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Original Research Article

Role of eustachian tube function in outcomes of tympanoplasty: A prospective study

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Abstract

Background: The eustachian tube (ET), or pharyngotympanic tube, is critical for middle ear pressure regulation and clearance. ET dysfunction (ETD) is a common condition in otolaryngology, particularly in children, and is linked to inflammatory responses within the ET lumen. This study evaluates the role of ET function in the success of tympanoplasty in patients with chronic suppurative otitis media (CSOM) of the mucosal type.
Methods: A prospective study was conducted at a tertiary care center in Adilabad, Telangana, India, from April 2023 to March 2024, involving 100 patients aged 18-65 years. Patients underwent otoendoscopy, diagnostic nasal endoscopy, pure tone audiometry, and ET function tests (Valsalva, methylene blue, saccharine, and Toynbee). Tympanoplasty, with or without mastoidectomy, was performed, and outcomes were correlated with ET function.
Results: Results showed that 76% of patients had normal ET function, with 97.4% of these achieving successful graft uptake compared to only 25% of those with poor ET function ($p < 0.001$). The most affected age group was 31-40 years (35%), and males comprised 67% of the cohort. Hearing loss was the primary complaint (55%), with anterior perforation noted in 47%. Preoperative and postoperative hearing thresholds were significantly better in patients with normal ET function ($p < 0.001$).
Conclusion: The study underscores the importance of assessing ET function preoperatively to enhance tympanoplasty success and recommends corrective measures for patients with partial or absent ET function to optimize surgical outcomes and minimize complications.

Keywords: Eustachian tube, Eustachian tube dysfunction, Puretone audiometry, ET Function tests.

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1. Introduction

The Eustachian tube is named after the Italian anatomist Bartolomeo Eustachi. He noticed a fibrocartilaginous tube which connects the middle ear to the nasopharynx. And the eustachian tube is also called the pharyngotympanic tube.[1] The Eustachian tube is located in the para-pharyngeal space and was found to be closely associated with the infratemporal fossa. The eustachian tube measures an average of 36 mm in an adult. The eustachian tube is mainly divided into two parts: the bony part and the cartilaginous part.[2] The eustachian tube's primary function is maintaining pressure between the outside atmosphere and the middle ear; the other functions of the eustachian tube are the drainage and the protection of the middle ear.[3]

Eustachian tube dysfunction is the failure of the eustachian tube to maintain the pressure and the clearance function. Eustachian tube dysfunction is divided into two categories: acute eustachian tube dysfunction and chronic eustachian tube dysfunction.[4] Various risk factors such as allergies, chronic sinusitis, the common cold, exposure to smoking, exposure to passive smoking, increase in the body mass index, frequency change in altitude such as the frequency of air travel, acid reflux and anatomical abnormalities such as cleft palate, family history lead to the development of the eustachian tube dysfunction[5] Recent studies have shown that about 90% of patients develop otitis media with effusion following secondary to the eustachian tube dysfunction. The studies showed that approximately about 1% of the adult population had been suffering from

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eustachian tube dysfunction, and 40% of the children were found to be affected with eustachian tube dysfunction globally.6 Recently, the incidence of eustachian tube dysfunction is rising due to the rapid rise in urbanisation and also due to the change in the lifestyle of the patients. The infection and inflammation of the eustachian tube were found to be a more common pathophysiology causing the eustachian tube dysfunction, leading to the development of the otitis media with effusion.7 Over some time, the patient can develop into acute otitis media and then progress to chronic otitis media.

Aural fullness, popping, or discomfort in the ear and pain are the most common symptoms encountered among patients with eustachian tube dysfunction. The evaluation of the patient induces the head and neck examination, followed by the patient being subjected to the otoscopic examination and diagnostic nasal endoscopic examination. Various Eustachian tube tests have also been used to determine the function of the Eustachain tube; they are the Valsalva test, Politzer test, Catheterisation, Toynbee test, radiological test, saccharine or methylene blue test, sonotubometry and the William test. Although many diagnostic tests were available to evaluate the eustachian tube function, none was found to be accurate, and there is a non-single gold standard test to measure the eustachian tube function accurately and its relation to tympanoplasty.

The eustachian tube not only had its role in the pathogenesis of the disease but also in the hearing and the outcome of the disease after the surgery. However, few studies evaluate the eustachian tube function in patients with chronic suppurative otitis media with mucosal type in the preoperative period and assess the outcome of the surgery based on the results of the eustachian tube function. So, this study was done to assess the eustachian tube function and predict the outcome of patients with chronic suppurative otitis media.

2. Aims and Objectives

2.1. Aim

To evaluate the role of ET function in predicting outcomes of tympanoplasty in patients with CSOM.

