Original Research Article

Comparison of middle ear pressure in patients with and without nasal obstruction

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Abstract

Background: Maintaining the physiological pressure in the middle ear depends on the gaseous balance between air intake through the Eustachian tube and gas diffusion from the middle ear to the systemic circulation. **Aim:** To compare middle ear pressure in patients with and without nasal obstruction. **Material and Methods:** 50 patients with nasal obstruction (Group A) and 50 without nasal obstruction (Group B) were included in the study. Middle ear pressure was measured through impedance audiometer AT235 and a tympanogram recorded on thermal paper. **Results:** Out of total 100 ears examined in patients with nasal obstruction (Group A subjects) 41% have middle ear pressure in the normal range and 59%were having negative middle ear pressure. However, in subjects without nasal obstruction (Group B) only 3% have negative middle ear pressure and 97% have middle ear pressure in normal range. **Conclusion:** nasal obstruction has a significant effect on eustachian tube function and middle ear pressure in the majority of cases in the study population especially in 0-20 years age group.
Key words: Nasal obstruction, middle ear pressure, Eustachian tube, tympanogram

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INTRODUCTION

The nasal cavities are in direct continuity with nasopharynx which is directly connected to middle ear through Eustachian tubes. So, any mechanical obstruction or pathological disease affecting the function of eustachian tubes will lead to blockage of eustachian tubes and changes in middle ear pressure.[1] The eustachian tube serves to regulate air pressure in the middle ear and mastoid system, clear material from the middle ear, and prevent reflux of material or sound from the nasopharynx.[2] Middle ear and mastoid gas exchange continuously generates a net absorption of gases resulting in an increasingly negative pressure between tubal dilatations. Maintaining the physiological pressure in the middle ear depends on the gaseous balance between air intake through the eustachian tube and gas diffusion from the middle ear to the systemic circulation. It is evident from above knowledge that nasal cavity, nasopharynx and middle ear are closely related to each other and goal of this study was to find out whether nasal obstruction leads to change in middle ear pressure. The present study was conducted to compare middle ear pressure in patients with and without nasal obstruction.

MATERIAL AND METHODS

This comparative study was conducted in the Department of Otorhinolaryngology and Head and Neck Surgery and Pathology, over a period of two years. Permission from Institutional Ethical Committee was obtained prior to the commencement of the study. A written informed consent was taken from each participant. During the study period, 50 patients with nasal obstruction (Group A) and 50 without nasal obstruction (Group B) were included in the study.

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Inclusion criteria

- Patients with complaints of unilateral or bilateral nasal obstruction.
- Patients without nasal obstruction.
- Patients giving consent for study.
- Patients below age 60 years.
- Patients above the age of 1 year.

Exclusion criteria

- Age >60 years or <1year.
- Patients with ear discharge, otitis externa, acute otitis media, outer ear defects such as complete stenosis or atresia of external auditory canal and excessive wax.
- Patients with perforation of tympanic membrane.
- Patients using nasal drops/spray.
- Patients with previous ear surgery

Methodology

Detailed history obtained from study participants regarding nasal obstruction, unilateral or bilateral involvement, duration of nasal obstruction, allergic symptoms, nasal discharge, ear discharge, earache, decreased hearing, headache, tinnitus, mouth breathing at night, congenital hearing loss, previous surgical procedures. Clinical examination of patient was done including general physical examination and systemic examination for assessing the general condition of participants. A thorough ENT examination was done including anterior rhinoscopy, posterior rhinoscopy, ear examination, throat examination. Various nasal patency tests such as cold spatula test, cotton wool test, cottle's test were performed to assess and compare the nasal breathing on bilateral nasal cavities. Middle ear pressure was measured through impedance audiometer AT235 and a tympanogram recorded on thermal paper. Middle ear pressure was measured in mm of water pressure or Deka Pascal units. The pressure at which the tympanogram shows the highest compliance is the pressure of the air in the middle ear cavity. The most accepted range is +50mm of water pressure to -50mm of water pressure was taken as normal.

