Article

Comprehensive rehabilitation of patients after septoplasty

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Abstract: The aim of the work was to evaluate the effectiveness of the use of photobiomodulation therapy (PBMT) in combination with Respiro Mirtol forte in order to improve the rehabilitation period of patients after septoplasty. 92 patients underwent septoplasty under general anesthesia (55 men and 37 women, age ranged from 18 to 46 years), followed by tamponade of the nasal cavity. Patients of the 1st group did not undergo PBMT; in patients of the 2nd group, PBMT was performed 3 hours, 6 hours and 24 hours after septoplasty (infrared pulsed laser radiation, λ = 0.890 μm, P = 10 W, 2 minutes in the projection of the wings of the nose); Patients of the 3rd group were given PBMT in the indicated regimen and Rispiro Mirtol forte 5 days before and within 10 days after septoplasty. In 48 hours, after removing the tampons, in patients of the 2nd and 3rd groups, intranasal PBMT was used with a nozzle in the red range, with λ = 0.63 μm, P = mW, for 2 minutes. Heart rate variability (HRV) was assessed: ultra-low frequencies (ULF), high frequencies (HF), low frequencies (LF) and total power of heart rate variability (HRV), pain syndrome. ULF, LF, HF, total HRV power were significantly lower in group 2, compared with group 1, but higher than in group 3. In the period from 6 to 24 hours after septoplasty, the patients of the 1st group experienced a pain syndrome of greater intensity than the patients of the 2nd and 3rd groups ($p < 0.001$). The patients of the 3rd group had minimal pain values compared to the 2nd group. Thus, the use of PBMT in combination with Respiro Myrtol forte in the postoperative period after septoplasty against the background of nasal tamponade helps to minimize pain, reduce inflammation in the area of surgical damage, and, consequently, less pronounced changes in the autonomic nervous system in response to surgical stress.

Keywords: septoplasty, pain, photobiomodulation, heart rate variability, Respiro Mirtol forte.

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1. Introduction

Surgical correction of the curved nasal septum (IPN) – septoplasty – is one of the most common operations in rhinosurgery. Frequent complications after septoplasty are nosebleeds, nasal septum hematoma, acute rhinosinusitis and pain syndrome [1, 2]. After septoplasty, hemorrhagic and purulent-mucous crusts may form, under which the secret of the mucous glands may accumulate, which aggravates the rehabilitation period after septoplasty [3]. Septoplasty consists in the separation of the muco-suprachrachial and /or muco-periosteal leaves and the removal of curved areas of the cartilaginous and / or bony parts of the nasal septum. As a rule, smooth sections of the extracted cartilaginous part of the nasal septum are placed back between two leaves of the suprachristle. At the same time, the nasal cavity is tamponed after surgery to avoid complications [4].

A special position is occupied by the issue of rehabilitation of patients after septoplasty, which includes high-quality anesthesia, analgesic therapy, the use of local medicines. For example, we have previously demonstrated that septoplasty by itself [5], as well as with poor–quality anesthetic aid, provokes the development of a distress syndrome - an imbalance of the autonomic nervous system, severe pain syndrome and a violation of the quality of life in the early postoperative period, which is confirmed by changes in the balance of the autonomic nervous system (ANS) and changes in heart rate variability (HRV) [6].

To reduce the manifestation of side effects after septoplasty (pain, swelling of tissues, inflammation, ecchymosis, etc.), photobiostimulation has been increasingly used recently [67], which improves and accelerates tissue repair, and consequently, the healing of surgical wounds. These photobiostimulation effects are based on improving intracellular calcium metabolism and accelerating the synthesis of adenosine triphosphate in mitochondria [8, 9]. Photobiomodulation therapy (FBMT) is a form of light therapy. PBMT uses non–ionizing light sources, such as lasers or light-emitting diodes (LEDs) with a wavelength of 0.6-1 microns and a power of less than 500 MW per diode [10], to cause a photochemical reaction that leads to an increase in ATP synthesis in mitochondria, signal transmission in biological membranes and cells, DNA synthesis, proliferation cells, differentiation and modulation of pro- and anti-inflammatory mediators, leading to a decrease in pain and inflammation [11-13]. PBMT is widely used for the treatment of various diseases – diabetic ulcers, blood diseases, musculoskeletal complications, coronary heart disease, as well as for wound healing, pain and inflammation reduction, tissue repair and regeneration [14, 15].

