



The functional state of the mucous membrane of the nasal cavity and paranasal sinuses after radical and minimally invasive surgical interventions

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Available online at: www.isca.in

Received 12th January 2021, revised 7th September 2022, accepted 5th January 2023

Abstract

Improving the effectiveness of treatment of chronic rhino sinusitis (CRS) is a priority task of modern otorhinolaryngology, not only domestic, but also foreign. The goal of our study was to increase the effectiveness of treatment of chronic rhino sinusitis, based on the differential diagnosis of the morphofunctional state of the mucous membrane of the nasal cavity and paranasal sinuses before surgery. The study included 200 people. A significant difference in the heating capacity of the mucous membrane of the nasal cavity indicates the irreversibility of the functional state of the mucous membrane of the VSP, which is confirmed by the data of the histological examination of the mucous membrane of the VSP.

Keywords:

Introduction

Improving the effectiveness of treatment of chronic rhino sinusitis (CRS) is a priority task of modern otorhinolaryngology, not only domestic, but also foreign¹. This interest in the problem is due to the widespread prevalence of this pathology. In the structure of the main diseases of the paranasal sinuses (PNS), the largest share in the adult population is occupied by inflammation of the maxillary sinus (MS), in which there is an annual increase in the incidence of 1-1.5%, the second most frequent is inflammation of the ethmoid labyrinth cells, then the frontal and sphenoid sinuses^{2,3}.

According to domestic and international recommendation documents (EPOS, IDSA, CHRONOS), rhino sinusitis, as a rule, does not occur in the form of an isolated lesion of PNS, other sinuses and the nasal mucosa (MMNC) are also involved in the pathological process^{4,5}. The development of new technologies in diagnostics and surgical approaches in CRS allows a different approach to the issue of managing patients with this pathology⁶. Today the most common treatment for CRS is functional endoscopic rhino sinus surgery (FESS)⁷. The main task of FESS is to restore the mucous membrane of the PNS and its functional activity⁸.

At the same time, it is known that not all cases when using the methods of functional surgery lead to a positive result, which makes it necessary to study the causes of failures, to look for ways to improve methods of diagnosis and treatment of chronic diseases of PNS^{9,10}. Despite the development of new technologies, classical surgical approaches in rhino surgery have not lost their relevance, when functional surgery, firstly, is not justified if the mucous membrane of the PNS is irreversible, and

secondly, the surgical approach does not always allow to completely remove the altered mucous membrane. But at the stage of examination, it is impossible to assess the reversibility of the pathological process (morphological state) of MMNC and PNS and to clearly define the criteria for choosing the tactics of surgical treatment¹¹. This circumstance became the goal of our study, forced to look for methods of differential diagnosis of the morphofunctional state of MMNC and PNS in CRS at the stage of examination¹².

In accordance with the above, the goal of our study was to increase the effectiveness of treatment of chronic rhino sinusitis, based on the differential diagnosis of the morphofunctional state of the mucous membrane of the nasal cavity and paranasal sinuses before surgery.

Methodology

The study included 200 people. Of these, 180 patients were patients with CRS, who were divided into two comparison groups by the free sampling method and 20 patients of the control group without pathology of the nasal cavity and PNS. Group 1 - all patients (n=105) underwent endoscopic endonasal infundibulotomy; Group 2 - all patients (n = 75) underwent a radical operation on the MS according to Coludwell-Luc; the distribution of patients by sex was as follows: 75 women (37.5%) and 125 men (62.5%), as can be seen from the data, men predominated than women.

Results and Discussion

According to the results of the study of the control healthy group, the MCT of the nasal cavity was 13.2±1.5 minutes in the

norm, the BVR was 7.4 ± 0.2 Hz, the excretory capacity of the MMNC was 0.03 ± 0.01 g/minute, the absorption capacity of the SOS was 2.2 ± 0.7 h.s.s. The study of the VSP was limited to the definition of MCT, which was 20 ± 1.7 minutes, and the NRD, the data of which were similar to those of the MMNC and amounted to 7.4 ± 0.2 Hz.

Measurement of the temperature of SOSN in the control group in the anterior parts of the NNR was $t_1 = 33.50 \pm 0.1$ °C, in the posterior parts of the NNR $t_2 = 33.80 \pm 0.2$ °C, and in the area of the natural anastomosis of the upper junction. Normally, the heating capacity of MMNC, T average (T), was 33.40 ± 0.5 .

