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NASAL OBSTRUCTION AND EUSTACHIAN TUBE DYSFUNCTION: HOW ARE THEY RELATED?

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ABSTRACT

Eustachian tube is an osseocartilagenous tube which connects middle ear with nasopharynx. It has been suggested that any pathology affecting the nose, paranasal sinuses or nasopharynx may lead to Eustachian tube dysfunction and middle ear hypoventilation. Hence, we decided to take up a study to assess the effect of nasal obstructive lesions on Eustachian tube function by Impedance Audiometry and to see if it improves or not after corrective surgery. The present study was conducted prospectively in 44 patients with a male: female ratio of 2.14:1 and age ranging from 18 to 68 years, having abnormal tympanograms (type B/C) in atleast one ear who underwent nasal surgery for nasal obstructive lesions. The study favours the observation that surgery for nasal obstruction significantly improves tubal function and middle ear ventilation by 4 weeks postoperatively. Nasal obstructive lesions lead to Eustachian tube dysfunction by causing airflow turbulence in the post nasal space as a result of asymmetrical airflow in the two nasal passages. Hence, corrective surgery for nasal obstruction should be considered atleast 4 weeks before undertaking the middle ear surgery to improve middle ear ventilation, thereby improving the success rates of middle ear surgery.

KEYWORDS: Eustachian tube, paranasal sinuses, osseocartilagenous, nasopharynx.

INTRODUCTION

Eustachian tube is an osseo-cartilagenous tube connecting gas filled middle ear with nasopharynx. Its a key component of an entire physiological system consisting of the soft palate, nasal cavity, nasopharynx, middle ear and mastoid cavity. Numerous physiological or pathological factors of nose, para-nasal sinuses and nasopharynx may alter this intricate system.[1] The potential interactions between middle ear mucosa, Eustachian tube, pharynx and nasal cavities have been studied by several authors. The pathogenesis of otitis media has been related to the presence of prior or concurrent nasal obstructive diseases. An important clinical implication of poor tubal function and consequent middle ear hypoventilation is the decreased success rate of middle ear surgery. This event is particularly common in patients with chronic nasal obstruction.[2,3] Thus, the aim of this study was to investigate the effect of nasal obstruction on Eustachian tube function and middle ear ventilation by Impedance Audiometry and to see if it improves after surgery or not. Many methods have been discovered to determine Eustachian tube function like sonotubometry, radiological studies, flourescein dye clearance, sound pressure chambers, but none of them is superior to Impedance Audiometry as it not only measures anatomical patency but also functional integrity of Eustachian tube and middle ear in just a few minutes and is reproducible, non-invasive and economical.[4]

MATERIALS AND METHODS

It was a hospital based prospective study conducted in the Department of Otorhinolaryngology for a duration of two years from November 2011 to October 2013 after clearance from Institutional Ethics Committee. We investigated a total of 44 patients who fulfilled the below mentioned criteria.

INCLUSION CRITERIA

Patients with abnormal tympanogram (type B/C) in atleast one ear who are undergoing surgery for pathologies causing nasal obstruction.

EXCLUSION CRITERIA

- Adhesive tympanic membranes or tympanosclerosis interfering with tympanometry.
- Otosclerosis or ossicular chain dysfunction as suspected clinically or by Pure Tone Audiometry and confirmed by tympanometry.
- Congenital ear or palate malformation.
- History of previous nasal or sinus surgery.
- History of radiotherapy to head and neck region.
- History of allergy as diagnosed clinically and by tests of allergy.
- Patients not willing for follow up.
- Patients requiring the surgical correction of more than one nasal obstructive pathology because then it would be difficult to attribute changes solely to any pathology

STUDY DESIGN: Prospective Study.