A review of the literature shows that after septoplasty, FBMT is applied intranasally after the removal of tampons, or immediately in the case of splints [16]. At the same time, there is practically no data where the effectiveness of PBMT was evaluated when exposed during tamponade in the first two days after septoplasty.

Considering the above data, this study was conducted to evaluate the effectiveness of photobiomodulation therapy in combination with the use of Respiro Myrtol forte in order to improve the rehabilitation period of patients after septoplasty.

2. Patients and Methods

2.1. Rhinosurgery.

92 patients underwent septoplasty under general anesthesia. Among them there were 55 men and 37 women aged 18 to 46 years. The patients were randomly divided into 3 groups. The first group included 30 patients who did not use FBMT and did not use Respiro Myrtol forte 5 days before and 10 days after septoplasty, 1 capsule 3 times a day. There were 31 patients in the 2nd (group with PBMT) and 3rd groups (group with a combination of FBMT and Respiro Myrtol forte). Women underwent septoplasty during the periovulatory period, as it is known that it is during this phase of the ovarian-menstrual cycle that the risk of nosebleeds after rhinosurgery is minimal [17]. Immediately after the operation, all patients had an anterior nasal tamponade with gauze swabs in glove rubber for 1-2 days. All patients underwent septoplasty using local infiltration anesthesia with 1% procaine solution (250 mg) together with 0.1% epinephrine solution (10 mg) and general anesthesia, for which fentanyl (30 mcg/ml), propofol (150 mg), cisatracuria bezilate (nimbex) (6 mg), tranexamic acid was used (tranexam) (1000 mg), atropine (0.5 mg) and metoclopramide (cerucal) (10 mg). In order to prevent the development of acute bacterial inflammation of the paranasal sinuses, oral antibacterial therapy of azithromycin 500 mg once in the morning for three days with the first intake in the morning on the day of surgery was prescribed.

2.2. PBM therapy.

After 3 hours, 6 hours and 24 hours after septoplasty, patients of the 2nd and 3rd groups underwent laser therapy. The emitter heads generated infrared pulsed laser radiation with a wavelength of 0.890 microns and an installed power of 10 watts (LASMIC-01 apparatus, Russia). The emitter heads were installed in the projection of the lateral cartilage and the large cartilage of the nose wing on both sides for 2 minutes.

24-48 hours after surgery, nasal tampons were removed in patients of both groups and in groups 2 and 3, intranasal PBMT with a nozzle was performed in a continuous, modulated mode of operation in the red optical range, with a wavelength of 0.63 microns and with a radiation power of 8 MW. The heads were installed in both halves of the nose for 2 minutes (the device "LAZMIK-01", Russia).

2.3. HRV and pain syndrome analysis.

To assess heart rate variability (HRV), a daily Holter electrocardiogram (ECG) was recorded using MT-200 devices (Schiller, Swiss). The ECG recording system was installed in patients 30 minutes before septoplasty and removed 24 hours after it. The parameters of HRV in the frequency range were studied – low frequencies (LF, ms2), ultra-low frequencies (ULF, ms2), high frequencies (HF, ms2) and total power (Total power, ms2).

Pain syndrome was assessed using a visual analog scale [5] (Fig.1) 1, 3, 6, 12, 24 and 48 hours after septoplasty, and in group 2 immediately after laser therapy sessions. Patients were asked to place a vertical line or dot at the point on the scale that they thought corresponded to the pain they were experiencing. The scale length was 100 mm. The intensity of pain was measured in mm.

Figure 1. Visual-analogue scale for assessing the intensity of acute pain syndrome.

2.4. Statistical analysis.

All statistical data processing was performed using the HASP software package, version 0.14.0 (University of Amsterdam, The Netherlands) for Windows®. Continuous variables (pain magnitude, LF, ULF, HF, Total power) were presented as the mean±error of the mean (M±SE) and analyzed using the t-test of independent samples after checking normality using the Shapiro-Wilk test. Normally distributed data were evaluated using the Student's t-test of independent samples, and abnormally distributed data were evaluated using the Mann-Whitney U-test. The values of $p<0.05$ were considered statistically significant.

