The Impact of Unilateral Nasal Obstruction Upon Middle Ear Ventilation of Both Sides: A Prospective Comparative Study

Hoda Ali Ibrahim¹, Randa A Abdallah¹, Gehan Saied Shalaby¹, Soaad Yahea¹, Mariam Alkandari²

¹AL Azhar University Hospitals, Cairo, Egypt
²AL Sabah Hospitals, Kuwait

Corresponding Author: Randa A Abdallah
randa.atwa@yahoo.com

ABSTRACT

Aim: to determine the effect unilateral nasal obstruction on the middle ear pressure, Eustachian tube function and the type of Tympanometry of both ears before and after operation. Patients and Methods: Total 70 patients with unilateral nasal were recruited for this study. Tympanometry, Eustachian tube function and middle ear pressure were compared for all patients before and after operation. Result: 39 patients had type A tympanogram, 8 type B and 24 type C before operation for the same side of ACP while for the other side there were (50 type A, 2 type B and 15 type C) tympanogram patients but after FESS operation there were (55 type A, 1 type B and 14 type C) tympanogram patients for the same side and (68 type A, 0 type B and 2 type C) tympanogram for the other side. also middle mean ear pressure for the same side before surgery was (-125±9.3) and (-92.42±7.4) for the other side and became (-45.14±6.39) for the same side and (38.3±6.1) for other side, while ETF tests were bad for all ears on the same side of lesion and for (45) ears on the other side before surgical correction of nasal obstruction which became good ETF tests for all (70) patients on both sides. Furthermore, there were no significant correlations between type of tympanogram, middle ear pressure or ETF tests with the age and sex of patients. Conclusion: there was a definite relationship between nasal obstruction and type of tympanogram, MEP and ETF. Good Eustachian tube function tests aren’t always associated with type A tympanogram.

Keywords: middle ear pressure, tympanometry, Eustachian tube function, antrochoanal polyp

1. INTRODUCTION

Eustachian tube roles as a connection between two major cavities of interest, the middle ear cleft and the nasopharynx, also it preserves ear ventilation with maintaining a good middle ear pressure and cleaning of the ear being a drainage route (Bluestone C.D. et al.1988)¹. Nasal pathology was considered as one of the major causes of Eustachian tube dysfunction leading to interference of its function performance (Ciprandi G., et al 2005)². Middle ear diseases are usually associated with nasal obstruction. It is clear for all surgeons that nasal obstruction interferes with the function of auditory tube and impact middle ear ventilation and pressure (Lildholdt T et al, 1980)³. many authors have proved the pathogenesis of otitis media has been caused by any prior or concurrent nasal disease as upper respiratory tract infection and allergic rhinitis (Sims E.J. et al,2002)⁴.

Eustachian tube function involves the (Toynbee and Valsalva’s maneuver) give useful information about the ability of the Eustachian tube to equalize the middle ear pressure (Bluestone C.D. et al 1975)\(^5\). Tympanometry can be widely used to evaluate the middle ear pressure with an intact tympanic membrane with a great success rate in the diagnosis and follow up of middle ear diseases (Salvinelli F,et al.2005)\(^6\). The aim of our study is to determine the effect of unilateral nasal obstruction on the middle ear pressure, Eustachian tube function and the type of tympanometry of both ears before and after operation.

2. PATIENTS AND METHODS

The current study was carried out on (70) patients thirty of them were admitted to otorhinolaryngology department of Al-Zahraa university Hospital, AL – Azhar university Egypt and (40) patients were admitted to otolaryngology department of al Sabah hospitals, Kuwait city from aperiod of (2013 to 2017) to study effect unilateral nasal obstruction on the type of tympanogram, the middle ear pressure. Eustachian tube function of both ears before and after operation all patients aged from (17-39) years old including (39 males and 31 females) diagnosed with unilateral antrochoanal nasal polyp who had undergone a surgery for treatment of nasal polyp under general anesthesia, figure 1 showed an endoscopic view for one case with right antrochoanal polyp. A verbal consent for agreement to join the study was taken from each patient. The diagnosis of antrochoanal nasal polyp was based on patient history, clinical examination, and nasal endoscopy and computed tomography. Patients with tympanic membrane perforation, acute rhinitis, ear operation and a recent history of middle ear infection were excluded from the study.

