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Rhinological Status of Patients with Nasolacrimal Duct Obstruction

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Abstract

Introduction Studying the state of the nasal cavity and its sinuses and the morphometric parameters of the inferior nasal conchae, as well as a comparative analysis of obtained values in patients with primary (PANDO) and secondary acquired nasolacrimal duct obstruction (SALDO), is relevant.

Objective To study the rhinological status of patients with PANDO) and SALDO).

Methods The present study was based on the results of computed tomography (CT) dacryocystography in patients with PANDO ($n = 45$) and SALDO due to exposure to radioactive iodine ($n = 14$). The control group included CT images of paranasal sinuses in patients with no pathology ($n = 49$). Rhinological status according to the Newman and Lund-Mackay scales and volume of the inferior nasal conchae were assessed. Statistical processing included nonparametric statistics methods; χ^2 Pearson test; and the Spearman rank correlation method.

Results The difference in values of the Newman and Lund-Mackay scales for the tested groups was significant. A significant difference in scores by the Newman scale was revealed when comparing the results of patients with SALDO and PANDO. Comparing the scores by the Lund-Mackay scale, a significant difference was found between the results of patients with SALDO and PANDO and between the results of patients with PANDO and the control group.

Conclusion It was demonstrated that the rhinological status of patients with PANDO was worse than that of patients with SALDO and of subjects in the control group. No connection was found between the volume of the inferior nasal conchae and the development of lacrimal duct obstruction.

Keywords
- Nasolacrimal Duct
- sinus
- computed tomography
- dacryocystography
- newman scale
- lund-mackay scale

Introduction

The relationship of the state of the structures of the nasal cavity with the possible development of nasolacrimal duct obstruction was demonstrated in a large number of studies. The source of this relationship has not yet been discovered, and this problem is still discussed. Most of the hypotheses explaining the relationship of the state of the structures of the nasal cavity with possible development of nasolacrimal duct obstruction are reduced to the anatomical narrowing of the inferior nasal meatus, as well as to an increased inflammatory state of the mucous membrane in the nasal cavity

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and its sinuses.[1] However, data supporting these hypotheses are not always reliable but are often contradictory. Besides, well-known trials are always focused on primary acquired nasolacrimal duct obstruction (PANDO) and do not mention the possible association between the rhinological status of the patient and the development of secondary acquired lacrimal duct obstruction (SALDO) due to any specific reasons.

Studying the state of the nasal cavity and its sinuses based on the accepted integral radiological parameters and morphometric parameters of the inferior nasal conchae, as well as a comparative analysis of obtained values in patients with PANDO and SALDO, is relevant.

The objective of the present study is to study the rhinological status of patients with PANDO and SALDO.

Method

The present study was a retrospective study, and it was performed after obtaining informed voluntary consent of the patients, as well as after the approval of the Scientific Research Institute of Eye Diseases.

The object of the present study included results of the computed tomography (CT) of paranasal sinuses with contrast enhancement of nasolacrimal ducts (dacryocystography) in 59 patients with nasolacrimal duct obstruction, including those with PANDO ($n = 45$) and SALDO caused by radioactive iodine therapy ($n = 14$). The average age of the patients was 65 ± 16 years old. The control group included results of the CT of paranasal sinuses of 49 patients who were being prepared for treatment for oncological diseases of extra-rhinological origin, obtained, inter alia, from The Cancer Imaging Archive.[2,3] The average age of the patients was 62 ± 10 years old.

During the analysis of the CT results in patients with nasolacrimal duct obstruction, we evaluated the localization of obstruction, the state of the mucous membrane of the maxillary, ethmoid, sphenoid, and frontal sinuses, the width of nasal passages, and the state of the ostiomeatal complex. Based on the data obtained, an integral indicator of the state of the nasal cavity and of the paranasal sinuses was calculated according to the Lund-Mackay[4] and Newman[5] scales. Additionally, in all cases, the volume of the inferior nasal conchae on the affected side was measured. For patients in the control group, we evaluated the state of the mucous membrane of the nasal cavity and of the paranasal sinuses with the calculation of integral indicators and defined the volume of the inferior nasal concha on one side. All measurements were performed using Vidar Dicom Viewer program (Vidar Software, Vidar Software, Moscow, Russia).

