PharmacologyOnLine
Archives • 2021 • vol.3 • 652-662

A METHOD OF INCREASING THE EFFECTIVENESS OF ANTIBACTERIAL THERAPY WITH CEFTRIAXONE IN THE COMPLEX TREATMENT OF INFLAMMATORY DISEASES OF THE MAXILLOFACIAL AREA IN CHILDREN

Viktor Shevchuk, Nataliia Odushkina, Yuliia Mikulinska-Rudich, Viktoriia Mys, Rozana Nazaryan*
Kharkiv National Medical University, Nauki 4, 61022, Kharkiv, Ukraine

*rosnazaryan@gmail.com

Abstract

Assessment of the results of treatment of 100 patients with odontogenic purulent-inflammatory diseases revealed a pronounced positive result when used in the complex treatment of intratissue electrophoresis of ceftriaxone. The proposed method promotes faster normalization of the general condition, reduces the symptoms of endotoxicosis, creates long-term therapeutic concentrations of the antibiotic in the area of inflammation and accelerates healing of purulent wounds. Normalization of the main laboratory indicators of inflammation also occurs faster, significantly affecting the duration and quality of treatment.

Keywords: *children, intratissue electrophoresis, ceftriaxone, odontogenic inflammatory diseases, maxillofacial area*

Introduction

Inflammatory diseases of the maxillofacial area (MFA) are the most common disorders localized in this zone [1, 2]. In addition to the constant increase in the number of patients, a number of researchers describe a tendency to an atypical clinical course, which causes some difficulties in diagnosis and timely adequate treatment. Insufficient effectiveness of treatment is also due to the emergence of resistant microflora due to irrational antibiotic therapy, low social standard of living, which leads to untimely treatment and deterioration of the immune system [3, 4]. In childhood, the course and treatment of inflammatory diseases is complicated by the peculiarities of histomorphological and functional development of the body at different ages [5, 6].

Treatment of inflammatory processes at the present stage is a complex measure that involves an active impact on all components of the abnormal process [7, 8]. However, the use of antibacterial therapy remains the main link. Moreover, preference is given to the simplest and most effective ways of its administration [9], creating the highest and longest concentrations of drugs in the area of inflammation [10, 11].

Traditional methods of antibacterial therapy are not without drawbacks, including toxic and allergic effects on the body as a whole, adverse effects on the excretory organs (liver, kidneys, bladder, intestines), inflammatory infiltrates and abscesses when administered intramuscularly, development of antibiotic resistance [12, 13]. In addition, being distributed throughout the body, therapeutic concentration of antibiotics does not become sufficient in the area of inflammation and its effectiveness is also reduced due to local acidosis [14].

Therefore, the search for alternative methods of antibacterial therapy is relevant at the present stage. This can be achieved by the combined use of antibiotics with a simultaneous local effect on the postoperative wound of galvanic current (intratissue electrophoresis).

The purpose of our study was to study the effectiveness of intratissue electrophoresis of ceftriaxone in the complex treatment of odontogenic inflammatory diseases of the MFA.

Methods

Clinical studies are based on examination and comparative analysis of the results of comprehensive treatment of 100 children with acute odontogenic inflammatory diseases of the maxillofacial area aged 2 to 17 years.

All patients underwent surgical dissection of the purulent center, washing it with antiseptic solutions and subsequent drainage with rubber tubes, as well as extraction of the tooth, which caused the development of the disease. Patients were prescribed ceftriaxone, general tonic and physiotherapy. Taking into account the severity of the disease, patients were prescribed detoxification and antipyretic therapy.

Subsequently, due to differences in the routes of administration of the antibacterial drug, all patients were divided into two groups. In the first group of patients (control), amounting 59 subjects, the daily dose of the antibiotic (ceftriaxone) was administered intramuscularly or intravenously twice.

In the second group of patients (main), amounting 41 subjects, the daily dose of the antibiotic (ceftriaxone) was administered once intravenously by intratissue electrophoresis (ITEP). Cutaneous plate electrodes were fixed so that the postoperative area was located in the interelectrode space. The daily dose of ceftriaxone, calculated according to the patient's weight and diluted in 100 ml of 0.9% sodium chloride solution, was administered intravenously. After infusion of ½ of the mixture volume, the inflammation zone was galvanized for 40 minutes. The course of treatment comprised 3-5 sessions, which were held once a day. Antibacterial therapy in both groups lasted 5-8 days.

