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The role of rhinomanometry in evaluating the effectiveness of laser surgical treatment in children with chronic hypertrophic rhinitis

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Abstract. ***Background.*** *Rhinomanometry is an objective way of assessing nasal patency. Due to advances in technology and the use of microcomputers connected to measuring instruments, the use of this approach has increased. Rhinomanometry evaluates nasal resistance by measuring airflow and transnasal pressure gradient. With the help of this examination, the presence of a nasal respiratory obstruction is detected, and it is evaluated which nosological structure continuously causes it, in this case the hypertrophy of the inferior nasal turbinates. The purpose of the research is to evaluate the effectiveness of the functional examination such as the anterior rhinomanometry in monitoring the results of laser surgical treatment in children with chronic hypertrophic rhinitis.* ***Materials and methods.*** *The given study was carried out in the pediatric otorhinolaryngology clinic of the Emilian Coțaga Republican Children's Clinical Hospital. The research involved a group of 120 children with hypertrophic chronic rhinitis, aged between 8–17 years, divided into three groups of 40 children each, treated surgically by 3 techniques: group 1 — cauterization of the inferior nasal turbinates with bipolar forceps, group 2 — shaver mucotomy and group 3 — diode laser surgery. In all patients, rhinomanometry was performed as an objective preoperative and postoperative examination on the 7th day, after one month, one year and in 12 months.* ***Results.*** *The analysis of the functional examination results demonstrates that the surgical interventions had a beneficial effect in terms of the recovery of the space parameters of the nasal cavities. A more pronounced improvement of the endonasal architectural indices is determined in group 3 where the diode laser surgical technique was used compared to group 2 — only shaver mucotomy and group 1 where the standard surgical technique of cauterization with bipolar forceps was practiced.* ***Conclusions.*** *The functional rhinomanometric results were statistically different after the surgical treatment in all study groups that indicates an important diagnostic value of this examination in the monitoring of postoperative dynamics.*

Keywords: *rhinomanometry; chronic hypertrophic rhinitis; nasal permeability; nasal obstruction*

Introduction

The term chronic hypertrophic rhinitis defines a state of congestion of the mucous membranes of the nasal membrane and the submucosal tissues of the inferior nasal turbinates, which manifests symptoms such as unilateral, bilateral nasal obstruction, snoring, oral breathing, hyposmia-anosmia, anterior or posterior rhinorrhea [5]. Chronic hypertrophic rhinitis is one of the most common pathologies in rhinology. Although it is a benign chronic condition, the disease has a major impact on the patients' quality of life.

The prevalence of chronic hypertrophic rhinitis in children is 20–55 %, and in recent years this index has been increasing. Epidemiological data on chronic hypertrophic rhinitis estimate that more than 200 million people worldwide suffer from this condition. In the pediatric population, the disease showed a prevalence of 16.1 % by the age of 5 years and a prevalence of 42.3 % by the age of 14 years [4].

One of the perspective directions in improving medical care for children with chronic hypertrophic rhinitis is the establishment of risk factors that contribute to the development of the pathology.

In this sense, the group of children predisposed to chronic hypertrophic rhinitis can be identified, which would contribute to early diagnosis, dispensary and timely performance of treatment and prophylaxis actions, reducing the possibilities of chronicity and the occurrence of complications. One of the major symptoms presented by the patient with chronic hypertrophic rhinitis is nasal obstruction,

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which is a subjective parameter. The etiology of the obstruction and the treatment are often based on clinical, rhinoscopic data and very rarely — on objective methods [7].

The need for objective assessment of nasal breathing in diagnosis, treatment and its effectiveness in patients with chronic hypertrophic rhinitis is currently supported by both medical practitioners and scientific researchers. Along with the development of new technologies, there are possibilities to investigate the physiological processes occurring in the nasal cavity, especially nasal breathing, and to objectify these changes in the pre- and postoperative period [2]. In the current conditions, the assessment of the effectiveness of the surgical treatment by means of different methods, including rhinomanometry, becomes an indispensable necessity. Rhinomanometric methods are increasingly used in scientific research and allow the accumulation of information about nasal architecture [6, 10].

Previous rhinomanometry allows us to appreciate and study the dynamics of the nasal ventilation function, which implies the measurement of the resistance of the nasal cavities based on the measurement of the total air volume and the total resistance [1, 11].