Morphofunctional state of the mucous membrane of the maxillary sinus in chronic rhinosinusitis before surgery.

The transport capacity of the mucous membrane of the MS prior to surgical treatment was 55 ± 1.3 minutes, the total volume of the upper respiratory tract was 3.9 ± 0.5 Hz; with a pronounced thickening of the mucous membrane of the VSP, the MCT was 61 ± 1.2 minutes, the NPV of the VSP was 2.8 ± 0.5 Hz. A decrease in the motor activity of the cilia of the ciliated epithelium in chronic inflammation of the mucous membrane of the VSP indicates the inhibition of its transport capacity.

Morphological examination of the mucous membrane of the MS in CRS was performed in all operated patients. Were identified 3 types of morphological state of the mucous membrane of the MS. The first type of morphological changes in the mucous membrane of the MS was characterized by the absence of metaplasia of the epithelium and fibrosis of the submucosal layer of the mucous membrane of the MS in 76 (42.2%) patients. The second type is the most common metaplasia of the epithelium, but without fibrosis of the submucosal layer of the mucous membrane of the VSP and amounted to 33 (18.4%) patients. The third type is metaplasia of the epithelium with fibrosis of the submucosal layer of the mucous membrane of the VSP was 71 (39.4%) patients.

Thus, the histological examination of the mucous membrane of patients with chronic inflammation of the MS can detect objective signs characteristic of CRS. Correlation relationships between the heating state of MMNC and morphological characteristics of MMNC before surgery. When comparing the morphological and functional data of the mucous membrane of the MS and the calorific state of the mucous membrane of the MS before the operation, we were able to determine the temperature difference in the nasal cavity depending on the morphological state of the mucous membrane of the MS.

In the absence of squamous cell metaplasia and fibrosis in the submucosal layer of the mucous membrane of the MS, the temperature at the first point was $t_1 = 33.40 \pm 0.20$ °C, at the second point $t = 33.70 \pm 0.20$ °C. The temperature formula was $t_1 < t_2$.

The average temperature in the nasal cavity was 33.20 ± 0.50 °C ($p > 0.05$). In the presence of areas of squamous metaplasia, but without fibrosis in the submucosal layer of the mucous membrane of the VSP, the temperature at the first point was $t_1 = 32.20 \pm 0.3$ °C, at the second point $t_2 = 32.50 \pm 0.3$ °C. The temperature formula was $t_1 < t_2$. The average temperature in the nasal cavity was 32.10 ± 0.3 °C ($p > 0.05$).

In the presence of areas of squamous cell metaplasia and fibrosis in the submucosal layer of the mucous membrane of the MS, the temperature at the first point was $t_1 = 29.60 \pm 0.3$ °C, at the second point $t_2 = 29.70 \pm 0.2$ °C. The temperature formula was $t_1 < t_2$. The average temperature in the nasal cavity was 29.50 ± 0.2 °C ($p < 0.05$). The transport capacity of the mucous membrane of the VSP before the surgery was 55 ± 1.5 minutes, the NPD - 3.9 ± 0.2 Hz, which was significantly reduced ($p < 0.05$) in relation to normal values (MCT - 20 ± 1 , 5 minutes; BWR - 7.4 ± 0.2 Hz).

Morphological and functional state of the mucous membrane of the maxillary sinus in patients after endoscopic infundibulotomy.

After surgery, the patients of the comparison groups were divided into subgroups, depending on the morphological changes in the mucous membrane: 1a subgroup of 76 (42.2%) patients without metaplasia of the mucous membrane of the MS after endoscopic infundibulotomy; 1b subgroup of 29 (16.1%) patients with mucosal metaplasia and fibrosis of the submucosal layer of the mucous membrane of the MS after endoscopic infundibulotomy; Chronic rhinosinusitis without metaplasia of the epithelium of the nasal cavity and VSP after endoscopic infundibulotomy group 1a, $n = 76$. The transport capacity of the mucous membrane of the VSP 6 months after endoscopic infundibulotomy MCT - 32 ± 1.5 minutes, PBS - 5.7 ± 0.2 Hz. After 12 months - MCT - 25 ± 1.5 minutes, BPS - 6.9 ± 0.4 Hz (Table-3). The calorific capacity of MMNC in subgroup 1a 6 months after endoscopic sinusitis, the temperature at the first point t_1 was 33.30 ± 0.2 °C, at the second point t_2 was 33.70 ± 0.2 °C. The mean indicator was $T = 33.10 \pm 0.2$ °C. After 12 months, the average temperature was 33.30 ± 0.2 °C, where at the first point $t_1 = 33.40 \pm 0.2$ °C, at the second point $t_2 = 33.80 \pm 0.2$ °C, where $p > 0.05$ (Table-1).