Statistical analysis

Data were entered in Microsoft Excel sheet. The continuous variables were presented using mean/ median. For categorical variables proportions were used. Means were tested using student t-test and proportions using Chi-square and Z-test. Level of significance was set at $p<0.05$. The statistical analysis was done using Epi Info v7 software.

RESULTS

A total of 50 patients of either sex with a subjective complaint of nasal obstruction and an equal number of subjects without complaint of nasal obstruction were grouped as Group A and group B respectively. The study population (Group A) comprised of 15 (30%) male adults, 7 (14%) female adults, 16 (32%) male children and 12 (24%) female children. Out of overall 50 subjects studied 31 (62%) were males and 19 (38%) were females in study Group A. The study population (Group B) comprised of 12 (24%) male adults, 13 (26%) female adults, 13 (26%) male children and 12 (24%) female children. Out of overall 50 subjects studied 25 (62%) males and 25 (50%) females in study Group B. Out of the total 50 subjects studied in Group A all cases 50/50 (100%) presented with nasal obstruction, other associated symptoms were as follows, 15/50 (30%) subjects were having symptom of post nasal discharge, 4/50 (8%) subjects have pain in ear, 8/50(16%) have headache, 9/50 (18%) have decreased hearing, 29/50 (58%) complain of mouth breathing at night, 16/50 (32%) complains of excess sneezing and only 1/50 (2%) have associated tinnitus. Out of the total 50 subjects studied in Group B 1/50 (2%) have pain in ear, 1/50 (2%) have complaint of decreased hearing, and only 1/50(2%) have associated tinnitus.

Table 1: Clinical diagnosis in Group A patients

Clinical diagnosis	Frequency	Percentage (%)
Adenotonsillitis	21	42%
Allergic rhinitis/ Allergic rhinosinusitis	05	10%
Nose and PNS Polyposis	06	12%
Turbinate hypertrophy	06	12%
DNS / Spur / CSD	02	04%
Nasal Packing	04	08%
Rhinolith	01	02%
Adenoiditis + Turb. Hypertrophy	02	04%
DNS + ITH + Polyp	01	02%
DNS/ITH/CSD + ITH	02	04%

In study participants of Group A, adenoidits/ tonsillitis/ adenotonsillitis was the most common clinical diagnosis in 21 (42%). Various other causes observed were allergic rhinitis/ allergic rhinosinusitis 05 (10%), nose and paranasal polyposis 06 (12%), turbinate hypertrophy 06 (12%) (Table 2). Out of 50 subjects studied in Group A 14/50 (28%) subjects were having complaint of unilateral nasal obstruction and rest 36/50 (72%) were having bilateral nasal obstruction. In Group A 37 (74%) were having complaints of nasal obstruction for duration between 0-20 months, 8 (16%) for 21-40 months, 4 (8%) for 41-60 months and 1 (2%) for 61-80 months of duration.

Table 2: Frequency distribution of the middle ear pressure in 200 ears in both groups (Group A and B)

Middle ear pressure in daPa	Group A (100 ears) Frequency (%)	Group B (100 ears) Frequency (%)
+101 to +150	01 (01%)	01 (1%)
+51 to +100	01 (01%)	00 (0%)
0 to +50	14 (14%)	54 (54%)

0 to -50	25 (25%)	42 (42%)
-51 to -100	15 (15%)	02 (2%)
-101 to -150	14 (14%)	1 (1%)
-151 to -200	09 (9%)	0 (0%)
-201 to -250	07 (7%)	0 (0%)
-251 to -300	04 (4%)	0 (0%)
-301 to -350	06 (6%)	-
-351 to -400	04 (4%)	-

