

ORIGINAL ARTICLE

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Relationship between nasal polyposis and Eustachian tube function

Mohammad Waheed El-Anwar^{*} , Nadia Mohamed Elnabity, Ebtessam Nada and Said Abdelmonem

Abstract

Background: No previous study investigated the relationship between different stages and duration of nasal polyposis (NP) and Eustachian tube (ET) functions. Thus, the aim of the current study was to assess the relationship between the NP and ET functions by studying different staging and duration of the NP. The study included adult patients with bilateral NP. The tridimensional endoscopic staging of the NP was performed to provide information on the location of the NP within the nasal cavity in the three dimensions; horizontal, vertical, and anteroposterior planes. Tympanometry was performed 1 day before endoscopic staging, and the tympanometric results were distinguished into 3 grades; type A, normal curve; type C; and type B.

Results: Within 40 patients (80 nasal cavities, 80 ears), tympanometry showed type A curve in 48 ears (60%), type B curve in 14 ears (17.5%), and type C in 18 ears (22.5%). So, NP was associated with 40% ET affection with non-significant differences with different NP stages at the horizontal plan ($P=0.989567$), at the vertical plan ($P=0.666$), and at the anteroposterior plane ($P=0.628$). While ET affection (ET dysfunction or OME) was reported significantly more with NP of longer duration ($P<0.0001$).

Conclusion: NP is associated with a high ET dysfunction rate that is significantly higher with NP of longer duration, while different NP stages did not significantly differ in affecting the ET function.

Keywords: Nasal polyposis, Otitis media with effusion, Eustachian tube dysfunction, Tympanometry, Endoscopy

Background

ET is a bidirectional gas-exchange passage which balances the middle ear physiologic pressure. During swallowing, ET opens and allows gas to flow into the middle ear, equalizing pressure on both sides of the tympanic membrane [1, 2].

Nasal polyposis (NP) is a chronic inflammatory process of the nasal mucosa, characterized by the presence of multiple and bilateral nasal polyps [3]. Its pathophysiology is still unclear, with numerous theories described in the literature [4, 5]. Some type of NP staging is recommended in order to follow disease evolution in these patients and for the comparison between different types of treatment [6].

Nasal and paranasal sinus diseases can cause Eustachian tube (ET) dysfunction. Both inflammatory and mechanical factors could contribute to the ET dysfunctions [7].

The first study investigated the ET function in patients with nasal obstruction due to NP by Bakhshae et al. [8], but they included patients with infection and concluded that polyposis could impede ET function; however, it is probably not because of its obstructive nature, but because of the associated increased risk of infection. In addition, they did not classify the NP according to their duration and staging that appeared to might have an effect on ET functions.

However, no previous study investigated the relationship between different stages and duration of NP and ET functions. Therefore, the aim of the current study was to assess the effect of NP on the ET functions taking into consideration the staging and duration of the NP.

*Correspondence: mwenteg1973@gmail.com
Otolaryngology Head and Neck Surgery Department, Faculty of Medicine,
Zagazig University, Zagazig, Egypt

Methods

This study was conducted in the Department of Otorhinolaryngology Head and Neck Surgery, University Hospitals, in the period from February 2018 to January 2020. The study included adult patients (> 18 years) who had bilateral NP. Syndromic patient, nasopharyngeal masses (including antrochoanal polyp), and previous nasal surgery or ventilation tube insertion were excluded.

Thorough history taking (including the duration of the NP), otorhinolaryngology examination (including otoscopic ear examination), and routine laboratory tests (to exclude systemic disease associated with NP) were performed. Any associated acute infection was properly treated first.

Tympanometry was done using MADSEN Zodiac 901 tabletop tympanometer from Otometrics Copenhagen.

Staging of NP

The tridimensional staging of de Sousa et al. [6] was used: the endoscopic evaluations were carried out by one single examiner, with a 4-mm sinuscope.

The examination started in the right nasal cavity, inspecting its floor, all the way to the choana. Whenever possible, we visualized the sphenoid-ethmoidal recess, then the middle meatus and the superior region of the nasal cavities, trying to see the NP in the three planes.

