



Pre tympanoplasty assessment of patency and mucociliary function of Eustachian tube

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Abstract:

Introduction: Patency of the eustachian tube has been proved to be mandatory for successful tympanoplasty. Preoperative evaluation of the eustachian tube through Saccharin and methylene blue tests provides adequate information about the mucociliary function and patency of the eustachian tube

Objective: We aimed to evaluate the mucociliary function of the eustachian tube using saccharin and methylene blue tests, hence we could predict the outcome of tympanoplasty.

Patients and methods: This prospective study was done on 50 adult patients who were diagnosed as having unilateral tubotympanic type of chronic suppurative otitis media. All patients were subjected to preoperative evaluation of hearing and eustachian tube mucociliary function through saccharin and methylene blue dye clearance tests. Then, we correlated the results and the outcome of the surgery.

Results: According to our results, normal eustachian tube function (ETF) was found in 39 patients, while mild and gross dysfunction was found in eight and three patients respectively. The correlation between ETF and the outcome of tympanoplasty was proved to be statistically significant ($P < 0.001$), as 85.3% of patients with successful tympanoplasty had a normally functioning ET, while all of the patients with a gross dysfunction of ET had a failed surgery.

Conclusion: We found that both tests could be a helpful tool to assess the mucociliary function and anatomical patency of the eustachian tube. While, the Saccharin test has the advantages of cost-effectiveness, avoiding the painting produced by the dye, and lacking the need for an endoscope.

Keywords: Eustachian tube dysfunction, Ear surgery, Saccharin test, Methylene blue.

Introduction

A sound Eustachian tube (ET) is essential for a normal middle ear function. It plays a critical role in pathogenesis of otitis media, drainage of the middle ear, and therefore it represents an essential demand for the best results in tympanoplasty.¹

A preoperative evaluation of ET function is therefore of a great interest, particularly if such a test provides the ability of predicting the chances of achieving the optimum result of

tympanoplasty. ET patency has been assessed by many tests as Valsalva, Toynbee, and the Politzer maneuvers. Other tests include tympanometry, sonotubometry, and the nine step inflation deflation tympanometric tests.²

Still these methods do not estimate the drainage function, which may be impaired even though the tube is anatomically patent.³

Saccharin and methylene blue dye tests give acceptable information about

the mucociliary function and patency of the eustachian tube.⁴

Patients and Methods:

We enrolled 50 adult patients who were diagnosed as having unilateral tubotympanic type of chronic suppurative otitis media (dry perforation). Their age ranged from 18-65 with mean age of 38.26 ± 11.77 .

Exclusion criteria included; Active stage of CSOM, atticointral type of CSOM, cleft palate, severely deviated nasal septum, adenoids, sinonasal polypi, otomycosis, previous middle ear surgery, loss of taste sensation, and patients with sensorineural hearing loss.

All patients were enrolled after explaining the study and obtaining a written consent.

I-Preoperative evaluation

1. **Detailed history** was obtained to exclude vertigo, recent ear discharge, ear trauma, middle ear surgery, and the status of other ear. Then, nasal and pharyngeal examination was done to rule out any associated infection, which could affect the result of tympanoplasty. Finally, otoscopic examination was done to detect the size and site of perforation. We classified the perforation into anterior, posterior, and subtotal perforation.
2. **Audiological tests:** Pure tone audiometry (PTA) (Audiometer AD229, interacoustics company, Denmark) was done. We recorded the type and degree of hearing loss, and, air conduction thresholds and the mean air bone gap between 0.5-4 KHz. Then, tympanometry (Audiometer AZ26, interacoustics company, Denmark) was done to measure the middle ear pressure.

3. Testing clearance function of Eustachian tube by Saccharin and Methylene blue test.

Saccharin test:

We prepared Saccharin solution with one teaspoon saccharin granules dissolved in 10 ml sterile water.

Then, the patient was seated and head was tilted to the other side, two drop of sterile sugary Saccharin solution were placed in the middle ear through the TM defect by a dropper.

