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Tympanometric Assessment of Eustacian Tube Function in Chronic Suppurative Otitis Media

Dr Apurva Nischal, Dr Anmol, Dr Divya, Dr Amit Modwal, Dr Man Prakash, Dr Rakesh Saboo
(ENT DEPARTMENT,NATIONAL INSTITUTE OF MEDICAL SCIENCES AND RESEARCH ,INDIA)

Abstract
Background
A satisfactory result of tympanoplasty for CSOM patients is achieved by doing pre-operative test of eustachian tube function.
Three main functions of eustachian tube are ventilation and regulation of middle ear pressure, middle ear clearance of secretions, and protection against nasopharyngeal sound pressure and reflux of nasopharyngeal secretions.
AIMS: *To determine eustachian tube function in chronic suppurative otitis media and to assess the success rate of tympanoplasty in relation to the eustachian tube function.*
METHODOLOGY: *It is a prospective longitudinal study, patients of 10- 60 years of age groups with features of chronic suppurative otitis media were included in the study. The total number of study subjects included in our study were 90 patients with CSOM. The eustachian tube function were assessed preoperatively by doing tympanometric assessment ,based on impedance audiometry findings, patients of tubo-tympanic disease are categorized as totally impaired, partially impaired, and normal eustachian tube function.All patients with CSOM underwent tympanoplasty surgery and outcome of surgery was assessed.*
RESULT: *The overall success rate of tympanoplasty surgery was 75.3%.It was observed in our study that the success rate of tympanoplasty was higher among patients with normal eustachian tube function.*
CONCLUSIONS: *In our study correlation between eustachian tube function and graft uptake was statistically analyzed and was found to be highly significant.*

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I. Introduction

Chronic otitis media (COM) is equivalent to the classic terminology chronic 'suppurative' otitis media (CSOM) which is no longer advocated to be used since COM is not always necessarily resulting from 'the gathering of pus'.[1] Chronic otitis media is defined as a permanent abnormality of the pars tensa or flaccida, likely resulting from an earlier acute otitis media, negative middle ear pressure or otitis media with effusion. There is distinction between active COM, wherein there is inflammation and production of pus, and inactive COM, wherein this is not the case though there is the potential for the ear to become active at some time. [2] The Eustachian tube plays an important role in this disease, and dysfunction of this tube is found in 70% of patients undergoing middle ear surgery[2,3]. When dysfunction of the Eustachian tube occurs, the pressure equilibration in the middle ear is impaired, and the middle ear aeration is perturbed, resulting in the classic symptoms of chronic suppurative otitis media.[4,5] Acquired hearing-loss is also characteristically found in patients with this condition and, if left untreated, can lead to further morbidity and mortality.[2027]Eustachian tube has three functions with respect to middle earTympanometry is an audiological investigation where resistance offered by the middle ear structures to pressure changes in external auditory canal is measured. It is an objective test, widely used in clinical practice and is particularly useful in children[6,7,8] It consists of: Tympanometry & Acoustic reflex measurements.Impedance audiometry (Toynbee's test) is an essential tool to assess eustachian tube function in perforated tympanic membrane and William's test is an essential tool to assess the eustachian tube function in intact tympanic membrane. Our present study is undertaken to assess the eustachian tube function in patient with CSOM with reference to its treatment outcome. Based on impedance audiometry findings, patients of tubo-tympanic disease are categorized as totally impaired, partially impaired, and normal eustachian tube function.

II. Materials And Methodology

STUDY DESIGN: Prospective Study
STUDY AREA: Department of Otorhinolaryngology, National Institute of Medical Science Research and Hospital, Shobhanagar, Jaipur.
STUDY POPULATION: Patients of 10-60 years of age groups suffering from chronic suppurative otitis media coming to the Department of Otorhinolaryngology, National Institute of Medical Sciences & Research, Shobhanagar, Jaipur; having normal mental & physical status and are willing to participate in the study.
STUDY PERIOD: 1st January 2021 to 30th June 2022
Sample Size; n=90
Time frame :18 months
SELECTION CRITERIA OF PATIENTS:
INCLUSION CRITERIA:
1) Patients Having Chronic otitis media mucosal type.
2) Patient in age group of 10 – 60 years.
EXCLUSION CRITERIA:
1) Patient having chronic otitis media squamosal type.
2) Patients having nasopharyngeal pathologies such as tumors or mass in the nasopharynx.