Assessment of the effectiveness of ITEP involved a number of clinical and laboratory research methods: determination of the time course of pain on a visual analogue scale (VAS) [15]; cytological and microbiological analysis of purulent wound cleansing [16, 17]; evaluation of planimetric indicators; intra-wound temperature (IWT); criteria for assessing endogenous intoxication (leukocyte intoxication index (LII), the level of molecules of

medium weight (MMW) [18, 19]. The studies were performed on days 1, 3 and 5 of treatment. Statistical processing of the results was performed using the Student's t test. The pairwise correlation coefficient was used to determine the relationship between quantitative traits.

Results

The study showed that the microbial landscape of the wound was mainly represented by facultative aerobic flora [20]. A significant proportion was represented by monocultures of coccal flora, the major part of which were golden, epidermal, and purulent streptococci. Two-component *S.aureus* and *S.pyogenes,* as well as *S.aureus* and *S.epidermidis* predominated among the associations of microorganisms.

The study of microorganisms showed that the isolated strains had a pronounced sensitivity to ceftriaxone. This is especially true of staphylococci, which have shown 100% sensitivity to the drug. The obtained results led to the use of this antibiotic in the treatment of odontogenic inflammatory diseases.

Assessment of the time course of purulent wound cleansing in patients with odontogenic purulent-inflammatory diseases showed a qualitative result in patients of the main group. It was found that wound cleansing in 45.9% (Table 1) of patients in the main group occurred on the 2nd day, on the 5th day in 100% of patients, whereas in patients of the control group, these figures were 18.2% and 95.5% respectively (Fig. 1).

Evaluation of pharmacodynamics of the antibiotic (ceftriaxone) in the saliva of patients of both observation groups showed that the use of intratissue electrophoresis of ceftriaxone in the treatment of inflammatory diseases of the MFA increased its concentration in saliva by 2-5 times compared to other routes of antibiotic administration.

Statistical processing of the obtained data revealed a significant difference in the concentration of antibiotic in the saliva of patients of the main group in comparison with the control, and this difference was stable throughout the observation period. Thus, the use of ITEP in the complex treatment of inflammatory diseases of the MFA contributed to the creation of constant therapeutic concentrations of the drug in the center of inflammation, accelerating the rate of purification of the purulent wound.

In order to comparatively assess the processes of purulent wound regeneration in patients of the control and main groups, we conducted a planimetric and cytological examination of the wound. It has been demonstrated that the use of ITEP of antibiotics in the complex therapy of odontogenic inflammatory processes stimulates reparative processes in the form of faster changes in the phases of the wound process.

Physical examination of the purulent wound on the first day of the study showed no significant differences in patients of both groups: there were hyperemia and edema of the wound tissue, pronounced density and tenderness on palpation of the wound edges, moderate purulent exudation of the wound and purulent-necrotic plaque on the walls and fundus of the wound. However, during treatment, the macroscopic picture of the wound in patients of the main group was characterized by pronounced processes of purification, repair and epithelialization. Thus, on the 3rd day of the study, a small amount of serous-purulent exudate and a thin layer of fibrin were determined only on the wound walls. There were single granulations on the fundus of the wound. On the 5th day, there was a contraction of the wound edges and a pronounced growth of the granulation wound.

Patients of the control group on the 5th day still had slight redness and infiltration of the wound edges, which remained compacted, but painless. A small amount of serous exudate was discharging from the wound. Signs of the third phase of the wound process were poorly represented in the form of a single growth of granulation tissue, bleeding easily when touched.

The macroscopic characteristics of the purulent wound were confirmed by planimetric examination. Contraction rate in patients of the main group was found to be higher than in patients of the control group during the entire observation period.

Analysis of the time course of the main laboratory parameters also confirmed the advantage of using

intratissue electrophoresis of ceftriaxone in the complex treatment of inflammatory diseases of the MFA (Table 2). In the main group, the decrease in LII and segmental neutrophils occurred on the 3rd day of postoperative treatment. Similarly, a normalization of the number of lymphocytes in patients of the main group occurred in the direction of their increase. The level of MMW on the 5th day of treatment was significantly lower compared to the first day, in contrast to the control group, where this figure decreased slightly during the study period.