The time needed to taste the saccharin (Saccharin perception time SPT) was measured. The results were classified into three groups; if SPT less than 20 minutes, ET function is considered normal, if SPT between 20- 45 minutes, patients were considered to have a partial dysfunction of ET and, if SPT more than 45 minutes, patients were considered to have a gross dysfunction of the ET.

Methylene blue dye test:

At first, we applied a nasal pack soaked in a solution composed of mixture of xylometazoline hydrochloride 0.1% and xylocaine 10% (1:1) for 10 minutes. Then, we applied three drops of sterile methylene blue dye in the middle ear through the TM perforation after tilting the head to the opposite side.

Then, 0-degree sinuscope (Karl Storz, Germany) is passed through the nose till we could see the opening of the ET. The time interval between the applications of the dye till its appearance in the nasopharyngeal opening was measured.

The results were classified into three groups as follows; if methylene blue clearance time less than 10 minutes, patients were considered to have a normally functioning ET, if clearance time between 10 to 20 minutes, patients were considered to have a partial dysfunction, and if clearance time more than 20 minutes, patients were

considered to have a gross ET dysfunction.

II-Operative interference: All patients had underlay tympanoplasty type 1 without mastoidectomy using surgical microscope (Leica Microsystems, Germany) under general orotracheal anesthesia through postauricular incision. We utilized either, temporalis fascia graft alone or combined with conchal cartilage graft .

III-Postoperative evaluation:

All patients were evaluated three months postoperatively as follows; otoscopic examination for graft healing and PTA including calculation of both hearing gain and mean air bone gap through comparing preoperative and postoperative PTA at each frequency.

The study was reviewed by the scientific and ethical committee of the Faculty of Medicine, Assiut University, and ethical approval was obtained (No: 17100061).

Statistical analysis:

We used Statistical Package for the Social Science (SPSS), version 20, IBM, and Armonk, New York.

Continuous data was expressed in type of average mean \pm SD while of nominal type was expressed in type of percentage. Frequency tables and charts were used. Chi-square test was used to compare nominal data of different groups.

The standard of certainty was hold at 95% and thus, if the P value was < 0.05 , it was considered as significant.

Results:

We enrolled 50 patients with their age ranged from 18 to 65 years old. The mean age was 38.26 ± 11.77 years. Out of the patients; 31 (62%) patients were males and 19 (38%) patients were females. Also, 39 (78%) patients were

nonsmokers and 11 (22%) patients were smokers.

It was also noticed that diabetes mellitus, hypertension and both of them were present in nine (18%), three (6%), and two (4%) patients respectively. all patients had a history of ear discharge of variable duration.

Earache, hearing loss, tinnitus, and vertigo were reported in some patients. Preoperative tympanometry showed leakage in 39 patients and a flat curve at high pressure as shown in (Table 1).

Table 1: Patients' characteristics

Variable	Number	%
Ear discharge	50	100%
Hearing loss	42	84%
Tinnitus	45	90%
Vertigo	20	40%
Ear ache	31	62%
Tympanometry		
Leakage	39	78%
Flat at high pressure	11	22%

As regards to Saccharin test, normal eustachian tube function was found in 38 patients (76%), partial ET dysfunction was found in nine patients (18%), and gross ET dysfunction was found in three patients (6%).

Saccharin perception time ranged from 12 to 48 minutes with a mean value of 18.18 ± 6 minutes. On the other hand, methylene blue dye test showed normal function in 40 patients (80%), partial ET dysfunction in seven patients (14%), and gross ET dysfunction in three patients (6%). The mean value for methylene blue clearance time was 7.98 ± 3.5 minutes with a range of 5-26 minutes.

Then, the mean values of both tests was calculated, thus we found a normal eustachian function in 39 patients, partial dysfunction in eight, and a gross dysfunction in three patients (Table 2).

We also noticed, the mean age in patients with normal eustachian tube

was 35.38 ± 9.64 years, that was significantly lower ($P < 0.001$) than the mean age in patients with partial (44.13 ± 13.06 years) and gross dysfunction (60 ± 5 years) (table 3).

