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Eustachian tube functional assessment among patients with CSOM undergoing tympanoplasty surgery

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ABSTRACT

Background: Pre-operative test of eustachian tube (ET) function is important for achieving a satisfactory result of tympanoplasty for CSOM patients. The saccharin test and methylene blue test seems to provide adequate information of the mucociliary function and patency of the ET. The aim was to study the ventilatory and mucociliary function of Eustachian tube in patients with chronic suppurative otitis media planned for tympanoplasty surgery and to assess the success rate of tympanoplasty in relation to the Eustachian tube function

Methods: A prospective longitudinal study was conducted for a period of one year. Patients aged more than 15 years with features of chronic suppurative otitis media of either tubotympanic type or atticoantral type were included in the study. The total number of study subjects included in our study was 82 patients with CSOM. The ventilatory and the mucociliary functions of the auditory tube were assessed preoperatively using saccharin test and methylene blue test. All patients with CSOM underwent tympanoplasty surgery and the outcome of the surgery was assessed.

Results: The overall success rate of tympanoplasty surgery was 76.8%. It was observed in our study that the success rate of tympanoplasty was higher among patients with normal eustachian tube function.

Conclusions: Preoperative evaluation of eustachian tube function is mandatory for all the patients planned for tympanoplasty. Preoperative and intraoperative corrective measures should be taken in patients with partial and absent tubal function to improve the success rate of tympanoplasty surgeries.

Keywords: Eustachian tube functions, CSOM, Tympanoplasty, Saccharine test, Methylene blue test

INTRODUCTION

The eustachian tube (ET) is a dynamic conduit between the middle ear and the nasopharynx with secretory, ciliary, and dilatory functions. It serves to regulate air pressure in the middle ear and mastoid system, clear secretions from the middle ear, and prevent reflux of material or sound from the nasopharynx. The normal length of ET in adults measures between normal 31–38 mm. Fluid and secretions in the middle ear are cleared by a combination of muscular pumping action associated with the tubal closing process and by mucociliary activity.^{1,2} The bony portion which is lined by a thin layer

of cuboidal respiratory epithelium, is a fixed conduit, and is normally patent.³

In a study done by Gimenez et al had quoted that a properly functioning Eustachian tube is an integral part of a normally functioning middle ear and the existence of good tubotympanic mucociliary drainage constitutes a favorable prognostic factor in the outcome of middle ear reconstructive surgery.⁴ Choi et al concluded that tubal function as evaluated by inflation-deflation method was a good indicator of well aerated tympanum, as well as of better postoperative hearing attainment. They further stressed that tubal function can be used in planning and

selection of surgical methods for tympanoplasty.⁵ A pre-operative test of tubal function is important for achieving a satisfactory result of tympanoplasty.

In general, middle ear lesions in patients with chronic otitis media accompany structural changes that affect the sound transmission mechanism from the tympanic membrane to the oval window. These include destruction of the ossicular chain, tympanic membrane perforations, Eustachian tube dysfunction, and cholesteatomas.⁶ Mishiro, et al reported that abnormalities of the ossicular chain are the most important factor affecting hearing outcomes after a long-term follow-up of >5 years.⁷ In contrast, Kim, et al reported that the preoperative presence of cholesteatoma or otorrhea can affect postoperative hearing outcomes, and other reports also considered whether the status of middle ear mucosa, Eustachian tube function, and revision surgery can affect postoperative hearing.^{8,9}

There is a general agreement that adequate eustachian tube function is necessary for successful middle ear surgery.¹⁰ Opinions have differed on the value of preoperative tubal function tests in chronic otitis media. Studies of eustachian tube patency have been studied by the Politzer, Valsalva, and Toynbee maneuvers. In other cases it has been accomplished by testing air transport through the eustachian tube by tympanometry, sonotubometry, and air pressure equalization technique. However, these methods do not evaluate the drainage function, which may be impaired even though the tube is anatomically open.¹¹ The saccharin test seems to provide adequate information of the mucociliary function and patency of the ET. As of today only very few studies had been conducted in assessing the eustachian tube functions prior to tympanoplasty surgeries and so the present study was undertaken in assessing the ET function by using saccharine perception time and methylene blue clearance time before performing tympanoplasty surgery and assessing the post-surgical impact based on the ET function.

AIM

To study the ventilatory and mucociliary function of Eustachian tube in patients with chronic suppurative otitis media planned for tympanoplasty surgery and to assess the success rate of tympanoplasty in relation to the Eustachian tube function.

