 to 2025 and included 300 patients aged 12–65 years with inflammatory middle ear disorders. Patients with prior ear surgery, non-inflammatory conditions, cleft palate, or ear trauma were excluded. All participants underwent otoscopic examination, pure tone audiometry, impedance audiometry, and diagnostic nasal endoscopy. The Eustachian tube opening was graded endoscopically. Clearance of instilled drops was measured in patients with a perforated tympanic membrane. The chi-square test was used for statistical analysis, and $p < 0.05$ was considered significant. **Results:** There were 300 patients (mean age, 37 years), including 155 (52.6%) males and 145 (47.3%) females. Most respondents (54.3 percent) were 1237 years old, while 45.7 percent were between 38 and 65 years old. ETD was identified in 73% (n = 219). In 39.3%-retraction, 23%-perforation of the tympanic membrane was found. There was a statistically significant association between ETO grade and tympanic membrane mobility ($p < 0.05$), with higher grades generally associated with less mobility. Impedance audiometry showed a significant correlation with ETO grading ($p < 0.001$), with Type B and Type C tympanograms more common at higher grades. The instilled easy drop clearance in the perforated tympanic membrane was also strongly correlated with the ETO grade ($p < 0.001$), with low middle ear clearing observed with progressing tubal constriction. However, the upgraded grade also showed some differences. **Conclusion:** Objective measures of middle ear performance are significant in terms of their relationship with endoscopic grading of the Eustachian tube opening. Central to the presence of inflammatory middle ear disease has been the high prevalence of ETD. A joint anatomical and functional examination provides a more detailed evaluation and can help improve clinical decision-making and preoperative assessment.

Keywords: Function of the eardrum, Trypanometry, ventilation of the middle ear, endoscopy of the nostrils, and motion of the drum.

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Introduction

The Eustachian tube (pharyngotympanic tube) is a movable anatomical channel linking the pharynx and the middle ear cavity, which is a vital structure in ventilation and pressure in the middle ear [1]. Early embryogenesis Embryologically and histologically, the tube differentiates epithelially in early development, and develops a conduit that is mucosal-lined, necessary in middle ear homeostasis.[1] The precise descriptions of the anatomy of the human auditory tube highlight its dual structure as a comb, combining cartilaginous components and serving its own role toward the mechanical and functional integrity.[2]

The eustachian tube plays a physiological role in conducting middle ear aeration, pressure equalisation, and secretion removal. Tubal patency and function profoundly affect gas exchange and pressure conditions in the middle ear cleft.[3] Its structural complexity and muscular attachments have been described in classical anatomy as enabling periodic opening during swallowing and yawning.[4]

Dysfunction of the Eardrum (eardrum dysfunction) in the middle ear has significant consequences for middle ear pathology. Hearing outcomes in paediatric populations undergoing ossicular reconstruction procedures can be impaired by tubal dysfunction and are associated with chronic otitis media.[5] As experimental studies have shown, middle ear pressure regulation can be

Address for correspondence: Dr. Dhivyanka M, Final Year Postgraduate, Department of ENT, A.C.S Medical College and Hospital, Poonamallee High Road (Chennai–Bengaluru Highway, NH4), Velappanchavadi, Chennai, Tamil Nadu, India
E-mail: dhivyankamadan@gmail.com

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modified due to the effect of viral infections, as they can impair the effect of the tubal functioning.[6] It has also been demonstrated that environmental exposures like tobacco smoke also negatively influence the ability of the Eustachian tube to operate as it relates to the development of the recurring inflammatory middle ear disease.[7]

Reflux-related inflammation has become a significant etiological factor, and repeated efforts to clear nasopharyngeal refluxate lead to a momentary dysfunction of the Eustachian tube.[8] The genetic abnormalities, such as those in cleft lip and palate patients, predispose victims to chronic ETD and its consequences.[9] Moreover, the patients receiving radiotherapy treatment for nasopharyngeal carcinoma exhibit structural and functional degeneration of the Eustachian tube, which reduces its susceptibility to external aggression.[10]

