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TYPES OF THE NASAL SEPTUM DEVIATIONS AND THEIR INFLUENCE ON THE STATE OF MUCOCILIARY CLEARANCE OF THE NASAL CAVITY IN PATIENTS WITH POSTNASAL OBSTRUCTION SYNDROME

Viaheslav Didkovskiy, Yurii Shevchuk, Serhii Konovalov

The flow of nasal secretions into the pharynx and larynx manifests itself differently throughout the day. At night, this mucus flows into the larynx, irritates reflexogenic zones and causes coughing, and during the day these complaints are less noticeable, due to involuntary swallowing of secretions. We hypothesized that different types of nasal septum deviations may affect mucociliary clearance and, as a result, lead to postnasal drip syndrome. However, we did not find any studies in the literature that examined the effect of types of nasal septum deviation (NSD) on mucociliary clearance (MCC). Therefore, in our study, we evaluated the effect of the types of nasal septum deviations on MCC.

***The aim of the study**. To investigate the activity of mucociliary clearance of the mucous membrane of the nasal cavity in patients with different types of NSD.*

***Materials and methods.** 100 patients were investigated. All patients underwent an endoscopic examination of the nasal cavity, a ST scan of the nasal cavity, and a saccharin test.*

***The results.** The analysis made it possible to reveal that in most patients with type 2 deviation of the nasal septum with the presence of a unilateral caudal ridge, which cuts into the middle turbinate, there is PNDS. At the same time, while the average ST time of the concave side of the nasal mucosa in patients with type 1 was almost unchanged, it was significantly longer in patients with type 2 (P=0,02). Therefore, in this study, the ST indicator in min. was longer on the concave side of the nasal cavity than on the convex side.*

***Conclusions.** Our research has shown that nasal septum deviation reduces nasal mucociliary activity, and this effect can be easily assessed using the saccharin test. According to our observations and research results, it was the 2nd and 3rd types of deviation that significantly disturbed the architecture of the nasal cavity, due to the presence of contralateral vertical deviation of the nasal septum, contralateral hyperplasia of the nasal turbinates, and contralateral conchobulosis. And, as a result, led to a decrease in mucociliary clearance*

***Keywords:** nasal septum, histology, nasal cavity, mucous membrane, postnasal drip syndrome, mucociliary clearance*

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1. Introduction

The term "postnasal drip syndrome" (PNDS) refers to clinical situations characterized by a chronic inflammatory process of the upper respiratory tract, accompanied by drip on the back wall of the pharynx [1].

Normally, the mucous membrane of the nose secretes about 100–500 ml of mucus per day, which serves to maintain the moist state of the nasal cavity, moisten the inhaled air, adhere pollutants and remove them from the nasal cavity into the nasopharynx due to the activity of the ciliated epithelium, and subsequent imperceptible swallowing. In the case of excess production of mucus, or a change in its consistency to a thicker one, this becomes noticeable to the patient [2, 3]. The flow of nasal secretions into the pharynx and larynx manifests itself differently throughout the day. At night, this mucus flows into the larynx, irritates reflexogenic zones and causes coughing, and during the day these complaints are less noticeable, due to involuntary swallowing of secretions.

Excessive production of mucus is an important pathophysiological manifestation of such diseases as: chronic rhinosinusitis, allergic rhinitis, COPD (chronic obstructive pulmonary disease), asthma, bronchiectasis, cystic fibrosis, and other chronic inflammatory diseases of the respiratory tract [1, 2].

In the pathogenesis of PNDS, the most important factor is a violation of the mechanism of cleaning the mucous membrane of the nasal cavity - mucociliary clearance. The main manifestation of a violation of this important function is hypersecretion of mucus with a violation of its evacuation. Thus, increased secretion of mucus and violation of its rheological properties, as a rule, leads to a violation of the function of the ciliated epithelium and deterioration of mucociliary transport, which leads to stagnation of mucus secretions [1].

Mucociliary activity (MA) is an important indicator of the function of the nasal cavity. Ciliary activity was discovered for the first time in 1835 by Sharpey, and only 100 years later this indicator began to be considered as a leading indicator in the physiology of the nasal cavity and paranasal sinuses [4, 5]. MA can be measured using direct (stroboscopy, microcinematography) or indirect methods (sac-

charin test and rhinoscintigraphy). Previous studies have shown that disturbances in the architecture of the nasal cavity, such as nasal septum deviation (NSD), worsen MA due to partial loss of cilia, increased inflammation, and decreased density of glandular acini [4].

However, we did not find any studies in the literature that studied the effect of NSD types on MCC. Therefore, in our study, we evaluated the effect of the types of distortions of the nasal septum on MCC.

