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ORIGINAL PAPERS

The impact of nasal obstruction upon Eustachian tube function – a correlation between rhinomanometric and tubal manometric measurements

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ABSTRACT

OBJECTIVE: Nasal obstruction is one of the most common upper airway symptoms and it can have a great impact upon health. A consequence of nasal airway resistance is Eustachian tube dysfunction. The aim of the study was to make an objective evaluation of the impact of nasal obstruction upon Eustachian tube function by comparing the results of rhinomanometry and tubal manometry.
MATERIAL AND METHODS: An 18 months retrospective study was performed on 139 adult patients. Observations included nasal endoscopic examination, tympanometry and stapedian reflex, rhinomanometric recorders of the nasal airway resistance and tubal manometry for evaluating the Eustachian tube function.
RESULTS: A nasal airway resistance range between 0.41-1.17Pa/cm3/s was found. The middle ear pressure was found at values between -50 and -387daPa. The comparison of both test results showed that there was a specific distribution of the Eustachian tube dysfunction grades according to the degree of the nasal obstruction. The data analyzes showed a statistically significant correlation between the grade of nasal obstruction and the degree of the Eustachian tube dysfunction ($p<0.0001$).
CONCLUSIONS: Nasal obstruction and Eustachian tube dysfunction represent two related pathologies, regarding the fact that the severity of the nasal airway resistance can influence the grade of Eustachian tube dysfunction.
KEYWORDS: nasal obstruction, Eustachian tube dysfunction, rhinomanometry, tubal manometry

INTRODUCTION

Nasal obstruction, one of the most common upper airway symptoms, can be caused by a diversity of nasal and sinus diseases such as deviated nasal septum, turbinate hypertrophy, allergic or non-allergic rhinitis, acute or chronic rhinosinusitis, etc.

Chronic nasal obstruction has a great impact upon health and quality of life. One of the consequences of nasal airway resistance is a malfunction of Eustachian tube. The mechanism of the Eustachian tube dysfunction (ETD) depends on the cause of nasal obstruction.

The nasal airway resistance can be measured by different methods, most used being rhinomanometry. However, there are cases in which the measurements do not agree with patient's perception of nasal obstruction[1]. The same problem can be found when talking about Eustachian tube dysfunction. Of great use in evaluating the auditory tube function is tubal manometry.

The aim of the study was to make an objective evaluation of the impact of nasal obstruction upon Eustachian tube function by comparing the results of rhinomanometry and tubal manometry.

MATERIAL AND METHODS

A retrospective study was performed on 139 adult patients, aged 31 to 60 (the mean age = 41), during 18 months (Figure 1). The demographic data revealed a men/women ratio of 1/1.04 (68 men/71 women).

In the study were included those patients who presented at their first evaluation chronic nasal obstruction and aural symptoms, like aural fullness or hypoacusis (Table 1).

Study exclusion criteria:

- Rhinopharynx tumors
- Acute or chronic otomastoiditis
- Pregnancy

All patients were investigated as follows: nasal endoscopy, otic endoscopy, tympanometry and stapedian reflex. The four-phase rhinomanometry was used to evaluate the grade of the nasal obstruction and the tubal manometry for assessing the Eustachian tube function. The results of these two tests were correlated to determine the correspondence of the parameters of nasal and tubal dysfunction.

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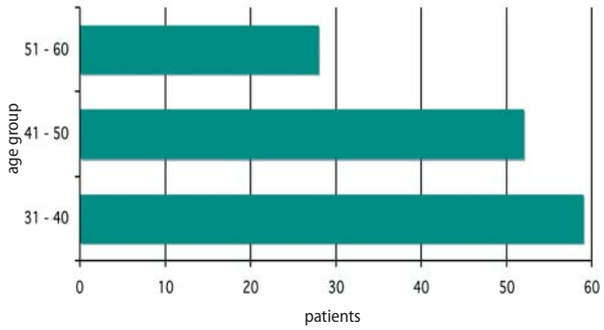

Figure 1 Group age repartition

RESULTS

In each patient the diagnostic protocol began with the nasal endoscopic examination which revealed the cause of the nasal obstruction. We found a deviated nasal septum in 17.98% of the cases (25 patients), turbinate hypertrophy in 30 patients (21.58%), nasal polyposis in 18 patients (12.95%) and chronic rhinosinusitis in 20 patients (Table 2). All these pathologies were found alone or in different combinations. We had 11 patients with deviated nasal septum and turbinate hypertrophy, 22 patients with deviated nasal septum and chronic rhinosinusitis. In 5 patients the examination showed the existence of both turbinate hypertrophy and chronic rhinosinusitis, and 8 patients presented deviated nasal septum and nasal polyposis.

