

Clinicoanatomical Relationship between Eustachian Tube Dysfunction and Middle Ear Disease

Chaitanya C. Bharadwaj¹, Hanumant Giri², Pooja Nayak³, Deepti Kulkarni⁴,
Rahul Shenoy⁵

¹Associate Professor, Department of Otorhinolaryngology, SMBT Institute of Medical Sciences & Research Centre, Nashik, Maharashtra

²Associate Professor, Department of Otorhinolaryngology, SMBT Institute of Medical Sciences & Research Centre, Nashik, Maharashtra

³Assistant Professor, Department of Otorhinolaryngology, SMBT Institute of Medical Sciences & Research Centre, Nashik, Maharashtra

⁴Assistant Professor, Department of Otorhinolaryngology, SMBT Institute of Medical Sciences & Research Centre, Nashik, Maharashtra

⁵Resident, Department of Otorhinolaryngology, SMBT Institute of Medical Sciences & Research Centre, Nashik, Maharashtra

Received: 30-10-2022 / Revised: 20-11-2022 / Accepted: 02-12-2022

Corresponding author: Dr Deepti Kulkarni

Conflict of interest: Nil

Abstract

Objectives: The main objective of this study is to assess the ET function and its relationship with middle ear disease and outcome of tympanoplasty.

Method: The patients, age ranges from 13 yrs to 55 yrs presented with perforation of tympanic membrane were selected. Anatomical evaluation of Eustachian tube patency was tested clinically, radiologically. Patients underwent tympanoplasty. Post operative results were analysed and compared with preoperative analysis of the Eustachian tube function.

Results: Total 30 patients were included in study, amongst whom 11 were males and 19 were females. Ear discharge followed by loss of hearing were main complaints preoperatively. Patients with normal Eustachian tube function preoperatively showed good results in terms of tympanic membrane healing and improvement in hearing. Patients with hypofunction or obstruction of Eustachian tube showed persistent of ear discharge, non-healing of tympanic membrane or non-improvement in hearing in postoperative period.

Conclusion: There is positive correlation between the Eustachian tube dysfunction and middle ear disease. Patients with the Eustachian tube dysfunction in preoperative period has negative effect on surgical outcome.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Among several factors related to the outcome of ear surgery, Eustachian tube function has been considered to be one of the more important prognostically. The relation

between the results of tympanoplasties and tubal function has been studied and found to be useful to predict the outcome of surgery. It has been still mystery about the role of

Eustachian tube etiological, pathological or prognostic in case of middle ear disease and various middle ear surgeries. Therefore in this study, pre-operative clearance function, ventilatory function and anatomical patency of Eustachian Tube, studied on CT scan has been compared with post operative clinical features and impedance audiometry. The main objective of this study is to assess the ET function and its relation with middle ear disease and outcome of tympanoplasty.

Material and Methods

30 patients of otitis media were examined. The patient's age ranges from 13 yrs to 55 yrs (24 yrs). All 30 patients were presented with perforation of tympanic membrane, in which tympanoplasties were performed with temporalis fascia graft and underlay technique. The follow up period was 2 to 8 months for tympanoplasty patients. The mean period was 4 months.

The surgery was judged to be successful when there was no perforation, no atelectasis of eardrum, disappearance of otorrhoea and On the other hand, outcome of surgery was judged to be unsuccessful when more than one of the four criteria was unsatisfied. Anatomical evaluation of Eustachian tube patency was tested clinically, radiologically. Clinical evaluation was done by history taking, clinical examination.

Detailed history was taken and recorded accordingly in ear, nose or throat complaints.

Detailed clinical examination was done which included ear, nose and throat examination in detail. Ear examination included external auditory canal, pinna and tympanic membrane examination, mastoid tenderness and tuning fork tests. Presence or absence of septal deviation, cold spatula test were included in nose examination. While examining throat, congestion and or enlargement of tonsils, post nasal drip was

noted. In neck, any lymph node enlargement was noted.

During Valsalva's maneuver, swallowing and Toynbee maneuver movement of tympanic membrane noted. Also dye test done in patients with TM perforation in which methylene blue in middle ear discharged from the pharyngeal orifice of the tube within 15 mins.