Statistical analysis was performed using IBM SPSS Statistics 26 (IBM Corp., Armonk, NY, USA). To determine the normality of the distribution of values in groups, the Shapiro-Wilk test was used. To assess the intergroup differences in values, methods of nonparametric statistics were used. To determine differences in groups with binary values, the χ^2 Pearson test was used. The correlation was calculated using the Spearman rank correlation method. The difference was considered significant at $p \leq 0.05$.

Results

The description of the study results in groups is shown in ►**Table 1**.

The distribution of cases by localization of the nasolacrimal duct obstruction is shown in ►**Table 2**.

Statistical analysis by the Kruskal-Wallis test revealed that the difference between values of the integrated indicator of the state of nasal mucosa and sinuses evaluated by the Newman and Lund-Mackay scales was statistically significant in three tested groups ($p = 0.021$ and 0.003, respectively). However, paired comparisons of the values obtained when assessing the

Table 1 Results of the evaluation of computed tomography images

Group	Median	SD	Range
Newman scale			
PANDO	10 points	6 points	0 — 30 points
SALDO	3 points	5 points	0 — 18 points
Control group	6 points	6 points	0 — 20 points
Lund-Mackay scale			
PANDO	4 points	3 points	0 — 12 points
SALDO	2 points	2 points	0 — 4 points
Control group	2 points	3 points	0 — 10 points
Volume of inferior nasal concha			
PANDO	4.73 cm^3	1.58 cm^3	2.27 — 8.89 cm^3
SALDO	4.89 cm^3	1.63 cm^3	2.56 — 7.24 cm^3
Control group	4.53 cm^3	1.32 cm^3	1.11 — 7.57 cm^3

Abbreviations: PANDO, primary acquired nasolacrimal duct obstruction; SALDO, secondary acquired lacrimal duct obstruction; SD, standard deviation.

Table 2 Location of nasolacrimal duct obstruction

Location	Number of cases	
	PANDO	SALDO
Lacrimal sac	23	3
Nasolacrimal duct	9	8
Opening of nasolacrimal duct	13	3

rhinological status by the Newman scale taking into account the Bonferroni correction for multiple comparisons demonstrated a statistically significant difference only when comparing the results of patients with SALDO and PANDO ($p = 0.036$). When comparing the values obtained during the assessment of the rhinological status by the Lund-Mackay scale, a similar statistical study revealed significant differences between the results of patients with SALDO and PANDO ($p = 0.005$), as well as between patients with PANDO and control ones ($p = 0.050$). The difference in the values of the volumes of the inferior nasal conchae in the three tested groups was statistically insignificant ($p = 0.479$).

Since the difference in values obtained from patients with PANDO and controls was statistically significant (according to the Newman scale) or close to it ($p = 0.133$ by the Lund-Mackay scale), an attempt was made to calculate the odds ratio (OR) for nasolacrimal duct obstruction depending on these values. It was found that the possibility of developing PANDO with a score > 7 by the Newman scale increases 3.28-fold $\pm$ 0.44 (95% confidence interval [CI]: 1.39–7.74) when compared with lower scores; similarly, a score > 4 by the Lund-Mackay scale increases the possibility of developing PANDO 2.02-fold $\pm$ 0.44 (95%CI: 0.85–4.81).

A comparison was made of the thickness of the mucous membrane of the corresponding nasal sinuses in patients with PANDO, SALDO, and in the control group. A statistically significant difference was found only when comparing mucous membrane thickness of the cells of the ethmoidal labyrinth in patients with PANDO and in the control group ($p = 0.048$). The median of these values was 2.1 ± 2.4 mm in patients with PANDO and 1.8 ± 2.0 mm in subjects of the control group.

No correlations were found between integral indicators of the state of the mucous membrane of the nasal cavity and paranasal sinuses, the volume of inferior nasal conchae, and the location of the nasolacrimal duct obstruction.