Rhinomanometry provides objective and quantitative indications regarding nasal permeability, which is dependent on two parameters: differential pressure (Δp), flow rate (V). The differential pressure (Δp) represents the pressure difference between the atmospheric pressure measured in the mask at the level of the nasal vestibules and the inspiratory and expiratory pressure at the level of the choana. Respiratory flow rate (V) corresponds to the volume of air passing through the nasal passages [3, 8].

Previous rhinomanometry is a method of choice. It confirms the nasal obstruction, objectifying the subjective symptoms. Taking into account the etiological diagnosis, rhinomanometry allows to detail the mechanism of nasal obstruction from an organic aspect, that is, it plays a fundamental role in assessing the form of conservative or surgical treatment. Rhinomanometry validates interventions to clear the nasal passages and presents a secondary medico-legal importance [9, 12].

Purpose. The purpose of the research is the evaluation of the effectiveness of the functional examination such as the anterior rhinomanometry in monitoring the results of laser surgical treatment in children with chronic hypertrophic rhinitis.

Materials and methods

The given study was carried out in the pediatric clinic of the Department of Otorhinolaryngology of USMF "Nicolae Testemițanu" on the basis of the Emilian Coțaga Republican Children's Clinical Hospital. The research was carried out on a group of 120 children with hypertrophic chronic rhinitis, aged between 8–17 years, divided into three groups of 40 ($X^2 = 0$; $p > 0.05$). The general average age of the patients in the study groups was 13.9 years. The analysis of the distribution by gender showed that 59 (49.2 %) of the patients are male, and 61 (50.8 %) are female. Therefore, a statistically significant difference according to the given parameter $X^2 = 1.73$, $P > 0.05$ was not found. Depending on the surgical treatment applied, the patients included in the study were divided into three groups. Group 1 consisted of 40 patients (21 boys and 19 girls) with chronic hypertrophic rhinitis, operated by the method of cauterization of the inferior nasal turbinates with bipolar forceps. Group 2 was made up of 40 patients (18 boys and 22 girls), also with the pathology of chronic hypertrophic rhinitis, treated by the shaver mucotomy method. Group 3 was made up of 40 patients (20 boys and 20 girls), homogeneous according to the nosological structure, the patients were surgically operated with the help of the diode laser.

The examination of nasal permeability was carried out through the ATMOS PC 2000 rhinomanometer (Germany), directed with the help of the simple standard menu, it also has an integrated printer and display. The results of the examination are displayed on the rhinomanometer screen, in the form of a rhinogram or Y/t graph. The pressure difference between the choana and the inside of the mask is measured by the device, the values being converted into electrical signals with the help of a differential pressure converter. Electrical signals are processed by means of microprocessors. By simultaneously measuring the differential pressure and the flow, a flow-pressure curve is obtained that represents the nasal resistance curve.

The examination was carried out in a special room isolated from external noise, under conditions of constant temperature and humidity, the air temperature being 20–22 °C. For accommodation, the patient was in that room for around 20 minutes. The investigation was done in the child's sitting position.

After the mandatory calibration of the device, the mask was chosen, the adapter corresponding to the size of the nostril and connected to the rhinomanometer tube. In this technique, the tube for measuring choanal pressure was sealed to a nostril using a sponge (nasal) ampoule. To avoid sound loss, it is important that the connection between the mask, adapter and nostril is airtight. The investigation was carried out during the apnea phase, in short periods of time in order not to distort