METHODS

A prospective longitudinal study was conducted in the ENT department of Thanjavur Medical College Hospital for a period of one year between January 2014 to January 2015. The study was started after getting the clearance from the institutional ethical committee. Patients aged more than 15 years with features of chronic suppurative otitis media of either tubotympanic type or atticotympanic type were included in the study. Patients less than 15

years, with any fungal infections or a tumor or mass in the nasopharynx causing ET dysfunction were excluded from the study. Based on our inclusion and exclusion criteria the total number of study subjects included in our study was 82 patients with CSOM. A detailed history and a complete ENT examination were performed to rule out any other ENT diseases which would have an impact on the outcome of tympanoplasty surgery. All patients who were subjected for surgeries underwent an otoendoscopic examination and a diagnostic nasal endoscopy.

The ventilatory and the mucociliary functions of the auditory tube were assessed preoperatively in all the patients by the following methods.

Valsalva test

This test was performed by creating high positive nasopharyngeal pressures on the Eustachian tube. If the tube is patent, bulging or the movement of the tympanic membrane is seen with the help of otoscope or otoendoscope. In partial dysfunction or total dysfunction of the tube restricted or nil movement is seen. This is the most sensitive and a valuable test.¹²

Siegelization

It is performed by using snugly fitting ear speculum and Siegel's bulb attached to the otoscope. The gush of air is transferred into the external auditory canal and then over the tympanic membrane to produce a movement of the membrane, provided there should not be any adhesions between the membrane and the middle ear.¹²

This test is a simple and cost effective test can be done in all the patients to detect the ventilatory function.

Saccharin test

The patient was made to lie in a supine position than using the microscope the saccharin powder is kept in the middle ear through the perforation and the time required for feeling the sweetness was measured. Based on the results the patients were classified as normal (perception time <20 mins), partial dysfunction (perception time 20–45 mins) and gross dysfunction (perception time >45 mins).¹²

Methylene blue dye test

Four to six drops of sterile blue dye was placed using the operating microscope on the middle ear mucosa through the defect in the tympanic membrane. By using the 0° Hopkins rod the nasopharyngeal end of the Eustachian tube orifice was focused to assess the clearance time of the dye and based on the results the patients were classified as normal (clearance time <10 mins), partial dysfunction (clearance time 10–20 mins) and gross dysfunction (clearance time >20 mins).¹²

The surgery was done through the William Wilde's postaural approach, the graft used for this procedure was taken from the temporalis fascia. The eroded ossicles were removed which was later used as an autologous graft for the ossiculoplasty. The mastoid cavity drilled by using the electrical burr, the antrum, the aditus were identified, the diseased air cells and the granulation tissue were removed. The cholesteatoma found along the way were removed. Depending upon the disease pathology the simple or modified radical mastoidectomy was done to the patient. The harvested temporalis fascia was kept in the underlay technique with anterior tucking done. The ossicular chain reconstruction was done in patients with eroded ossicles simultaneously, the ossicular graft was stabilized by the gelfoam and the middle ear packed with the gelfoam in order to support the temporalis fascia graft. The graft status was assessed by the otoendoscopy once in 15 days, at the end of the 3rd month the graft was assessed again with the otoendoscopy, tympanometry and pure tone audiometry. The outcome of the surgery was classified as

- Successful - the healed graft with proper middle ear aeration.
- Retracted or atelectatic graft.
- Graft failure or perforation of graft secondary to otitis media.

The later two outcomes (b and c) were taken as failures.

All data were entered and analyzed using SPSS version 22. Mean and standard deviation were derived for all parametric variables. Statistical inference was derived either by using T test or ANOVA for parametric variables and similarly Chi-square or Man-Whitney U test for non-parametric variables considering $p < 0.05$ as statistically significant.