Radiologically, in all preoperative patients, sequential contrast CT scan done at an exposure speed of 1 scan / sec. the tests were carried out with patients in prone position, chin slightly elevated to in parieto-submental view of the ET. A balloon catheter was inserted into the external auditory canal and about 5 ml of contrast medium instilled in the middle ear space via perforation in the drumhead with sufficient pressure. This was confirmed by instructing patient to indicate when the contrast material appeared in the pharynx. ET movement during swallowing was filmed at 1 scan/ sec for 10 sec. Each patients pure tone audiogram was done. In T'plasty patient's pre-operative and post operative PTA done. Also post operative patients with intact tympanic membrane were evaluated with tympanogram.

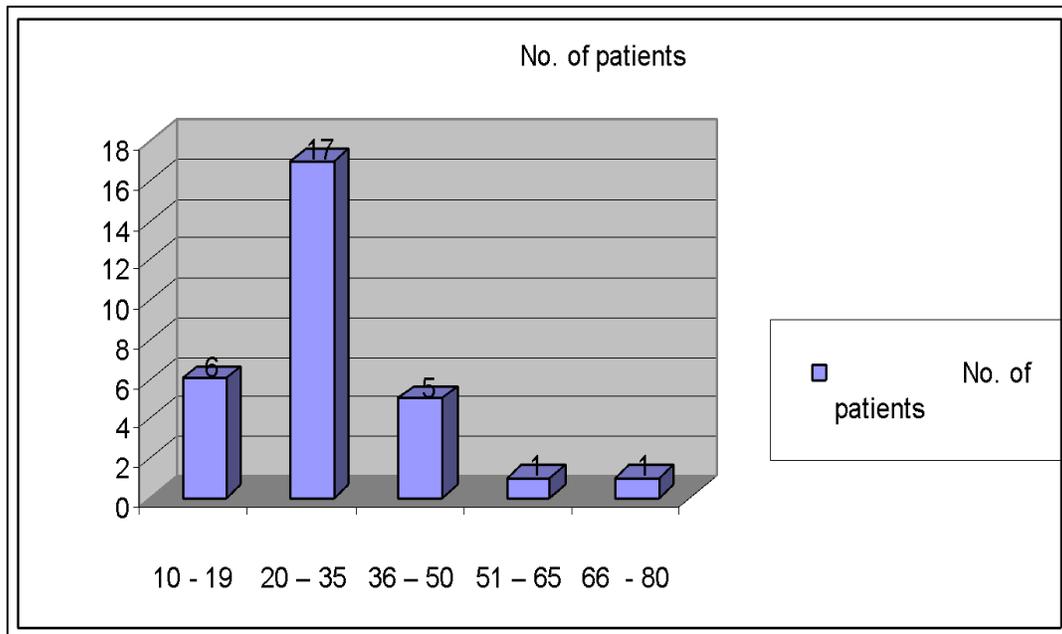
Patients presented with ear discharge with small to moderate size perforation were taken for surgery. Patients were given a course of antibiotics, antihistamines and local steroid drops. Ear was dry at the time of surgery. Temporalis fascia graft was harvested and Tympanoplasty was done in all patients using underlay technique.

Post operative, suture removal was done after one week. Patient was given one week of oral antibiotics. After suture removal, patient was kept on antihistaminic and local steroid ear drops for 3 weeks. They were asked to keep ear dry.

Post operative after 2 months, PTA and tympanogram were repeated.