Audiological assessment for tympanogram type, Eustachian tube function tests (valsalva and toynbayee ) and middle ear pressure were estimated for both ears of all patients before and one month after operation. Nasal polyps biopsies were taken during the functional endoscopic sinus surgery, after surgery the definitive diagnosis of the polyp was confirmed by histopathological examination which revealed no malignant or pre malignant criteria in our specimens. After FESS operation anterior nasal packs (merocel nasal packs 8 cm long) were applied for 2 days duration, then tympanometry, Eustachian tube function test (valsalva, toynbayee) and middle ear pressure were repeated again after one month of operation.

**Figure (1): Right Antrochoanal polyp**

**Eustachian tube function tests (Salvinelli F et al, 2005)**\(^6\)

Were done for all patients to evaluate the ability to inflate the middle ear before and one month after surgery in the form of:

- I-Valsalva maneuver: patient was asked to close his nose and mouth while inflating the checks during forced expiration until he achieved a sensation of fullness in the ears. Then patient was instructed to release the nose and to avoid any
further swallowing or mandibular movement while a tympanogram was being obtained in each ear. If the a tympanometric peak shift was less than 10 daPa it indicated poor ETF, but greater than 10 daPa indicated a good ETF.

- II-Toynbee maneuver: Patient was asked to swallow while closing his nose and then to release his nose and avoid any further swallowing or mandibular movement, while a tympanogram was being done for each ear. If Tympanometric peak pressure shift was less than 10 daPa it indicated poor ETF, whereas a tympanometric peak pressure shift of greater than 10 daPa indicated a good ETF.

Then the ETF tests results were either

- I-Good Eustachian tube function: means a peak tympanometric shift of >10 dapa on both Valsalva and Toynbee maneuvers.
- II-Poor Eustachian tube function: means a peak tympanometric shift of <10 in one or both of the above stated maneuvers.

**Tympanometry**
(MAICO Diagnostic GmbH, Impedance Meter MI 44, Saizuer 13/14, Berlin) middle ear pressure analyzer was used for all patients.

The tympanometer probe was inserted into the ear canal after ear examination.

The tympanograms were classified according to Jerger J criteria (Jerger J, 1973):

- I-If the peak of middle ear pressure came between (+200 and −99 daPa), it was considered as type (A) tympanogram,
- II-If the peak of middle ear pressure peak = (−100 daPa or more negative) it was considered as type(C) tympanogram,

III- A tympanogram with a flattened peak of less than 0.3 ml impedance was classified as type (B).

### Statistical method
The data were analyzed using IBM SPSS program (version 22). Data were expressed as (mean ± SD). The level of significance was taken as p-value ≤ 0.05 and the results are presented in tables. Comparison of the study groups was done by Chi-square test (χ²) and Macnemar test. Non parametric test (Wilcoxon test) was used for data that showed abnormal distribution. One way Anova test was used to compare between more than two means.

## 3. RESULTS

### The demographic line data
The study involved 70 patients with unilateral antrochoanal nasal polyps 39(55.5%) male and 31(44.3) female with male predominance. The age range was 17-39 years and mean age (31.5 ± 4.8), there were 49 (70%) represented with unilateral nasal obstruction, 21(30%) bilateral nasal obstruction, 25 (35.7%) headache, 35 (50%) facial pain, 70 (100%) postnasal discharge, while about 35 (50%) were complaining of unilateral, 12(17.1%) bilateral ear ringing, 42 (60%) unilateral, 16 (22.8%) bilateral ear fullness, 13 (18.5%) unilateral, 5 (.71%) bilateral ear ache and 8 (1.1%) unilateral, 0(0%) bilateral decrease hearing.

Among male patients there were 20 (51.3%) patients showed type (A) tympanometry, 6(15.4%) type (B) and 13(33.3%) showing type (C) before operation while among female patients there were 18(58.1%) type (A), 2(6.5%)type (B)patients and 24(34.3%) type (C)patients before operation. It didn’t show any significant statistical difference regarding to the demographic data of the patients (as shown in table: 1).