RESULTS

The majority of the study subjects were in the age group between 20 and 30 years with a minimum age of 17 and the maximum age was 56 with a mean age of 26.8 years. In our study the females had outnumbered males with a male: female ratio of 0.67: 1, it shows that the CSOM was found to be more common among females than the

males (Table 1). The distribution of age group between males and females did not show a statistical significant difference ($p=0.384$). In our study subjects unilateral CSOM was found to be more common and the bilateral CSOM was seen only in 23% of the study subjects. CSOM was classified as attico antral type and tubo-tympanic type. Attico-antral type was found to be more common than the tubo-tympanic type and the involvement of right ear was more common than the left ear (Table 2). Saccharine perception time test was done to assess the functional aspect of Eustachian tube. In our patients we found only 29% with CSOM had normal Eustachian tube function, where as 14.5% had partial dysfunction and more than 50% of the patients had total dysfunction of the Eustachian tube. The Eustachian tube dysfunction did not show a statistical significant association between the type of CSOM, the type of dysfunction was found to be almost similar in both the attico-antral type and tubo-tympanic type (Table 3). Another test which was performed to assess the Eustachian tube patency was methylene blue clearance time and the results shown was almost similar to the results of the saccharine perception time test, where the clearance time did not show any difference between the attico-antral type and the tubo-tympanic type (Table 4). All the CSOM patients had underwent tympanoplasty surgery which is measured in terms of success and failure rates and the rates were compared with their Eustachian tube functions. The overall success rate of tympanoplasty surgery was 76.8%. It was observed in our study that the success rate of tympanoplasty was higher among patients with normal Eustachian tube function followed by patients with partial dysfunction, whereas in total dysfunction of Eustachian tube the success rate was only 64% and the difference in the rate was found to be statistically significant. So it can be inferred that Eustachian tube function is one of the major predictor for the successful outcome of tympanoplasty surgery (table 5). It was also seen in our study that the type of CSOM had influenced the outcome of the tympanoplasty surgery. Patients with tubo-tympanic type of CSOM had a higher success rate than the patients with attico-antral type and this difference was found to be statistically significant (Table 6). Similarly the success rate of the tympanoplasty surgery in unilateral CSOM was found to be significantly higher than the bilateral CSOM.

Table 1: Age and gender wise distribution of the study subjects.

Variables	Male	Female	Total	P value
Age group (in years)	N (%)	N (%)	N (%)	
15-20	0	3 (6.1)	3 (3.6)	0.384
21-25	13 (39.3)	23 (46.9)	36 (43.9)	
26-30	12 (36.3)	13 (26.5)	25 (30.4)	
31-35	1 (3)	2 (4)	3 (3.6)	
36-40	3 (9)	4 (8.1)	7 (8.5)	
41-45	1 (3)	3 (6.1)	4 (4.8)	
46-50	2 (6)	0	2 (2.4)	
>50	1 (3)	1 (2)	2 (2.4)	
Total	33 (100)	49 (100)	82 (100)	
Mean±SD	27.3±6.4	25.7±7.5	26.8±6.8	

Table 2: Distribution of the study subjects based on the type of CSOM and the side of involvement of CSOM.

Type of CSOM	Right ear	Left ear	Bilateral	Total
	N (%)	N (%)	N (%)	N (%)
Attico antral type	24 (70.5)	16 (55.1)	13 (68.4)	53 (64.6)
Tubo tympanic type	10 (29.4)	13 (44.8)	6 (31.5)	29 (35.3)
Total	34 (100)	29 (100)	19 (100)	82 (100)

Table 3: Saccharine perception time and the type of CSOM among the study subjects.

Saccharine perception time	Attico antral type	Tubo tympanic type	Total	P value
	N (%)	N (%)	N (%)	
<20 mins (normal)	16 (30)	8 (27.5)	24 (29.2)	0.271
20–45 mins (partial dysfunction)	7 (13.2)	5 (17.2)	12 (14.6)	
>45 mins (total dysfunction)	30 (56.6)	16 (55.1)	46 (56)	
Total	53 (100)	29 (100)	82 (100)	

Table 4: Methylene blue clearance time and the type of CSOM among the study subjects.

Methylene blue clearance time	Attico antral type	Tubo tympanic type	Total	P value
	N (%)	N (%)	N (%)	
<10 mins (normal)	17 (32)	8 (27.5)	25 (30.4)	0.269
10–20 mins (partial dysfunction)	6 (11.3)	5 (17.2)	11 (13.4)	
>20 mins (total dysfunction)	30 (56.6)	16 (55.1)	46 (56)	
Total	53 (100)	29 (100)	82 (100)	

Table 5: Postoperative outcome of tympanoplasty surgery with their eustachian tube function.

ET function	Tympanoplasty outcome		Total	P value
	Success	Failure		
	N (%)	N (%)	N (%)	
Normal	24 (96)	1 (4)	25 (100)	<0.001
Partial dysfunction	10 (83.3)	2 (16.7)	12 (100)	
Total dysfunction	29 (64.4)	16 (35.6)	45 (100)	
Total	63 (76.8)	19 (23.2)	82 (100)	

Table 6: Postoperative outcome of tympanoplasty surgery based on the type of CSOM.