Table-1 Functional state of the nasal mucosa and PNS before and after endoscopic infundibulotomy in subgroup 1a As can be seen from the above data, the transport and heating capacity of the MMNC before the operation were reduced, but after a year they fully recovered.

According to the results of a histological examination of the mucous membrane of the VSP, after endoscopic infundibulotomy in subgroup 1a after 12 months, in 76 (100%) cases, a single-layer multilayer cylindrical ciliated epithelium was determined, leukocyte infiltration in 11 (14.4%) cases, while in 8 (10, 5%) cases, the integrity of the ciliated epithelium is impaired, fibrosis of the submucosa was detected

in 4 (5.2%) cases, hyperplasia of the own glands in 27 (35.5%) cases, hyperplasia of the ciliated epithelium in 36 (47.3%) cases. Thus, the calorificatory state of SOSN is not reliable ($p > 0.05$) and indicates the reversibility of the functional state of the mucous membrane of the MS, which is confirmed by the data of the histological examination of the mucous membrane of the MS. Chronic rhinosinusitis with metaplasia of the epithelium and fibrosis of the submucosal layer of the mucous membrane of the mucous membrane and upper spinal cord after endoscopic infundibulotomy, group 1b, $n = 29$.

The transport capacity of the mucous membrane of the VSP 6 months after the operation for the VSP was 49.2 ± 1.7 minutes MCT, and 3.8 ± 0.4 Hz for the VSP. After 12 months - MCT - 44.1 ± 1.7 minutes, BPS- 4.1 ± 0.4 Hz (Table-4). The calorific capacity of MMNC in subgroup 1b 6 months after endoscopic infundibulotomy, the temperature at the first point t_1 was $30.90 \pm 0.2^\circ\text{C}$, at the second point t_2 was $31.30 \pm 0.2^\circ\text{C}$; at the third point t_3 was $30.50 \pm 0.3^\circ\text{C}$. The average indicator was $T - 30.90 \pm 0.2^\circ\text{C}$. After 12 months, the average temperature was $31.80 \pm 0.2^\circ\text{C}$, where at the first point $t_1 = 31, 90 \pm 0.2^\circ\text{C}$, at the second point $t_2 = 32.30 \pm 0.2^\circ\text{C}$, at the third point $t_3 = 31.20 \pm 0.3^\circ\text{C}$ (Table-2).

As can be seen from the above results, in patients of this group, the PCP of the PCP did not recover after 1 year and T was significantly reduced in relation to the norm, both before and after the operation ($p < 0.05$), but in the postoperative period the difference in indicators between three points remains, where the temperature formula was $t_1 < t_2$.

The functional state of the nasal mucosa and PNS before and after endoscopic infundibulotomy in subgroup 1b 12 months after endoscopic infundibulotomy in subgroup 1b morphologically, in 29 (100%) atrophy, detachment and deformation of the cilia of the multilayer single-layer columnar epithelium, in 22 (75.8%) cases, fibrosis of the submucosal layer, in 7 (24.1%) cases hyperplasia of its own glands (goblet

cells), hyperplasia of the ciliated epithelium in 26 (89.2%) cases, in 6 (20.6%) cases, an increased content of inflammatory cells (lymphocytes, leukocytes), which is characteristic of an exacerbation of a chronic inflammatory process.

Morphofunctional state of the mucous membrane of the maxillary sinus in patients after radical surgery for the maxillary sinus according to Caldwell-Luc.

After radical surgery on the VCP according to Caldwell-Luc, the patients of the comparison groups were divided into subgroups, depending on the morphological changes in the mucous membrane: 2a, subgroup 33 (18.4%) patients with areas of mucosal metaplasia and without fibrosis of the submucosal layer of the MS after radical surgery for the lower respiratory tract according to Caldwell-Luc; 2b, a subgroup of 42 (23.3%) patients with mucosal metaplasia and fibrosis of the submucosal layer of the MS after radical surgery on the upper limb by Caldwell-Luc; Chronic rhinosinusitis with areas of mucosal metaplasia and without fibrosis of the submucosal layer of the MS after radical surgery on the MS according to Caldwell-Luc 2a, $n = 33$ The transport capacity of the mucous membrane of the VSP after 6 months is 49 ± 1.4 minutes, after 12 months 41 ± 1.5 minutes, which is significantly reduced in relation to normal values, where $p < 0.05$.