It was found that, different grades of eustachian tube function had insignificant correlation ($P = 0.68$) to sex as shown in (Table 4).

There was a significant correlation between eustachian tube function and presence of general medical comorbidity where majority (79.5%) of patients with normal function had no comorbidities, while diabetes mellitus was significantly correlated to gross dysfunction of ET (Table 5).

Regarding to the type of graft material, we have utilized temporalis fascia graft alone in 27 patients (54%), cartilage graft in 12 patients (24%), and both grafts in 11(22%). Three months postoperatively, it was found that the graft was taken in 43 (86%) patients, while seven (14%) patients had broken graft. Patients with broken grafts had recurrent otorrhea within the first month postoperatively either after an attack of upper respiratory catarrh or due to a trauma .

Hearing threshold was evaluated 3 months postoperatively and 22 (44%) patients showed a normal audiogram, while 12 (24%) and seven (14 %) patients had a mean air conduction threshold of 29.34 dB and 43.33 dB respectively (Table 6).

It was noticed that the function of Eustachian tube significantly affects the outcome, since 85.3% of patients (35 out of 41) with a successful outcome had a normally functioning eustachian tube. Also, none of the patients that had a gross dysfunction had a successful outcome. In other words, 89.7% of patients with a normally functioning eustachian tube (35 out of 39) had a successful outcome (Table 7).

Table 2: Results of saccharin and methylene blue dye test.

ET function	Saccharin test	Methylene blue test	Mean of both tests
Normal	38 (76%)	40 (80%)	39 (78%)
Partial dysfunction	9 (18%)	7(14%)	8 (16%)
Gross dysfunction	3 (6%)	3 (6%)	3 (6%)
Range (minutes)	12-48	5-26	-
Mean time	18.18 ± 6	7.98 ± 3.5	-

Data expressed as frequency (percentage).

Table 3: Correlation between age of patients and ET Function.

ETF	Mean age in years	Number of patients
Normal	35.38 ± 9.64	39(78%)
Partial dysfunction	44.13 ± 13.06	8(16%)
Gross dysfunction	60 ± 5	3(6%)
P value < 0.001		

Data expressed as mean (SD). P value was significant if < 0.05

Table 4: Correlation between sex of patients and Eustachian tube function

ET function	Male	Female	Total
Normal	23 (59%)	16 (41%)	39 (78%)
Partial dysfunction	6 (75%)	2 (25%)	8 (16%)
Gross dysfunction	2(66.7%)	1 (33.3%)	3 (6%)
Total	31(62%)	19(38%)	50 (100%)
P value	0.68		

Data expressed as mean (SD). P value was significant if < 0.05

Table 5: Correlation between the presence of comorbidity and Eustachian tube function

	Normal ETF (N= 39)	Partial dysfunction (N= 8)	Gross dysfunction (N= 3)	Total
DM	4 (10.3%)	3 (37.5)	2 (66.7%)	9
HTN	2 (5.1%)	1 (12.5%)	-	3
DM& HTN	2 (5.1%)	-	-	2
None	31 (79.5%)	4 (50%)	1 (33.3%)	36
P value 0.01				

Data expressed as frequency (percentage). N: number, ETF: eustachian tube function; DM: diabetes mellitus, HTN: hypertension

Table 6: Preoperative and 3 months postoperative hearing thresholds among enrolled patients

Degree of hearing loss (dB)	Number of patients	
	Preoperative	Postoperative
Normal <20	0	22(44%)
Mild (25-40)	22	12(24%)
Moderate (40-55)	10	7 (14%)
Moderately severe (55-65)	18	9 (18%)

Data expressed as frequency (percentage).