3. Results

3.1. Heart rate variability.

After the PBMT sessions, the ultra-low frequency component of HRV spectral analysis was significantly lower in the 2nd group (8086±3003 ms2), compared with the first (18580±2067 ms2) ($p<0.001$) (Fig. 2a). The low-frequency component of HRV was significantly higher in the 1st group (1871±405 ms2), compared with the 2nd (1095±190 ms2) ($p<0.005$), which indicates an increase in the tension of the sympathetic part of the ANS in the group without the use of PBMT (Fig. 2b). Based on the analysis of the high-frequency component of HRV, a decrease in the activity of the parasympathetic nervous system during the perioperative day was also recorded in the 2nd group as a whole – 1157±220 ms2 versus 1630±263 ms2 in the 1st group ($p<0.01$) (Fig. 2b). In group 2, the total HRV power was significantly lower (13498±3226 ms2) than in group 1 (26808±2371 ms2) ($p<0.001$) (Fig. 2g). In the third group, the total power (9502±2508 ms2), the ultra-low-frequency component (4722±1595 ms2), the low-frequency component (664.57±156.61 ms2) and the high-frequency component (899±135 ms2) were significantly lower than in the second group ($p<0.01$).

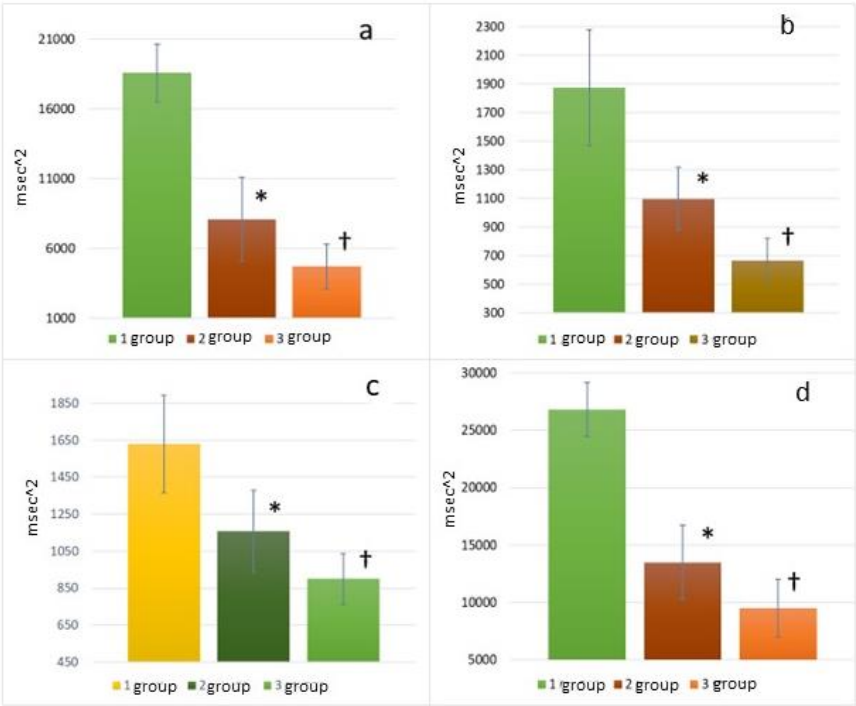

Figure 2. Changes in the frequency of heart rate variability with the use of PBMT after septoplasty and without it: a-ULF, b-LF, c-HF, d-Total power. The error bars indicates standard error.

3.2. Pain syndrome.

In the first 3 hours after surgery, the intensity of pain severity did not differ between the groups ($p=0.07$). In group 1, the intensity of pain increased after 6 hours compared to 3 hours after

surgery, but no significant difference was recorded (p=0.01). After 6 hours in group 2, the intensity of the pain syndrome began to decrease compared to the previous period (p<0.05) (Fig. 3). Patients of group 3 experienced pain significantly lower than patients of group 2 from the 3rd hour after surgery (Fig. 3, Table. 1). Further, the pain syndrome continued to decrease in all groups and 48 hours after septoplasty, patients did not feel pain. At the same time, in the period from 6 to 24 hours after surgery, group 1 patients experienced pain significantly higher than patients with PBMT and a combination of PTMT and Respiro Myrtol forte (p<0.001) (Fig. 3, Table 1).

Table 1. Intensity of acute pain syndrome after septoplasty.