Discussion

The pathogenesis of nasolacrimal duct obstruction remains unknown to this day. Previously, much attention was paid to the fact that inflammation that resulted in the development of fibrosis could be ascending. However, no convincing pathological evidence of this origin of the inflammation of the nasolacrimal duct was revealed until now. On the contrary, recent studies, mainly related to immunohistochemical studies of the wall of the nasolacrimal ducts, demonstrated that dysfunction of tear ducts resulting in obstruction can be of primary origin associated with biochemical unbalance and dystrophic and inflammatory changes in the nasolacrimal ducts.[1,6–8]

In the present study, it was found that changes in the mucous membrane of the nasal cavity and paranasal sinuses are associated with PANDO. ►**Figs. 1** and **2** show the distribution of the integral parameters of rhinological status in patients with PANDO, SALDO, and in control subjects.

Data on these figures and the above information demonstrate that patients with PANDO tend to present increased values by both scales, while values obtained in patients with SALDO are within the range typical for the control group. Thus, the present study shows that the worsening state of the mucous membrane of the nasal cavity and paranasal sinuses is associated with PANDO, but is not typical for SALDO due to

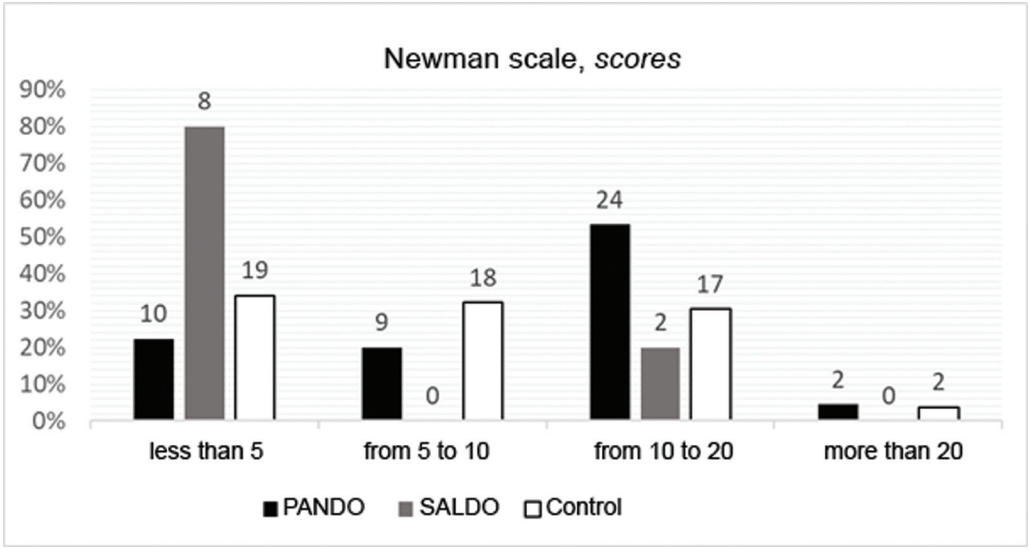

Fig. 1 Distribution of values obtained by evaluating computed tomography results by the Newman scale.