Results:**Table 1: Age incidenc**

Age in years	No. of patients
10 – 19	6
20 – 35	17
36 – 50	5
51 – 65	1
66 - 80	1

**Figure 1: Age distribution****Table 2: Sex incidence**

Sex	No. of patients	Percentage
Male	11	36.66
female	19	63.33

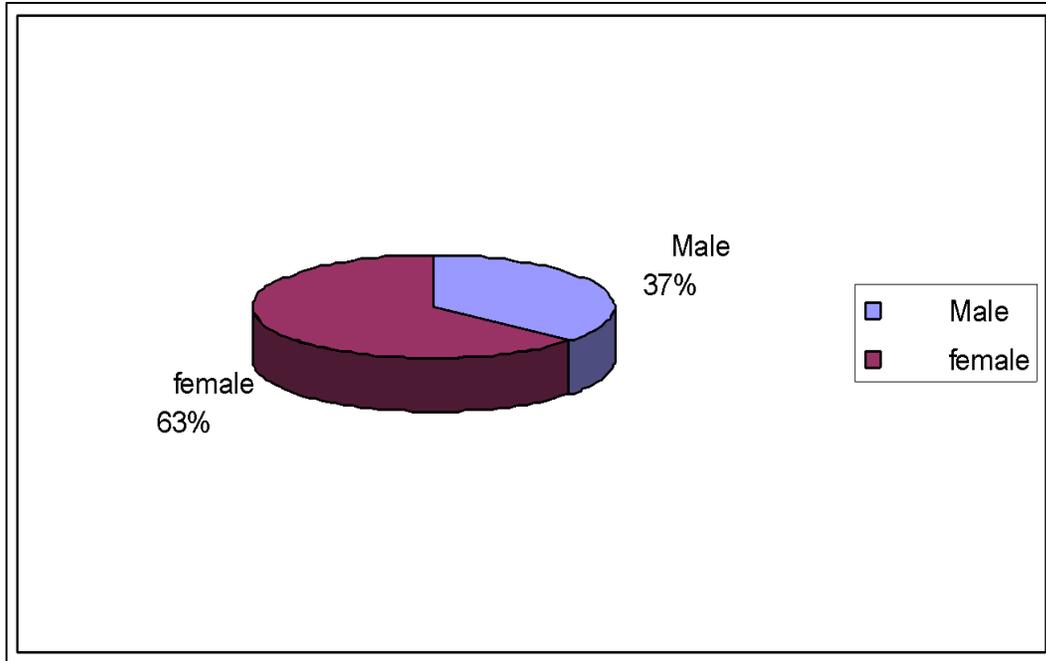


Figure 2: Sex distribution

Table 3: Clinical feature

Features	No. of patients	Percentage
Ear discharge	27	90
Hearing loss	13	43.33
Associated URTI	21	70
Associated DNS	7	23.33

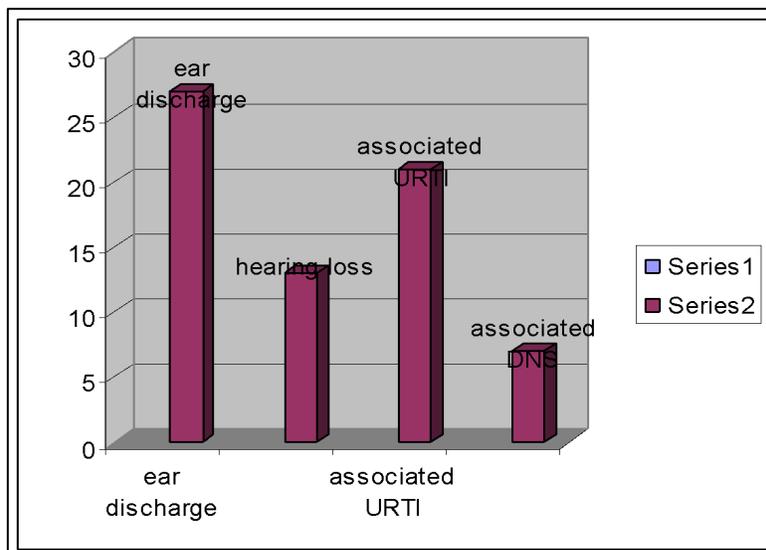


Figure 3: Clinical features

Table 4: Audiological findings Pre operative and post operative audiogram comparison

Hearing status	No of patients	Percentage
Static	2	6.66
Improved	26	86.68
worsened	2	6.66