2.2. Objectives

1. To assess ventilatory and mucociliary ET function in CSOM patients planned for surgery.
2. To evaluate clinical outcomes of tympanoplasty with or without mastoidectomy.
3. To enhance tympanoplasty success rates through ET function assessment.

3. Materials and Methods

3.1. Study design

This prospective study was conducted at the Department of ENT, RIMS Adilabad, Telangana, India, from April 2023 to March 2024, after obtaining approval from the Institutional Ethics Committee.

3.2. Inclusion criteria

1. Patients aged 18-65 years diagnosed with CSOM (mucosal type, inactive for at least three months) were included.
2. No active nasal or paranasal sinus infections
3. Adequate cochlear reserve
4. Traumatic tympanic membrane perforation
5. Informed consent.

3.3. Exclusion criteria

1. Patients with less than 18 years of age and more than 65 years
2. Patients with active ear infections, uncontrolled hypertension, history of ear surgery.
3. Patients who are diagnosed with chronic suppurative otitis media – unsafe type disease (Attico-Antral Disease),
4. Patients diagnosed with chronic granulomatous diseases of the ear
5. Patients with tumours of the ear.
6. Pregnant women.
7. Patients with bleeding disorders.
8. Unstable hemodynamic disorders.
9. Comorbidities like uncontrolled Diabetes mellitus with random blood sugar values of >200mg/dl with oral or injectable antidiabetic drugs.
10. When the other ear is dead or unsuitable for hearing aid rehabilitation.
11. Patients who are not willing for surgery & not fit during anaesthesia checkup.

3.4. Data collection

Patients underwent otoendoscopy, diagnostic nasal endoscopy, pure tone audiometry, and ET function tests.

3.5. Valsalva test

Pinch nose, take deep breath, close mouth, and blow air into ears. Outward tympanic membrane movement (seen via otoscope) indicates air entry. Hissing sound suggests perforation. Avoid in atrophic tympanic membrane or nose/nasopharynx infections.

3.6. Politzer test

For children unable to perform Valsalva. Insert olive-shaped tip into one nostril, close other, and inflate middle ear using a rubber bag or compressed air while patient swallows. Hissing sound via auscultation tube confirms patent tube.

3.7.*Catheterisation*

Anaesthetise nose, insert catheter to nasopharynx, rotate medially 90°, pull back to engage septum, then rotate laterally 180°. Inflate with Politzer bag; air entry confirmed via auscultation tube.

3.8. Toynbee test

Evaluates eustachian tube function using negative pressure (±250 mm water) over 40 seconds. Patient swallows up to 4 times to normalise pressure. Failure indicates dysfunction.

3.9. Tympanometry

Applies positive/negative pressure in external ear; patient swallows repeatedly. Normal tubal function equalises pressure to ambient levels.

3.10 Radiological test

Instill radioopaque dye into middle ear via perforation, take X-ray to check for obstruction and note dye travel time to nasopharynx. No longer used.

3.11. Saccharine/methylene blue test

Place saccharine or methylene blue in middle ear via perforation. Note time for sweet taste (saccharine) or nasopharynx staining (methylene blue).

3.12. Sono-tubometry

Non-invasive; present tone to nose, record in external ear. Louder tone indicates patent or patulous eustachian tube. Swallowing sounds may interfere.

3.13. William test

Uses impedance audiometer to measure middle ear pressure at rest, during swallowing, and Valsalva in patients with intact tympanic membrane. Normal: near ambient at rest, negative on swallowing, positive on Valsalva. No pressure change indicates severe dysfunction.

Tympanoplasty, with or without mastoidectomy, was performed. Surgical success (graft uptake) and hearing outcomes were correlated with ET function.

3.14. Statistical analysis

Data were entered into Microsoft Excel and analyzed using SPSS (Version 25). Descriptive statistics (frequency and percentage) were used for ET function and surgical outcomes, with chi-square tests for associations and t-tests for hearing threshold comparisons.

4. Results

A total of 100 patients with CSOM (mucosal type) participated, with 76% exhibiting normal ET function and 24% showing poor function. The most affected age group was 31-40 years (35%) (**Table 1**), and males comprised 67% of the cohort. Hearing loss was the primary complaint (55%), with anterior perforation observed in 47%.

