ASSESSMENT OF THE EFFECT OF ANESTHESIA METHODS ON HRV AND PAIN SYNDROME AFTER SEPTOPLASTY

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Abstract: ***Aims*****: to evaluate various methods of anesthesia during septoplasty for changes in heart rate variability (HRV) and acute pain syndrome in the early postoperative period.** ***Patients and methods*****. All patients received local anesthesia with 2% procaine solution. In group 1(105 people) premedication was used with 2% promedol solution and 60 mg of ketorolac in the evening, in group 2 (108 people) - fentanyl, propofol, cisatracuria besylate, tranexamic acid, atropine and metoclopramide, in group 3 (78 people) - atracuria besylate, sodium thiopental, nitrous oxide and halothane. In groups 2 and 3, 100 mg of ketoprofen was administered intramuscularly in the evening on the day of surgery. The frequency domain of HRV was estimated per day. Pain was assessed using a visual analogue scale (VAS).** ***Results*****. ULF and LF were significantly higher in groups 2 and 3 than in the local anesthetic group. VLF in the second group was significantly lower than in groups 1 and 3. Groups 2 and 3 had low HF. The VHF of group 2 was significantly lower than in groups 1 and 3, which also differed from each other - the VHF values in group 1 were higher than in group 2. Total power in group 2 was significantly lower than in groups 1 and 3. Pain syndrome was less pronounced in group 2.** ***Conclusion*****. The following scheme may be less stressful when performing septopalstics for general anesthesia: fentanyl, propofol, cisatracuria besylate, tranexamic acid, atropine and metoclopramide.**

Keywords: **septoplasty, stress, HRV, anesthesia.**

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Introduction. A nasal septum deviation (NSD) can cause reduced airflow in the nasal cavity, chronic irritation of the mucous membranes and postnasal dript [1]. The association between upper airway obstruction and cardiovascular disease has previously been investigated in relation to cardiac arrhythmias, pulmonary vascular reactivity and cardiac mortality. The mechanisms underlying this relationship have been attributed to increased oxidative stress and increased sympathetic nervous system (SNS) tone [2]. Septoplasty is still the most common surgical procedure for NSD [3]. The choice of septoplasty as a treatment method for patients with nasal septum deviation is beyond doubt. So, over the next 6-12 months, septoplasty leads to an improvement in nasal breathing and, as a result, to an improvement in the quality of life. At the same time, the general antioxidative status of patients improves.

In our previous studies on experimental septoplasty simulation in rats, the degree of its stressfulness was shown. Thus, in the first two days in animals, a depressive-like state develops [4] changes in the cytoarchitectonics of the pyramidal layer of the hippocampus and there is an increase in p53-positive neurons in it[5] as a result of local inflammatory reactions and narrowing of the common nasal passages in response to damage to the nasal septum, and also the subsequent severe imbalance of the autonomic nervous system (ANS) [6].

Surgical interventions in the human nasal cavity lead to changes in the balance of ANS [1], as well as to the occurrence of cardiac arrhythmias [7]. When performing septoplasty, it is important to use both local and general anesthesia with sedation, since severe pain can cause a decrease in heart rate due to the predominance of the tone of the parasympathetic nervous system (PNS) over the sympathetic (SNS), which, in turn, lowering the pulse, and leads to a dangerous drop in blood pressure. These side effects can be monitored using a daily recording of a Holter electrocardiogram and an analysis of heart rate variability (HRV).

HRV is a physiological parameter influenced by the balance between SNS and PNS [8]. A decrease in HRV with short ECG records is a manifestation of the reactions of normal adaptability of the body, but with daily monitoring of the ECG, such rigidity is a sign of a violation of the adaptive reactions of the body [9].