Changes in middle ear pressure may also occur as a secondary effect of anaesthetic intervention, especially with nitrous oxide, due to the sensitivity of tympanometric measures to Eustachian tube function.[11] Mastoid aeration and tubal dysfunction are associated with chronic middle ear disease, affecting its development and progression, as well as its recurrence.[12] The entire system of mastoid air cells and the tympanic membrane serve as a pressure buffer, a compensatory process that relies heavily on sufficient tubal ventilation.[13]

Various clinical test protocols have been developed to assess Eustachian tube function. Some bedside techniques, such as tasting instilled otologic drops, have, however, been shown not to be reliable for assessing tubal patency.[14] One of the objective tools still in use in the assessment of the dynamic nature of middle ear pressure, as well as some tympanometric signs, especially the Type B curves, have been linked to conductive hearing loss and the middle ear effusion.[15]

Although a variety of diagnostic modalities are available, none reliably assesses both the anatomy and physiology of the Eustachian tube. Additionally, there is a lack of studies examining the correlation between endoscopic assessment of the Eustachian tube opening and objective otologic outcomes. Since persistent ETD has adverse effects on surgical outcomes in chronic middle ear disease, a systematic appraisal of tubal status using endoscopic and audiological methods is clinically indicated.

Thus, the current research aims to investigate the correlation between endoscopic assessment of the Eustachian tube orifice and the range of tympanic membrane motility in patients with inflammatory disease of the middle ear and to provide an addition to a more systematic method of preoperative diagnosis and disease treatment.

Materials and Methods

This was an observational study with descriptive and analytical components conducted in the Department of Otorhinolaryngology at ACS Medical College and Hospital, Chennai, a tertiary care facility in an urban area, over 1 year between 2024 and 2025. The descriptive was used to describe the socio-demographic and clinical characteristics of patients with inflammatory middle ear disorders, and the analytical was used to evaluate the relationship between Eustachian tube function and otological outcomes.

The study population consisted of patients, both female and male, aged 12-65 years, with a diagnosis of middle-ear inflammatory disorders. The study excluded patients with non-inflammatory middle ear conditions, those who had previously undergone middle ear surgery, those with cleft palate, and those with ear trauma.

The sample size was calculated using the standard formula:

$$n = \frac{Z_{\alpha}^2 \times P \times Q}{L^2}$$

whereat a 95% confidence level, and the allowable error (L) was taken as 10%. The 277 was the minimum sample size calculated. With non-responding rates expected to be 10 percent, the survival sample was estimated at 300 participants.

The Institutional Ethics Committee provided ethical approval, and the study was undertaken in accordance with the principles of the Declaration of Helsinki and Good Clinical Practice.

All participants provided written informed consent before enrolment. The privacy and anonymity of patient data were also protected throughout the research.

The outpatient and inpatient departments were involved in collecting the data using a pre-designed, structured proforma. The clinical history regarding middle ear disease was obtained in detail, and an ear, nose, and throat examination was performed. Otoscopic and otoendoscopic findings were recorded systematically.

Audiological evaluation included pure-tone and impedance audiometry. Eustachian tube function was assessed using the Valsalva maneuver and the Toynbee test.

Diagnostic nasal endoscopy was performed using 0° and 45° rigid nasal endoscopes to visualise the nasopharyngeal opening of the Eustachian tube, and the Eustachian tube opening was graded based on endoscopic findings. The grade of adenoids was also assessed and documented.

In patients with perforated tympanic membranes, the clearance of instilled otologic drops from the middle ear was assessed as an indirect measure of Eustachian tube function. Additional investigations, including a nasopharyngeal X-ray and relevant laboratory tests, were performed when clinically indicated.

The primary outcome measure was the correlation between endoscopic grading of the Eustachian tube opening and tympanic membrane mobility. Secondary outcome measures included the distribution of Eustachian tube dysfunction across inflammatory middle ear disorders and its association with impedance audiometry findings and drop clearance.

All data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software version XX. Descriptive statistics were expressed as frequency, percentage, mean, and standard deviation. Inferential statistics were used to assess associations between categorical variables using the Chi-square test. Fisher's exact test was used where appropriate. A p-value of less than 0.05 was considered statistically significant, and $p < 0.001$ was considered highly significant.