METHODOLOGY

It was a time bound study. All consecutive patients fulfilling the above mentioned criteria were included. At the first visit, patients were informed about the nature and objectives of the study and consent was taken before recruiting them into the study. Detailed history, thorough clinical examination and relevant investigations were carried out. Before considering surgery, all patients were treated with a 4-week course of medications depending on their symptoms and comorbid disease. All patients were subjected to Impedance Audiometry by INTERACOUSTICS AT-235 which included Tympanometry and Eustachian tube function (ETF) tests, the day before the surgical intervention, which were then repeated 4 weeks after surgery. The extent of surgery was tailored to each patient depending on his/her pathology.

The tympanograms were classified in the standard manner similar to that originally described by Jerger.[5] In the present study, a tympanogram with peak middle ear pressure between + 200daPa and -99daPa was classified as type A. A tympanogram with the peak middle ear pressure at -100 daPa or more negative was classified as type C. A tympanogram with flattened peak of 0.3 ml compliance or less was classified as type B.

Eustachian tube function (ETF) tests comprised of the following two manoeuvres: [6]

1. Valsalva manoeuvre- Patients were asked to pinch the nose and inflate the cheeks through forced expiration with the mouth closed until a sensation of fullness was achieved in the ears. Subjects were then instructed to release the nose and refrain from further swallowing or mandibular movement and an experimental tympanogram was obtained in each ear. A tympanometric peak pressure shift (generally positive) between baseline and experimental tympanogram <10 daPa indicated poor ETF, while a tympanometric peak pressure shift of ≥10 daPa indicated a good ETF.
2. Toynbee manoeuvre -. Patients were asked to swallow whilst pinching the nose. Subjects were then instructed to release the nose and refrain from further swallowing and mandibular movement and an experimental tympanogram was obtained from each ear. A tympanometric peak pressure shift (generally negative) between baseline and experimental tympanogram <10 daPa indicated poor ETF, while a tympanometric peak pressure shift of ≥10 daPa indicated a good ETF.

Good ETF in an ear means a peak tympanometric shift of ≥10 daPa on both Valsalva and Toynbee manoeuvres. Poor ETF in an ear means a peak tympanometric shift of <10 daPa on atleast one of the two above stated manoeuvres.

PARAMETERS STUDIED

- ☐ Type of tympanogram – A/B/C
- ☐ Middle ear pressure (MEP) in daPa
- ☐ Eustachian tube function (ETF) – Good/ Poor.

STATISTICAL ANALYSIS

The analysis was performed using Statistical Package for Social Sciences Software (SPSS 11.0 for Windows, SPSS Inc., Chicago, IL, USA) and R-programming language. The statistical significance was evaluated at 5% level.

RESULTS

We investigated 44 patients with a male: female ratio of 2.14:1 and age ranging from 18 to 68 years. 30 (68.2%) patients had Deviated Nasal Septum while 14 (31.8%) had Nasal Polyposis.

Figure 1 provides the stacked bar chart presentation of distribution of ears according to preoperative and 4 weeks post-operative tympanograms for Deviated Nasal Septum and Nasal Polyposis. Out of 60 ears of 30 patients with deviated nasal septum, preoperatively, 26 (43.3%) ears showed normal type A tympanogram while 34 ears showed abnormal tympanogram out of which 2 (3.4%) ears showed type B and 32 (53.3%) ears showed type C tympanogram. 4 weeks postoperative tympanograms of 48 (80%) ears were normal type A, while 12 (20%) ears showed abnormal type C curve. There was statistically significant increase in the proportion of type A cases pre and post-operatively ($P < 0.0001$) as per *chi-square test with Monte-Carlo simulation.* Out of 28 ears of 14 patients with nasal polyposis, preoperatively, 5 (17.8%) ears showed normal type A tympanogram while 23 ears showed abnormal tympanogram out of which 7 (25%) ears showed type B and 16 (57.2%) ears showed type C tympanogram. 4 weeks postoperative tympanograms of 18 (64.3%) ears were normal type A, while 10 ears showed abnormal curves out of which, 3 (10.7%) ears were type B and 7 (25%) ears were type C. There was statistically significant increase in the proportion of type A cases pre and post-operatively ($P = 0.0011$) as per *chi-square test with Monte-Carlo simulation.* This shows that surgery for nasal obstruction significantly improves Eustachian tube function by 4 weeks post-operatively as evident by statistically significant normalization of tympanograms when compared to pre-operative status.