Discussion

Since antibiotic therapy is a vital part of management of odontogenic infections, this will guide in providing adequate empirical antibiotics including Ceftriaxone (3rd generation cepholosporin) [21]. This will reduce mortality and morbidity associated with inflammation of maxillofacial area. Antibiotics are often prescribed in a manner that is schematic and unreasonable (on patient's request), particularly, in viral infections or fever of unknown aetiology, which results in greater number of unfavorable complications [12, 22]. So, detection of nature of pathological process should be primary [23, 24] in management of patients with inflammatory diseases of the maxillofacial area [25, 26].

Indicative results of our study is the characteristic of the difference in changes in the cellular composition of the wound at different stages of treatment in the form of reduction of alternative and exudative disorders in patients of the main group, the formation of cellular diferons characteristic of the proliferation phase (epithelial cells and fibroblasts). The analysis of smears-imprints of both groups on the 5th day of treatment revealed that in patients of the main group the number of neutrophils during treatment was reduced by 2 times and lymphocytes by 3.1 times compared with patients in the control group. Most neutrophils in the smears of patients of the main group were characterized by complete phagocytosis, which indicated the purification of the wound from pathogenic microflora that is connected with previous study [27].

We analyzed pathogenesis of odontogenic inflammatory diseases of the MFA in children. There was a pronounced periodic dependence of odontogenic inflammatory processes on the age and sex of the child. Based on the study of the frequency of exacerbations, there were three age groups: from 3 to 8 years, from 8 to 11 years, and 12 years or more. The study showed that the periods of the maximum number of exacerbations of inflammatory diseases of the MFA occurred at the beginning of each age period, and the largest deviations of laboratory parameters from the norm were observed in the first two years of each age period. Accordingly, it can be assumed that the beginning of each age period corresponds to the most severe course of the disease, i.e., children aged 3-4, 8-9, 12-13 and 17 years are a "risk group" in the development of complicated forms of odontogenic inflammatory diseases of the MFA.

Periosteitis is more common in children under 8 years of age and phlegmons are more typical in children aged 8-12 years. The predominant involvement of the mandible was determined. The severity of the disease was determined by the volume and nature of presentation, general disorders (weakness, fever, intensity of pain), as well as local manifestations of the inflammatory process, such as tenderness on palpation, swelling, redness, dysfunction of the dental apparatus.

Evaluation of laboratory parameters on the first day of observation revealed that most of them were within normal limits. Above normal, on average, were indicators of leukocytes, segmental neutrophils and ESR. The intensity of the inflammatory process was also indicated by increased values of medium weight molecules and leukocyte intoxication index.

Some laboratory parameters have been linked to intra-wound temperature. Thus, the total body temperature was closest to normal while maintaining normal IWT, and increased with the deviation of IWT in the direction of lower and higher values. The scatter of values of indicators of blood increases both at the lowered, and at the raised IWT. Thus, both decrease and increase of IWT are an unfavorable sign of purulent inflammatory process.

It was found that the connections of blood parameters were obtained only for IWT and were not so clear for body temperature, i.e. they were caused by an abnormal inflammatory process in the maxillofacial area. This may be due to the degree of infection of the wound, the type of microflora and their toxic life products.

The study involved an assessment of features of a course of inflammatory process depending on the diagnosis. Patients with odontogenic phlegmon were found to have markedly elevated values of MMW and LII, indicating an acute onset of the disease, and a combination of high values of segmental neutrophils and the lowest values of lymphocytes. Almost all cases occurred during the cold season. In patients with phlegmon, the examination revealed a combination of normal values of IWT and an increased number of lymphocytes with a faster decrease in MMW. That is, the disease can be described as acute, not prone to recurrence, occurring secondary to a normal immune response.

Patients with odontogenic periosteitis of the jaws were usually found to have a moderate increase in the level of MMW and LII, with the maximum increase in the number of patients aged 3-4, 8, 12 and 17 years. The minimum mean age of patients was 7.2 ± 0.5 years, maximum IWT, maximum deviation of neutrophils (above normal) and lymphocytes (below normal). The decrease in the level of MMW during treatment was somewhat slower than in patients with phlegmon, which may be due to insufficient immune response to acute inflammation, which can trigger re-exacerbation of the inflammatory process.

