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EFFECTS OF LOW-FREQUENCY ULTRASOUND ON THE NASAL AND PARANASAL SINUS MUCOSA IN CHILDREN WITH ACUTE BACTERIAL RHINOSINUSITIS.

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Annotation.

This article examines the effect of low-frequency ultrasound on the nasal mucosa and paranasal sinuses in children suffering from acute bacterial rhinosinusitis. Acute bacterial rhinosinusitis is a common disease in children, which is characterized by inflammation of the nasal mucosa and paranasal sinuses. The article describes the method of using low-frequency ultrasound for the treatment of this disease in children. The study is based on the observation of patients who were treated with low-frequency ultrasound, and an assessment of its effect on the condition of the mucous membrane of the nasal cavity and paranasal sinuses. The results of the study allow us to conclude about the potential effectiveness of using low-frequency ultrasound in the treatment of acute bacterial rhinosinusitis in children. This technique can help reduce inflammation, improve drainage and relieve symptoms of the disease. In general, the article represents an important contribution to the field of treatment of acute bacterial rhinosinusitis in children and can serve as a basis for further research and development of effective methods of treatment of this disease.

Keywords: children, acute bacterial rhinosinusitis, mucous membrane, paranasal sinuses, low frequency ultrasound

Currently, the management of acute rhinosinusitis involves a combination of approaches, as outlined in both international guidelines (EPOS-2007, EPOS-2012) and Uzbekistan's healthcare standards [1, 2, 3]. Despite varying recommendations, the predominant method for treating acute bacterial rhinosinusitis in Uzbekistan and many other countries within the Commonwealth is puncture-based evacuation of purulent material from the affected sinus. Punctures are carried out strictly when indicated and in the presence of mucopurulent discharge within the affected sinus, which can limit the use of comprehensive pathogenetic therapy [1, 2, 4, 5].

In pediatric practice, some researchers have observed that rhinosinusitis is most frequently diagnosed in children under 10 years old (82%) [1, 6]. During this age range, the sinuses are developed but relatively small in size, making puncture of the affected sinus potentially risky. Additionally, various saline solutions, " YAMIK-catheters," and other methods are employed as part of comprehensive sinusitis therapy. The underlying principle for their usage is the manipulation of fluid dynamics to create negative pressure in the nasal cavity, thereby facilitating sinus ventilation and drainage [1, 2, 6]. The development of minimally invasive techniques for treating bacterial rhinosinusitis is of paramount importance. In recent times, natural and artificially generated physical factors have gained significance. One such factor is low-frequency ultrasound, which is employed both as an independent physiotherapy modality and for creating an ultrasonic cavitation environment. This medium modifies the properties of the solution, optimizing and enhancing treatment effectiveness [7, 8].

Low-frequency ultrasound exposure results in a combination of mechanical vibrations, physico-chemical interactions, neuroreflective effects, and the release of heat in tissues due to ultrasound absorption. The primary effect of low-frequency ultrasound, cavitation, leads to the destruction of bacteria, fungi, and viruses within the ultrasonic field. Microvibrations generated during the "voicing" of the solution provide micro-massage at cellular and subcellular levels, promoting improved microcirculation processes and increased cell membrane permeability [9, 10].

Ultrasound exposure, combined with the administration of a drug solution, allows for achieving therapeutic effects using significantly lower drug doses and reduces the risk of potential side effects associated with other methods of drug administration [11].

Despite the advantages and disadvantages associated with low-frequency ultrasound rehabilitation of the nasal cavity and paranasal sinuses, the full implementation of this technology in the management of acute bacterial rhinosinusitis in children has not yet been realized.

PURPOSE.

The aim of this study is to improve the effectiveness of treatment of children with acute bacterial rhinosinusitis by using low-frequency ultrasound.

MATERIALS AND METHODS.

The research was conducted at the Children's Ear, Nose, and Throat (ENT) Department of Bukhara State Medical Institute in the city of Bukhara. The study involved a total of 109 children aged between 5 and 17 years, all diagnosed with acute bacterial rhinosinusitis. These patients were randomly divided into two groups: the main group and the comparison group.

The main group comprised 54 patients, consisting of 29 (53.7%) boys and 25 (46.3%) girls, with an average age of 11.04±0.3 years. In contrast, the comparison group included 55 patients, comprising 28 (50.9%) boys and 27 (49.1%) girls, with an average age of 10.64±0.4 years.

Patients in the main group received comprehensive treatment that involved the use of low-frequency ultrasound, while patients in the comparison group received comprehensive treatment following the conventional method of nasal cavity sanitation. Low-frequency ultrasound was delivered using the FOTEK AK101 device using 0.9% saline solution.