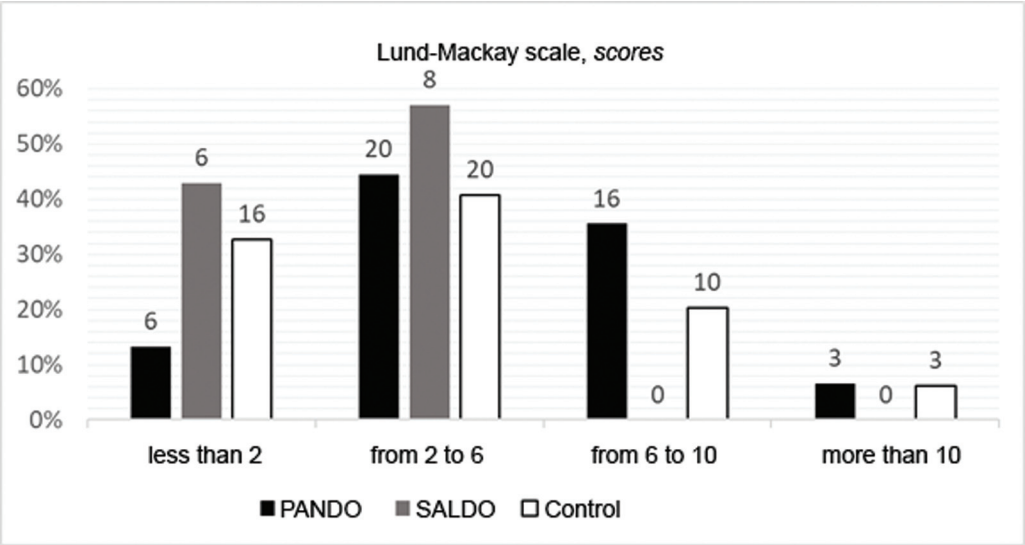

Fig. 2 Distribution of values obtained by evaluating computed tomography results by the Lund-Mackay scale.

treatment with radioactive iodine. ►**Fig. 3a** shows the result of CT dacryocystography of a patient with SALDO with no signs of paranasal sinus problems. This gives no reason to consider the worsening rhinological status as a trigger for the development of nasolacrimal duct obstruction; however, it can be regarded as one of the risk factors apparently contributing to the development of nasolacrimal damage together with other factors. A comparative analysis of the results obtained in patients with PANDO and SALDO showed that, in the presence of an intralacrimal fibrosis trigger (for example, exposure to radioactive iodine), obstruction development is possible without rhinological risk factors. This, in turn, can be of practical importance in terms of identifying patients who require preventive measures during treatment with radioactive iodine.

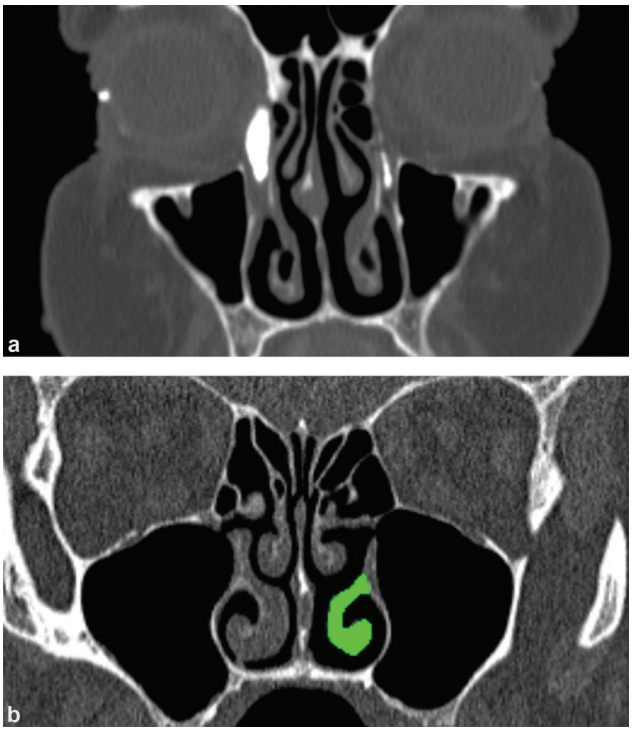

Fig. 3 Computed tomography results in a patient with SALDO (a) and PANDO (b) during inferior nasal concha volume measurement.

There were earlier studies related to investigating the effect of rhinological status on PANDO development. For example, a relationship was shown between the development of nasolacrimal duct obstruction and deviation of the nasal septum, impaired ventilation of the ethmoid sinuses, presence of *concha bullosa*, and changes in the ostiomeatal complex.[9–11] However, the state of the mucous membrane of the nasal cavity and its sinuses has not been studied carefully. It seems to us unlikely that several pathological conditions associated with a changed volume of the nasal cavity, in particular, deviation of nasal septum and presence of *concha bullosa*, can cause and maintain the inflammatory process in nasolacrimal ducts. It seems more reasonable that swelling of nasal mucosa associated with these conditions (as well as swelling not associated with these conditions) contributes to the abnormal outflow of tear fluid from the tear ducts that can contribute to the inflammatory process inside them. In this regard, we, in the present study, did not study these deviations themselves but integrated parameters of the state of the mucous membrane of the nasal cavity and paranasal sinuses taking into account the fact that the epithelial lining of the nasal cavity, paranasal sinuses, and nasolacrimal ducts are structural elements of a single system.