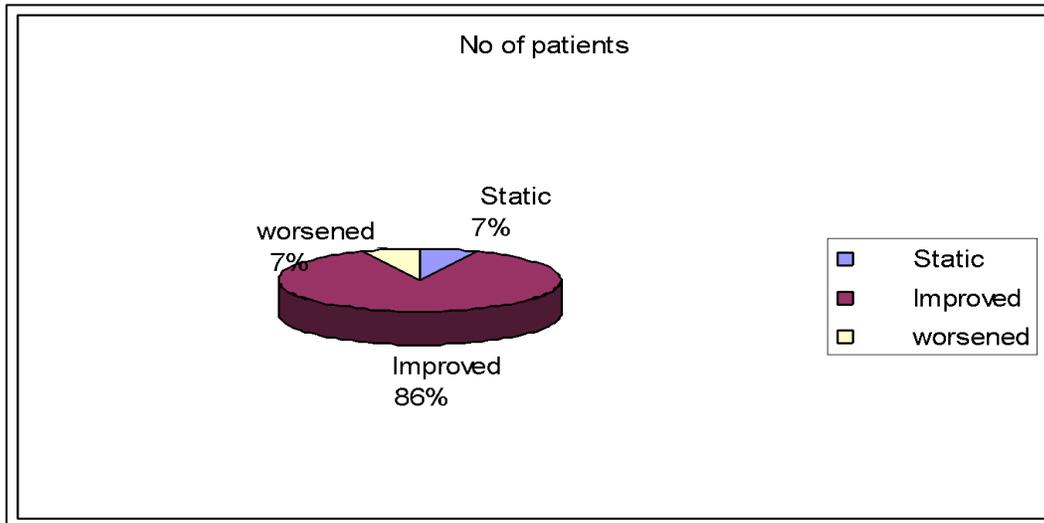


Figure 4: Hearing status

Radiological patency

The patient with dry perforation without middle ear inflammation, the contrast material instilled into the middle ear prior to swallowing was sucked into the cartilaginous portion at the beginning of swallowing; it was then lead to pharynx at the end of swallowing. During swallowing the tubal cavity of cartilaginous portion become enlarged due to larger movements of the walls.

In patients having active, discharging otitis media the cartilaginous portion did not open at all during swallowing but contrast medium did appear in the pharynx, probably as a result of relatively high pressure inside the ET. In those patients who had edematous mucosa in the middle ear, the instilled contrast medium did not enter into the ET even at the height of swallowing and only the osseous portion could be filmed.

Table 5: ET anatomical patency

ET function	No of patients	Percentage
Normal ET	16	57.14
Hypofunction	9	32.21
Obstruction	3	10.07

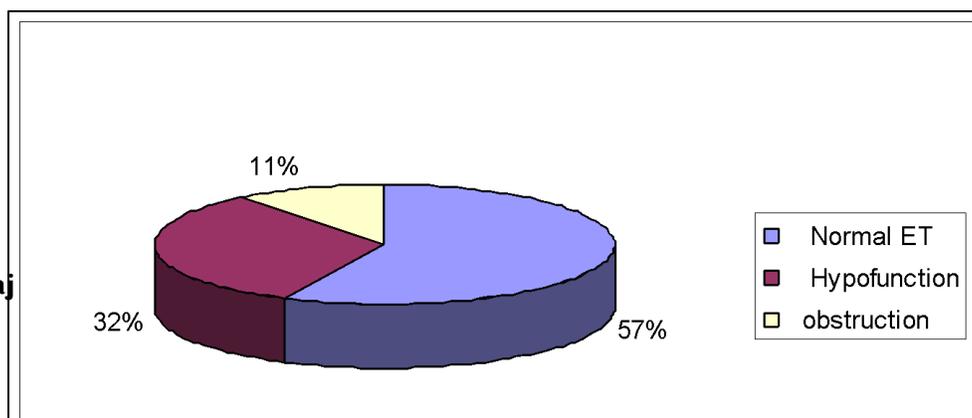


Figure 5: ET function on CT scan

Table 6: Pre operative CT findings and post operative tympanogram findings

ET function	Tympanogram A	Tympanogram B
Normal (16)	13	3
Hypo Function(9)	3	5
Obstru-Ction (3)	1	0

Discussion

It is difficult to distinguish between acute otitis media and otitis media with effusion. These are clinically two distinct conditions that affect two different age spectra.

Viral and bacterial infections

Most children have history of preceding upper respiratory tract infection which initially will be viral and will affect not only the mucosa of upper respiratory tract but also Eustachian tube and middle ear. Bacteria involved are invariably normal residential flora of upper respiratory tract. Streptococcus pneumoniae and Haemophilus influenza are the commonest organisms, making around 80 % of the isolates. Moraxella catarrhalis, Staphylococcus aureus are isolated in that order.