We hypothesized that different types of nasal septal deviation may affect mucociliary clearance and, as a result, lead to PNDS.

The aim of the work. To study the activity of mucociliary clearance of the mucous membrane of the nasal cavity in patients with different types of NSD.

2. Materials and methods

The research was conducted in the period from the end (winter) of 2019 to the fall of 2022. In the study, 100 people with a diagnosis of various types of nasal resection were analyzed. All patients were examined at the Department of Otorhinolaryngology of the Bogomolets National Medical University. Exclusion criteria were the presence of patients with allergic rhinitis, chronic rhinosinusitis with and without polyposis, those patients who smoke, patients who had systemic diseases; pregnant women, persons under 18 years of age. The average age of the patients was 45.34±3.3 years.

All patients underwent an endoscopic examination of the nasal cavity, ST scan of the paranasal sinuses (computed tomography of the paranasal sinuses), as well as a saccharin test to determine the function of mucociliary clearance, as a standard diagnostic method.

The work was carried out in accordance with the Code of Ethics of the World Medical Association (Helsinki Declaration), GCP standards within the framework of the RTD "Innovative approaches to the diagnosis and treatment of acute and chronic pathology of the ear, upper respiratory tract and adjacent areas", state registration No. 0123U1000921 and within the scope of research that received the approval of the bioethical examination of Bogomolets National Medical University dated 11.13.2019, protocol No. 126. The informed consent protocol is attached.

Microsoft Office 365 Excel software was used for basic statistical analysis (means, medians, standard deviations, etc.) of raw data and database formation. The obtained processed results were evaluated, categorical variables are presented using frequency and percentages. The relationship between categorical variables was evaluated using the χ^2 test and Fisher's test in IBM SPSS Statistics Version 22 software. A value of $p<0.05$ was considered statistically significant.

3. Results

We analyzed the examinations of 100 patients who were treated at the Department of Otorhinolaryngology of Bogomolets National Medical University with the established diagnosis – "Nasal septum deviation" in 2019–2022. Among the examined 100 patients were 55 women and 45 men over the age of 18 (Table 1).

Table 1

Distribution of patients by age and sex

Age	Distribution by sex	
	women (n=55)	men (n=45)
18–45	35	27
46–65	20	18

100 people were recruited for the study. These patients were divided into 6 groups according to the type of septal deviation. Deformations of 1–6 types occurred in 14 (14 %), 22 (22 %), 16 (16 %), 24 (24 %), 16 (16 %) and 8 (8 %) patients. The most common was type 4, and the least common was type 6 (Table 2). ST, olfactory function, and SNOT-22 convexity and concavity were measured preoperatively and 6 weeks postoperatively. There was no difference in preoperative convexity and concavity ST scores among deviation subtypes ($P>0.05$) (Table 4). There was no difference in the convex side between pre- and postoperative results ($P>0.05$). On the other hand, the concave side showed a difference in type 1 and 2 deviations ($P<0.05$), but not in the others ($P>0.05$). In addition, mean postoperative ST values on the concave side were higher than preoperative ($P=0.009$) (Table 4). There was no difference in preoperative results between the curved side and the concave side ($P>0.05$) (Table 4). There was no significant difference in preoperative olfactory test scores between groups ($P>0.05$). Comparison of pre- and postoperative scores revealed statistically significant differences ($P<0.05$) by type of deviation: types 1, 2, 3 and 4 showed a significant increase, but types 5 and 6 did not differ ($P>0.05$). In addition, there was no statistically significant difference between subtypes of abnormalities after surgery ($P>0.05$) (Table 4). There was no significant difference in preoperative SNOT scores between groups ($P>0.05$). Comparison of scores before and after surgery revealed a statistically significant decrease ($P<0.05$) according to the type of deviation: types 2, 3, 4 and 5 showed a decrease ($P<0.05$), but types 1, 5 and 6 did not show a difference ($P>0.05$). In addition, there was no statistically significant difference between subtypes of abnormalities after surgery ($P>0.05$) (Table 3).

There was no difference between subtypes of abnormalities in mean ST changes on both the concave and convex sides ($P>0.05$).

There was also no difference in changes in the olfactory score ($P>0.05$). On the other hand, SNOT changes showed significant differences. Tukey's post hoc test showed that type 3 showed more difference than the other groups ($P<0.05$). However, improvement of other types showed no significant difference between subtypes ($P>0.05$) (Table 3). Analyzing the data of the endoscopic examination of patients, we found that we observed a unilateral deviation of the nasal septum in about 67 %, in turn, a bilateral deviation was observed in 33 %. For more convenient data analysis, we classified the deviation of the nasal septum into 6 types (Table 2).