It should be noted that, in earlier studies, other researchers used a modified Lund-Mackay scale for analyzing rhinological status in patients with PANDO.[12] However, we found it more suitable to use a scale that considers – in addition to the state of the paranasal sinuses – the state of the mucous membrane of the nasal cavity and also provides a more accurate evaluation of the thickness of the mucous membrane of the paranasal sinuses in millimeters, not in points, which makes it more unbiased. For this purpose, we chose

the Newman scale, which is relatively common in studying allergic rhinological diseases. To compare obtained results with the results of similar studies, as well as to create a stratification scale for assessing risk factors for the development of PANDO and SALDO based on the more popular Lund-Mackay system, we also evaluated rhinological status using this scale. It should be noted that a significant strong correlation was observed between the values obtained by both scales ($p = 0.01$).

When analyzing the OR, we showed that there were some boundary values of these integral scales (7 points by the Newman scale and 4 points by the Lund-Mackay scale) that, when exceeded, greatly increased the risk of developing PANDO. No such patterns were found for SALDO. This fact proves our assumption that nasolacrimal duct obstruction is a multifactorial condition that requires the presence of one or more strong triggers (for example, exposure to radioactive iodine), or several weaker risk factors (in particular, unfavorable rhinological status).

Besides, in the present study, we analyzed the distribution of the volume of the inferior nasal conchae in patients of different groups, since the literature contains information that hypertrophy of the inferior nasal conchae may be one of the factors contributing to the development of nasolacrimal duct obstruction.[11–13] ►**Fig. 3b** shows the process of measuring the volume of the inferior nasal concha. We found no differences in the volume of the inferior nasal conchae in patients and subjects of different groups. This suggests that the excess volume of the inferior nasal conchae is not a separate risk factor for PANDO development, nor does it contribute to the induction of obstruction after exposure to radioactive iodine. However, there are reports that different interventions regarding the inferior nasal concha associated with a decrease in its volume or with changes in its position can have a positive effect on the function of the tear drainage system. In this regard, researches related to this problem should be continued.

Conclusion

The present paper is another study of rhinological risk factors for the development of nasolacrimal duct obstruction; however, unlike previous studies, it analyzes cases of nasolacrimal duct obstruction of different natures, and also uses an approach that allows taking into account not only the state of the mucous membrane of the sinuses but also that of the nasal cavity, as well as the volume of the inferior nasal concha. Comparison of CT results in patients with PANDO, SALDO due to exposure to radioactive iodine, as well as in control subjects, demonstrated that the rhinological status in patients with PANDO was worse than in patients with SALDO and in control subjects. This suggests that the unfavorable state of the mucous membrane of the nasal cavity and the paranasal sinuses can be considered as a risk factor for the development of nasolacrimal duct obstruction, but it is not an established condition for its development.

The relationship between hypertrophy of the inferior nasal conchae and the development of nasolacrimal duct obstruction due to a possible mechanical narrowing in the area of the opening of the nasolacrimal duct seems quite reasonable. However, the present study revealed no such relationship, and it was shown that the volume of the concha was the same in patients with normal and obliterated nasolacrimal ducts. We have not studied many factors related to the relationship of the inferior nasal concha and the opening of the nasolacrimal duct. In particular, there are no studies on the relationship between the bone and the soft tissue of the concha, the angle of inclination of the inferior nasal concha to the side wall of the nose, etc. Studying above mentioned features seems to bring us closer to understanding rhinological risk factors for the development of nasolacrimal duct obstruction.

It remains unclear whether the elimination of identified rhinological risk factors for PANDO will lead to an interruption of the pathogenic chain and to the prevention of nasolacrimal duct obstruction. Apparently, this issue may become the subject of further research.

Note

The present paper has never been presented at any conferences.

Compliance with Ethical Standard

The present work complies with the institutional ethical standards and with the 1964 Helsinki Declaration and its later amendments.

Informed Consent

All participants of the present study have given their written informed consent for the research and for publication. The results were analyzed retrospectively.

Data Availability

All available data can be obtained by contacting the corresponding author.

Ethical Approval

The present work has received the ethical approval from the Biomedical Ethics Committee of the Scientific Research Institute of Eye Diseases.

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Conflict of Interests

The authors have no conflict of interests to declare.

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