Time after surgery	1 hour, mm	3 hours, mm	6 hours, mm	12 hours, mm	1st day, mm	2nd day, mm
1 group	17,15±2,46	21,82±2,83	25±2,02	21,64±2,36	16,68±1,01	3,68±1,01
2 group	14,16±2,31	18,88±2,45	16,43±2,08	12,83±2,38	10,84±1,15	3,84±1,15
3 group	10,33±1,99	15,31±2,43	11,75±2,14	10,012,06±	3,44±0,98	2,55±1,96

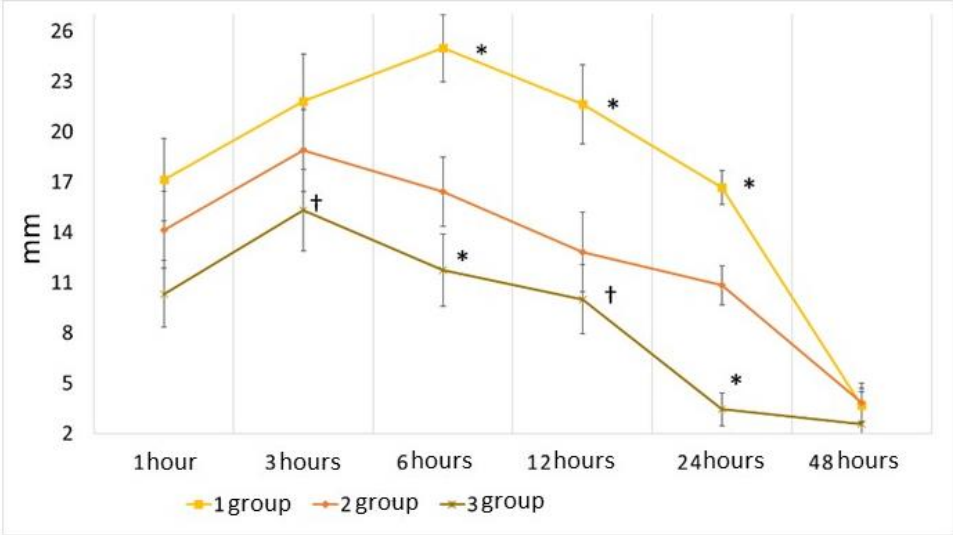

Figure 3. Intensity of pain syndrome after septoplasty. * – significant differences between groups at p<0.001, † – significant differences between groups at p<0.01.

4. Discussion

It is known that removal of tampons is advisable no later than 2 days after surgery, when the inflammatory processes decrease and at the same time the restoration of the mucous membrane begins, normalization of blood supply to cartilage and bone tissues [1, 2], therefore, we considered it important to use PBMT during the first 2 days. In the available literature, we have not found any works where PBT would be performed in patients after septoplasty with intra-nasal tampons and with a high frequency of therapy sessions on the first day after rhinosurgical interventions.

The generally accepted theory of the mechanism of biological effects of PBM is the absorption of light by chromophores [18]. PBMT leads to the following effects: reduction of edema and inflammation, reduction of pain, collagen synthesis, increased elasticity, increased tissue perfusion and increased tissue vascularization, increased cell proliferation, especially fibroblasts, which generally leads to the restoration of damaged tissues [7]. Recent studies have shown that PBMT is effective in various conditions from diabetic foot to androgenic alopecia and mucositis after chemotherapy, as well as in wound healing and inflammation [8, 9, 18-20]. PBMT can play a role in reducing the number of new hemorrhages after surgical interventions in the maxillofacial region. At the same time, PBMT is positioned as a new alternative to other interventions since it is an easy-to-use and minimally invasive method [7].

Hersant et al. the effect of a low-intensity laser on the results of flap survival in facial plastic surgery was evaluated. The authors have shown that PBMT promotes higher survival of the flap, accelerates wound healing [20]. Enwemeka et al. It was found that PBMT with high efficiency promotes the restoration of damaged tissues during all three phases and reduces pain syndrome [22].

The effects of PBMT described above, especially the restoration of damaged tissue and neovascularization, provide a reduction in edema and inflammatory reactions, a decrease in the likelihood of hemorrhage [7] and, consequently, pain in the tissue after septoplasty. With the intranasal application of laser therapy, systemic effects are also achieved through cells and blood components [23], which can probably contribute to a positive neurotherapeutic effect [24]. The tissues around the nasal cavity have an abundant blood supply with relatively slow blood flow. It has been shown that PBMT improves blood rheology [25], reduces blood viscosity [25] and improves blood clotting status [27] in various pathological conditions. In group 2 patients, a significantly lower intensity of pain syndrome, a decrease in power compared to group 1 patients, indicates relatively low inflammatory reactions from the blood system in the damaged area after the use of PBMT [28].