METHODOLOGY
A Clinical Proforma will be filled up for each patient incorporating details regarding particulars of the patient, detailed clinical Examination & Investigations
Routine InvestigationsCBC, ESR, RFT, LFT, BT, CT, Viral markers.
Hearing assessment by pure tone audiometry
Specific investigations for Eustachian tube functioninclude impedance audiometry (evaluation of compliance in response to air pressure and physical volume testing)
Radiological Investigations – Conventional X-Ray of Both Mastoid (Schuller's View), X-Ray Soft tissue Lateral view Nasopharynx.
Patient was followed up on 1st ,2nd, 4th and 8th week regularly. Pure tone audiometry was done on 8th week following surgery.
STATISTICAL ANALYSIS -Descriptive statististics were performed on all the study variables. Chi squared test and student t test were employed to determine the statistical significance of the differences observed among the variables.

III. Results

The age of patients in our study ranged from 10 years to 60 years with a mean age of 28.08 years with standard deviation of 14.37 years.

Age Group (in years)	Number of Cases
10-14	11
15-19	23
20-24	10
25-29	10
30-34	13
35-39	5
40-44	3
45-49	5
50-54	3
55-60	7

Table 3. Age distribution

Descriptive Statistics

	AGE (in Years)

Descriptive Statistics

	AGE (in Years)
Mean	28.078
Std. Deviation	14.373
Minimum	10.000
Maximum	60.000

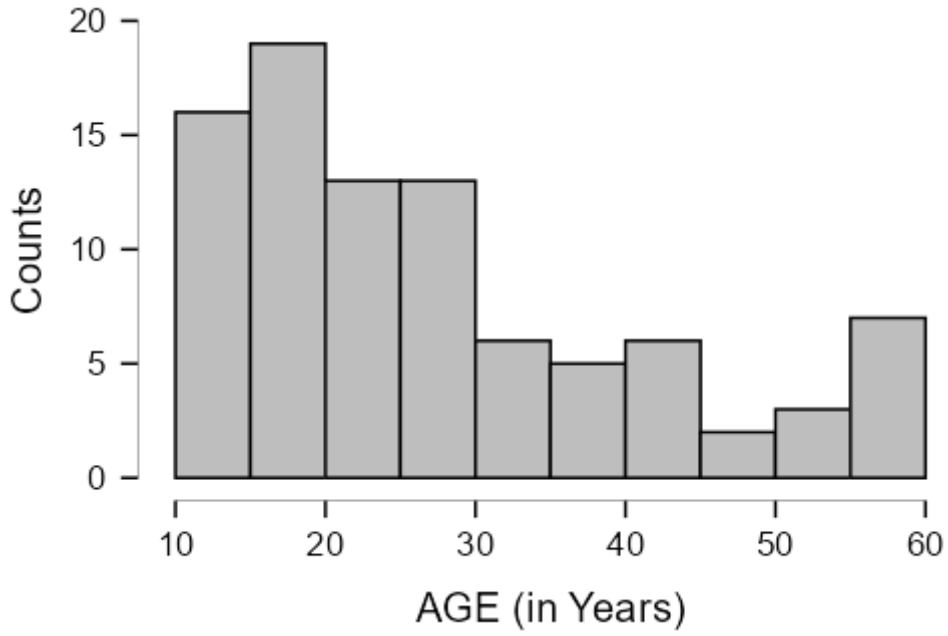

Figure 7. Age Distribution

Table 6. Frequencies for Symptoms

Symptoms	Frequency	Percent	Valid Percent	Cumulative Percent
L - ear discharge , L- hearing loss	46	51.111	51.111	51.111
R - ear discharge , R- hearing loss	44	48.889	48.889	100.000