Despite the lower level of MMW compared to patients with phlegmon and periosteitis, at the end of treatment the MMW values were higher than in other selected groups. Even in the case of initial consultation, we can assume that when diagnosing periosteitis there is an exacerbation of a chronic disease with a pronounced systemic component. In the case of periosteitis, especially at the age of 5, it may be a primary exacerbation, which, due to an imbalance of the immune response, can develop into a chronic process. Accordingly, the set of therapeutic measures should include methods aimed at maintaining the immune status of the body.

Patients with different diagnoses differed markedly by gender, age, and some clinical features. These differences need to be considered when evaluating the effectiveness of treatment methods. The dependence of odontogenic inflammatory diseases on the general condition of the body was also manifested in the fact that in most obese adolescents, high LII values were detected more often. The coincidence of the periods of exacerbation of odontogenic diseases with the periods of development of the child's body allows us to draw conclusions about their close relationship.

Characterizing the time course of changes in general condition, pain and volume of tissue edema, it should be noted that the restoration of these criteria was almost the same in both groups of the study. However, there was a tendency to faster normalization of the general condition and reduction of pain among patients in the main group. Already on the 3rd day of treatment, more than half of the children had the symptoms of endotoxicosis eliminated, and the pain indicators for VAS significantly decreased. Restoration of mandibular function and reduction of inflammatory tissue edema also occurred more rapidly in patients who underwent intratissue ceftriaxone electrophoresis in combination therapy.

The study showed that the gradual decrease in the level of MMW took place regardless of the method of treatment. However, in some patients the change in this indicator had its own characteristics. Based on the data obtained, patients were divided into three groups. The first group consisted of children who had low values of MMW at the beginning of treatment, which increased significantly at the end. In the second group, the values of MMW were moderately increased at the beginning of treatment, and significantly decreased by the end. In the third group at the beginning of treatment, the values of MMW were significantly increased, at the end of treatment decreased to a minimum compared to other selected groups.

Patients in the formed groups differed in clinical and laboratory parameters. A moderate increase in the MMW values at the beginning of the disease was shown to be a favorable sign for the further course of the disease. The values of MMW from 0.250 to 0.325 corresponded, on average, to a lower level of toxicity (LII), smaller deviations from the norm of the number of neutrophils and lymphocytes. A moderate increase in stab neutrophils (within normal limits) was also usually accompanied by a milder course of the disease.

The proposed method of treatment contributed to a faster normalization of the general condition, reducing the symptoms of endotoxicosis by neutralizing the effects of pathogenic microflora and their toxic life products. The latter was achieved by a targeted effect on the source of inflammation of the galvanic current, which contributed to the creation of elevated concentrations of the antibiotic and prolonged its therapeutic effect in the abnormal area. Due to the change in redistribution of the antibiotic in the body, the risk of allergic reactions was reduced, which was confirmed by a steady trend in reducing the number of eosinophils during treatment.

The use of a combined effect of antibiotics and galvanic current accelerated the healing time of a purulent wound. Normalization of the main laboratory indicators of inflammation was also faster, significantly affecting the duration and quality of treatment. There were no complications and chronicity of acute inflammatory processes during intra-tissue antibiotic electrophoresis in the study period.

Our study was limited by localization of patients in one region with overlooking possible influence of environment condition [28, 29] and harmful habits [30, 31]. So that study could be continued with modern methods of investigation [32].

Thus, the study of the findings indicated a pronounced positive result in the use of intra-tissue electrophoresis of antibiotics in the complex treatment of acute odontogenic inflammatory diseases in children in comparison with other routes of administration. The method is promising and can be recommended for widespread use in clinical practice.

Conclusions

1. The use of intratissue administration of ceftriaxone helped to reduce alternative and exudative disorders, which was manifested in a 2-fold decrease in the number of neutrophils, 3.1-fold decrease in the number of lymphocytes in comparison with traditional treatment.

2. In intratissue electrophoresis of ceftriaxone, purification of the purulent wound from pathogenic microflora on the 2nd day was observed in almost 50% of patients. Traditional antibacterial therapy helped to clean the wound in only 18.2% of patients on the 2nd day of treatment. The proposed method of treatment increased the concentration of ceftriaxone in saliva by 2-5 times and created long-term therapeutic concentrations of the drug in the inflammatory focus.