Eustachian tube

It seems that the adynamic bony part could be blocked by the mucosal oedema associated with an upper respiratory tract infection and be an aetiological factor in acute otitis media. Normal 3 yr old children are less able than adults to equalize an artificially induced negative middle ear pressure. This is because of the relative shortness and horizontal position of the tube might allow easier access

of bacteria from the nasopharynx to the middle ear.

In case of *otitis media with effusion*, along with infection and Eustachian tube dysfunction there are other factors like

Adenoid hypertrophy

Unresolved acute otitis media

In adults post nasal tumors mainly nasopharyngeal tumors, radiotherapy which is causing scarring at the opening of the ET tube, and AIDS can cause effusion in middle ear.

In 1960, W. House commented on the need for elimination of mucus membrane edema and granulations preoperatively and the use of polyethylene tubing in the Eustachian tube at the time of surgery. He concluded that closure of the ET seriously limited the possibility of success in tympanoplasty

In 1969, House, Glasscock and Miles reported on the technique of Eustachian tuboplasty through middle fossa approach.

Methods for testing the ET function across intact Tympanic membrane [1].

Early methods

A. Methods for recording the displacement of the drum.

1. Microscope inspection of the drum movements when air is passing through the tube
2. Determination of air passages through the Eustachian tube by auscultation in ear canal
3. Closed ear canal manometry
4. Quantitative determination of the volume displacement of the drum by flow volume meter [2].

B. Methods for recording the middle ear pressure change after air passage through the ET.

1. The impedance method
2. The pneumophone method)

C. Radiological methods for the anatomical patency of the Eustachian tube.

1. Narrowest (isthmus) portion of Eustachian tube: A computer aided three-dimensional reconstruction and measurement study [3].
2. Magnetic resonance imaging of Eustachian tube
3. Evaluation of clearance function of the Eustachian tube by sequential contrast CT [4]