Middle ear pressure measured in Group A 50 subjects (total = 100 ears) shows that in right ear 17/50 (34%) have middle ear pressure in the normal range (-50 to +50 daPa) and 34/50(68%) were having negative middle ear pressure (< -50 daPa). In left ear 24/50 (48%) have middle ear pressure in the normal range (-50 to +50 daPa) and 26/50(52%) were having negative middle ear pressure (< -50 daPa). Out of total 100 ears examined in Group A subjects 41/100(41%) have middle ear pressure in the normal range (-50 to +50 daPa) and 59/100(59%) were having negative middle ear pressure (< -50 daPa). In Group B subjects the observed findings of middle ear pressure in right ear shows 49/50(98%) have normal middle ear pressure(-50 to +50 daPa) and only one(2%) have negative middle ear pressure. In left ear 48/50 (96%) normal middle ear pressure (-50 to +50 daPa) and 02 (4%) were having negative middle ear pressure (<-50 daPa). Out of total 100 ears examined in Group B subjects 97/100(97%) have middle ear pressure in the normal range (-50 to +50 daPa) and 03/100(3%) were having negative middle ear pressure < -50 daPa).

Table 3: Frequency distribution of the type of tympanogram in both groups

Type of tympanogram	Group A	Group B
	Frequency	Frequency
A	45	97
Ad	04	0
As	01	0
B	16	0
C	34	3

In Group A subjects, right ear tympanometry showed 23 (46%) were having type A, 02 (4%) type Ad, 07 (14%) type B, 18 (36%) type C tympanograms and left ear tympanometry showed 22 (44%) were having type A , 02 (4%) type Ad , 01 (2%) type As , 09 (18%) type B, 16 (32%) type C tympanograms. So out of total 100 tympanograms of Group A subjects 45% were type A, 4% were type Ad, 1% were type As, 16% were type B and 34% were type C tympanograms. In Group B subjects right ear tympanometry showed 49 (98%) were having type A and 01 (2%) type C tympanogram and left ear tympanometry showed 48 (96%) were having type A and 02/50(4%) type C tympanograms. So out of total 100 tympanograms of Group B subjects 97% were type A and 3% were type C tympanograms.

Table 4: Frequency distribution of the compliance in 200 ears (Group A and B)

Middle ear compliance	Group A		Group B	
	Right ear	Left ear	Right ear	Left ear
0ml to 0.35ml	16	16	11	06
0.36ml to 1.40ml	29	30	32	42
>1.40ml	05	04	07	02

Acoustic compliance is an expression of elastic movement or springiness of the middle ear system and is reciprocal of stiffness. It is measured in millilitres. In our study observation in Group A subjects middle ear compliance in right ear was low (0 to 0.35 ml) in 16/50(32%), normal (0.36ml to 1.40 ml) in 29/50(58%) and high (>1.40 ml) in 5/50(10%). Middle ear compliance in left ear of Group A participants was low (0 to 0.35 ml) in 16/50(32%), normal (0.36ml to 1.40 ml) in 30 (60%) and high (>1.40ml) in 4 (8%). So, in all the 100 ears examined in Group A subjects middle ear compliance in right ear was low (0 to 0.35 ml) in 32 (32%), normal (0.36ml to 1.40ml) in 59 (59%) and high (>1.40ml) in 9 (9%). In Group B subjects middle ear compliance in right ear was low (0 to 0.35ml) in 11 (22%), normal (0.36ml to 1.40ml) in 32 (64%) and high (>1.40ml) in 07 (14%). Middle ear compliance in left ear of Group B participants was low (0 to 0.35 ml) in 06 (12%), normal (0.36ml to 1.40 ml) in 42 (84%) and high (>1.40 ml) in 02 (4%). So, in all the 100 ears examined in Group B subjects middle ear compliance in right ear was low (0 to 0.35ml) in 17 (17%), normal (0.36ml to 1.40ml) in 74 (74%) and high (>1.40ml) in 09 (9%).