Acute bacterial rhinosinusitis is an inflammation of the nasal mucosa and paranasal sinuses caused by a bacterial infection. The comprehensive examination described in the text was conducted to verify this diagnosis.

The survey included the following procedures:

Analysis of patient complaints, clinical symptoms, and medical history: The physician conducted a comprehensive assessment to ascertain the nature of patient complaints, symptomatology, and their prior medical conditions.

Objective examination: This encompassed the utilization of nasal cavity endoscopy for visual evaluation of the mucous membrane condition and the identification of inflammatory signs. Additionally, computed tomography of the paranasal sinuses was conducted to detect structural alterations within the sinuses.

Laboratory techniques: These comprised a comprehensive clinical blood test, determination of immunoglobulins of classes A, M, and E, cytological analysis of nasal mucosa smear prints, and assessment of the microbial composition within the middle nasal passages. These analyses were employed to identify markers of inflammation and pinpoint the causative infectious agents.

Evaluation of ciliary epithelium transport activity within the nasal mucosa using the "saccharin test": This test quantified the time taken for saccharin placed in the nasal cavity to reach the posterior nasal wall, facilitating an assessment of ciliary epithelium function.

Furthermore, patients underwent examinations by a pediatrician and other specialists as needed to rule out alternative potential causes of their symptoms.

A 20- item SNOT-20 questionnaire was employed to evaluate patient symptoms. Following questionnaire administration and data analysis, subjects displaying low symptom intensity (scoring less than 1 point) during the pre-treatment phase were excluded from the study. This resulted in 10 remaining points, which were subsequently assessed using a 5-point scale.

Determination of disease severity followed international guidelines (EP3OS 2007, 2012) employing a 10-cm visual analog scale (VAS). Scores ranging from 0 to 3 cm (points) indicated mild disease severity, while scores from 4 to 7 points suggested moderate severity, and scores from 8 to 10 points indicated a severe form of the disease.

The study included children aged 4 to 16 years with an established diagnosis of acute bacterial rhinosinusitis, lasting at least 10-14 days. Patients had to give informed consent and be compliant (follow the prescribed treatment).

The exclusion criteria were as follows: children under 4 years of age, the presence of acute and / or chronic diseases that could affect the results of the study, violations of the architectonics of the bone structures of the nose (for example, curvature), severe and/ or complicated course of acute bacterial rhinosinusitis, as well as patient incompetence (non-compliance with prescribed treatment).

During the study, all patients received complex treatment, including protected aminopenicillins or cephalosporins of the third generation, antihistamines (in the presence of concomitant histamine- induced processes) and nasal decongestants.

In the comparison group, local therapy was performed by washing the nasal cavity, paranasal sinuses and nasopharynx using a nasal shower using 50 ml of saline solution.

In the main group, patients received sanitation of the nasal cavity and paranasal sinuses by cavitated low-frequency ultrasound using NaCl0.9% NaCl solution and FOTEK AK101 device.

The effectiveness of the therapy was evaluated by the dynamics of the intensity of nasal symptoms. For statistical data processing, the SPSS version 16 program was used.For interval data, the average, median, standard error of the

average, minimum, and maximum were calculated. For nominal data, frequencies and percentages of the group's total volume were specified. Parametric tests (Student's t- test) and nonparametric tests (Mann- Whitney test for unpaired observations, Wilcoxon testfor paired observations) were used to compare the mean values.

RESULTS AND DISCUSSION

Table 1 shows that patients were distributed according to gender and age. Analyzing the complaints expressed by patients according to the SNOT-20 scale, the main symptoms were violation of nasal breathing, the presence of nasal discharge, the flow of discharge from the nose into the throat and coughing.

Table 1.

Distribution of patients by gender and age groups

Group	Men	Women	Total	% in group	% of gender (total)
Comparison	28	27	55	50.9%	49.1%
Basic	29	25	54	53.7%	46.3%

Note: *The table shows data on the distribution of patients by gender in the "Comparison" and " Main" groups. Total indicates the total number of patients in each group. The group percentage reflects the proportion of patients of each gender within each group, and the percentage of gender reflects the proportion of patients of each gender relative to the total number of patients in the corresponding group.*

Evaluation of the rhinoscopic picture was carried out using a 4-point visual-analog scale, based on the observed signs. Hyperemia of the nasal mucosa, swelling of the lower nasal concha, purulent discharge from the middle nasal passages, and draining of the discharge along the back wall of the pharynx were noted in all patients during rhinoscopy. These data confirm the presence of a clinical- rhinoscopic complex characteristic of acute bacterial rhinosinusitis.

Analyzing the data of computed tomography scans before starting treatment, the following results were revealed in patients of both groups:

Unilateral darkening of the maxillary sinus with a clear horizontal level was diagnosed in 46 (42.2%) cases.