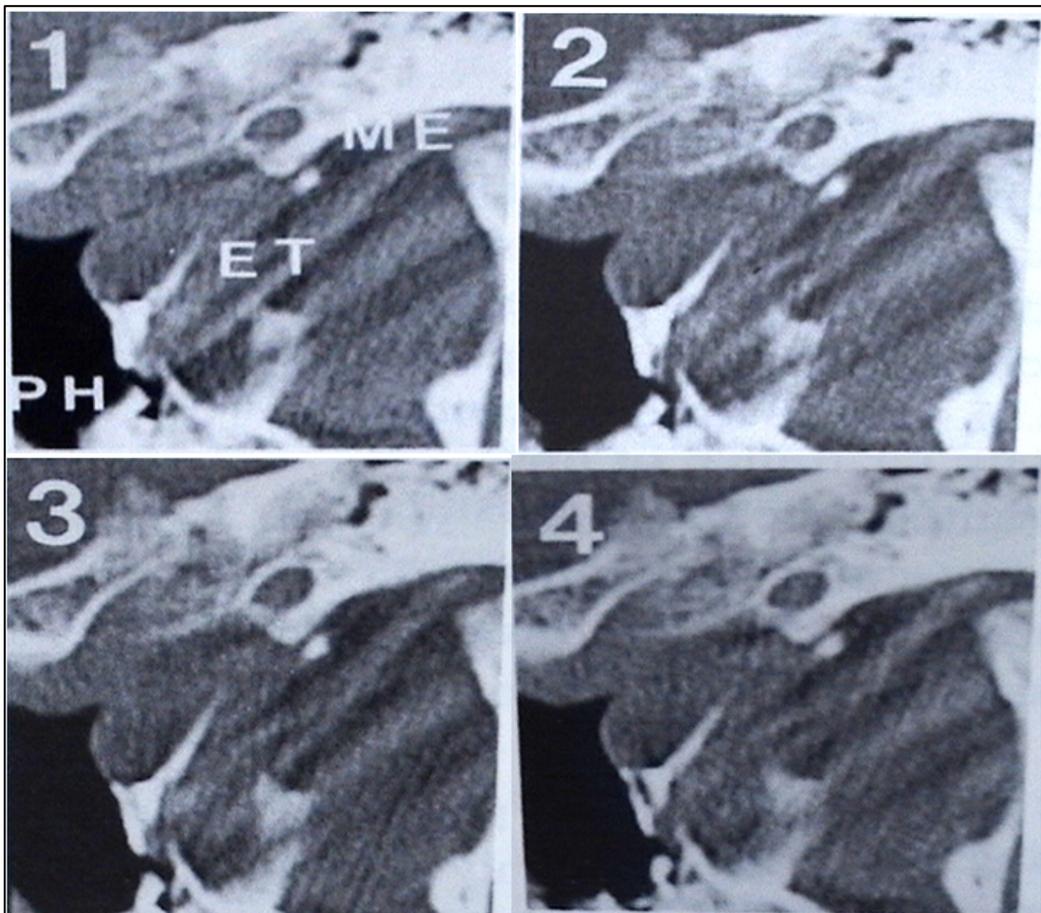


Figure 6: Contrast sequential CT in a perforation case before (1), during (2) and at the end of (3) swallowing

Preoperative assessment of Eustachian tube function in patients with middle ear disease has been purported to be predictive of the outcome of tympanoplasty in adults [5]. Holmquist [6]. MacKinnon, Palva [7] and Siedentop [8] reported that tympanoplasty was more successful in patients who could equilibrate negative pressure during inflation deflation ET function tests than those who could not.

The accurate diagnosis depends not only on single piece of information but on the evaluation of a number of factors.

In this study all patients were included with middle ear disease and central tympanic membrane perforation. Most of the patients were presented with ear discharge (27 out of 30). Ear discharge was mainly mucopurulent, non-fowl smelling. But in some patients it was bloodstained. In most of the patients, ear discharge was intermittent, recurrent which was previously treated by medications. Discharge was profuse in amount. Patients with associated upper respiratory tract infection were 21 out 30. most of these patients had recent attack of common cold or pharyngitis which was followed by ear discharge. Also when asked about ear drops reaching throat, 23 out of 30 patients gave positive response. 13 patients were presented with hearing loss either as a major complaint or associated with ear discharge. None of the patient had history of giddiness or vomiting.

12 patients were having nose symptoms, particularly nose blockage on the side of ear complaints. 7 patients were having recurrent sore throat, amongst which one patient was having history of tonsillo – adenoidectomy.

None of the patients were having complaints about regurgitation of food, or any congenital history of hearing loss. Also none of the patient had history of radiation or any other medical or surgical illness in past.

In this study, thorough ear, nose and throat examination was done. In ear mainly tympanic membrane examination was done with the help of otoscope. All patients had perforation of tympanic membrane which was central, small to moderate size. Patients were asked to perform Valsalva's maneuver and asked for any air sensation in middle ear. 17 out of 30 patients had given positive response. Mastoid tenderness was not noted in single patient. None of the patient was presented with facial paralysis or nystagmus. Tuning fork tests showed negative Rinnes test in all patients and Weber was lateralizing to the diseased ear. Dye test was performed in all patients in whom dye was injected into the middle ear of patient through perforation and time measured between the injection and time when it came in pharynx. 18 patients out of 30 took more than 15 mins. But the test was quite subjective and didn't give any reliable observations so not included in study.

All patients were undergone audiological testing. 13 patients were having mild conductive hearing loss, 16 patients were having moderate conductive hearing loss and one patient was having moderate to severe conductive hearing loss. Also in thorough examination of the nose and throat, deviated nasal

septum, enlarged tonsils can be seen.

Instrumentation needed to assess ET function in the clinical setting

Otoscopy:

Tympanometry:

Methods for assessing ET function

- Classical tests of tubal patency: Valsalva's and Politzer
- Toynbee test:
- Patulous ET test:
- Nine step inflation deflation tympanometric test:

- Modified inflation deflation test (nonintact Tympanic membrane)

In this study, 28 out of 30 patients were undergone CT examination. 3 patients were not cooperative. Out of 28, 16 patients showed normal Eustachian functioning, 9 patients showed hypofunction and 3 patients showed obstruction of Eustachian tube.