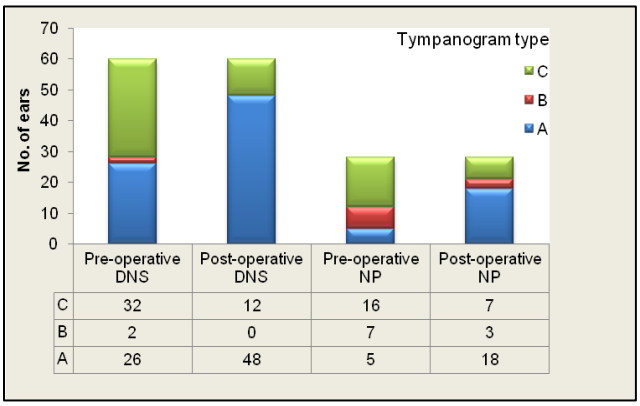

Figure 1. Stacked bar chart presentation of distribution of ears according to preoperative and 4 weeks post-operative tympanograms for deviated nasal septum (DNS) and nasal polyposis (NP) pathologies.

Figure 2 provides the stacked bar chart presentation of change in the status of Eustachian tube function pre- and 4 weeks post-operatively for both pathologies. In Deviated Nasal Septum patients, 15 (25%) ears had good tubal function pre-operatively, while 4 weeks post-operatively, 45 (75%) ears had good tubal function. The increase in the proportion of ears with good tubal function pre- and 4 weeks post-operatively was statistically significant with *P*-value < 0.0001 as per *chi-square test.* Among Nasal Polyposis patients, 5 (17.8%) ears had good tubal function pre-operatively, while 4 weeks post-operatively, 16 (57.1%) ears had good tubal function. The increase in the proportion of ears with good tubal function pre- and 4 weeks post-operatively was statistically significant with *P*-value of 0.006 as per *chi-square test.* Thus, septal surgery and surgery for nasal polyposis have individually shown statistically significant improvement in tubal function by 4 weeks post-operatively.

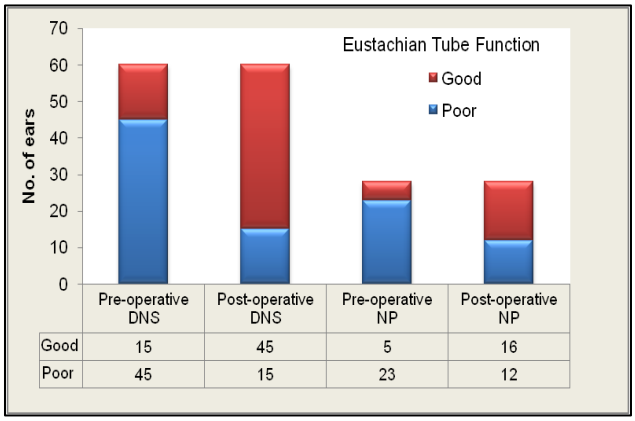

Figure 2. Stacked bar chart showing comparison of Eustachian tube function pre-operatively and 4 weeks post operatively for deviated nasal septum (DNS) and nasal polyposis (NP) pathologies

Figure 3 provides the line graph depiction of median Middle Ear Pressure (MEP) values pre-operatively and 4 weeks post-operatively for both pathologies. For patients diagnosed with Deviated Nasal Septum (DNS), the median MEP pre-operatively was -103.5 daPa while 4 weeks post-operatively, it was -55.0 daPa. The difference in the median MEP values pre-operatively and 4 weeks post-operatively was statistically significant with *P*-value < 0.0001 as per *Wilcoxon signed rank test.* For patients diagnosed with Nasal Polyposis (NP), the

median MEP pre-operatively was -151.5 daPa and 4 weeks post-operatively, it was -83 daPa. The difference in the median MEP values pre-operatively and 4 weeks post-operatively was statistically significant with *P*-value < 0.0001 as per *Wilcoxon signed rank test*. Thus, septal surgery and surgery for nasal polyposis have individually shown statistically significant improvement in middle ear ventilation by 4 weeks post-operatively.