Table 1: Distribution of the patients based on age (N=100)

Age (in years)	Frequency (n)	Percentage (%)
18-30	25	25
31-40	35	35
41-50	32	32
51-65	8	8

ET function distribution showed 76% normal and 24% poor (**Table 2**). Graft uptake was successful in 80% of cases, with 97.4% success in patients with normal ET function compared to 25% in those with poor function ($p < 0.001$) (**Table 3**). Hearing thresholds improved significantly in patients with normal ET function (preoperative: 39.41 s 5.162 dB; postoperative:´ 19.41 s 5.162 dB) compared to those with poor function (preoperative: 38.42´ s 5.358 dB; post-´ operative: 28.42 s 5.348 dB;´ $p < 0.001$) (**Table 4**).

Table 2: Distribution of the patents based on the eustachian tube function.

Eustachian tube function	Frequency (n)	Percentage (%)
Normal	76	76
Poor	24	24

Table 3: Correlation between ET function and graft uptake rate.

Graft uptake	ET function				p-value
	Normal		Poor		
	n	%	n	%	
Success	74	97.4	6	25	<0.001
Failure	2	2.6	18	75	

Table 4: Comparison of hearing threshold between the patients with normal and poor ET function

ET function	Hearing threshold				t-value
	Pre-operative		Post-operative		
	Mean	SD	Mean	SD	
Normal	39.41	5.162	19.41	5.162	<0.001
Poor	38.42	5.358	28.42	5.348	

5. 3-Month Follow-Up

1. **Graft Uptake**: ~80% overall success; 97.4% (74/76) in normal Eustachian tube (ET) function group, 25% (6/24) in poor ET group. Failures evident in poor ET group (75% failure rate).
2. **Hearing**: Normal ET group improved to mean 19.41 ± 5.162 dB (ABG ≤20 dB in ~75–80%); poor ET group at 28.42 ± 5.348 dB, indicating partial improvement.

6. 6-Month Follow-Up

1. **Graft Uptake**: Stabilized at 80% overall; 97.4% success in normal ET group, 25% in poor ET group ($p < 0.001$). Poor ET linked to persistent failures.

2. **Hearing**: Stable at 19.41 dB (normal ET) and 28.42 dB (poor ET), reflecting sustained ABG closure in normal ET group and limited gains in poor ET group.

7. Discussion

The Eustachian tube is located in the parapharyngeal space. The ET plays a pivotal role in middle ear aeration, drainage, and protection, making its function critical for successful tympanoplasty. Eustachian tube dysfunction is divided into two categories: acute eustachian tube dysfunction and chronic eustachian tube dysfunction. Various factors are associated with eustachian tube dysfunction. The eustachian tube dysfunction involves the inability of the eustachian tube to open or close appropriately. The eustachian tube dysfunction is secondary to the epithelium's inflammatory response within the eustachian tube's lumen. Studies have shown that the eustachian tube function plays a significant role in the outcome of the patient undergoing tympanoplasty.

This study found that patients with normal ET function had a 97.4% graft uptake success rate, significantly higher than the 25% in those with poor function, aligning with prior studies. The 31-40 age group was most affected (35%), consistent with findings by Setiawan EP et al,[8] who reported a mean age of 40.67 years. Males were more commonly affected (67%). In contrast, females contributed to only 33% of total study population according to study by Mahdiani S et al.[9] And in another study by Abraham Z et al.[10] was shown that prevelance of CSOM was higher among males than females.

Hearing loss was the predominant symptom (55%), followed by ear discharge.Ear discharge and earpain are the second most common symptom according the study by Morris P et al.[11] Rosario DC et al.[12] also showed that hearing or hearing loss was the most common symptom of CSOM Anterior perforation was frequent (47%). ET function tests, including methylene blue and saccharine, indicated normal function in 76% of patients, similar to Monier W et al (85.9% normal).A Study by Ravikumar A et al.[13] used the Toynbee test to determine the eustachian tube function.Postoperative hearing outcomes were significantly better in patients with normal ET function, supporting P H et al.[14] whose study showed that about 96% of patients had successful tympanoplasty outcomes with normal ET function and Moneir W et al who reported higher complication rates in patients with poor ET function. The study by El-Antably A. et al.[15] also showed the eustachian tube function significantly affected the outcome of tympanoplasty surgery.

The study highlights the necessity of preoperative ET assessment to predict tympanoplasty success and guide intraoperative interventions. Limitations include the lack of a gold-standard ET function test and the single-center design, which may limit generalizability.

8. Conclusion

This study demonstrates a strong association between normal ET function and successful tympanoplasty outcomes in CSOM patients, with 97.4% graft uptake in those with normal function versus 25% in those with poor function. Preoperative ET function assessment is essential for optimizing surgical success and minimizing complications. Corrective measures for partial or absent ET function should be considered to enhance outcomes. Further research is needed to standardize ET function testing and validate these findings in diverse populations.

9. Source of Funding

None.

10. Conflict of Interest

None.

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