Results

The present hospital-based observational study was conducted

over 1 year, from 2024 to 2025, and included 300 patients diagnosed with inflammatory middle ear disease. The findings are presented below.

Table 1: Demographic Characteristics of Study Participants (N = 300)

Variable	Category	Frequency	Percentage (%)
Gender	Male	155	52.6
	Female	145	47.3
Age Group	12–37 years	163	54.3
	38–65 years	137	45.7
Mean Age	37 years	—	—

The study population demonstrated a relatively balanced gender distribution, with a slight male predominance (52.6%), suggesting that inflammatory middle ear disease affects both sexes equally in this population. The majority of patients (54.3%) were in the 12–37-year age group, indicating that middle ear inflammatory conditions are more common in the active, younger population.

The mean age of 37 years reflects the chronic nature of disease progression, where long-standing Eustachian tube dysfunction and recurrent infections contribute to persistent pathology. This age distribution also suggests that environmental exposures, upper respiratory tract infections, and lifestyle factors may contribute to the development and persistence of Eustachian tube dysfunction.

Eustachian tube dysfunction was observed in the majority of the study population. Of 300 participants evaluated, 219 (73%) demonstrated evidence of Eustachian tube dysfunction, whereas 81 (27%) had normal Eustachian tube function. This finding indicates that impaired Eustachian tube function is highly prevalent among patients presenting with inflammatory middle ear disease.

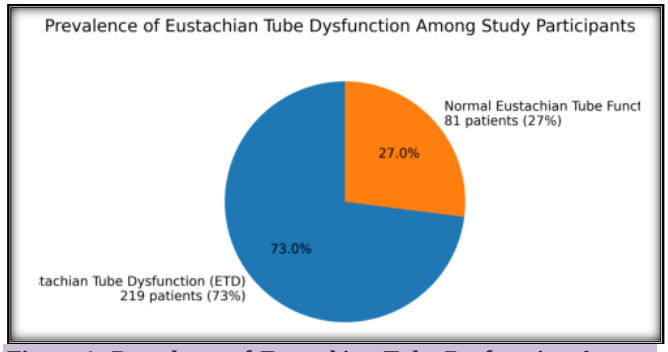

Figure 1: Prevalence of Eustachian Tube Dysfunction Among Study Participants (N = 300).

Table 2: Distribution of Eustachian Tube Dysfunction Among Patients (N = 300)

Impression	Frequency	Percentage (%)
ETD	219	73.0
Normal ET Function	81	27.0
Total	300	100.0

Dysfunction of the eardrums: Eardrum dysfunction was found in 73% of patients, and a significantly higher prevalence of dysfunction was observed in patients with inflammatory middle ear disease. This result provides robust evidence for the key role of Eustachian tube dysfunction in the pathogenesis of middle ear pathology.

The high percentage of ETD suggests that underlying mechanisms, such as inadequate ventilation, dysregulation of pressure, and poor clearance of middle-ear secretions, are more evident in these patients. Preserved tubal physiology was uncommon (27% of participants demonstrated normal Eustachian tube function).

This result supports the hypothesis that ETD is not only a correlated factor but also a major contributing factor in the development and continuation of inflammatory middle ear disease.

Table 3: Frequency of Otoscopic Findings in Middle Ear Pathology (N = 300)

Ear Finding	Absent n (%)	Present n (%)
Congestion	238 (79.3)	62 (20.7)
Retraction	231 (77.0)	69 (23.0)
Perforation	182 (60.7)	118 (39.3)
Fluid Level	261 (87.0)	39 (13.0)
Discharge	288 (96.0)	12 (4.0)

The field of pathological observation under an otoscope encompassed a wide range of cases observed during the active and chronic stages of middle ear disease. The most prevalent abnormality (39.3%) was tympanic membrane perforation, suggesting an old disease and secondary destruction of the tympanic membrane.

The tympanic membrane was retracted in 23% of patients, suggesting continuous negative middle ear pressure due to EUSTD dysfunction. The congestion (20.7%) is probably an earlier or an ongoing inflammatory stage.