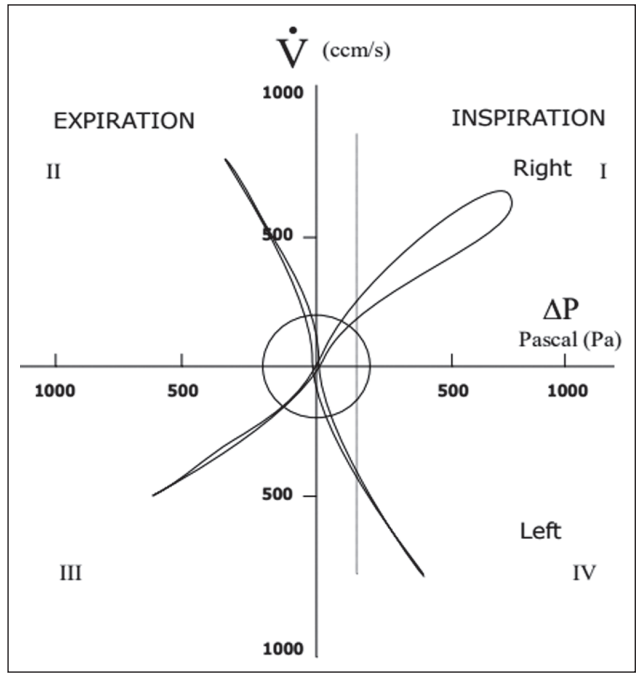

Figure 1. Graphical representation of the rhinomanometry examination

Table 1. Acoustic rhinometry data in patients from the preoperative study groups

Rhinometric values	Norm	Study groups		
		1	2	3
Total volume (150 Pa)	564 ± 125	518.00 ± 0.84*	516.00 ± 0.74*	521.00 ± 0.19*
Total strength (150 Pa)	0.37 ± 0.17	0.480 ± 0.014*	0.470 ± 0.009*	0.460 ± 0.001*

Note: * — statistically significant differences between groups 1, 2 and 3.

Table 2. Rhinomanometry data in the children of the postoperative remote study groups

Rhinometric values		In 7 days		One month after		Six months after		In a year	
		M	m	M	m	M	m	M	m
Summary volume (150 Pa), cm^3/sec	Group 1	521***	0.98	528***	0.87	535***	1.12	539***	1.32
	Group 2	524***	1.05	534***	0.92	542***	1.24	546***	1.82
	Group 3	539***	0.36	552***	0.77	560***	1.04	563***	0.21
	P	$P_{1,3} < 0.001$; $P_{2,3} < 0.001$		$P_{1,3} < 0.05$; $P_{2,3} < 0.001$		$P_{1,3} < 0.001$; $P_{2,3} < 0.001$		$P_{1,3} < 0.001$; $P_{2,3} < 0.05$	
Total strength (150 Pa), Pa/cm^3/sec	Group 1	0.49	0.012	0.47	0.011	0.44	0.07	0.42	0.05
	Group 2	0.50**	0.007	0.45**	0.004	0.40**	0.002	0.39*	0.02
	Group 3	0.48***	0.008	0.47*	0.005	0.41***	0.002	0.38***	0.002
	P	$P_{2,3} < 0.05$		$P_{1,2} < 0.05$; $P_{2,3} < 0.05$		$P_{1,3} < 0.01$; $P_{2,3} < 0.05$		$P_{1,3} < 0.01$; $P_{2,3} < 0.05$	

Notes: * — P < 0.05; ** — P < 0.01; *** — P < 0.001 of the values of the corresponding stage compared to the baseline; $P_{1,2}$ — indicates the significance of the difference between the means of group 1 and group 2; $P_{1,3}$ — indicates the significance of the difference between group 1 and group 3 means; $P_{2,3}$ — indicates the significance of the difference between group 2 and group 3 means.

the results obtained through the influence of changes in the pituitary mucosa caused by the nasal cycle. We avoided a hard compression on the nostril, which can lead to the deformation of the nasal vestibule and the modification of the research results. The sound generator was included and the examination was carried out, 2 times for each nostril. The duration of the examination was up to 3–4 minutes. The average curve for each nostril is displayed on the rhinomanometer monitor.

In addition to the flow-pressure curve, the rhinomanometer also displays the following measurements:

— FLOW R, L — respiratory flow at 75, 150, 300 Pa for each nostril;

— FLOW INC. R, L — the flow rate increase percentage for each pressure increase (from 75 to 150 and from 150 to 300 Pa);

— FLOW RATIO — right/left nostril flow ratio.

The graphic representation (Fig. 1) allows the rapid and precise determination of nasal permeability. If the curves move away from the abscissa, the breathing is good, and if they come closer, the breathing is deficient.

Rhinomanometry allows the confirmation of nasal obstruction, objectifying the subjective symptoms.

Results and discussion

Objective exploration of nasal resistance revealed signs of nasal obstruction in children with chronic hypertrophic rhinitis. According to literature data, the normal indices of the nasal compartments in children are: total volume at 150 Pa — 564 ± 404 cm^3/sec; the total resistance at 150 Pa is 0.37 ± 0.24 Pa/cm^3/sec. Preoperatively, the MRI examination was performed, which revealed results that demonstrate a decrease in the parameters studied by MRI compared to the norm presented in Table 1.