After 6 months, the NPR was correspondingly reduced to 4.1 ± 0.7 Hz and after 12 months the NPR increased to 4.5 ± 0.3 Hz, which was significantly reduced in relation to the norm, where $p < 0.05$. The calorific capacity of SOSN in subgroup 2a after 6 months, after radical Caldwell-Luke surgery, the temperature at the first point t_1 was $32.50 \pm 0.2^\circ\text{C}$, at the second point t_2 was $32.60 \pm 0.3^\circ\text{C}$. The average was $T - 32.50 \pm 0.2^\circ\text{C}$. After 12 months, the average temperature was $32.70 \pm 0.2^\circ\text{C}$, where at the first point $t_1 = 32.70 \pm 0.3^\circ\text{C}$, at the second point $t_2 = 32.80 \pm 0.2^\circ\text{C}$ (Table-3).

Table-1: Functional state of the nasal mucosa and PNS before and after endoscopic infundibulotomy in subgroup 1a.

	Norm	Before surgical treatment *	After endoscopic infundibulotomy *	
			6 months	12 months
MCT MS, minutes	$20 \pm 1,7$	$55 \pm 1,3$	$32 \pm 1,5$	$25 \pm 1,5$
ChBR MS, Hz	$7,4 \pm 0,2$	$3,9 \pm 0,5$	$5,7 \pm 0,2$	$6,9 \pm 0,4$
ChBR MMNC, Hz	$7,4 \pm 0,3$	$5,3 \pm 0,2$	$7,3 \pm 0,2$	$7,3 \pm 0,2$
ChBR MMNC, Hz	$33,40 \pm 0,5$	$33,20 \pm 0,5$	$33,10 \pm 0,2$	$33,30 \pm 0,2$

*without squamous cell metaplasia and fibrosis in the submucosal layer of the mucous membrane of the MS.

Table-2: The functional state of the nasal mucosa and PNS before and after endoscopic infundibulotomy in subgroup 1b.

	Norm	Before surgical treatment ***	After endoscopic infundibulotomy ***	
			6 months	12 months
MCT MS, minutes	20 ±1,7	61 ±1,2	49,2 ±1,7	44,1±1,7
ChBR MS, Hz	7,4±0,2	2,8 ± 0,5	3,8 ±0,4	4,1 ±0,4
ChBR MMNC, Hz	7,4±0,3	3,2 ± 0,3	5,7±0,4	5,7±0,4
ChBR MMNC, Hz	33,40 ±0,5	29,50 ± 0,5	30,90±0,2	31,80±0,2

***with the presence of squamous cell metaplasia and fibrosis in the submucosal layer of the mucous membrane of the MS.

Table-3: The functional state of the nasal mucosa and PNS before and after Caldwell-Luc in subgroup 2a.

	Norm	Before surgical treatment **	After a radical Caldwell-Luke CPP operation **	
			6 months	12 months
MCT MS, minutes	20 ±1,7	55 ±1,3	49±1,4	41± 1,5
ChBR MS, Hz	7,4±0,2	3,9 ± 0,5	4,1±0,7	4,5 ± 0,3
ChBR MMNC, Hz	7,4±0,3	5,3±0,2	7,2 ±0,2	7,2 ±0,2
ChBR MMNC, Hz	33,40 ±0,5	32,10 ± 0,5	32,50±0,2	32,70 ± 0,2

** with the presence of squamous cell metaplasia, but without fibrosis in the submucosal layer of the mucous membrane of the MS.

As can be seen from the above data, in patients of this group, T before the operation was below normal, but the difference in indicators between the three points, the NPV of the VSP remained in the lower limits. After the operation, after 1 year, the NRF is reduced and there is no difference in T at three points, where the temperature formula looks like $t_1 \leq t_2$.

According to the data, histological examination after radical surgery on the VCP according to Caldwell-Luc in 16 (48.4%) preparations was determined by a single-layer multilayered columnar ciliated epithelium, which had areas of damage, separation and deformation.