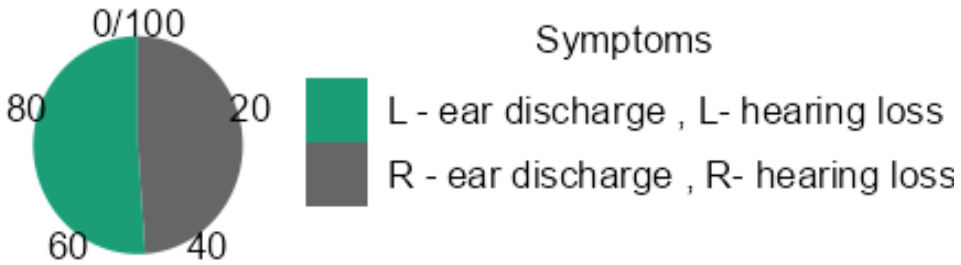

Figure 11. Symptoms distribution

Table 7. Frequencies for Type of perforation

Type of perforation	Frequency	Percent	Valid Percent	Cumulative Percent
Large, central	28	31.111	31.111	31.111
Medium ' central	16	17.778	17.778	48.889
Small , central	25	27.778	27.778	76.667
Subtotal, central	21	23.333	23.333	100.000

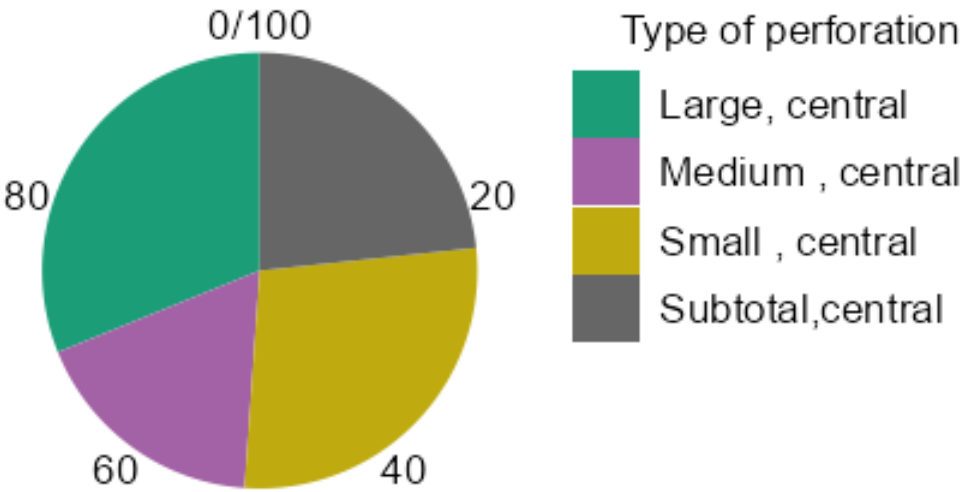

Figure 12. Type of Perforation distribution

On tympanometric assessment 62 (68.9%) patients had normal Eustachian tube function and 28 (31.1%) patients had impaired Eustachian tube function.

Table 8. Frequencies for Tympanometry

Tympanometry	Frequency	Percent	Valid Percent	Cumulative Percent
ETF Normal	62	68.889	68.889	68.889
ETF impaired	28	31.111	31.111	100.000

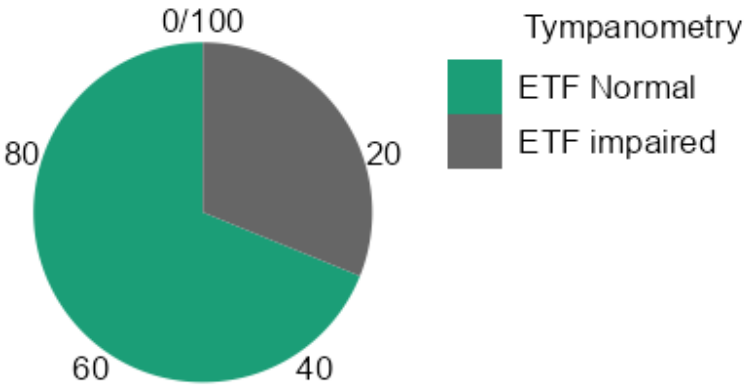

Figure 13. ETF function distribution

Among the patients included in the study, on x-ray mastoid, 52 had diploiec finding, 2 had pneumatised finding, and 36 had sclerotic finding.

