Study of Eustachian Tube Function in Normal Adults And Those With Middle Ear Disease

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Abstract:
Objective: Middle ear diseases are very common in Indian population as Eustachian tube is a part of middle ear cleft its dysfunction can result in middle ear pathologies, also failure of surgeries for chronic otitis media with tympanic membrane perforation. Aim is to study Eustachian tube function in those having middle ear pathologies.

Materials and Methods: 50 adults with normal tympanic membrane and 50 patients with chronic otitis media (inactive mucosal type) were selected including retracted tympanic membrane, healed central perforation and post operative patients who underwent myringoplasty or type I tympanoplasty. Age range was between 18 to 49 yrs. All patients were subjected to pure tone audiometry and graphical recording of their hearing threshold were made. Tympanometry was done in all patients.

Eustachian tube function was assessed by Valsalva test, pneumatic otoscopy (siegelization), nasopharyngoscopy & tympanometry. Comparative and multivariate study between indicator factors conducted.

Results: In 50 Chronic otitis media patients with dry central perforation, 32 patients (64%) had Eustachian tube dysfunction and only 18 patients (36%) had normal function. In patients with retracted tympanic membrane, healed central perforation and post operative patients who underwent myringoplasty or type I tympanoplasty, 7 out of 8 [87.5%] patients with healed central perforation and 10 out 12 [83%] post tympanoplasty patients had normal tubal function suggesting that normal functioning of Eustachian tube function plays a major role in healing of the perforation and success of Tympanoplasty.

Conclusion: . In most of the CSOM patients and patients with retracted ear drum also the impairment of Eustachian tube function was found to be statistically significant. ET function was found to be partially or grossly impaired in most patients with recurrent or residual CP.

Keywords: Chronic otitis media, Eustachian tube, Eustachian dysfunction, Eustachian tube function tests, middle ear diseases

I. Introduction

The Eustachian tube, otherwise pharyngotympanic tube connects the middle ear space with the Nasopharynx. The Eustachian tube (ET), middle ear, and mastoid cavity are components of middle ear cleft.
Three important physiologic functions of the ET are:- Regulation of the middle ear pressure, protection of the middle ear and clearance of the middle ear space. Eustachian tube dysfunction is widely recognised as the triggering factor of middle ear disease. Eustachian tube dysfunction predisposes the ear for chronic middle ear disease. Etiology of eustachian tube dysfunction are upper respiratory tract infection, chronic rhinitis, adenoid hypertrophy, tobacco smoke, reflux, cleft palate, radiation, reduced mastoid air cell system, Nitrous oxide. There are various methods to test the functioning of Eustachian tube: Pneumatic otoscopy, Nasopharyngoscopy, Eustachian tube catheterisation, Valsalva manoeuvre, Politzer’s test, Toynbee test, Impedance audiometry. Imaging, Inflation-Deflation method and Sonotubometry. Saccharine/methylene blue test are the methods available for testing the function of Eustachian tube. Testing the pressure regulation function of Eustachian tube by modern impedance audiometers is an non-invasive simple cost effective method. Tympanometry has also been used to find function of eustachian tube in cases of intact or perforated tympanic membrane.

Recent studies show that the success rates of tympanoplasty were found to be lesser when surgery was done in ears having poor tubal function compared to ears with normal Eustachian tube function. These studies have made surgeons realise the importance of Eustachian tube and testing the functioning of Eustachian tube. Chronic otitis media is any structural change in the middle ear system associated with a permanent defect in the tympanic membrane (TM). Two types of chronic otitis media – mucosal or tubotympanic type & squamous or attico antral type. Patient’s with mucosal type of chronic otitis media (COM) are classified into healed COM.

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Perforations of the TM are described according to their anatomic location and are separated into two categories. Central perforations involve the pars tensa and are circumferentially surrounded by residual TM. Subtotal perforations describe large defects in which there is only a narrow rim of residual pars tensa near the annulus. Marginal perforations have no remnant of Tympanic membrane adjacent to the bone of the posterior canal wall Cholesteatomas are retraction pockets or cysts lined with squamous cell epithelium and filled with keratin debris occurring within the pneumatized spaces of the temporal bone. The eustachian tube serves to ventilate the middle ear so that pressure equalization occurs between this space and the surrounding environment.