DISCUSSION

During measurement of middle ear pressure we observed that out of total 100 ears examined in Group A subjects 41/100(41%) have middle ear pressure in the normal range (-50 to +50 daPa) and 59/100 (59%) were having negative middle ear pressure (<-50 daPa). So, most of the findings observed by Shrivastva *et al*[3] were congruent with our study. During a prospective study Murthy A *et al*[4] while analysing the role of allergic rhinitis and its effect on the middle ear pressure in two groups of patients, who had not taken any medication Group A (n=68) and patients who were on anti-allergy medications Group B (n=60) observed that patients already on anti-allergy medications (Group B) were having normal middle pressure on their first and subsequent visits also. In our study, out of total 100 tympanograms of Group A subjects 50% were type A, 16% were type B and 34% were type C tympanograms in my study. Salaheldin AH5 studied the effects of deviated nasal septum and hypertrophy of inferior turbinate on middle ear pressure on 34 patients observed that type c tympanogram <-100dapa was found in only 5 patients (14.71%) and rest

of the patients 29 85.29%) had MEP within the normal range. Similar findings observed in our study and observed that out of total 100 ears examined in Group A subjects 41/100(41%) have middle ear pressure in the normal range (-50 to +50 daPa) and 59/100 (59%) were having negative middle ear pressure (<-50 daPa). During a study on effect of nasal obstruction surgery on middle ear ventilation Awad OGA *et al*6 observed that out of 60 ears examined preoperatively, 47 (78.3%) ears were type A, 24 ears of them had poor ETF and 23 ears had good ETF. Thirteen (21.6%) ears were type C, all of them had poor ETF. The postoperative results of ETF tests were significantly better than preoperative results (P <0.002). Significant improvement in tympanometeric values was also found (P <0.05). Preoperatively, 28 patients (93.3%) had sensation of ear fullness. At 30 days after removal of nasal packs, 20 patients (66.7%) still had sensation of ear fullness, with significant improvement (P<0.001). Similar findings observed in my study as out of total 100 tympanograms of Group A subjects 45% were type A, 4% were type Ad, 1% were type As, 16% were type B and 34% were type C tympanograms. Chronic rhinosinusutis is associated with inflammatory changes ranging from polypoid mucosa to gross nasal polypi. Nasal polypi cause post nasal drip which is considered to cause eustachian tube dysfunction. The tube is frequently involved in different pathological conditions of the nasal, paranasal and nasopharyngeal cavities. Therefore, nasal obstruction can alter eustachian tube function. Most inflammatory disorders of the middle ear are thought to be due to inadequate ventilation through the eustachian tube. The lymphatics of the middle ear and eustachian tube course along the posterior-inferior aspect of the eustachian tube, getting afferent from nasal cavity, paranasal sinuses, nasopharynx and adenoids. Efferent from plexus terminate in retropharyngeal lymph nodes. Inflammation and oedema in these areas cause obstruction to the flow, resulting in retrograde obstruction of tympanic and tubal lymphatics producing tubal dysfunction and middle ear effusion. Although tubal dysfunction and middle ear effusion may occur simultaneously, but effusion can occur in absence of frank obstruction of eustachian tube lumen and development of middle ear vacuum. As evident from above literature nasal obstruction can result from various causes in nose, paranasal sinuses, and nasopharynx. Various causes of nasal obstruction in our study directly or indirectly interfere with normal eustachian tube function and cause blockage of eustachian tube which leads to formation of a closed chamber in middle ear cleft. During course of time air entrapped in middle ear cleft gets absorbed by mucosal lining of middle ear cleft and generation of negative pressure in middle ear cleft. Due to negative pressure in middle ear cleft various aural symptoms arise in patients such as aural fullness, decreased hearing. Due to intimate relation between nose, nasopharynx and middle ear through eustachian tube any condition leading to nasal obstruction and simultaneous obstruction of eustachian tube can have negative impact on proper functioning of middle ear.

CONCLUSION

To conclude, nasal obstruction has a significant effect on eustachian tube function and middle ear pressure in the majority of cases in the study population especially in 0-20 years age group.

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