After doing all the examinations, they were copied to a single DVD disk, of which copies were made and handed over to the other two examiners simultaneously.

This staging provides information on the location of the NP within the nasal cavity in the three dimensions of the space; in the horizontal, vertical, and anteroposterior planes.

In the horizontal plane (H), polyps were classified as follows:

- H0—No polyps
- H1—Polyps restricted to the middle meatus
- H2—Polyps expand beyond the middle meatus, without touching the nasal septum.
- HT—Polyps expand beyond the middle meatus and touch the septum.

In the vertical plane (V), the polyps were classified as follows:

- V0—No polyps
- V1—Polyps in the middle meatus only
- V2—Polyps extending inferiorly to the middle meatus, going beyond the upper border of the inferior turbinate

- VS Polyps extending superiorly to the middle meatus, between the septum and the middle turbinate
- VT Polyps occupying the entire vertical aspect of the nasal cavity

In the anteroposterior plane (P), the polyps were classified as follows:

- P0 No polyps
- P1 Polyps in the middle meatus only
- PA Polyps extending anteriorly to the middle meatus, reaching the head of the inferior turbinate
- PP Polyps extending posterior to the middle meatus, reaching the tail of the inferior and middle turbinate
- PT Polyps occupying the entire anteroposterior aspect of the nasal cavity

Diagnosis of ET function

Tympanometric examinations were performed 1 day before endoscopic staging. The tympanometric results were distinguished into 3 grades [9] as classified by Jerger [10] and modified by Poulsen and Tos [11]; type A, normal curve (pressure +50/−90 daPa); type C (negative pressure); and type B (flat curve). The diagnosis of otitis media with effusion (OME) was considered in type B, also, in cases with enlarged tympanogram width (wide tympanogram) or reduced tympanogram gradient which were considered stages of development or resolving of OME whether associated with type A or type C tympanograms [9–12].

Tympanometry was done twice in a sweep procedure allowing the examiner to compare the second sweep and measure the pressure difference if any. The second tympanogram was done after the patient was instructed to create an over-pressure (positive pressure) in the middle ear by closing the mouth, holding the nose, and blowing to create the over-pressure in the throat, then swallowing was done to open the ET. Opening the tube was achieved by instructing the patient to drink a glass of water, relieving the positive pressure if the ET Function was normal. The sweep following Valsalva was more positive and the one following swallowing was more negative compared to the original one if the ET was properly functioning.

Statistical analysis

Comparison between data of preoperative and postoperative evaluations was done by χ^2 test (version 17, SPSS Statistical Package for Social Sciences; SPSS, Inc., Chicago, IL). $P < 0.05$ was considered significant.

Results

Forty patients (80 nasal cavities, 80 ears) were included, 24 males (60%) and 16 females (40%). Their ages ranged from 24 to 62 years with a mean of 41.5± 3.1 years (Table 1).

Tympanometry showed type A (normal) curve in 48 ears (60%), type B (flat) curve in 14 ears (17.5%), and type C in 18 ears (22.5%). So, NP was associated with 40% ET dysfunctions.

On revising the different stages of NP, tympanometric results showed non-significant differences with different NP stages at the horizontal plan (H) ($P= 0.989567$), at the vertical plan (V) ($P= 0.666$), and at the anteroposterior plane (P) ($P= 0.628$) (Table 2).

The mean duration of NP was 42.1± 39.9 months (range; 5 months to 10 years). The mean duration in the patients who had normal middle ear pressure was 6.05± 2.8 months. While the mean NP duration in the patients had ET dysfunctions was 72.6± 33.76 months (range; 1.5–6 years) with significant difference ($t= 2.5287$, $P= 0.016$). While in the OME patients, the mean duration

was 7.8± 1.79 (range 5–10 years) with a significant difference from normal ears ($t= 5.0563$, $P< 0.0001$) (Fig. 1). It was clear that OME did not develop in any patients with an NP duration of less than 5 years (Table 3). The most common nasal symptoms in included patients were described in Table 4.