This study was performed to find the functioning of Eustachian tube in normal adults and those with middle ear disease. This study was done in Department of ENT, Coimbatore Medical College Hospital, Coimbatore in patients with normal tympanic membrane, in COM patients with dry central perforation, in patients with retracted tympanic membrane and in patients with healed central perforation. Post operative patients who underwent myringoplasty and type 1 tympanoplasty were also tested for Eustachian tube function.

II. Objectives of the study

- To evaluate Eustachian tube function in normal adults.
- To test the functioning of Eustachian tube in patients with dry central perforation.
- To compare ET functioning of normal adults with patients having chronic otitis media.
- To find out whether it is important in healing of tympanic membrane in patients with central perforation.
- To evaluate its role in outcome of Myringoplasty and Type 1 Tympanoplasty.
- To evaluate its role in patients with retracted tympanic membrane.

III. Materials And Methods

This study was done in the department of ENT, Coimbatore Medical College, Coimbatore from December 2012 to November 2013. It consists of 50 adults with normal tympanic membrane and 50 patients with chronic otitis media (inactive mucosal type). As a part of the study eustachian tube function was also evaluated in patients with retracted tympanic membrane, healed central perforation and post operative patients who underwent myringoplasty or type 1 tympanoplasty. Age range was between 18 to 49 yrs.

Control group: 50 adults who came to ENT outpatient department for hearing assessment with normal hearing and normal tympanic membrane were subjected to Eustachian tube function tests.

Study group: 100 adult patients who visited ENT outpatient department with middle ear disease were subjected to Eustachian tube function tests.

Inclusion criteria
1. Chronic otitis media with dry central perforation including post operative patients with residual perforation
2. Retracted pars tensa of tympanic membrane (grade 1 & 2)
3. Healed central perforation
4. Post operative patients who underwent myringoplasty or type 1 tympanoplasty before 3 months

Exclusion criteria
- Patients with active ear discharge or squamous type of chronic otitis media
- Post operative patients who underwent surgery within three months
- Retracted pars tensa of tympanic membrane (grade 3 & 4)
- Patients with upper respiratory tract infection
- Patients with structural abnormality like cleft palate
- Age below 18 years and above 49 years

A detailed history was recorded for all patients. Past surgical history was elicited in detail. Ear examination including tuning fork tests and video otoscopy was done for all patients. Other clinical examinations like nasal, oral cavity examination were done. All patients were subjected to pure tone audiometry and graphical recording of their hearing threshold were made and pure tone average in both ears were recorded. Tympanometry was done in all patients. Eustachian tube function was assessed by Valsalva test, pneumatic otoscopy (siegalization), nasopharyngoscopy & tympanometry. Eustachian tube function was assessed with impedance audiometer with two tests. William’s test was done in patients with intact tympanic membrane. Toynbee test was used in patients with perforated ear drum. In our study we used AMPLAID
Audiometer for testing Eustachian tube function in perforated drum and MAICO 34 for testing Eustachian tube function in intact tympanic membrane.10,85

William’s test
Middle ear pressure was measured at the start (resting pressure), after patient swallows (with nose and mouth closed) and after Valsalva manoeuvre. Normal ambient middle ear is usually slightly negative. Middle ear pressure becomes more negative on swallowing and becomes positive on Valsalva manoeuvre.

Interpretation:
• Partial impairment: Middle ear pressure becomes negative on swallowing but it doesn’t become positive on Valsalva or vice versa.
• Gross impairment: Middle ear pressure doesn’t change for both swallowing and Valsalva.

Toynbee’s test:
A negative or positive pressure (-250 or +250 dapa) is created in the middle ear and the patient is asked to swallow 5 times. Change of air pressure in the middle ear is recorded each time when the patient swallows. The ability to equilibrate the pressure indicates normal tubal function. The test can also be used to find the patency of the grommet placed in the tympanic membrane in cases of serous otitis media.