3. Clinical and laboratory study showed that intratissue electrophoresis of ceftriaxone significantly affected both the time course of the general condition and laboratory parameters, which was manifested in the normalization of clinical symptoms in more than 50% of patients on the 3rd day of treatment, a statistically significant decrease molecules of medium weight from 0.360 to 0.280 standard units ($p < 0.05$) on the 5th day of treatment, reduction in the number of segmental neutrophils, intoxication index (LII) from 2.01 to 1.07 standard units ($p < 0.05$) on the 3rd day of postoperative treatment.

Acknowledgments

This study is a part of the scientific research work "Optimization of early diagnosis, prevention and treatment of oral tissue diseases with smoking addiction", 0120U102057, Kharkiv National Medical University".

References

1. Taub D, Yampolsky A, Diecidue R, Gold L. Controversies in the Management of Oral and Maxillofacial Infections. Oral Maxillofac Surg Clin North Am. 2017;29(4):465-473. doi:10.1016/j.coms.2017.06.004

2. Polyvianna Y., Chumachenko D., Chumachenko T. Computer aided system of time series analysis methods for forecasting the epidemics outbreaks. 2019 15th International Conference on the Experience of Designing and Application of CAD Systems, CADSM 2019:1-4. doi: 10.1109/CADSM.2019.8779344
3. Ritwik P, Fallahi S, Yu Q. Management of facial cellulitis of odontogenic origin in a paediatric hospital. Int J Paediatr Dent. 2020;30(4):483-488. doi:10.1111/ipd.12613
4. Lajolo C, Favia G, Limongelli L, et al. Brain abscess of odontogenic origin in children: a systematic review of the literature with emphasis on therapeutic aspects and a new case presentation. Acta Otorhinolaryngol Ital. 2019;39(2):67-74. doi:10.14639/0392-100X-2281
5. Nechyporenko AS, Alekseeva VV, Sychova LV, Cheverda VM, Yurevych NO, Gargin VV. Anatomical prerequisites for the development of rhinosinusitis. Lek Obz 2020;6(10):334-338.
6. Nazaryan RS, Kryvenko LS, Gargin VV. The role of nitric oxide synthase in the modulation of the immune response in atopic disease. New Armenian Med J 2017;11(2):52-57.
7. Kovach I, Kravchenko L, Khotimska Y, Nazaryan R, Gargin V. Influence of ozone therapy on oral tissue in modeling of chronic recurrent aphthous stomatitis. Georgian Med News. 2017;(264):115-119.
8. Denga O, Pyndus T, Gargin V, Schneider S. Influence of metabolic syndrome on condition of microcirculatory bed of oral cavity. Georgian Med News. 2017;(273):99-104.
9. Leroy R, Bourgeois J, Verleye L, et al. Are systemic antibiotics indicated in children presenting with an odontogenic abscess in the primary dentition? A systematic review of the literature. Clin Oral Investig. 2021;25(5):2537-2544. doi:10.1007/s00784-021-03862-3
10. Lim SW, Lee WS, Mani SA, Kadir K. Management of odontogenic infection in paediatric patients: a retrospective clinical study. Eur Arch Paediatr Dent. 2020;21(1):145-154. doi:10.1007/s40368-019-00466-0
11. Al-Malik M, Al-Sarheed M. Pattern of management of oro-facial infection in children: A retrospective. Saudi J Biol Sci. 2017;24(6):1375-1379. doi:10.1016/j.sjbs.2016.03.004
12. Kon K, Rai M. Antibiotic Resistance: Mechanisms and New Antimicrobial Approaches. Antibiotic Resistance: Mechanisms and New Antimicrobial Approaches; 2016. p. 1-413.
13. Salama AH. Antimicrobial peptides synthesis and mechanism of action. Pharmacologyonline 2021;2:1404-1410.
14. Shepherd L, Borges Á, Ledergerber B, et al. Infection-related and -unrelated malignancies, HIV and the aging population. HIV Med. 2016;17(8):590-600. doi:10.1111/hiv.12359
15. Michael JA, Hibbert SA. Presentation and management of facial swellings of odontogenic origin in children. Eur Arch Paediatr Dent. 2014;15(4):259-268. doi:10.1007/s40368-014-0110-7
16. Weckwerth GM, Dionísio TJ, Costa YM, et al. CYP450 polymorphisms and clinical pharmacogenetics of ibuprofen after lower third molar extraction. Eur J Clin Pharmacol. 2021;77(5):697-707. doi:10.1007/s00228-020-03046-0
17. Ivannik VYu, Torianyk II, Moiseienko TM, et al. Antimicrobial Activity Derivatives 2Hpirano[2,3-c]piridines against Pathogens of Intestinal Yersiniosis. J Pharm Nutr Sci 2021; 11: 87-92.
18. Doll C, Carl F, Neumann K, et al. Odontogenic Abscess-Related Emergency Hospital Admissions: A Retrospective Data Analysis of 120 Children and Young People Requiring Surgical Drainage. Biomed Res Int. 2018;2018:3504727. Published 2018 Aug 26. doi:10.1155/2018/3504727
19. Heim N, Wiedemeyer V, Reich RH, Martini M. The role of C-reactive protein and white blood cell count in the prediction of length of stay in hospital and severity of