Table 9. Frequencies for Mastoid Pneumatisation

Mastoid Pneumatisation	Frequency	Percent	Valid Percent	Cumulative Percent
Diploeic	52	57.778	57.778	57.778
Pneumatised	2	2.222	2.222	60.000
Sclerotic	36	40.000	40.000	100.000

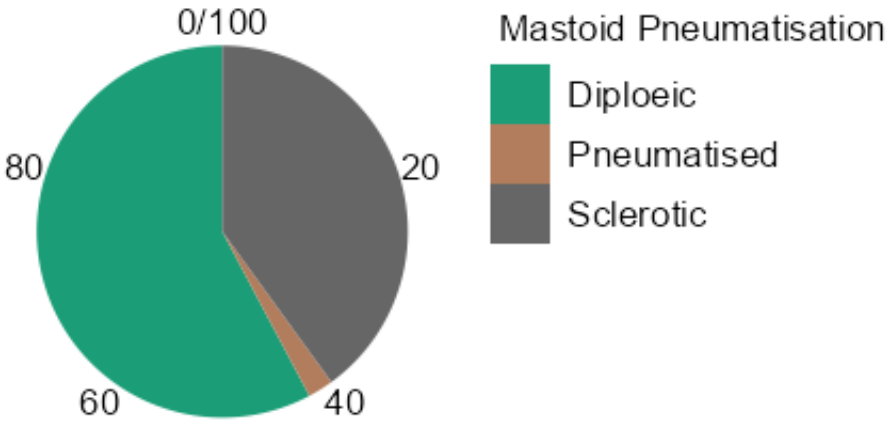

Figure 14. Mastoid pneumatisation distribution

For treatment 44 patients underwent right tympanoplasty and 46 patients underwent left tympanoplasty.

Table 10. Frequencies for Treatment plan

Treatment plan	Frequency	Percent	Valid Percent	Cumulative Percent
LT Tympanoplasty	46	51.111	51.111	51.111
RT Tympanoplasty	44	48.889	48.889	100.000

Table 10. Frequencies for Treatment plan

Treatment plan	Frequency	Percent	Valid Percent	Cumulative Percent

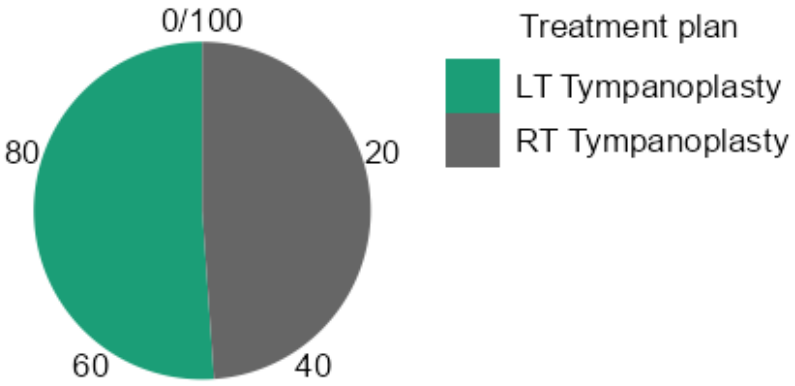

Figure 15. Treatment Plan

Post operatively (tympanoplasty) graft uptake is seen 81 (90%) patients and in 9 (10%) graft uptake was absent.