Elements of an atrophic nature were found in 22 (66.6%) cases. Hyperplasia of the own glands in 13 (39.3%) cases, the presence of cells of chronic inflammation (lymphocytes, leukocytes) in 7 (21.2%) cases, hyperplasia of the ciliated epithelium in 9 (27.2%) cases. Chronic rhinosinusitis with epithelial metaplasia and fibrosis of the submucosal layer of the nasal mucosa and MS after radical surgery for MS according to Caldwell-Luke 2b, (n = 42). The transport capacity of the mucous membrane of the VSP after 6 months is 49.2 ± 1.7 minutes, after 12 months 44.1

± 1.7 minutes, where $p < 0.05$, which is significantly reduced in relation to the normal indicator.

After 6 months, the NPR was correspondingly reduced to 3.6 ± 0.4 Hz, and after 12 months, the NPR increased to 3.9 ± 0.4 Hz, where $p < 0.05$, which was significantly reduced in relation to the normal indicator. The calorific capacity of SOSN in subgroup 2b after 6 months, after radical Caldwell-Luke operation, the temperature at the first point t_1 was $30.20 \pm 0.2^\circ\text{C}$, at the second point t_2 was $30.30 \pm 0.2^\circ\text{C}$. The average was $T - 30.20 \pm 0.2^\circ\text{C}$. After 12 months, the average temperature was $30.30 \pm 0.2^\circ\text{C}$, where at the first point $t_1 = 30.30^\circ\text{C}$, at the second point $t_2 = 30.30^\circ\text{C}$ (Table-4).

As can be seen from the above data, in patients of this group, T before the operation was below normal, the difference in indicators between the three points did not persist, and the BNR of the VSP remained in the lower limits. After the operation, after 1 year, the NRF decreased and there is no difference in T at three points, where the temperature formula was $t_1 \leq (t_2 = t_3)$.

Table-4: Functional state of the nasal mucosa and PNS before and after radical Caldwell-Luc operation in subgroup 2b.

	Norm	Before surgical treatment ***	Caldwell-Luke after radical CPP surgery ***	
			6 months	12 months
MCT MS, minutes	20 ±1,7	61 ±1,2	49,2±1,7	44,1± 1,7
ChBR MS, Hz	7,4±0,2	2,8 ± 0,5	3,6±0,4	3,9 ± 0,4
ChBR MMNC, Hz	7,4±0,3	3,2 ± 0,3	5,7 ±0,4	5,7 ±0,4
ChBR MMNC, Hz	33,40 ±0,5	29,50 ± 0,5	30,20±0,2	30,30 ± 0,2

*** with the presence of squamous cell metaplasia and fibrosis in the submucosal layer of the mucous membrane of the MS.

According to the results of a histological examination of the mucous membrane of the VSP, after a radical operation on the VSP according to Caldwell-Luc, after 12 months in 19 (45.2%) preparations, a single-layer multilayered cylindrical ciliated epithelium was determined, which had areas of damage, detachment and deformation.

Elements of an atrophic nature 31 (73.8%) and fibrosis of the submucosal layer were detected in 30 (71.4%) cases. Hyperplasia of the own glands in 16 (38%) cases, the presence of cells of chronic inflammation (lymphocytes, leukocytes) in 8 (19%) cases, hyperplasia of the ciliated epithelium in 11 (26.2%) cases. Along with the above-listed manifestations, in 23 (54.8%) cases, complete metaplasia of the epithelium into a multilayered squamous non-keratinizing epithelium was determined.

Conclusion

Thus, the heating capacity of MMNC is significantly reduced ($p < 0.05$) in comparison with the norm, both before and after a radical operation on the VCP according to Caldwell-Luc. A significant difference in the heating capacity of the mucous membrane of the nasal cavity indicates the irreversibility of the functional state of the mucous membrane of the VSP, which is confirmed by the data of the histological examination of the mucous membrane of the VSP.

The morphofunctional state of the mucous membrane of the nasal cavity and maxillary sinus was studied in patients with chronic rhinosinusitis: a significant ($p < 0.05$) decrease in thermometry parameters and the frequency of beating of cilia of the nasal cavity mucosa and PNS was proved (T average = $29.50 \pm 0.3^{\circ}\text{C}$; $t_1 \leq (t_2=t_3)$ and $\text{BPS} = 2.8 \pm 1.2\text{Hz}$) with squamous cell metaplasia and / or.

A comparative analysis of the morpho-functional state of the mucous membrane of the nasal cavity and paranasal sinuses proved the irreversibility of functional disorders in squamous metaplasia of the mucous membrane and / or fibrosis of the submucosal layer of the SOS and PNS; in case of reversible changes in SOS and PNS, the multi-row cylindrical ciliated epithelium completely restores its histoarchitectonics and functionality in the remote postoperative period.

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