36 (33.02%) patients had darkening of the maxillary sinuses on both sides with a clear horizontal level.

27 (24.77%) patients had darkening of all sinuses on one side (maxillary, ethmoid, frontal, if developed).

The results of determining the microbial landscape are shown in Table 2.

Table 2.

Composition of microorganisms in the middle nasal passage in children suffering from acute bacterial rhinosinusitis

Pathogen	Number of patients	Percentage
of H. influenzae	27	24.8%
H. influenzae+Str. pneumonia	17	15.6%
Staph. aureus	12	11.0%
Str. pneumonia	49	45.0%
Str. pyogenes	4	3.7%

Note: *Pathogens are listed in descending order of their prevalence among patients with acute bacterial rhinosinusitis.*

The following was observed in cytological smears-prints:

There is an increase in the number of neutrophils, an abundant growth of bacterial microflora and a minimal number or absence of lymphocytes, which indicates the presence of an acute bacterial process.

Inhibition of transport activity of the ciliated epithelium was established. The saccharin test time increased to 15.39-18.59 minutes, averaging 17.44±0.34 minutes.

When analyzing the immunological reactivity of the body in children from both groups, an increase in the concentration of immunoglobulins of class A (4.2±0.12 g/l in the main group and 4.3±0.14 g/l in the comparison group) and class M (2.5±0.12 g/l and 2.3±0.10 g / l, respectively; $p<0.05$).

On the third day of treatment of patients of the main group who underwent nasal cavity sanitation by cavitated low-frequency ultrasound with 0.9% saline solution using the FOTEK device, a more pronounced positive dynamics of the main clinical symptoms was observed compared to the comparison group. In the main group, there was a significant improvement in nasal breathing (1.8±0.7 points), while in the comparison group, this indicator was 2.6±0.7 points; a decrease in nasal discharge by patients in the main group was 1.5±0.8 points, and in the comparison group 2.04±0.9 points; there was practically no discharge flowing down the back wall of the pharynx in the main group, and was 0.9±0.8 points, and in the comparison group, this indicator was at the level of 1.6±0.1 points; the presence of cough was almost the same in both groups: in the main group-0.4±0.7 points and in the comparison group-0.5±0.8 points. There was also a positive trend in restoring the time of transport activity of the ciliated epithelium. Compared to the first day, patients in the main group had a decrease in the saccharin test time by 6.19±0.1 minutes, and in patients in the comparison group-by 5.05±0.1 minutes [11.12.13.14.15].

From the presented data, it follows that by the end of the course of treatment (on day 6), both groups of patients showed a significant improvement in their condition. In the main group of patients, nasal breathing was almost completely restored, there was no discharge from the nose, draining of discharge into the pharynx and coughing. In the comparison group, there was also a positive dynamic of recovery of nasal respiration and reduction of nasal discharge, but positive changes in the indicator стеканияof discharge flow along the posterior pharyngeal wall were noted only in 2 cases (3.6%).

By the end of the course of treatment, there was also a recovery in the transport activity of the ciliated epithelium, and this recovery was statistically significantly higher in patients of the main group compared to the comparison group.

In patients from the main group, the effect of treatment was achieved already on day 3, while in patients from the comparison group on day 3, there was no obvious turning point.

According to the data obtained 30 days after the end of the main course of treatment, the comparison group showed an increase in the number of patients with worsening of clinical symptoms compared to the 6th day of the main course of treatment. Control computed tomography of the paranasal sinuses performed 1 month after treatment showed complete restoration of pneumatization of the paranasal sinuses in most patients in both groups, but a clearer restoration of the structure of the paranasal sinus mucosa was observed in patients of the main group compared to the comparison group.

Conclusion.

In conclusion, the results of the study indicate that the method of using cavitated low-frequency ultrasound solutions is effective in the complex treatment of rehabilitation of the nasal cavity and paranasal sinuses, as well as in acute bacterial rhinosinusitis in children. The observed significant improvement in patients ' condition, including restoration of nasal respiration, reduction of nasal discharge, and positive dynamics of restoration of ciliated epithelial transport activity, confirms the effectiveness of this method.

In addition, the results of control computed tomography show complete restoration of pneumatization of the paranasal sinuses in most patients, especially in the main group, indicating a positive effect of the method on the structure of the paranasal sinus mucosa.

Thus, the method of using cavitated low-frequency ultrasound solutions deserves consideration and application in clinical practice in the treatment of children with acute bacterial rhinosinusitis and rehabilitation of the nasal cavity

and paranasal sinuses. Further research and clinical observations may help to better assess the effectiveness and potential of this method.

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