Table 11. Frequencies for GRAFT UPTAKE

GRAFT UPTAKE	Frequency	Percent	Valid Percent	Cumulative Percent
No	9	10.000	10.000	10.000
Yes	81	90.000	90.000	100.000

Descriptive Statistics of Hearing Loss Before and After Surgery

	Hearing Loss (db) Before Surgery	Hearing Loss (db) After Surgery
Mode	28.8	35.5
Median	37.8	30
Mean	37.07	27.053
Std. Deviation	8.558	8.287
IQR	14.3	12.35
Variance	73.241	68.682
Minimum	20.6	15.6
Maximum	49.8	50.8

The mean hearing loss for the patients included in our study improved from 37.07±8.56 dB before surgery to 27.05±8.29 dB after surgery.

Descriptive Statistics of Air Bone Gap Before and After Surgery

	Air Bone Gap (dB) Before Surgery	**Air Bone Gap (dB) After Surgery**
Mode	15	5
Median	15	10
Mean	16.989	9.778
Std. Deviation	7.688	5.274
IQR	14	7
Variance	59.112	27.815
Minimum	5	5
Maximum	30	30

The mean air bone gap for the patients included in our study improved from 16.99±7.69 dB before surgery to 9.78±5.27 dB after surgery.

Descriptive Statistics				
	Air Bone Gap (dB) Before Surgery		**Air Bone Gap (dB) After Surgery**	
	ETF Normal	**ETF impaired**	**ETF Normal**	**ETF impaired**
Mode	15	30	5	10
Median	15	20	8	10
Mean	15.919	19.357	8.226	13.214
Std. Deviation	7.342	8.038	3.38	6.935
IQR	12.5	15	5	5.25
Variance	53.911	64.608	11.424	48.101
Minimum	5	10	5	5
Maximum	30	30	15	30

Contingency Tables

	Graph Uptake		
Tympanometry	**No**	**Yes**	**Total**
ETF Normal	1	61	62
ETF impaired	8	20	28
Total	9	81	90

Chi-Squared Tests

	Value	**df**	**P**
X^2	15.576	1	< .001
N	90		

Chi squared test to see the association between normal eustachian tube function and graft uptake had a p value<0.001 and hence showed a significant association.

Independent Samples T-Test for association between Hearing Loss and Tympanometry

	t	df	P
Hearing Loss (db) Before Surgery	-0.926	88	0.357
Hearing Loss (db) After Surgery	-3.663	88	< .001 [a]

Student t test had a p value <0.001 and showed that there was significant association between normal eustachian tube function and improvement in hearing loss after surgery.

Independent Samples T-Test for association between Air Bone Gap and Tympanometry

	t	df	P
Air Bone Gap (dB) Before Surgery	-1.996	88	0.049
Air Bone Gap (dB) After Surgery	-4.601	88	< .001 [a]

Student t test had a p value <0.001 and showed that there was significant association between normal eustachian tube function and improvement in air bone gap after surgery.

Table 14. Contingency Tables for ETF and Type of Perforation

		Type of perforation				
Tympanometry		**Large, central**	**Medium , central**	**Small , central**	**Subtotal,central**	**Total**
ETF Normal	Count	23	14	13	12	62
	% of total	25.556 %	15.556 %	14.444 %	13.333 %	68.889 %
ETF impaired	Count	5	2	12	9	28
	% of total	5.556 %	2.222 %	13.333 %	10.000 %	31.111 %
Total	Count	28	16	25	21	90
	% of total	31.111 %	17.778 %	27.778 %	23.333 %	100.000 %

χ^2 test was employed to test the association of Eustachian tube function with type of perforation. It had a p value of 0.02 and showed that there was significant association between Eustachian tube function and type of perforation.

Table 16. Contingency Tables for ETF and Graft Uptake

		GRAFT UPTAKE		
Tympanometry		**No**	**Yes**	**Total**
ETF Normal	Count	1	61	62
	% of total	1.111 %	67.778 %	68.889 %
ETF impaired	Count	8	20	28
	% of total	8.889 %	22.222 %	31.111 %
Total	Count	9	81	90
	% of total	10.000 %	90.000 %	100.000 %

χ^2 test was employed to test the association of Eustachian tube function with outcome of surgery in the form of graft uptake. It had a p value of <0.001 and showed that there was significant association between Eustachian tube function and outcome of surgery in the form of graft uptake.