Although there are several studies in the literature investigating the relationship between HRV and NSD [10], as well as the effect of septoplasty on postoperative HRV [1], however, to date, there are no studies that have evaluated the effect of anesthesia choice during septoplasty on stress responses in the early postoperative period - imbalance of the autonomic nervous system and acute pain syndrome. In the present study, an attempt was made to determine the least stressful method of anesthesia during septoplasty based on the assessment of heart rate variability and acute pain.

Patients and methods. In the period from 2014 to 2021. The study involved 291 people with NSD who underwent septoplasty. We studied the three most popular methods of anesthesia in clinics in Moscow (Russia) (Table 1).

164 men and 127 women (from 18 to 45 years old) were operated on. The study included only those women who had surgery during the periovulatory period (endometrial proliferation phase) of the menstrual cycle, since it was previously shown that it is during this period of the ovarian-menstrual cycle that the risk of nosebleeds is minimal when performing surgical interventions in the nasal cavity.

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Table 1. Study Design.

	1st group		2nd group		3rd group	
Number of patients	n=105		n=108		n=78	
Age (years)	18-44		18-45		17-42	
Sex	men	women	men	women	men	women
	n=58	n=47	n=62	n=46	n=44	n=34
Premedication	sol. Promedolum 2% 1ml. За 30-45 минут до операции		no			
Local infiltration anesthesia	sol. Procaini 1% (250 mg), sol. Epinephrini 0,1% (10 mg)					
General anesthesia	no		sol. Phentanyli (30 mkg/ml), sol. Propofoli (150 mg), sol. Nimbexi (6 mg), sol. Traneksami (1000 mg), sol. Atropini (0,5 mg), sol. Cerucali (10 mg)		sol. Tracriumi (20 ml), sol. Thiopentali sodiumi (750 mg), Nitrogenium oxydulatum (1 л/ч), Phthorothanum 1 об/%	
Analgesic therapy on the day of surgery at 20-22 pm	sol. Ketorolaci (60 mg)		sol. Ketoprofeni (100 mg)			
Patient examination methods	Holter ECG 24-hour monitoring VAS					

Exclusion criteria. The study excluded patients with severe chronic diseases of the cardiovascular system, lungs, kidneys, cancer patients, mental illness, with concomitant nasal and paranasal sinus pathologies (polypous rhinosinusitis, hypertrophy of the inferior turbinates, papillomas, chronic sinusitis, paranasal sinus cysts).

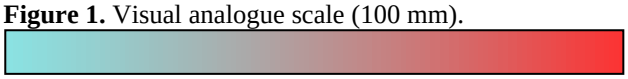
Perioperative anesthesia and pain management. Patients were randomly assigned to groups according to the type of anesthetic aid. In the first group (105 people), septoplasty was performed under local anesthesia. Local infiltration anesthesia was also used in both other groups using 2% procaine solution, and to reduce the risk of intraoperative nosebleeds - 0.1% epinephrine solution. Ketarolac (60 mg) was used intramuscularly as an anesthetic in this group in the evening (Table 1).

In the second group (108 patients), in addition to local anesthesia, fentanyl, propofol, cisatracuria besylate (nimbex), tranexamic acid (tranexam), atropine and metoclopramide (cerucal) were used. 78 patients of the 3rd group received atracuria besylate, sodium thiopental, nitrous oxide and halothane (fluorothane) as general anesthesia. As a non-steroidal anti-inflammatory drug in patients of groups 2 and 3, 100 mg of ketoprofen was used intramuscularly in the evening hours on the day of surgery (Table 1). For all patients for anterior nasal tamponade, foam tampons with a rubber glove were used. In the 1st and 2nd groups, the operated surgeons removed the tampons two days after the operation, and in the second - one day later.

Heart rate variability. 40-60 minutes before the surgical intervention, the Schiller MT-210 (Schiller, Switzerland) daily Holter ECG monitoring system was installed for 24 hours. To assess the state of the vegetative system, the parameters of the HRV frequency range were evaluated: ultra-low-frequency component (ULF), very low-frequency component (VLF), low-frequency component (LF), high-frequency component (HF), very high-frequency component (VHF), as well as total power.