Analyzing the presented data, we can say that in the children with chronic hypertrophic rhinitis in the study groups, the total volume of the nasal fossa is reduced, compared to the established norms, and a statistical difference is present in all children ($P < 0.05$). An increase in the total resistance to 150 Pa ($P < 0.05$ in all three groups) compared to the control group is attested. The results of the determination of the rhinomanometric parameters of the nasal cavity: the total volume and the total resistance at 150 Pa in different states of the nasal mucosa obtained by the previous rhinomanometry method are presented in Table 2.

In the early postoperative period, the first rhinomanometric examination was performed on the children from the study groups on the 7th postoperative day. From the data presented, we observe that the obstruction of the nasal cavity is still maintained — the total volume of the nasal cavity does not reach normal values, a statistical difference is determined in order to analyze the square meter volume of the nasal cavities between the groups ($P_{1,3} < 0.001$; $P_{2,3} < 0.001$). There is a considerable difference between the volumes assessed until decongestion, and the total nasal resistance that remains increased ($P_{1,2} < 0.05$; $P_{2,3} < 0.01$).

The analysis of the results of the previous rhinomanometry data over 6 months, attests that parallel to the increase in the volume of the nasal cavity, the total resistance decreases after treatment in all three groups with a true statistical difference ($P_{1,2} < 0.001$; $P_{2,3} < 0.001$), so an objective improvement is observed.

The rhinomanometric indices in groups 1, 2 and 3 were statistically significantly different from the data of the rhinomanometric examination 12 months after the operation ($P < 0.05$ for group 1 and $P < 0.001$ for groups 2 and 3). An increase in the volume indices of the nasal cavity is observed

in all groups of patients with a more significant increase in patients from group 2 and 1, but still resulting in a statistical difference between all groups during the examination of patients ($P_{1, 3} < 0.01$; $P_{2, 3} < 0.05$) (Table 2).

In the patients of group 3, the investigative indices approached in their value the results of the control group.

The analysis of the results of the functional examinations demonstrates that the surgical interventions had a beneficial effect, in terms of the recovery of the space parameters of the nasal cavities. A more pronounced improvement of the endonasal architectural indices is determined especially in group 3 where the diode laser surgical technique was performed compared to group 2 — treat only mucotomy with the shaver and compared to group 1 where the standard surgical technique of cauterization with bipolar forceps was practiced.

Conclusions

Rhinomanometry is an objective method of studying nasal permeability and can be applied to evaluate the volume and total rhinosinusal resistance in patients with chronic hypertrophic rhinitis. The functional rhinomanometric results performed were statistically different after performing the surgical treatment in all study groups, a fact that denotes an important diagnostic value of this examination in the monitoring of postoperative dynamic results.

References

1. Akmenkalne L, Prill M, Vogt K. Nasal valve elastography: quatitative determination of the mobility of the nasal valve. Rhinology Online. 2019;2:81-86. doi: 10.4193/RHINOL/18.086.

2. Clement PA, Gordts F; Standardisation Committee on Objective Assessment of the Nasal Airway, IRS, and ERS. Consensus report on acoustic rhinometry and rhinomanometry. Rhinology. 2005 Sep;43(3):169-79.

3. Gagnieur P, Fieux M, Louis B, Béquignon E, Bartier S, Vertu-Ciolino D. Objective diagnosis of internal nasal valve collapse by four-phase rhinomanometry. Laryngoscope Investig Otolaryngol. 2022 Mar 22;7(2):388-394. doi: 10.1002/lio2.784.

4. Hellings PW, Klimek L, Cingi C, et al. Non-allergic rhinitis: Position paper of the European Academy of Allergy and Clinical Immunology. Allergy. 2017 Nov;72(11):1657-1665. doi: 10.1111/all.13200.

5. Komshian SR, Cohen MB, Brook C, Levi JR. Inferior Turbinate Hypertrophy: A Review of the Evolution of Management in Children. Am J Rhinol Allergy. 2019 Mar;33(2):212-219. doi: 10.1177/1945892418815351.