Fluid levels were detected in 13 percent of cases, which was also indicative of middle ear effusion. Still, active discharge was not prominent (4%), suggesting that the majority of patients were in the chronic, not the acute, stage of suppurative processes.

In general, the results have shown that chronic structural

alterations, including perforation and retraction, are the dominant features compared to acute inflammatory characteristics and play a vital role in underscoring the chronic influence of Eustachian tube dysfunction.

The otoscopic appearance of the study participants showed a variety of pathological findings. The most common abnormality was tympanic membrane perforation, observed in 118 patients (39.3%). It was found that 69 patients (23%) had retracted tympanic membranes, and 62 (20.7%) had congestion. In 39 patients, 13% had fluid in the middle ear, and active ear discharge was relatively rare, seen in 12 patients (4%). These results describe the range of inflammatory middle ear pathology in the research group.

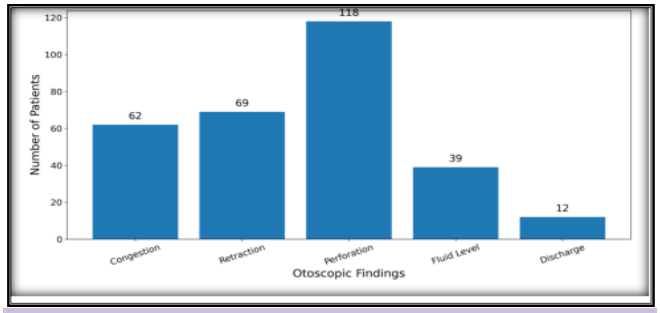

Figure 2. Frequency of Otoscopic Findings in Middle Ear Pathology (N = 300).

Table 4: Association Between ET Opening Grade and Tympanic Membrane Mobility (N = 300)

ET Opening Grade	TM Mobility NA	TM Mobility YES	TM Mobility NO	Total	P value
Grade 1	79 (0.14)	25 (0.21)	44 (0.49)	148	0.32
Grade 2	12 (<0.001*)	20 (0.52)	48 (<0.001*)	80	<0.001*
Grade 3	45 (0.03*)	20 (0.26)	7 (<0.001*)	72	0.002*
Total	136	65	99	300	<0.05*

A statistically significant association was observed between endoscopic Eustachian tube opening grade and tympanic membrane mobility ($p < 0.05$), indicating a strong relationship between anatomical and functional parameters.

Grade 1 patients with Eustachian tube opening showed fairly intact tympanic membrane mobility, which indicates sufficient tubal patency and pressure regulation. On the contrary, Grade 2 was associated with a larger share of diminished mobility, characterised by partial obstruction and deterioration of ventilation.

Interestingly, Grade 3 cases were characterised by significant impairment. Still, a degree of variability was observed, due to compensatory mechanisms such as mastoid air cell buffering or intermittent opening of the tubal cell.

These results suggest that as the Eustachian tube narrows, middle ear mechanics deteriorate, leading to decreased compliance of the tympanic membrane. This makes endoscopic grading a good surrogate measure of functional impairment.

[Figure 3] shows the correlation between the grade of the endoscopic Eustachian tube opening and the mobility of the tympanic membrane. Grade 1 Eustachian tube opening was associated with somewhat intact tympanic membrane mobility in the patients. G Grade 2, on the other hand, had a higher percentage of reduced mobility, whereas Grade 3 had mixed mobility patterns. A statistical test showed that there was a significant relationship between the grade of Eustachian tube opening and the motion of the tympanic membrane ($p < 0.05$), where a progressive narrowing of the Eustachian tube antrum was related to poor middle ear mechanics.