odontogenic abscess. J Craniomaxillofac Surg. 2018;46(12):2220-2226. doi:10.1016/j.jcms.2018.10.013
20. Popova TM, Kryvenko LS, Tishchenko OV, Nakonechna OA, Podrigalo LV, Nessonova TD, Gargin VV. Effect of Electronic Cigarettes on Oral Microbial Flora. J Pharm Nutr Sci 2021; 11(1):54-64
21. Adamson OO, Adeyemi MO, Gbotolorun OM, Oduyebo OO, Odeniyi O, Adeyemo WL. Comparison of sensitivity of bacteria isolated in odontogenic infections to ceftriaxone and amoxicillin-clavulanate. Afr Health Sci. 2019;19(3):2414-2420. doi:10.4314/ahs.v19i3.15
22. Orzechowska-Wylęgała B, Wylęgała A, Buliński M, Niedzielska I, Madej A. Pharmacoeconomic analysis of antibiotic therapy in maxillofacial surgery. BDJ Open. 2017;3:17002. Published 2017 Feb 10. doi:10.1038/bdjopen.2017.2
23. Gargin V., Muryzina I., Shcherbina N., Nechyporenko A., Baryshevska V., Vorobyova O., Alekseeva V. Relationship between bone density of paranasal sinuses and adrenal steroids pattern in women during menopausal transition. Anthropological Review. 2020;83(4):407–418. doi: 10.2478/anre-2020-0031
24. Pelchen-Matthews A., Ryom L., Borges Á.H., et al. Aging and the evolution of comorbidities among HIV-positive individuals in a European cohort. AIDS. 2018;32(16):2405-2416. doi:10.1097/QAD.0000000000001967
25. Nebogatov SS, Chulak LD, Shuturminsky VG, Chulak OL, Tatarina OV, Badiuk NS. Dental aesthetic inlay core – practical evaluation. Pharmacologyonline 2021;2:742-752.
26. Fesenko D, Glazunov O, Nakonechna O, Nazaryan R, Gargin V. Consequences of microsequences of microcirculatory distrurbances of oral mucosa in modeling of rheumatoid arthritis. Georgian Med News. 2019;(295):137-140.
27. Bondarenko AV, Pokhil SI, Lytvynenko MV, Bocharova TV, Gargin VV. Anaplasmosis: experimental immunodeficient state model. Wiad Lek. 2019;72(9 cz 2):1761-1764.
28. Ludwicki J.K., Góralczyk K., Struciński P., et al. Hazard quotient profiles used as a risk assessment tool for PFOS and PFOA serum levels in three distinctive European populations. Environ Int. 2015;74:112-118. doi:10.1016/j.envint.2014.10.001
29. Lenters V, Thomsen C, Smit LA, et al. Serum concentrations of polybrominated diphenyl ethers (PBDEs) and a polybrominated biphenyl (PBB) in men from Greenland, Poland and Ukraine. Environ Int. 2013;61:8-16. doi:10.1016/j.envint.2013.09.001
30. de Almeida AS, Kato CNO, Jácome-Santos H, Pinheiro JJ, Mesquita RA, Abreu LG. A retrospective analysis of oral and maxillofacial lesions in children and adolescents reported in two different services. J Clin Exp Dent. 2021;13(9):e894-e905. Published 2021 Sep 1. doi:10.4317/jced.58231
31. Nazaryan R, Kryvenko L, Zakut Y, Karnaukh O, Gargin V. Application of estimated oral health indices in adolescents with tobacco addiction. Pol Merkur Lekarski. 2020;48(287):327-330.
32. Krivenko S, Lukin V, Krylova O, Kryvenko L, Egiazarian K. A fast method of visually lossless compression of dental images. Appl Sci 2021;11(1):1-14.