Table 1
First evaluation of the aural symptoms

Symptoms	Patients number	Percentage (%)
Aural fullness	103	74.10
Hypoacusis	28	20.14
Rhinorrhea	13	9.35

Table 2
Nasal pathology

Nasal pathology	Patients number	Percentage (%)
Deviated nasal septum	25	17.98
Turbinate hypertrophy	30	21.58
Nasal polyposis	18	12.95
Chronic rhinosinusitis	20	14.39
Deviated nasal septum + turbinate hypertrophy	11	7.92
Deviated nasal septum + chronic rhinosinusitis	22	15.83
Deviated nasal septum + nasal polyposis	8	5.76
Turbinate hypertrophy + chronic rhinosinusitis	5	3.59
Total	139	100

Table 3
Rhinomanometry test results

	Mild nasal obstruction	Moderate nasal obstruction	Severe nasal obstruction
Patients number	50	49	40
Percentage (%)	35.97	35.25	28.78

With a range between 0.41-1.17Pa/cm^3/s at 150Pa, the measurements of the nasal airway resistance with the four-phase rhinomanometry helped us classify the nasal obstruction in (Table 3): mild (0.41-0.68Pa/cm^3/s) (Figure 2), moderate (0.69-0.89Pa/cm^3/s) (Figure 3) and severe (0.90 - 1.17Pa/cm^3/s) (Figure 4).

The next step in the evaluation of our patients was the assessment of the Eustachian tube function by using the tubal manometry. With a middle ear pressure range between -50 and -387daPa, the measurements revealed different grades of Eustachian tube dysfunction (Figure 5) – mild(pressure between -50 and – 100daPa), moderate (between -100 and – 199daPa) or severe (middle ear pressure between -200 and -387daPa).

The analyses of the both test results showed that there was a specific distribution of the Eustachian tube dysfunction grades according to the degree of the nasal obstruction. So, among those 50 patients with mild nasal airway resistance in rhinomanometry, 34, representing 68%, presented a mild Eustachian tube dysfunction and 16, representing 32%, a moderate one. Also, 75.51% (37 patients) of the 49 patients with a moderate nasal obstruction were found with a moderate tubal dysfunction, 16.33% (8 patients) with mild one, and 4 patients presented a severe Eustachian tube dysfunction. From those 40 patients with severe nasal obstruction, 7 patients, representing 17.5%, had a moderate Eustachian tube dysfunction and 33 patients, 82.5%, had a severe Eustachian tube dysfunction.

Analyzing all these results we can say that at the level of significance alpha=0.05 there is a statistically significant correlation between the grade of nasal obstruction and the degree of the Eustachian tube dysfunction ($p<0.0001$) (Table 4).

DISCUSSIONS

Eustachian tube, also known as the auditory tube, links two of the major areas of interest, the ear and the nasophar-