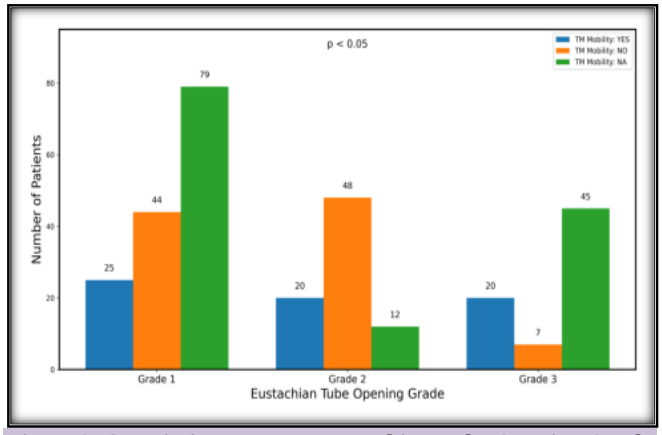

Figure 3: Association Between Eustachian Tube Opening Grade and Tympanic Membrane Mobility (N = 300).

Table 5: Association Between ET Opening Grade and Drops Clearance in Perforated TM (N = 300)

ET Opening Grade	Drops NA	Drops YES	Drops NO	Total	P value
Grade 1	69 (0.18)	37 (0.07)	42 (0.41)	148	0.09
Grade 2	68 (<0.001*)	6 (<0.001*)	6 (<0.001*)	80	<0.001*
Grade 3	27 (0.04*)	26 (0.02*)	19 (0.11)	72	0.01*
Total	164	69	67	300	<0.001*

There was a strong functional correlation between the Eustachian tube grade of opening and the grade of clearance of instilled drops ($p < 0.001$).

Grade 1 ET opening patients had better clearance, indicating preserved mucociliary and ventilatory capabilities. Conversely, the Grade 2 patients exhibited significantly lower clearance, indicating the considerable retardation of tubal function.

Grade 3 cases showed unpredictable clearance images, which may reflect intermittent structural damage, patency, or heterogeneity.

These results affirm that dysfunction of the Eustachian tubes directly affects middle-ear clearance mechanisms, leading to fluid retention and persistent inflammation.

Table 6: Association Between Impedance Curve Type and ET Opening Grade (N = 300)

Impedance Type	Grade 1	Grade 2	Grade 3	Total	P value
Type A	18 (0.02*)	30 (<0.001*)	0 (<0.001*)	48	<0.001*
Type AD	0 (0.08)	0 (0.06)	7 (<0.001*)	7	<0.001*
Type B	26 (0.41)	12 (0.22)	14 (0.09)	52	0.18
Type C	19 (0.03*)	26 (<0.001*)	6 (0.07)	51	<0.001*
NA	85 (<0.001*)	12 (<0.001*)	45 (0.02*)	142	<0.001*
Total	148	80	72	300	<0.001*

A highly significant association was found between impedance curve type and Eustachian tube opening grade ($p < 0.001$).

Type B and Type C tympanograms, which indicate middle ear effusion and negative pressure, respectively, were predominantly observed in higher grades of Eustachian tube narrowing. In contrast, Type A curves, representing normal middle ear function, were more common in lower grades.

The clustering of abnormal tympanometric patterns in higher grades reinforces the notion that structural narrowing of the Eustachian tube leads to measurable physiological dysfunction, particularly in pressure regulation and middle ear compliance.

Table 7: Association Between Tympanic Membrane Mobility and ET Dysfunction (N = 300)

TM Mobility	ETD	Normal	Total	P value
NA	92 (0.06)	44 (0.08)	136	0.07
NO	59 (<0.001*)	6 (<0.001*)	65	<0.001*
YES	68 (0.04*)	31 (0.05*)	99	0.04*
Total	219	81	300	0.001*

A statistically significant association was observed between tympanic membrane mobility and Eustachian tube dysfunction ($p = 0.001$).

Minimal or no mobility was mainly related to ETD, and more patients with normal Eustachian tube function had normal mobility.

The result suggests that tympanic membrane mobility is a good clinical sign of Eustachian tube function, reflecting pressure dynamics and the state of middle ear ventilation.