The distribution carried out by us corresponds to most of the currently published system classifications of internal deviations of NS [6–10].

All patients were surveyed according to SNOT-22. The prevalence of the main symptoms in these patients, considering the shape of the curvature, is shown in Table 2.

Table 2

Patients with deviation of the nasal septum

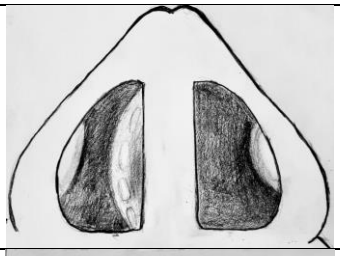
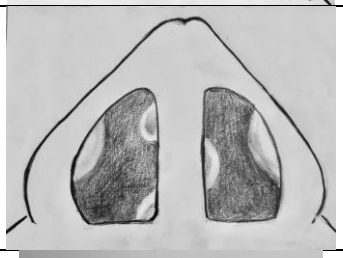
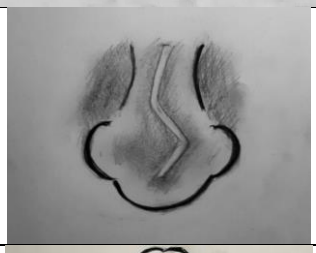
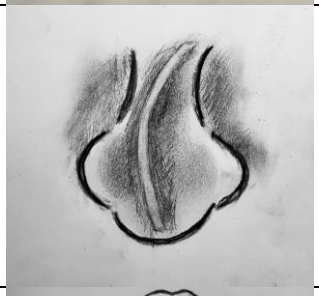
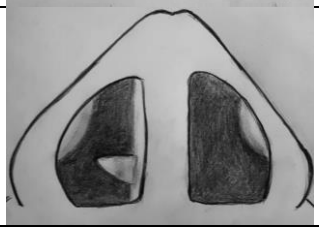
Type	Description	Scheme
Type 1	C-shaped deviation of the nasal septum along the entire length. Note: the reverse C-shaped deviation of the nasal septum is a mirror image.	
Type 2	Deviation of the nasal septum in the central part, S-shaped. Note: the reverse S-curve of the nasal septum will be a mirror image.	
Type 3	S-shaped deviation of the nasal septum in the upper part. Note: the reverse S-shaped deviation of the nasal septum is a mirror image.	
Type 4	Perforation of the nasal septum.	
Type 5	C-shaped deviation of the nasal septum in the horizontal plane. Note: the reverse C-shaped deviation of the nasal septum will be a mirror image.	
Type 6	Spike of the nasal septum.	

Table 3

Prevalence of main symptoms in patients with CRSdepending on the form

Symptoms	Type 1 (n=4)	Type 2 (n=7)	Type 3 (n=18)	Type (n=2)	Type 5 (n=25)	Type 6 (n=44)
1. Necessary to free the nose	4.6	3.9	4.4	4.6	4.1	4.5
2. Sneezing	3.5	2.1	3.2	3	3.5	2.1
3. Cough	2.5	1.7	2.3	2.5	1.2	2.3
4. Feeling of ear congestion	3.2	2.6	3.1	3.3	2.8	3.2
5. Dizziness	3.1	2.5	3.0	3.2	2.4	3
6. Pain in the ears	2.5	1.6	2.3	2.5	1.4	2.3

Continuation of Table 3

Symptoms	Type 1 (n=4)	Type 2 (n=7)	Type 3 (n=18)	Type (n=2)	Type 5 (n=25)	Type 6 (n=44)
7. Pain/feeling of pressure in the face	2.9	2.8	2.9	3	2.7	3
8. Difficulties falling asleep	2.7	2.6	2.7	2.7	2.5	2.7
9. Waking up at night	2.6	2.5	2.5	2.6	2.5	2.5
10. Lack of a good night's sleep	2.7	2.6	2.7	2.7	2.7	2.6
11. Waking up tired	2.9	2.6	2.8	3	2.5	2.9
12. Tiredness	2.9	2.7	2.9	3	2.7	2.9
13. Decreased productivity	3.0	2.9	3.0	3.1	2.9	3
14. Decreased concentration	2.9	2.9	2.9	3	2.8	3
15. Irritability	2.9	2.9	2.9	3	2.8	2.9
16. Feeling sad	2.8	2.7	2.8	2.8	2.6	2.8
17. Embarrassment	2.6	2.4	2.6	2.6	2.2	2.6

The analysis made it possible to reveal that PNDS occurs in most patients with type 2 deviation of the nasal septum with the presence of a unilateral caudal ridge that cuts into the middle turbinate. Based on the results of mucociliary transport assessment using the saccharin test, we obtained the following results Table 4.