Assessment of the intensity of pain syndrome. The severity of acute pain after septoplasty was assessed using a visual analogue scale (VAS) (Fig. 1).

Figure 1. Visual analogue scale (100 mm).



Patients were asked to mark with a vertical line the place of the scale that, in their opinion, corresponded to the pain experienced. The gradation of pain intensity was as follows. From 0 to 25 mm pain was assessed as mild or absent, from 26 to 50 mm pain was considered moderate, severe pain corresponded to the range 56-75 mm, and very severe and unbearable pain - 76-100 mm. VAS was offered to patients 1, 3, 6, after surgery. One day and two days after the operation, the pain intensity was assessed 1 hour after the removal of the anterior nasal tampons.

Statistics. The data were processed using Exel 2019, JASP 0.14.0.0, Schiller MT-210 programs. With a uniform distribution of the data sample, the Student's t test was used to determine the reliability of differences, and the Mann-Whitney test was used for an uneven distribution.

The study was conducted in accordance with the Ethical Principles for Medical Research Involving Human Subjects of World Medical Association Declaration of Helsinki; Federal Law No. 323-FZ "On the Basics of Health Protection of Citizens in the Russian Federation"; Order of the Ministry of Health of the Russian Federation No. 200n "Rules for Good Clinical Practice"

Results. ***HRV***. According to Student's test, the ultra-low-frequency component of HRV in the groups with general anesthesia was significantly higher than in the group with local anesthesia ($p < 0.01$) (Table 2, Fig. 2a).

Similar data were obtained when analyzing the low-frequency component ($p < 0.01$) (Table 2, Figure 2b). The very low-frequency component, according to the Mann-Whitney criterion, in the second group was significantly lower ($p < 0.01$), compared with groups 1 and 3, which did not differ from each other (Table 2, Fig. 2b). Comparison of the high-frequency component, according to Student's t-test, showed that the groups with general anesthesia had significantly low HF HRV ($p < 0.001$), compared with the group of local anesthesia, and did not differ between themselves (Table 2, Figure 2d). The very high frequency component of group 2 was significantly lower than in groups 1 and 3 ($p < 0.001$, Mann-Whitney test), which also differed among themselves – the VHF values in the first group were higher than in the second ($p<0,01$, Student's test) (Table 2, Figure 2e).

Table 2. Frequency Analysis Of HRV In Patients After Septoplasty

	ULF (Hz)	VLF(Hz)	LF (Hz)	HF (Hz)	VHF (Hz)	Total power
1st group	0,0005±0,00006	0,01±0,0003	0,08±0,00082	0,2±0,003	0,5±0,006	0,04±0,004
2nd group	0,0005±0,00005	0,01±0,0002	0,09±0,001	0,2±0,002	0,5±0,01	0,03±0,002
3rd group	0,0006±0,00006	0,01±0,0003	0,09±0,001	0,2±0,002	0,007	0,04±0,002

The total power spectrum, according to the Mann-Whitney test, in the second group was also significantly lower ($p < 0.001$) than in groups 1 and 3. However, the total power of the 3rd group was significantly higher than that of the 1st group ($p < 0.01$) (Table 2, Figure 2f).