Table 1. The concentration of ceftriaxone in saliva (μg / ml)

Time from the beginning of treatment, h	Patient group	
	Main (n=11)	Control (n=11)
1	0.18+0.08*	0.06+0.04
2	2.42+1.55*	0.48+0.25
3	2.20+1.62*	0.89+0.43
6	0.81+0.51*	0.43+0.23
12	0.40+0.25*	0.16+0.06
24	0.08+0.03*	0.05+0.02

*- significant difference of the indicator as compared with the control group

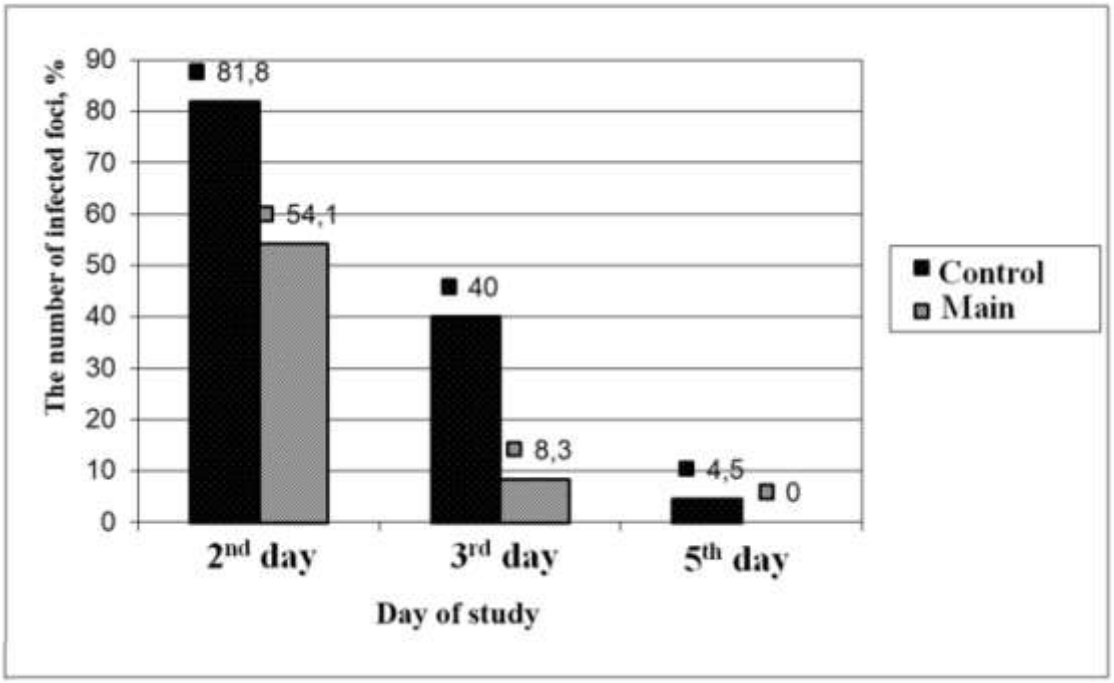

Figure 1. Time course of excretion of microorganisms from purulent foci in patients with odontogenic inflammatory diseases of the maxillofacial area