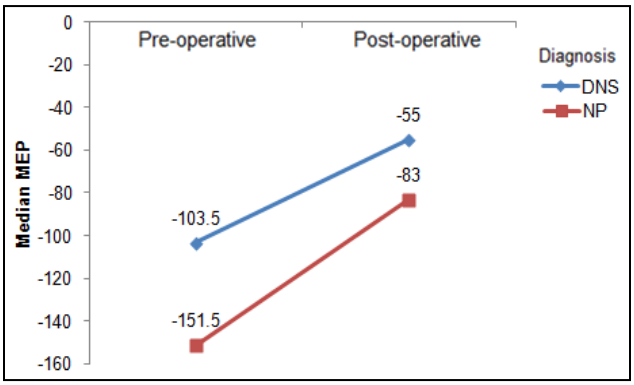

Figure 3. Line graph showing median Middle Ear Pressure (MEP) values pre-operatively and 4 weeks post-operatively for deviated nasal septum (DNS) and nasal polyposis (NP) pathologies.

DISCUSSION

The concept of a relationship between nasal obstructive lesions and Eustachian tube dysfunction is supported by our data. The physiologic mechanism of this effect is not fully documented. The most reasonable mechanism is airflow turbulence in the post-nasal space, leading to Eustachian tube malfunction. A physiologically normal Eustachian tube is prohibited from fulfilling its normal function of equilibrating the middle ear pressure as a result of distortion of the air current delivered to the nasopharyngeal orifice of the Eustachian tube, due to abnormality of the nasal airway. Three mechanisms have been postulated by which airflow turbulence in the post-nasal space may lead to Eustachian tube dysfunction.[7]

Firstly, airflow turbulence may lead to deposition of micro-organisms and air-pollutants in the region of the Eustachian tube opening, resulting in tubal epithelial or peritubal inflammation and mechanical obstruction of the Eustachian tube.

Secondly, post-nasal mechano-receptors and an autonomic nerve supply to the Eustachian tube have been described. Altered air currents may stimulate these mechano-receptors, leading to reflex alteration of Eustachian tube function.

Thirdly, the turbulent airflow in the post-nasal space has a marked drying effect on the mucous film in the post-nasal space, especially in the region of the tubal orifice. This drying effect would increase the viscosity of the mucus and surface tension at the tubal orifice, rendering it impossible for the mucous film to separate as it would do in a normal Eustachian tube, when the tube opens.

CONCLUSION

Thus, based on above observations, the following conclusions can be drawn:
Impedance Audiometry is an invaluable tool for evaluation of anatomical patency and functional integrity of Eustachian tube.

The Eustachian tube dysfunction and the consequent hypoventilation of middle ear are among the most frequent causes of failure of middle ear surgery. Thus, a complete evaluation of the naso-pharyngeal-tubal unit and nasal air flow is mandatory before middle ear surgery to increase the success rate. Impedance Audiometry should be performed in all patients who are subjected to middle ear surgery in order to evaluate the opportunity of improving nasal breathing before surgery thereby improving the success rates of surgery. Surgery for chronic nasal obstruction significantly improves tubal function and middle ear ventilation 4 weeks from the surgical procedure. Hence, corrective surgery for nasal obstruction should be considered at least 4 weeks before undertaking the middle ear surgery to improve middle ear ventilation, thereby improving the success rates of middle ear surgery.

CONFLICT OF INTEREST

Nil.

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