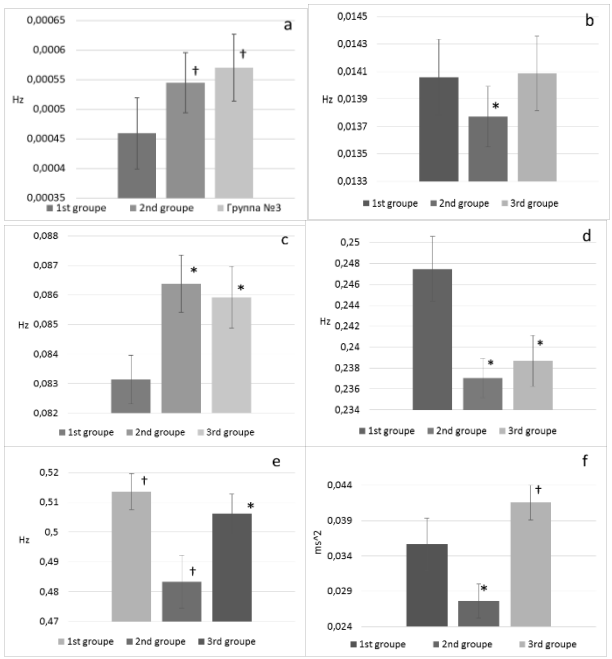


Figure 2. Changes in HRV in the frequency spectrum after septoplasty: a - ultra low frequency component (ULF), b - very low frequency component (VLF), c - low frequency component (LF), d - high frequency component (HF), e - very high frequency component (VHF), e - total power spectrum. * - significant differences between groups at $p < 0.01$; † - significant differences between groups at $p < 0.05$ (explanations in the text).

Pain intensity. According to the Mann-Whitney criterion, the pain syndrome during the first two hours after septoplasty was significantly lower in the second group than in the other groups ($p < 0.001$) (Fig. 3).

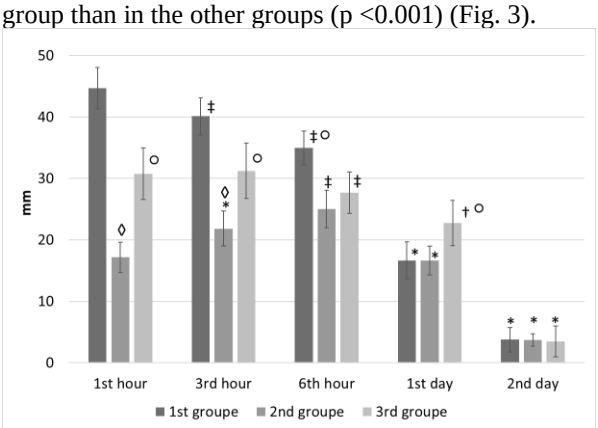


Figure 3. Comparison of pain syndrome in groups of patients with different anesthetic tactics using VAS: * - significant differences between the terms after surgery within the group at p <0.001; † - significant differences between the terms after surgery within the group at p <0.01; ‡ - significant differences between the terms after surgery within the group at p <0.05; ◊ - significant differences between groups at p <0.001; ○ - significant differences between groups at p <0.01; • - significant differences between groups at p <0.05.

Table 3. Change In Pain Intensity (mm).

Time after septoplasty	1st hour	3rd hour	6th hour	1st day	2nd day
1st group	44,65±3,37	44,65±3,37	44,65±3,37	44,65±3,37	44,65±3,37
2nd group	17,15±2,47	17,15±2,47	17,15±2,47	17,15±2,47	17,15±2,47
3rd group	30,75±2,21	30,75±2,21	30,75±2,21	30,75±2,21	30,75±2,21

At the same time, the intensity of acute pain in the first group was significantly higher than in the third (p <0.01). 6 hours after surgery, pain in the groups with general anesthesia was significantly lower than in the group with local anesthesia and premedication (p <0.01), and did not differ among themselves. One day after septoplasty, the severity of pain in the first two groups was statistically the same, but in the third group the pain was more intense (p <0.01) (Fig. 3). Two days later, in all groups, the intensity of the pain syndrome was low or it was not statistically indistinguishable (Tab.3).

The dynamics of the severity of acute pain within the groups was as follows. In the first group, its significant growth was noted at the 3rd (p <0.01) and 6th (p <0.05) hours after the operation (Fig. 3). Then there was a significant decrease (p <0.001). A gradual decrease in pain severity was observed in group 1 after 1 and 3 hours (p <0.05), as well as on days 1 and 2 after septoplasty (p <0.001). In patients of group 3, a decrease in pain syndrome was noted only 6 hours after surgery (p <0.05) with its gradual regression (Tab.3).