Type of CSOM	Tympanoplasty surgery		Total	P value
	Success	Failure		
	N (%)	N (%)	N (%)	
Attico antral type	39 (73.5)	14 (26.4)	53 (100)	<0.001
Tubo tympanic type	24 (82.7)	5 (17.3)	29 (100)	
Total	63 (76.8)	19 (23.2)	82 (100)	

DISCUSSION

The ETF has been the center of focus as a prognostic factor because of its presumed primary role in the pathogenesis of otitis media and in the aeration of middle ear cavity. The ETF is the most important determinant of

surgical outcome in patients with CSOM.¹³ A properly functioning Eustachian tube is an integral part of a normally functioning middle ear and the existence of good tubotympanic mucociliary drainage constitutes a favorable prognostic factor in the outcome of tympanoplasty.⁴ A preoperative test of tubal function is

therefore of the greatest interest, especially if such a test provides a possibility of estimating the chances of achieving a satisfactory result of tympanoplasty.¹⁰ Our study was conducted on 82 patients with CSOM for a period of one year and all the patients were followed up for a period of 3 months. The mean age of our study subjects with CSOM was 26.8 years which is almost in par with the study done by Shiromany et al and Tadke et al and further they had quoted that the incidence of CSOM was more prevalent in 2nd decade.^{14,15} In our study we found a female predominance in the incidence of CSOM and a similar type of results was also seen in the study done by Tadke et al and Holmquist et al, whereas few other studies had found a male preponderance and so we can't generalize a particular gender as more risk for developing CSOM.¹⁵⁻¹⁹

Foreign materials introduced into the middle ear are evacuated through the ET to the nasopharynx within minutes at a speed that corresponds with the known capability of cilia. The cilia are normally found embedded in a mucous layer over almost all the mucosa of the middle ear, on the inner layer of the TM, and in the ET. It is logical to assume that in disease states such as otitis media, the cilia play some part in evacuating the fluid that accumulates in the middle ear. Sade in 1967 reported qualitative studies on the mucociliary function of the ET. Several studies have evaluated ETF by using saccharin.²⁰ The saccharin test seems to provide adequate information of the mucociliary function and patency of the ET. This test is considered a valuable supplement to other existing tests for tubal function.¹⁰ The same concept is followed in our study for assessing the patency of eustachian tube and we found only 30% of patients with CSOM had normal functions of ET and the remaining 70% had either partial or total dysfunction of ET. The function of the Eustachian tube is a very important prerequisite for successful tympanoplasty. The study conducted by the Srivastava et al showed that there is a good graft uptake in the patients of normal tubal function.²¹ Similarly a study done by Prasad et al used Sacharrine and methylene blue test for assessing the patency of ET and most of the authors followed the same principle in evaluating the functions of ET.

In our study post-operatively we found the graft success rate was 96% among patients with normal ET function, whereas it was 83% in partial dysfunction of ET and 64% in total ET dysfunction and so we found a statistical significant association between the ET function and the tympanoplasty success rate and a similar type of findings was also quoted by Holmquist et al, Mackinnon et al, Moustafa et al.^{16,21,22} These studies had been conducted more than 3 decades ago but even the recent studies done by Shiromany and Belaldavar et al, Prasad et al had also mentioned a similar percentage of success and failure rates.^{12,14} Few other controversial results were also observed in few studies done by Sheehy and Glasscock, Sharp, Ekvall, Bluestone, Anderson where they observed a poor association between Eustachian tube function and

Tympanoplasty results in which they found more than 70% success rate in patients with poor tubal function.²³⁻²⁷

ETF is more complex than the test results reveal. Perhaps there are other functions or factors that are not ascertained by these tests. Although these tests assess the mucociliary transport mechanism, there may be factors related to the opening pressure or closure of the orifice or tube. Yet, the ETF tests are vital in the management of the middle ear with a TM perforation.

CONCLUSION

Preoperative evaluation of Eustachian tube function is mandatory for all the patients planned for tympanoplasty. Preoperative and intraoperative corrective measures should be taken in patients with partial and absent tubal function to improve the success rate. The saccharin test and the methylene blue test is an easy, simple, and cost effective method because it does not require any sophisticated equipment. It promises to be a useful diagnostic tool to assess the mucociliary function of the ET as well as its anatomical patency.

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