Table 7: Correlation between ETF and outcome of tympanoplasty

ETF	Successful	Failed	Total
Normal	35(85.36%)	4 (44.4%)	39(78%)
Partial dysfunction	6 (14.6%)	2 (22.2%)	8(16%)
Gross dysfunction	-	3(33.3)	3(6%)
P value	< 0.001		

Data expressed as mean (SD). N: number. P value was significant if < 0.05

Discussion:

Studies classifying eustachian tube function as normal, partial, and gross dysfunction according to SPT contain different values. In the research of Gimenez and Algarra, participants that had a SPT lower than 20 minutes were assorted to have a normal ETF, while those with a SPT of 20-90 minutes were considered to have partial ETD, and gross ETD was diagnosed if SPT was more than 90 minutes (5). Srivastava et al., classified participants into two categories as follows; SPT less than 45 minutes indicates a patent ET and SPT more than 45 minutes indicates a blocked ET (6). The variation in values of these researches seems to be due to the use of different materials that vary in their solubility. In our research, classification of ETF according to SPT was done in agreement with a study done by Prasad et al., with the same material and technique (7). Our research was supported by Rogers et al., who applied fluorescent dye and found that, dye injected in the middle ear can reach the nasopharynx in 10 minutes or less (8). Also, Takahashi et al., noted normal ET clearance to be within 10 minutes (9).

Regarding the use of methylene blue dye, Prasad et al., reported that normal methylene blue clearance time was less than 10 minutes (7). In our research, the classification of ETF as normal, partial dysfunction and gross dysfunction depending on the values of methylene blue clearance time, was similar to that

reported by Prasad et al., Rogers et al. and Takahashi et al. studies (8, 9).

Prolongation of SPT than methylene blue clearance time in different groups of ETF, seems to be due to the time needed for saccharin to stimulate taste receptors after being transmitted through the ET. In our study, results of Saccharin and methylene blue dye tests were nearly similar.

Both tests are described to have disadvantages, as they require keeping the patient in a certain position. Also, methylene blue dye test requires an endoscopic examination and results in blue painting of the mucosa. While, Saccharin test depends on the patient's response and integrity of the taste sensation. Although it might be argued that, instilling of a solution in the ear with a dry perforation may activate an episode of infection, this was not reported in any of our patients. Being of the same diagnostic values, more cost effective, avoid painting of the mucosa and done without the need of an endoscope, saccharin test seems to be more preferred in evaluating ETF.

Prasad et al., used Saccharin and methylene blue as a pre tympanoplasty evaluation of eustachian tube function. According to SPT, they found that out of 86 consecutive patients included in their study, 64 patients had a normal Eustachian tube function, 19 patients had a partial dysfunction and three patients had gross dysfunction. In methylene blue dye test, normal ETF was found in 67 patients, partial dysfunction in 16 patients, and gross

dysfunction in three patients (7). Their results were similar to these found in our study.

In our study, we found that gross dysfunction of ET was significantly related to diabetes mellitus, although such group was small in number. This could be explained by the implication of DM in causing recurrent infections.

Biswas settled that impaired tubal function is the main reason of persistent recurrent otorrhea and consequential contributing factor for tympanoplasty failure (10). In our study, we found that 89.7% of patients with a normally functioning eustachian tube and 75% of patients with a partially functioning eustachian tube had a successful tympanoplasty, and none of the patients with a gross dysfunction of eustachian tube had a successful outcome. Nearly similar results were found in the study of Prasad et al., who reported that 93% of patients with normal ETF and 68 % of patients with partial ETD had successful tympanoplasty. Those with gross dysfunction had a 100% graft failure (7).

Study limitations:

Although preoperative evaluation of eustachian tube function helped us to predict the outcome but, the tests needs good experience by the physician and cooperation from the patients. Saccharin test is also subjective and methylene blue results in blue staining of the mucosa which may hinder vision during surgery. Also, we have used different grafts which might affect the outcome.

Conclusion:

This study shows that ETF tests can help to predict the outcome of tympanoplasty and they must be a part of the investigations prior to manage a TM perforation. We also found that the

saccharin test is a very important method to assess the mucociliary function of the ET as well as its anatomical patency. Over the methylene blue test, the saccharin test has the advantages of cost effectiveness, avoiding the painting produced by the dye and lacking the need for an endoscope.

Conflicts of interest: None of the authors have any conflicts of interest to declare.

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