Table 2. Some laboratory parameters of patients of the main and control groups

Indicator		Groups					
		All patients		Phlegmon		Periosteitis	
		Main n = 41	Control n = 59	Main n = 16	Control n = 17	Main n = 25	Control n = 32
		1	2	3	4	5	6
Age, years	Day	8.9±0.7	8.9±0.5	11.3±0.8	8.9±1.1	5.0±1.2**	7.5±0.5
Hemoglobin	1	125±3	121±3	125±4	120±7	127±5	121±5
	5	124±2	128±3	124±3	127±4	125±4	133±4
Color indicator	1	0.85±0.008	0.84±0.006	0.85±0.012	0.84±0.011	0.85±0.016	0.84±0.008
	5	0.85±0.009	0.87±0.010^	0.84±0.012	0.86±0.011	0.87±0.019	0.89±0.018^
Leucocytes, 10^9/l	1	10.0±0.6	10.0±0.4	9.6±0.8	11.0±0.8	10.5±1.1	9.6±0.6
	5	7.1±0.4^	7.6±0.3^	6.9±0.4^	7.6±0.4^	7.0±0.8^	7.5±0.6^
Eosinophils, %	1	1.11±0.27	1.58±0.24	1.47±0.55	1.40±0.33	1.00±0.44	1.81±0.37
	5	1.42±0.27***	2.48±0.34^	1.41±0.32**	2.71±0.47^	1.33±0.47	2.36±0.62^
Stab, %	1	4.0±0.40	3.1±0.29	4.3±0.65	2.7±0.48	3.9±0.68	3.1±0.41
	3	3.2±0.28	3.3±0.23	2.9±0.30	3.4±0.33^	3.0±0.41	3.1±0.38
	5	3.2±0.21	2.7±0.25	3.1±0.23	2.5±0.38	2.9±0.42	2.6±0.36
Segmented, %	1	66.9±1.4	68.6±1.2	68.0±2.2	72.8±1.9	67.4±2.6	66.2±1.8
	3	59.1±1.4^	61.0±1.9^	61.6±1.4^	59.3±2.8^	53.8±2.3*^	64.9±3.1
	5	54.2±2.1^	55.5±1.9^	55.5±3.2^	55.1±2.6^	52.9±3.2^	53.2±3.2^
Lymphocytes, %	1	24.2±1.5	22.7±1.3	22.2±2.4	19.1±2.1	23.9±2.3	24.7±1.9
	3	32.5±1.5^	30.9±1.7^	30.4±1.5^	31.7±2.3^	38.0±26**^	28.2±2.9
	5	37.9±2.0^	35.7±1.8^	37.5±3.3^	35.9±2.4^	38.7±2.8^	37.6±2.9^
Monocytes, %	1	3.9±0.35	4.0±0.32	4.2±0.7	3.9±0.5	3.9±0.6	4.2±0.5
	5	3.0±0.36	3.7±0.34	2.7±0.29*^	3.6±0.40	2.9±0.56**	4.4±0.70
ESR, mm/h	1	9.4±1.4	8.0±0.9	9.1±1.5	11.1±1.9	6.4±1.6	6.9±1.0
	5	10.1±2.1	7.5±1.1	12.2±3.6	9.5±1.7	7.3±1.3**	4.2±0.52

LII	1	2.01±0.26	1.80±0.20	2.30±0.51	2.28±0.44	2.07±0.37	1.55±0.23
	3	1.07±0.16^	1.40±0.30	0.89±0.09^	1.21±0.27	0.76±0.10^	1.84±0.65
	5	0.81±0.08^	0.78±0.14^	0.83±0.09^	0.82±0.25^	0.72±0.14^	0.65±0.10^
MMW	1	0.36±0.019	0.33±0.010	0.39±0.036	0.34±0.025	0.34±0.25	0.32±0.011
	3	0.33±0.018	0.31±0.013	0.35±0.033	0.32±0.029	0.33±0.028	0.30±0.012
	5	0.28±0.009^	0.31±0.020	0.28±0.012*^	0.32±0.022	0.28±0.018^	0.31±0.044
IWT, degrees	1	36.7±0.19	37.0±0.16	36.5±0.21	36.7±0.36	37.4±0.19	37.2±0.13
	3	36.4±0.23	36.7±0.17	36.3±0.35	36.6±0.17	36.8±0.17^	36.9±0.12
	5	36.3±0.19^	36.3±0.27^	36.3±0.41	36.5±0.49	36.6±0.13^	36.7±0.29^

* p < 0.1; ** p < 0.05; (statistical significance of differences in indicators in the main and control groups)

^ p < 0.05; (statistical significance of changes in indicators during treatment in relation to the results of the study on the 1st day)