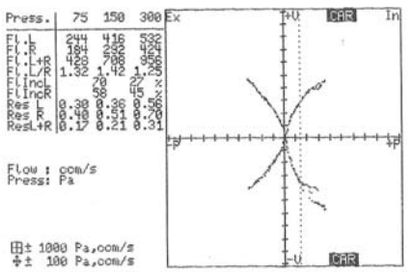

Figure 2 Mild nasal obstruction

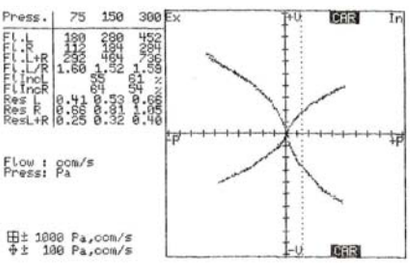

Figure 3 Moderate nasal obstruction

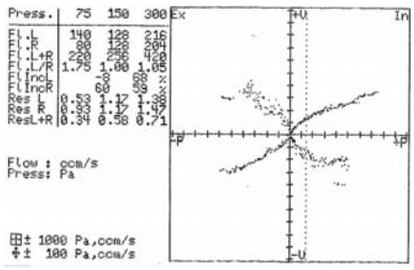

Figure 4 Severe nasal obstruction

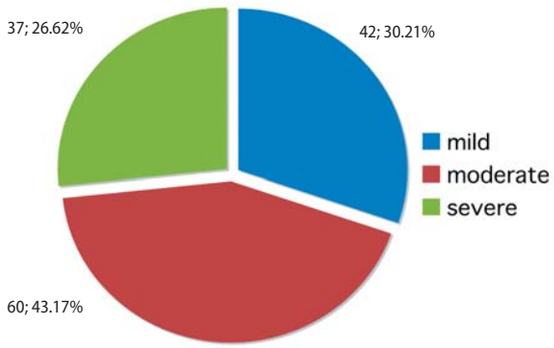

Figure 5 Tubal manometry results – Eustachian tube dysfunction grades

ynx, and also serves the ear through two important functions: ventilation by maintaining a good middle ear pressure and clearance, by being a drainage route[2]. As a consequence of Eustachian tube obstruction a negative pressure appears in the middle ear and an accumulation of fluid behind the tympanic membrane. Eustachian tube dysfunction is the starting point for the most acute and chronic otic inflammatory diseases and their complications.

One of the causes leading to a malfunction of the auditory tube is the nasal pathology. The most important mechanism of nasal obstruction is inflammation, between these two symptoms being a direct connection[3].

Due to the anatomical configuration, the lymphatics of the Eustachian tube get afferents from nasal cavity, paranasal sinuses and rhinopharynx. The inflammation and the edema in these areas can cause an obstruction in the flow of the peritubal plexus and rhinopharingeal nodes leading to a retrograde obstruction of the tubal lymphatics. The consequences are tubal dysfunction and middle ear effusion[4].

Nasal obstruction associated with a Toynbee phenomenon, like a partial vacuum, it can also be viewed as a factor of great impact in tubal dysfunction. This is why even an anterior obstruction of the nostrils, with a negative pressure behind the obstacle, can cause a Eustachian tube dysfunction[5].

To have an objective, sensitive and functional measure of the nasal patency the literature recommends a four-phase rhinomanometry to be performed. In subjects with normal nasal airway path, the mean total resistance measured at 150Pa has been reported to be around 0.23Pa/cm^3/s, with a rang between 0.15-0.39Pa/cm^3/s[6]. The greater the total resistance value is, the more increases the severity of the nasal obstruction, fact observed also in our study comparing the nasal endoscopic examination and rhinomanometry results.

Determination of the Eustachian tube function involves the Toynbee and Valsalva's test, also known as tubal manometry. It can give useful information about the ability of the Eustachian tube to equilibrate the middle ear pressure[7]. As shown in our study, the low capacity of providing a negative middle ear pressure at Toynbee maneuver or a positive one after Valsalva can indicate a tubal dysfunction.

Different studies reported in the literature support the idea of an existing connection between nasal obstruction and Eustachian tube dysfunction[8,9,10]. In an early study, Doyle determined the status of the middle ear and Eustachian tube function after intranasal challenge of rhinovirus[9]. The follow-up consisted in the assessment of auditory tube function and middle ear pressure using tympanometry and nasal patency using active posterior rhinometry. The results showed that all patients had

Table 4
Contingency Table and Chi-square (XLSTAT 7.5.2)

Contingency table:			
	ETD* - mild	ETD - moderate	ETD - severe
nasal obstruction - mild	34	16	0
nasal obstruction - moderate	8	37	4
nasal obstruction - severe	0	7	33

Chi-square independence test:	
Chi-square (observed value)	124,767
Chi-square (critical value)	9,488
One-tailed p-value	< 0.0001
Alpha	0,05

decreased nasal patency, 50% of the patients had Eustachian tube obstruction and 30% had abnormal negative middle ear pressure at one week after inoculation.

In an almost similar study Knight and Eccles demonstrated an inverse correlation ($r=0.32$, $r^2=0.11$, $p<0.001$) between the total nasal airway resistance, measured using rhinomanometry, and middle ear pressure[10]. They performed the study on 8 subjects with acute upper airway respiratory tract infection. So, our results can be correlated with those found in the international literature.

CONCLUSIONS

Nasal obstruction and Eustachian tube dysfunction represent two related pathologies, regarding the fact that the severity of the nasal airway resistance can influence the grade of Eustachian tube dysfunction. The four-phase rhinomanometry and Eustachian tube manometry are two very useful tests in evaluating the degree of nasal obstruction and auditory tube dysfunction. The significant statistical correlation observed between the results of rhinomanometric and tubal manometric measurements sustains, from objective point of view, the important impact of the nasal obstruction upon Eustachian tube function.

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