Table 8: Association of Impedance Curve Type with ET Dysfunction (N = 300)

Impedance Type	ETD	Normal	Total	P value
Type A	24 (0.06)	24 (0.05*)	48	0.05*
Type AD	7 (<0.001*)	0 (<0.001*)	7	<0.001*
Type B	45 (<0.001*)	7 (<0.001*)	52	<0.001*
Type C	51 (<0.001*)	0 (<0.001*)	51	<0.001*
NA	92 (0.09)	50 (0.08)	142	0.07
Total	219	81	300	<0.001*

A highly significant association was observed between impedance curve type and Eustachian tube dysfunction ($p < 0.001$).

ETD was predominantly associated with Type B and Type C curves, indicating impaired middle ear ventilation and negative pressure. Conversely, Type A curves were equally represented in the ETD and normal groups and were more indicative of intact function.

These results not only establish that impedance audiometry is a stable objective measure of Eustachian tube dysfunction but also that its outcomes are highly correlated with anatomical grading and clinical outcomes.

Discussion

This current research tested 300 cases (patients) with inflammatory disease of the middle ear, and the study proved that 73 percent (n = 219) had dysfunction of the Eustachian tube (ETD). Endoscopic Eustachian tube opening (ETO) grade was found to be statistically significantly associated with the tympanic membrane (TM) mobility ($p < 0.05$). Increasing levels of tubal constriction were related to diminished TM mobility. ETO grading ($p = .000$) was also significantly linked with impedance audiometry and drops clearance in the perforated tympanic membrane was significantly linked with the ETO grade ($p = .000$). Such results suggest that anatomical constriction, as endoscopically observed, is proportional to physiological impairment that can be measured.

Van Heerbeek, Ingels, and Zielhuis,[16] examined the effect of nasal decongestants in children with ventilation tubes. He did not find any measurable improvement in the function of the Eustachian tube. The poor therapeutic outcome they had indicates that long-established abnormality might not react to short-term pharmacologic interventions. In our report, although patients were typically managed clinically before evaluation, 73% still exhibited ETD, which supports the idea that inflammatory middle ear disease can often be persistent, but not acute tubal obstruction.

Silverstein and others,[17] investigated the use of transtympanic dexamethasone in chronic ETD. They found a response, with symptomatic improvement in some cases, but tubal function normalization was unreliable. On the same note, Shapiro, Bierman, and Furukawa,[18] reported better tympanometric

results in children treated with aerosolised nasal dexamethasone compared with placebo, although the effect was not universal. Unlike therapeutic outcome studies, our study yielded a quantitative measure of the structural-functional correlation. It showed that higher ETO grades were associated with abnormal impedance patterns (p = .000), indicating that anatomical grading has objective predictive value.

Tracy and co-investigators,[19] found that adjunctive intranasal beclomethasone therapy was better for resolving chronic middle ear effusion. On the other hand, Karlidag and others,[20] did not find any statistically significant incremental value in using topical steroids and antibiotics in a chronic, deafening ear with effusion. This discrepancy in medical response is similar to ours, with a significant percentage of patients (73) harbouring ETD despite traditional exposure, suggesting that structural dysfunction may not resolve with pharmacologic therapy.

It was also shown that mastoid and epitympanic obliteration minimised the formation of retraction pockets in canal wall up mastoidectomy (Lee, Choi, and Song).[21] On the same note, Gantz, Wilkinson, and Hansen,[22] found better long-term results with canal wall reconstruction with mastoid obliteration. These observations, carried out during surgery, emphasise the middle ear's aeration and pressure stability. Tympanic membrane retraction was found in 1/5 of this group. It was significantly correlated with increased ETO scores and worsened mobility, validating our hypothesis that chronic ventilation deficiency contributes to structural changes in the middle ear.

The differences between barotrauma and chronic otitis media syndrome were described by Sade, Ar, and Fuchs,[23] who emphasised the deficiency of gas in the middle ear as a pathogenic factor. This mechanism is reflected in our results on impedance findings: Type B and Type C tympanograms, representing negative or non-compliant middle ear pressure, were more often grouped in the higher ETO grades (p =.000), and functional gas imbalance reflects structural narrowing.