Discussion. Septoplasty, if performed by experienced surgeons, is a daily surgery due to its short duration and relative ease of postoperative rehabilitation [11]. Due to the peculiarities of the innervation of the nasal septum, it is strongly recommended to carry out high-quality control and prevention of bleeding during surgery and effective postoperative analgesia [12]. In the present study, the examined patients did not have massive intraoperative bleeding, and those who had them were not included in the study, since this would most likely affect the HRV results. Also, all patients underwent standard analgesic therapy with non-selective blockers of cyclooxygenases 1 and 2.

In the early postoperative period after septoplasty, inflammation (pronounced edema, hyperemia of the nasal mucosa, abundant mucous discharge, hemorrhagic crusts) persist for up to two days, followed by a decrease until the 14th day after surgery. This can explain the more pronounced pain syndrome in 3 group, since the tampons were removed within a day after septoplasty, which corresponds to our other data obtained earlier [13].

HRV helps to identify changes in ANS, metabolism, hormonal status, exposure to stress factors, etc. Both SNS and PNS activity contributes to HRV and is highly correlated with the power of the ULF, VLF and LF bands as well as the total power [14].

ULF is often associated with circadian rhythms. An increase in values in all three groups indicates a failure of the circadian rhythms as a result of surgical trauma, especially in the groups with general anesthesia.

VLF also shows a state of hyperactivity, mobilization of energy and metabolic reserves, centralization of the regulation of adaptive mechanisms by increasing the influence of higher autonomic centers and mobilization of the hypothalamic-pituitary-adrenal axis. In the group with local anesthesia and in the group with the use of atracurium besylate, sodium thiopental, nitrous oxide and fluorothane, VLF was increased, which clearly indicates the transition of control over the autonomic regulation of the heart from the spinal to a higher level - the level of the autonomic centers of the brain.

HF shows the tone of the parasympathetic nervous system, while LF, according to some authors, can reflect both sympathetic (predominantly) and parasympathetic tone [15]. In the present study, LF was increased in the general anesthesia groups, which may indicate an increased sympathetic effect on the heart. The high-frequency component of HRV was significantly higher in the group with local anesthesia, which indicates an increase in PNS and the development of normal adaptive responses in this group.

The presence of activity in the VHF range can serve as a diagnostic test for vagus nerve denervation [16]. An increase in VHF in groups 1 and 3 indicates a decrease in control from the PNS, as well as an increase in the "centralization" of autonomic regulation, which is confirmed by an increase in VLF in these groups.

Total power is the sum of the energy in the ULF, VLF, LF, and HF bands in 24 hours [17]. This indicator can characterize the general vegetative activity, with sympathetic activity being the main factor [18]. The increase in total power was also observed in groups 1 and 3, but it was less in the group with local anesthesia.

The worst indicators are possessed by groups 1 and 3, in which reactions of centralization of autonomic control were observed, in comparison with group 2. In patients of group 1, on the first day after the operation, the tone of the parasympathetic nervous system dominated, over the sympathetic, which was not observed in the groups with

general anesthesia. This can be regarded as a disruption of normal adaptive responses, since the SNS should first of all respond to stress [19]. Normal secondary activation of the sympathetic nervous system to secondary surgical stress occurred in the groups with general anesthesia, while in the second group it was less pronounced [20-25].

Among the presented schemes of anesthesia for septoplasty, the most preferable is the scheme for the use of fentanyl, propofol, cisatracurium besylate, tranexamic acid, atropine and metoclopramide, which is quite consistent with modern concepts of multimodal anesthesia [26]. The existing opinion about the best subjective indicators in patients after septoplasty with local anesthesia is not confirmed in this study.

Conflicts of interest. The authors have no conflicts of interest to declare.

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