There are various factors which correlates Eustachian tube functioning and tympanoplasty results [9]. Post operative after suture removal each patient was asked to follow up at least after 3 weeks. History of each patient was taken and thorough clinical examination was done.

The surgery was judged to be successful when there was no perforation, no atelectasis of eardrum, disappearance of otorrhoea and On the other hand, outcome of surgery was judged to be unsuccessful when more than one of the four criteria was unsatisfied.

On the follow up, history was noted and each patient was examined thoroughly. Out of 30 patients, 6 were presented with ear discharge, 7 patients were having hearing insufficiency. On examination, 12 patients were presented with atelectasis of tympanic membrane, and three patients were presented with perforation of drum.

Also post operative audiogram was done of all 30 patients and tympanogram was done in 27 patients. When preoperative and post operative audiograms were compared, it was found that 26 patients had hearing improvement, 2 patients had similar hearing loss as it was preoperatively. But 2 patients had worsening of hearing.

Also post operative tympanogram was done in 27 patients which showed, 19 patients with A type and 8 patients showed B type of tympanogram.

All the clinical findings and tympanogram were compared with the pre operative CT

scan findings. In patients with normal Eustachian tube functioning on the CT scan (16 patients), 2 patients presented with ear discharge, one patient complained about hearing loss. 6 patients were with atelectasis of tympanic membrane. None of the patient was presented with the perforation of drum.

Patients with hypo functioning of Eustachian tube (9 patients), three were with ear discharge, three with hearing insufficiency. One patient was presented with perforation and 3 patients with atelectasis of drum.

Out of 3 patients with obstructed Eustachian tube function on CT scan, all three patients were having hearing insufficiency. One patient was presented with ear discharge, one with atelectasis of drum. 2 patients were with perforation of tympanic membrane.

Conclusions

The conclusion to be drawn from these studies is that if the patient is able to equilibrate an applied negative pressure, regardless of age, the success of the tympanoplasty is likely, but failure to perform this difficult test will not help the clinician in deciding not to operate. Also even if Eustachian tube is found to be blocked intraoperatively, tympanoplasty can't be abandoned. The value of testing a person's ability to equilibrate negative pressure lies in the possibility of determining from the test results if a young child is a candidate for tympanoplasty when one might decide on the basis of other findings alone to withhold surgery until the child is older. These tests are also value in the diagnosis of severe or total mechanical obstruction, conditions which contraindicate the performing of a myringoplasty; further evaluation and medical or surgical management of such patients may be indicated depending upon the condition of the ear. When the tympanoplasty is performed and the function of the ET is thought to be poor, a tympanostomy tube should be inserted.

Bibliography

1. Elner A, Inngelstedt S, Ivarsson A. A normal function of Eustachian Tube. A study of 102 cases. Acta Otolaryngol (Stockh) 1971; 72: 302-8.
2. Inngelstedt S, Ortgren U. Qualitative testing Eustachian tube function. Acta Otolaryngol (Stockh) 1963: Suppl 182:7-23.
3. Sudo, Ikui, Sando, Suzuki. Narrowest (isthmus) portion of Eustachian tube: A computer aided three-dimensional reconstruction and measurement study. Ann. Otol Rhinol. Laryngol. 1997; 106:583-5884.
4. Niwa, Masakatsu Takahashi, Noruyoki Yanagita Shingi Nganawa. Evaluation of clearance function of the Eustachian tube by sequential contrast CT. Acta Otolaryngol (Stockh) 1990; Suppl. 471:43-50.
5. Miller GF, Bilodeau R. Preoperative evaluation of Eustachian tubal function in tympanoplasty. South Med J 1967; 60: 868.
6. Holmquist, J. the role of Eustachian tube in Myringoplasty. Acta Otolaryngol 1968; 66:289-95.
7. Palva, A. and Kajra J. Eustachian tube patency in chronic ears: preoperative Evaluation correlated to post operative results. Acta Otolaryngol, 1970; 263:25-28.
8. Siendentop, K. H. Eustachian tube dynamics, size of mastoid air cell system and results with tympanoplasty. Otolaryngol. Clin. North Am. 1972, 5:33-44.
9. Holmquist J. Renwall U. Eustachian tube function in secretory otitis media. Arch Otolaryngol 1974; 99:59-61.