Discussion

The entire respiratory tract, comprising the mucosa of the middle ear and the ET, nose and paranasal sinuses and the pulmonary tree, acts as one integrated functional component [13]. The ET and the middle ear are lined by the same respiratory mucosa, and they have direct connection with each other [7].

Sinonasal polyps are a common clinical disorder, affecting up to 4% of the general population and causes significant obstruction in the nasal cavity [3]. ET has a great role in middle ear ventilation, drainage, and protection [14].

Nasal problems usually lead to the development of ear diseases [15–17]. The frequency of developing otitis media in patients of NP is quite high [7, 8]. It is expected that NP causes ET dysfunction which in turn leads to negative middle ear pressure that could lead to OME. Such effect is theoretically expected to increase with larger polypi. Few papers have addressed the effect of NP on ET functions and the association between the nasal obstructive conditions including NP and the ET dysfunction is still a subject of debate [8].

There are several justifications for the ET dysfunction associated with nasal diseases such as mechanical obstruction of ET Orifice [18], increased secretions in the

Table 1 Age and gender distribution

Number of patients	40
Gender	
Male	24 (60%)
Female	16 (40%)
Age	
Range	24–62 years
Mean (SD)	41.5 (3.1) years

Table 2 Tympanometric results in different nasal polyposis staging

	Polyp staging	Normal (type A)	ETD (type C)	OME (type B)	X²	P value			
Horizontal plane (H)	H0	0	0	0	0.886	0.989567 NS			
	H1	16	4	4					
	H2	0	0	0					
	HT	32	14	10					
Vertical plane (V)	V0	0	0	0	4.077	0.666 NS			
	V1	36	12	14					
	V2	0	0	0					
	VS	12	6	0					
	VT	0	0	0					
	P0	0	0	0					
	Antero-posterior plane (P)	P1	30	16			10	4.358	0.628 NS
		PA	18	2			4		
PP		0	0	0					
PT		0	0	0					

ETD Eustachian tube dysfunction, OME Otitis media with effusion, X² Chi-square test, NS Non-significant

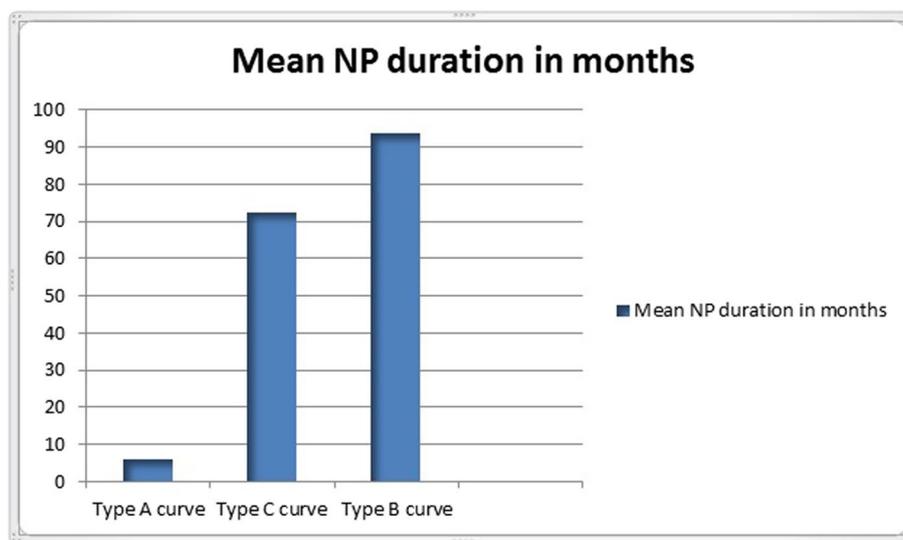


Fig. 1 The chart shows the relation between mean duration of the nasal polyposis and the tympanometric results

Table 3 Relation between duration of the nasal polyposis and the tympanometric results

	Normal (type A)	ETD (type C)	OME (type B)	P value
Mean NP duration	6.05 ± 2.8 months	72.6 ± 33.76 months	7.8 ± 1.79 years	< 0.0001
Range	5 months–10 years	1.5–6 years	5–10 years	F=169.912