6. Peksis K, Unger J, Paulauska S, et al. Relationships among nasal resistance, age and anthropometric parameters of the nose during growth. Rhinology Online. 2018;1:112-121. doi: 10.4193/RHINOL/18.032.

7. Rüttgers M, Waldmann M, Schröder W, Lintermann A. Correction to: Machine-Learning-Based Control of Perturbed and Heated Channel Flows. In: Jagode H, Anzt H, Ltaief H, Luszczek P, eds. High Performance Computing: ISC High Performance 2021, Lecture Notes in Computer Science. Springer, Cham; 2022. doi: 10.1007/978-3-030-90539-2_37.

8. Toh ST, Lin CH, Guilleminault C. Usage of four-phase high-resolution rhinomanometry and measurement of nasal resistance in sleep-disordered breathing. Laryngoscope. 2012 Oct;122(10):2343-9. doi: 10.1002/lary.23441.

9. Vogt K, Wernecke K-D, Argale M, Kaulina K. Classification of total nasal obstruction in 10,033 cases by 4-phase - rhinomanometry. Romanian J Rhinology. 2016;6(23):149-160. doi: 10.1515/rjr-2016-0017.

10. Vogt K, Bachmann-Harildstad G, Lintermann A, Nechyporenko A, Peters F, Wernecke KD. The new agreement of the international RIGA consensus conference on nasal airway function tests. Rhinology. 2018 Jun 1;56(2):133-143. doi: 10.4193/Rhin17.084.

11. Waldmann M, Grosch A, Witzler C, et al. An effective simulation- and measurement-based workflow for enhanced diagnostics in rhinology. Med Biol Eng Comput. 2022 Feb;60(2):365-391. doi: 10.1007/s11517-021-02446-3.

12. Waldmann M, Rüttgers M, Lintermann A, Schröder W. Virtual Surgeries of Nasal Cavities Using a Coupled Lattice-Boltzmann–LevelSet Approach. ASME J of Medical Diagnostics. 2022 Aug:5(3):031104. doi: 10.1115/1.4054042.

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Роль риноманометрії в оцінці ефективності лазерохірургічного лікування в дітей із хронічним гіпертрофічним ринітом

Резюме. Актуальність. Риноманометрія — об'єктивний спосіб оцінки назальної прохідності. Завдяки розвитку технологій і використанню мікрокомп'ютерів, підключених до вимірювальних приладів, популярність цього методу зросла. За допомогою риноманометрії оцінюють носовий опір шляхом вимірювання потоку повітря та трансназального градієнта тиску, виявляють наявність носової респіраторної обструкції та з'ясовують, яка нозологічна структура постійно її викликає, у цьому випадку гіпертрофія нижніх носових раковин. **Мета дослідження:** оцінити ефективність функціонального обстеження, такого як передня риноманометрія, у моніторингу результатів лазерохірургічного лікування в дітей із хронічним гіпертрофічним ринітом. **Матеріали та методи.** Це дослідження було проведено в клініці дитячої оториноларингології Республіканської дитячої клінічної лікарні ім. Е. Коцага. У ньому взяли участь 120 дітей віком 8–17 років із гіпертрофічним хронічним ринітом, розділених на три групи по 40 дітей у кожній, яких лікували 3 методиками: 1-ша група — каутеризація нижніх носових раковин біполярними щипцями, 2-га — шейверна мукотомія та 3-тя група — діодно-лазерна хірургія. Усім хворим

проводили риноманометрію як об'єктивне передопераційне та післяопераційне дослідження на 7-му добу, через місяць, рік та через 12 місяців. **Результати.** Аналіз результатів функціонального обстеження показує, що оперативні втручання були ефективні щодо відновлення просторових параметрів порожнин носа. Визначено більш виражене покращення ендоназальних архітектонічних показників у 3-й групі, де використовували діодно-лазерну оперативну техніку, порівняно з 2-ю (лише шейверна мукотомія) і 1-ю групою, де застосовували стандартну хірургічну техніку каутеризації біполярними щипцями. **Висновки.** Результати функціональної риноманометрії після хірургічного лікування статистично відрізнялися в усіх групах дослідження, що свідчить про важливу діагностичну цінність цього обстеження в моніторингу післяопераційної динаміки.

Ключові слова: риноманометрія; хронічний гіпертрофічний риніт; назальна прохідність; закладеність носа