<table>
<thead>
<tr>
<th>Type</th>
<th>Total N</th>
<th>Significant Test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>39(55.7%)</td>
<td>Chi-squared test=1.376</td>
<td>.503</td>
</tr>
<tr>
<td>female</td>
<td>31(44.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total N</td>
<td>70(100%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No Significant difference (p value>0.05) for relation of gender and Tympanogram before operation

### Tympanogram results before and after operation for both ears
As shown in Table (2), About 38(54.3%%)patients showed type (A) tympanogram, 8(11.4%) had type (B) and 24(34.3%)expressed type (C) before operation while after operation, tympanogram resulted in: 55(78.6%) type (A),1(1.4%)type (B) and 14(20%)type (C) showing a significant difference at p value <0.005 by using chi-square test then Macnemar test for the ear on the same side of the nasal pathology.
Table 2: Types of tympanogram for both ears before and after operation

<table>
<thead>
<tr>
<th></th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
<th>Significant test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same side pre op.</td>
<td>38(54.3%)</td>
<td>8(11.4%)</td>
<td>24(34.3%)</td>
<td>Chi-square test</td>
<td>0.000*</td>
</tr>
<tr>
<td>Same side post op.</td>
<td>55(78.6%)</td>
<td>1(1.4%)</td>
<td>14(20%)</td>
<td>Chi-square test</td>
<td>0.460</td>
</tr>
<tr>
<td>Other side pre op.</td>
<td>50(71.4%)</td>
<td>2(2.9%)</td>
<td>18(25.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other side post op.</td>
<td>68(97.1%)</td>
<td>0(0.0%)</td>
<td>2(2.9%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There is Significant difference (p value<0.001) for Tympanogram before and after operation for same side, No Significant difference (p value>0.001) for Tympanogram before and after operation for other side.

While the tympanogram results of the other side ear showed ; 50(71.4%%) type (A) tympanogram ,2(2.9%)type (B) tympanogram and 18(25.7%) tympanogram before operation and 68(97.1%) type (A) tympanometry,0(0.0%)type (B) tympanogram and 2(2.9%)type (C) tympanogram. As shown in Table (2) showing no statistical significant difference at p value 0.05 by the use of chi-square test and Macnemar tests.

Middle ear pressure before and after operation for both ears

As shown in table 3: the MEP value was (-125± -9.3) before FESS operation which became (-45.14± -6.39) one month after surgery for the ear on the same side of antrochoanal polyp shown in figure 2. While, for the contra lateral ear it was (-92.42± -7.4) pre operatively and became (-38.3± -6.1) one month postoperatively shown in figure 3.

It showed a statistical significance at p value<.05 for the MEP for both ears before and after operation using Wilcoxon non parametric test, this mean that the operation enhance the middle ear pressure for the patients with unilateral antrochoanal polyps.

Table 3: MEP both sides before and after operation

<table>
<thead>
<tr>
<th></th>
<th>Pre op. MEP (mean± SE)</th>
<th>Post op. MEP(mea± SE)</th>
<th>Significant test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same side</td>
<td>-125± -9.3</td>
<td>-45.14± -6.39</td>
<td>Wilcoxon Test</td>
<td>0.000</td>
</tr>
<tr>
<td>Other side</td>
<td>-92.42± -7.4</td>
<td>-38.3± -6.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant difference (p value<0.05) for MEP both sides before and after operation

Figure (2): MEP same side before and after operation

**ETFT before and after operation for both ears**

As shown in Table (4) all patients 70(100%) had poor Eustachian tube function and none of them has good Eustachian tube function before operation although post operatively all of them became expressed good Eustachian tube function tests.

At the same time, the ear on the other side of the nasal pathology showed 25(35.7%) with good ETFT and 45(64.3%) with poor Eustachian tube function tests but after operation all patients showed good Eustachian tube function tests 70(100%) as shown in table (4). Showing a significant difference at p value <0.005 by using chi-square test then McNemar test for the ear on the same side of the nasal pathology and the contralateral ear.

**Table 4: ETFT other for both ears before and after operation**

<table>
<thead>
<tr>
<th></th>
<th>Good ETF tests</th>
<th>Poor ETF tests</th>
<th>Significant test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same side pre op.</td>
<td>0(0.00%)</td>
<td>70(100%)</td>
<td>Chi-square test=68.014</td>
<td>0.000*</td>
</tr>
<tr>
<td>Same side post op.</td>
<td>70(100%)</td>
<td>0(0.00%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other side pre op.</td>
<td>25(35.7%)</td>
<td>45(64.3%)</td>
<td>Chi-square test=43.022</td>
<td>0.000*</td>
</tr>
<tr>
<td>Other side post op.</td>
<td>70(100%)</td>
<td>0(0.00%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. **DISCUSSION**