Table 17. Chi-Squared Tests for ETF and Graft Uptake

	Value	df	p
X^2	15.576	1	< .001
N	90		

Table 18. Log Odds Ratio for ETF and Graft Uptake

		95% Confidence Intervals		
	Log Odds Ratio	Lower	Upper	p
Odds ratio	-3.195	-5.334	-1.055	
Fisher's exact test	-3.155	-6.997	-1.052	< .001

IV. Discussion

Patients with impaired eustachian tube function i.e 28 (31.1%) graft uptakefollowing tympanoplasty seen in 20 (71.4%) and failure of graft uptake is seen in 8 (28.5%) patients.

χ^2 test was employed to test the association of Eustachian tube function with outcome of surgery in the form of graft uptake. It had a p value of <0.001 and showed that there was significant association between normal Eustachian tube function and outcome of surgery in the form of graft uptake. This proved that normal eustachian tube function plays a major role in the graft uptake.

Chi squared test to see the association between normal Eustachian tube function and graft uptake had a p value<0.001 and hence showed a significant association. Student t test had a p value <0.001 and showed that there was significant association between normal eustachian tube function and improvement in hearing loss after surgery. Student t test had a p value <0.001 and showed that there was significant association between normal eustachian tube function and improvement in air bone gap after surgery.

The most common presenting complaint of the patients in their study was otorrhoea occurring in 53.33% of the patients. The patients had a discharge duration of 1 to 10 years. Maximum number of cases were seen in the quiescent disease stage accounting for 65% of the total cases on the first otoscopy visit. Out of 60 patients, 35 (58.33%) had a large central perforation whereas 22 (36%) had a moderate perforation and 3 patients (5 %) had a small perforation. Preoperative air bone gap was between 30- to 45 dB in 51.66% of the patients, whereas air bone gap was between 15 to 30 dB in 46.66% of the patients, and air bone gap was more than 45 dB in 1.66% of the cases. Eustachian tube function was found to be normal in 65% of the patients on impedance audiometry and it was found to be impaired in 35% of the patients. All the patients included in the study underwent type I Tympanoplasty. Proper functioning of Eustachian tube is essential for maintaining the pressure in the middle ear at the level of the ambient atmospheric pressure. This sequentially is paramount for the middle ear in order to function of impedence matching.. The study infers that adequate functioning of Eustachian tube is a pre requisite for the success of reconstructive middle ear surgery

V. Conclusion

- Total number of patients taken under study are 90 in number.
- Our study population comprised of 36 males and 54 females with a mean age of 28.08±14.37 years.
- Out of 90 patients , 62 patients has normal eustachian tube function and 28 patients had impaired eustachian tube function.
- For treatment 44 patients underwent right tympanoplasty and 46 patients underwent left tympanoplasty. Among them 90% (81) patients has successful tympanoplasty with graft uptake and 10% (9) patients had graft uptake failure.
- On tympanometric assessment 62 (68.9%) patients had normal Eustachian tube function and 28 (31.1%) patients had impaired Eustachian tube function. Out of 62 (68.9%) patients with normal eustachian tube function, successful tympanoplasty with graft uptake was seen in 60 (96.7%) of patients and failure of graft uptake was seen in 2 (3.6%) patients.
- Patients with impaired eustachian tube function i.e 28 (31.1%) graft uptake following tympanoplasty seen in 20 (71.4%) and failure of graft uptake is seen in 8 (28.5%) patients.
- The mean hearing loss for the patients included in our study improved from 37.07±8.56 dB before surgery to 27.05±8.29 dB after surgery.
- The mean air bone gap for the patients included in our study improved from 16.99±7.69 dB before surgery to 9.78±5.27 dB after surgery.

- Chi squared test to see the association between Eustachian tube function and graft uptake had a p value<0.001 and hence showed a significant association.

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