In patients with the use of PBMT, HRV indicators had significantly lower overall power compared to patients without laser therapy. Thus, an ultra-low frequency component, which is often associated with circadian rhythms [29]. An increase in ULF power indicates a failure of circulatory rhythms because of surgical traumatization against the background of inflammatory phenomena in the group without the use of PBMT. The high-frequency component (HF) component of HRV shows the tone of the parasympathetic nervous system, while LF, according to a number of authors, can reflect both sympathetic (mainly) and parasympathetic tone [30]. The decrease in LF and HF after septoplasty with the use of PBMT reflects a decrease in sympathetic and parasympathetic tone after correction of IPN. The shift in the balance of the ANS towards its sympathetic component is physiologically justified and corresponds to the degree of severity of stress factors. However, an increase in the tone of the parasympathetic nervous system under stress may indicate an inadequate response of the body and correspond to [31], which may reflect the degree of surgical damage in the maxillofacial region [32]. Thus, it has been shown that after LF septoplasty, HRV can decrease sharply [30]. In our study, in a group of patients with the classic variant of postoperative rehabilitation, the activity of both the sympathetic and parasympathetic parts of the ANS was increased. Studies have shown a relationship between blood rheology, cognitive functions [28] and mood improvement [33]. It has been suggested that the systemic effects of PBMT after blood irradiation may also ultimately have a neuroprotective effect [24, 34, 35]. It is also known that intranasal blood irradiation has the same neurological consequences as intravenous or intravascular PBMT [36]. These facts may also give an understanding of a lower pain syndrome, smaller changes in the balance of the ANS in response to surgical damage after septoplasty in patients with the use of PBM in the early postoperative period.

Surgical traumatization of the nasal septum inevitably leads to secondary infection of the nasal cavity [37]. In addition to bacteria, fungal invasion can also occur [38, 39]. The European Society of Rhinologists recommends the use of phytopreparations in the complex treatment of acute bacterial and viral infections in the nasal cavity and paranasal sinuses [40]. The components of Respiro Myrtol forte have both antibacterial and antimycotic effects, improve the activity of the cilia of the pseudomonas epithelium lining the nasal cavity [41]. In a study in which patients were given standardized ivy leaf extract syrup along with nasal flushing, a statistically significant smaller number of nasal secretions was reported compared to those who were only flushed with saline solution. In addition, an endoscopic examination of the nasal cavity on the sixth day after removal of the nasal tamponade showed a statistically significant lower number of nasal secretions in patients who were injected with standardized ivy leaf extract syrup along with nasal rinsing. A statistically positive correlation was found between the subjective assessment of nasal secretion by the patients themselves and the results of nasal endoscopy. In the group that underwent only nasal lavage, five patients required antibacterial therapy on the sixth day after the removal of tampons. In the group receiving standardized dry ivy leaf extract, antibacterial therapy was not required. This difference was statistically significant [41]. The guideline for the introduction of antibacterial therapy was the appearance of a purulent secretion in the nasal cavity along with an increased body temperature (more than 38 °C) and a feeling of pain or pressure in the face area, more often on one side [42]. P. Federspil et al. using the example of treatment of acute non-purulent rhinosinusitis with secretolytic myrtol and vasoconstrictor xylometazoline for 6 days, it was shown that there was a significant decrease in mucus secretion, compared with the group that received placebo together with a vasoconstrictor [43]. In the myrtol group, 7.3% of patients needed antibiotic therapy, while in the placebo group, antibiotics therapy was required in 12.6% of patients. Tarantino et al . the advantages of secretolytic administration compared to placebo in eliminating nasal secretion in patients with rhinosinusitis have been reported, while Z. Szmeja et al. it was confirmed that secretolytic administration together with standard therapy shortens the duration of

recovery in patients with rhinosinusitis [44, 45]. P. Federpil et al. [46] studied the efficacy of myrtol, an herbal extract from essential oils, as a therapeutic alternative for acute rhinosinusitis (n = 331), compared with placebo and other essential oils. The results showed a statistically significant improvement and decrease in the total number of rhinosinusitis symptoms in the standardized myrtol group and the group of other essential oils, compared with placebo, after 14 days (10.5 vs. 9.2 points) with no difference between myrtol and other essential oils. The decrease in the intensity of the pain syndrome, the low power of HRV indicators in patients of group 3, compared with group 1, confirm the effectiveness of the strategy of comprehensive rehabilitation of patients in the postoperative period who underwent septoplasty.

5. Conclusions

Accordingly, the use of FBMT in combination with Respiro Myrtol forte in the postoperative period after septoplasty against the background of nasal tamponade helps to minimize pain syndrome, reduce inflammatory processes in surgical damage, and, consequently, less pronounced changes in the autonomic nervous system in response to surgical stress.

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