Table 4

The time of the saccharin test in patients with nasal septum deviation of different types

Group of patients	Nasal cavity	ST indicator (min.)
Type 1 (4 patients)	Concave side Curved side	17.91±3.11 17.36±1.81
Type 2 (7 patients)	Concave side Curved side	12.25±4.4 15.13±3.34
Type 3 (18 patients)	Concave side Curved side	15.25±4.81 11.75±3.72
Type 4 (2 patients)	Concave side Curved side	45.87±12.55 47.87±14.25
Type 5 (25 patients)	Concave side Curved side	20.60±5.75 17.12±8.14
Type 6 (44 patients)	Concave side Curved side	13.50±2.65 18.75±7.04

While the mean ST time of the concave side of the nasal mucosa in patients with type 1 was almost not different, it was significantly longer in patients with type 2 (P=0.02). Therefore, in this study, the ST value in min. was longer on the concave side of the nasal cavity than on the convex side. Previous investigators have also reported a significant increase in ST in patients with NSD.

4. Discussion of research results

The prognosis of the success of surgical treatment of nasal resection deviation with the presence of postnasal congestion may depend on various factors, among which the type of nasal resection deviation plays a key role [11]. It is the surgical correction of violations of the architecture of the nose that is preferred when the patient has pronounced subjective symptoms of the disease. The primary goal of such treatment is to improve the patient's quality of life.

Currently, there are several different classifications of distortions of the nasal resection, without a certain unification of them. Thus, in the conducted study, the classification according to Mladina [12] was used, which is, in our opinion, the most informative. It is worth noting that there are also other classifications – modified according to Rao [13], where 7 types of deformations are considered; Guyuron classification [8] (6 types-degrees); classification according to Buyukertan [14] (10 types), etc.

In our study, we determined the dependence of the type of deviation of the nasal septum on each side (convex and concave) with the severity of the mucociliary clearance violation on the corresponding side of the deformity. Similar studies were carried out by Eren et al. [15], where the relationship between mucociliary clearance disorders and the success of septoplasty (correction of the deviation of the nasal septum) was determined. Thus, it was found that patients with Mladina types 2, 4 and 6 curvatures demonstrated the greatest clinical and laboratory success. Also, Park et al., [16] in their prospective study showed that mucociliary clearance significantly improves in patients after septoplasty, however, it should be considered that in the first month MCC in patients after surgical treatment decreases, which is explained by the authors as processes regeneration of the mucous membrane of the nose after mechanical trauma due to intervention.

Despite a fairly large number of studies aimed at determining the dependence of the type of deviation of the nasal septum on the duration of MCC, there is still no consensus regarding the association of the deviation of each side, that is, the concave and convex parts, with

MCC and the association with nasal symptoms, primarily postnasal drip.

Analyzing the results obtained by us, it can be stated that the MCC is reliably more significantly disturbed on the convex side of the deviation of the nasal resection. On the other hand, according to the SNOT-22 patient questionnaire, more complaints were found. Such results are more characteristic of patients with the 2nd and 3rd types of nasal repartition curvature.

Study limitations. The saccharin test is a relatively objective method of studying the work of the MCC - part of the result depends on the correctness of the message from the patient's sensation of sweet taste. Therefore, in the future, this test should be replaced for further research and better objectification of data. Also, the SNOT-22 questionnaire involves direct interaction with the patient, which makes certain adjustments to the research results. However, these limitations have a minimal impact on the results of the study, which was considered in the study design, where the sample size reached 100 people.

Prospects for further research. Considering the obtained results, it may be possible to create a predictive mathematical model of the success of surgical treatment of nasal resection curvatures and conduct immunological and genetic studies to determine the aspects of the occurrence of postnasal drip syndrome from the convex and concave side of the deviation in patients, and conduct transmission electron microscopy of biopsy specimens of the nasal mucosa in violation of its architecture.

5. Conclusions

Thus, when analyzing the obtained data, this study showed that the deviation of the nasal septum reduces nasal mucociliary activity, and this effect can be easily evaluated using the saccharin test. According to our observations and the results of the study, it was the 2nd and 3rd types of deviation that significantly disturbed the architecture of the nasal cavity, due to the presence of contralateral vertical deviation of the nasal septum, contralateral hyperplasia of the turbinates, and contralateral conchobulosis. And, as a result, led to a decrease in mucociliary clearance.

Conflict of interests

The authors declare that they have no conflict of interest in relation to this study, including financial, personal, authorship, or any other, that could affect the study and its results presented in this article.

Financing

The study was conducted without financial support.

Data availability

Data will be provided upon reasonable request.

Use of artificial intelligence technologies

The authors confirm that they did not use artificial intelligence technologies when creating the presented work.

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