NP Nasal polyposis, ETD Eustachian tube dysfunction, OME Otitis media with effusion, F One-way ANOVA

Table 4 The most common nasal symptoms in NP in relation to the tympanometric results

	Normal (type A)	ETD (type C)	OME (type B)
The most common symptom	Nasal obstruction, nasal discharge	Nasal obstruction, nasal discharge	Nasal obstruction, mouth breather

NP Nasal polyposis, ETD Eustachian tube dysfunction, OME Otitis media with effusion

pharyngeal portion of ET that may accumulate and block the ET [19], lymphatic stasis due to edema of the ET submucosa compromising its lumen [20], changes in hydrostatic pressure and/or shortage of the surfactant that is assumed to aid ET opening. There can be inflammation due to allergic or infection associated with NP leading to ET dysfunction as suggested by Rajati et al. [21].

The impedance audiometry is the most useful tool to determine ET function. It not only measures anatomical patency of ET but also its functional integrity [9, 12, 15]. Thus, we used it to assess ET function in the current study.

In the current study, ET affection in patients with NP was high, 40%, categorized into 17.5% ET dysfunction and 22.5% OME. Similar results were reported by Bakhshae et al. [8]. Chaudhry et al. [22] reported that 50% of

the patients with bilateral NP had otitis media, but they include both acute otitis media and OME. Rajati et al. [21] found also significant more OME in patients who had NP than healthy control and patients with nasal obstruction without NP, and they suggested the cause may be inflammation due to allergic or infection associated with NP that leads to ET dysfunction. Mane and Dasgupta [23] detected ET dysfunction in 60% of patients who had NP.

But there are no previous studies on the effect of either different stages of the NP or the duration of the NP on the ET functions. We studied these issues in the current study, and we found that NP staging did not significantly relate to ET dysfunctions. But ET dysfunction and OME development significantly increase with the longer duration of the NP. It was also documented that OME did not

develop in any patients with an NP duration of less than 5 years. Therefore, the duration of the NP is a main determining factor influencing the ET function and development of the OME.

Thus, it is mandatory to examine the ear and do tympanometry in patients with long-lasting NP history and ET dysfunction should be added to the complication of the long-standing NP, and so early removal of NP is important. In addition, early treatment of NP is preferred to avoid ET dysfunction.

The value of the results presented in the current study is imperative since it displays a relationship between long-standing NP (more than 5 years) and the OME. Whether this OME would resolve postoperatively remains a question. Indeed, knowing this in future studies may assist in patients' preoperative counseling about the resolving of ET function after surgery.

Conclusions

ET dysfunction was significantly found in patients with NP with a significantly higher rate with NP of longer duration, while different stages of NP did not significantly differ in affecting ET function.

Abbreviations

NP: Nasal polyposis; ET: Eustachian tube; OME: Otitis media with effusion; H: Horizontal plan of the nasal polyposis; V: Vertical plan of the nasal polyposis; P: Antero-posterior plane of the nasal polyposis.

Acknowledgements

Not applicable.

Authors' contributions

MWE suggested and modified the idea, reviewed literature, designed the study and concept, revised endoscopic evaluation, did the statistical analysis, interpreted the data, tabulated the data, wrote and revised the article, and approved the final manuscript to be published; NME did the tympanometry for the patients, collected the data, analyzed the data, assisted in writing the methodology, revised the article, and contributed to the final approval of the article; EN reviewed the literature, analyzed the tympanometry, collected and tabulated the data, and contributed to the data interpretation and final approval of the article. SA: modified the research idea, did the endoscopic evaluation, revised the written manuscript, followed up the work progress, and contributed to the critical revision of the manuscript for important intellectual content. The authors have read and approved the final manuscript.

Funding

None; the authors declare no financial support or interest in this study.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Written informed consent was obtained from the study participants, and Zagazig University IRB approved the study proposal (IRB 117-1-18).

Consent for publication

Not applicable (no images or videos related to participants).

Competing interests

The authors declare that they have no competing interests.

Received: 26 May 2021 Accepted: 6 March 2022

Published online: 29 March 2022

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