According to Chao, Tseng, and Chang [24], Eustachian tube dysfunction was reported as a key contributor to the pathogenesis of cholesteatoma due to persistent negative middle ear pressure. In the current case, 39.3 per cent of patients had tympanic membrane perforation, and 23 per cent had retraction. The pathophysiological model that airflow obstruction by the liver blocks the entry of the middle ear cavity, allowing middle ear pathology, is supported by the statistically significant association between ETO grade and TM mobility.

Tos,[25] also noted that the proper functioning of the eardrums is a particularly crucial element in a successful middle ear surgery. This statement is supported quantitatively by our findings: of 300 patients, 219 had impedance-established ETD, and decreased TM mobility was significantly correlated with ETD (p = .001). This indicates that preoperative endoscopic grading could help to stratify prognosis.

According to Tarabichi and Najmi,[26] the distal cartilaginous part of the tube is a frequent site of obstruction in chronic ear disease. The significance of a systematic preoperative assessment of tubal anatomy was later recognised, further elaborated by Tarabichi and Kapadia.[27] Direct visualisation during nasal endoscopy, with a diagnostic and statistically significant correlation between macromolecular substrates and functional measures, supports the importance of anatomical evaluation before intervention in our study.

The historical treatment offered by Shampo and Kyle,[28] helps one remember that anatomical insights have always supported functional interpretation. The ventilation and clearance were described through the lining or epithelium, which was delicate, as described by Hentzer in his histologic study of normal mucosa.[29] Our cohort shows a strong association between endoscopic grade and physiological dysfunction, indicating impairment of this structural integrity during inflammatory conditions.

The concept of balloon dilatation of the cartilaginous portion of the Eustachian tube as an innovative therapeutic modality to restore tubal patency was proposed by Poe and Hanna.[30] Their experiment showed that mechanical dilation at a specific location can enhance ventilation, enabling it to overcome structural impediments at the cartilaginous stage. This new intervention reflects the sensitivity of anatomic restriction to proper description before allowable treatment. Abnormal impedance patterns ($p < 0.001$) in the present study were also strongly associated with higher Eustachian tube opening grades, indicating greater functional impairment. These results confirm the idea that endoscopic grading can be useful in addressing baseline narrowing, and the evidence supports a step in that direction by proposing interventions such as balloon tuboplasty.

Limitations

The study was conducted at a single tertiary care facility and may reflect patients with more severe or symptomatic inflammatory middle ear disease. Hence, the Eustachian tube dysfunction observed (73 percent) may not reflect the population at large.

The cross-sectional type does not allow causal inquiry. The study does not support whether the anatomical constriction is the direct cause of progressive middle ear pathology. However, it found significant relations between endoscopic Eustachian tube opening (ETO) grade and tympanic membrane mobility ($p < 0.05$), results of impedance audiometry (p = .000), and drops clearance (p = .000).

Diagnostic nasal endoscopy measures the nasopharyngeal Length of the Eustachian tube but fails to measure all cartilaginous or distal to the same. Likewise, impedance audiometry indicates middle ear pressure dynamics but does not localise the obstruction. Perforated tympanic membranes were the only ones for which drop clearance testing could be performed, which restricted the possibility of physiological comparison.

Possible confounding factors like allergic status, exposure of the person to smoking, reflux disease, and mastoid pneumatization were not analysed separately. Predictive interpretation could be enhanced through multivariate modelling and longitudinal follow-up.

Conclusion

In this study, 73% of patients with inflammatory middle ear disease had eustachian tube dysfunction. The statistical analysis

showed that endoscopic ETO grades were significantly associated with tympanic membrane mobility ($p < 0.05$), with higher-quality scores indicating cellular tubal narrowing and, therefore, reduced mobility. There was a significant correlation between impedance audiometry and ETO grading ($p = .000$), and clearance of drops in perforated tympanic membrane also showed a significant association ($p = .000$).

The results prove that diagnostic nasal endoscopy anatomical grading is associated with quantifiable physiological impairment. Structural assessment, coupled with functional evaluation, would provide a more detailed assessment of the Eustachian tube status.

Regular preoperative assessment of Eustachian tube function can help in risk classification and surgical planning in chronic inflammatory middle ear disease. The longitudinal research needs to be extended to evaluate its predictive value for long-term outcomes further.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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