Interpretation:
• Normal Eustachian tube function - The pressure built up by the impedance audiometer completely neutralized by repeated swallowing.
• Partial impairment – Persisting of some residual pressure even after five swallows
• Gross impairment - if the pressure built up by the impedance audiometer cannot be neutralized at all by repeated swallowing.

IV. Results and analysis
This study was performed to find the functioning of Eustachian tube in normal adults and those with middle ear disease. This study was done in department of ENT, Coimbatore Medical College & Hospital, Coimbatore in patients with normal tympanic membrane, chronic otitis media patients with dry central perforation, patients with retracted tympanic membrane and in patients with healed central perforation. Post operative patients who underwent myringoplasty and type 1 tympanoplasty were also tested for Eustachian tube function.

Eustachian tube function was assessed by Valsalva test, pneumatic otoscopy (siegelization), nasopharyngoscopy, tympanometry. Eustachian tube function was assessed with impedance audiometer with two tests. William’s test was done in patients with intact tympanic membrane. Toynbee test was used in patients with perforated ear drum. Control group was 50 normal adults in the age of 18 to 49 who were tested for Eustachian tube function. Out of 50 only one had partial ET dysfunction (2%).

Study group was 50 patients with dry central perforation of which 7 were post operative patients with failed tympanoplasty. Among 43 CSOM patients 26 had ET dysfunction (60.4%). In 7 patients with residual Central perforation, 6 had ET dysfunction (85.71%) suggesting ET dysfunction as the important cause for failure of surgery. No significant age or gender difference in Eustachian tube dysfunction found. As part of study 30 adults with retracted tympanic membrane and 8 patients with healed CP were tested for Eustachian tube function. In patients with retracted Tympanic membrane, ET dysfunction was identified in 27 patients (90%) of which 21 had partial and 6 had gross dysfunction suggesting ET dysfunction as a major factor for chronic retraction. In 7 out of 8 patients with healed tympanic membrane perforation ET function tests were normal suggesting that good Eustachian tube functioning plays a prominent role in the healing of tympanic membrane perforation. 12 patients who had undergone myringoplasty or type 1 tympanoplasty were tested for Eustachian tube functioning. 10 patients (83%) were found to have normal ET functioning while 2 had partial tubal dysfunction suggesting that ET function tests are an important prognostic indicator for success of surgery.

Statistical analysis was done for all variables in the study using NCSS software. The data was analysed for mean, standard deviation, range and percentage. The chi-square and student’s unpaired t tests were used for comparison between study and control groups.
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Table 1: Age Distribution & Sex Distribution

<table>
<thead>
<tr>
<th>Tympanic Membrane Status</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central perforation</td>
<td>50</td>
</tr>
<tr>
<td>Healed Central perforation</td>
<td>8</td>
</tr>
<tr>
<td>Post op neomembrane</td>
<td>12</td>
</tr>
<tr>
<td>Retraction (grade 1 &amp; 2)</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 2: Tympanic Membrane Status

<table>
<thead>
<tr>
<th>Age in years</th>
<th>No. of normal adults</th>
<th>No. of patients with dry Central perforation</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 - 20</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>21 - 25</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>26 - 30</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>31 - 35</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>36 - 40</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>41 - 45</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>46 - 49</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>MALE</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>FEMALE</td>
<td>24</td>
<td>21</td>
</tr>
</tbody>
</table>

Table 3: Eustachian tube function in patients with CSOM

<table>
<thead>
<tr>
<th>Patients with Dry CP (NOT OPERATED)</th>
<th>Normal Tubal Function</th>
<th>Partial Et Dysfunction</th>
<th>Gross Tubal Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>PATIENTS</td>
<td>43</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>POST OP PATIENTS WITH RESIDUAL CP</td>
<td>7</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>50</td>
<td>18</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 4: Normal Adults Vs Patients With Dry Central Perforation

<table>
<thead>
<tr>
<th>Total</th>
<th>Normal ETF</th>
<th>Eustachian Tube Dysfunction</th>
<th>Percentage (Normal ETF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Adults</td>
<td>50</td>
<td>49</td>
<td>1</td>
</tr>
<tr>
<td>Patients With Dry Cp</td>
<td>50</td>
<td>18</td>
<td>32</td>
</tr>
</tbody>
</table>

Chi-square with Yates correction
Chi squared equals 40.706 with 1 degrees of freedom. The two-tailed P value is less than 0.0001. The association between COM and ETF is considered to be extremely statistically significant.