The results of our study had supported the concept of relationship between nasal obstruction and impaired middle ear ventilation on top of Eustachian tube dysfunction, and so failure of any middle ear surgery can happen on top of nasal function impairment (Ruggeri C et al, 1990). The path physiologic mechanism for that isn’t fully clear, while the most acceptable theory is the turbulence of the air flow prohibiting the Eustachian tube from performance of its normal function to equalize the middle ear pressure as a result of distortion of air current to its nasopharyngeal orifice caused by nasal air flow abnormality in nasal obstruction patients. Airflow turbulence may lead to deposition of air pollutant or even microorganisms in Eustachian tube orifice causing tubal or pre tubal inflammation and mechanical obstruction, also disturbed air current may stimulate the post nasal mechanoreceptors leading to reflex alternation of Eustachian tube function, plus the marked drying effect of the postnasal mucous film caused by the turbulent air flow increasing the viscosity of the mucous and the surface tension at the tubal orifice interfering the mucous film to be separated as happens in the normal conditions during...
opening of the tube (Low WK, et al 1993) . In the current study, there was a significant improvement in the mean tympanometric results for the ear of the same side of antro choanal polyp, while the other ear expressed no significant changes when comparing the results pre and one month post nasal surgery conducting that unilateral nasal obstruction directly affects the Eustachian tube function of the same side moreover nasal operation for correction of this obstruction will positively improve it. Nurdat P et al. (10), had proven in their study of 28 ears of 14 patients of nasal polyps that there was a significant increase in the number of (type A) cases with reduction of (type B and type C) cases post operatively conducting that operations for correction of nasal obstruction will improve the Eustachian tube functions and so, will statistically improve the increase the tympanometric results towards the normal side after one month of operation, which supported our results. Tos and Bonding (11) got the same result in their study (Salvinelli F, et al. 2005) (6).

Also, according to our results, Eustachian tube function tests of the ear on the same side of nasal pathology and also on the other side show a significant difference in the results pre and post-operative that ETFT become good for all subjects after operations. Our study expressed, that the middle ear pressure in the patients with unilateral antrochoanal polyp have a significantly improvement after nasal surgery for both ears. Salvinelli F, et al. (12) revealed 43 ears of (total 80 ears) with bad Eustachian tube function prior to their surgeries for correction of nasal obstruction and the overall number of hypoventilated ears progressively decreased during the follow up period although they didn’t find any correlation between the obstructed nasal side and the ETF test or the tympanogram results also they showed a significant more improvement in ETF test on the 90th day postoperatively than the 15th or 30th day and also they conducting in the same study, middle ear pressure was significantly better on 15th , 30th and 90th days than immediate before operation or post pack removal . Also, Raluca E, et al. (13) had conducted a significant correlation between the rhinomanometric results and the tubal manometric measurements in their study of 139 patients represented with nasal obstruction. All those studies plus the results of our study had proven the importance of nasal obstruction and its impact on upon the Eustachian tube malfunction this concept was supported also by may international researches (Bluestone CD, et al 2005) (14) (Doyle WJ, et al 1988) (15) and (Knight LC, et al 1993) (16) in their international researches. Many authors (Curdy MC, et al 1997) (17) stated that, post operative nasal packing could interfere with peritubal lymphatic drainage causing reduction of the middle ear pressure which could bcorrected after removal of the nasal packing. The results of these literatures plus our study were supporting that the best result to be getten when performing any middle ear surgery like tympanoplasty or stapes surgery better not to be before three months after nasal correction.

There was no significant difference among all patients regarding to the age and sex of the patients.

5. CONCLUSIONS

Nasal obstruction is a frequent cause of Eustachian tube dysfunction that can lead to middle ear hypoventilation which appears as changes in tympanometry before any ear surgery, better to evaluate the Eustachian tube function and tympanogram result, moreover, any ear surgery should be postponed until nasal and nasopharyngeal operation to be finished first to get the best result because it will cause a significant improvement for ETF tests and middle ear ventilation.

ACKNOWLEDGMENTS

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CONFLICTS OF INTEREST

All authors have read and approved the manuscript and have no conflict of interest related to this paper.

INFORMED CONSENT

Informed consent was obtained from all individuals participants included in the study.

REFERENCES