Table 5: Eustachian tube function in patients with Retracted Tympanic membrane, Healed Central perforation, Post op patients

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Patients</th>
<th>No of pts</th>
<th>Normal ETF</th>
<th>Eustachian tube dysfunction</th>
<th>Percentage (normal ETF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Retracte tympanic membrane</td>
<td>30</td>
<td>3</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Healed central perforation</td>
<td>8</td>
<td>7</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postop patients</td>
<td>12</td>
<td>10</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Eustachian tube function testing can be an important tool for improving the success rate of tympanoplasty surgery. Earlier more importance was given for testing the anatomical patency of Eustachian tube. Merely testing the patency does not serve the purpose of identifying the physiological functioning of the tube. Otologists have started to test the functioning of Eustachian tube by testing the ability of the tube to regulate middle ear pressure. New impedance audiometers serve this purpose. In our study we used AMPLAID Audiometer for testing ETF in perforated drum and MAICO 34 for testing ETF in intact tympanic membrane.

Two tests were used. William’s test for patients with intact tympanic membrane and Toynbee’s test for patients with perforation. Eustachian tube function was abnormal in chronic otitis media patients whereas it was normal in patients with traumatic perforation. In our study only 1 had partial tubal dysfunction out of 50 normal adults whereas 32 out of 50 CSOM patients had tubal dysfunction. There was no significant age or gender difference in tubal dysfunction identified. 17 male (53%) and 15 female (47%) had tubal dysfunction in our study. Tubal function can be tested by impedance audiometer in tympanoplasty patients. Success rate of surgery was only 69% in patients with gross tubal dysfunction and 75% in patients with partial tubal dysfunction. Patients with normal ETF had graft uptake of 95%.

Toynbee’s test is performed in perforated drum. Success rate of surgery was only 66% in patients with gross tubal dysfunction and 80% in patients with partial tubal dysfunction. Success rate was 90% if the tubal pathology was corrected before tympanoplasty. The rate was only 68% in patients who tubal dysfunction and was not corrected before tympanoplasty. Anirban Biswas* in 1999 tested ETF using William’s test in 34 post operative cases who were successfully treated by myringoplasty or type 1 tympanoplasty. Out of 34 patients, 26 had perfectly normal function, 6 patients had partial impairment while only 2 had gross impairment. It compares with our study where only 2 out of 12 patients had partial dysfunction. Anirban Biswas tested ET function using Toynbee’s test in 83 patients with failed tympanoplasty. 83% of the patients had tubal dysfunction in our study, we did ET function test for 7 patients with failed tympanoplasty. Out of 7 patients, only 1 patient had normal function, 3 had partial dysfunction and 3 had gross impairment (85.7%) suggesting that ET dysfunction is an important cause for failure of surgery.

In our study we had similar results. While the tubal function was normal in 7 of the 8 patients with healed perforation, Eustachian Tube function was impaired in 6 of the 7 patients with failed tympanoplasty. Eustachian Tube function was normal in 10 out of 12 patients with successful tympanoplasty.

**VI. Conclusion**

From our study it is evident that Eustachian tube dysfunction is an important factor that determines the outcome of chronic otitis media. In most patients with healed central perforation and in post operative patients who were successfully treated by surgery, the Eustachian tube function was found to be normal. ET function was found to be partially or grossly impaired in most patients with recurrent or residual CP. In most of the CSOM patients and patients with retracted ear drum also the impairment of Eustachian tube function was found to be statistically significant. Chronic sinusitis, allergic rhinitis and smoking were the important causes of ET dysfunction.

Eustachian tube function testing by impedance audiometry is a simple non-invasive method of testing the Eustachian tube function and helps in identifying the tubal dysfunction. Patients with tubal dysfunction should be evaluated for underlying cause and treatable causes should addressed before proceeding for surgery as it increases the success rate of tympanoplasty.

**Bibliography**