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Efficacy of Complex Preparation of the Oral Cavity for Orthopedic Treatment

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Keywords: surgical preparation; bone tissue; correction with medicines; autoplasma; osteotropic agents; bone regeneration; orthopedic treatment

Abstract.

The article describes a comprehensive approach to preparing patients with dentition defects living in unfavorable environmental conditions for orthopedic treatment as well as the importance of the comprehensive approach including advanced surgical preparation, wider application and proper selection of osteotropic agents, correction with medicines affecting bone tissue regeneration and the course of the postoperative period.

Problem statement and analysis of the recent research

Atrophy and deformity of the alveolar process and a portion occurring after tooth extraction and pathological processes not only delay, but also significantly complicate the orthopedic treatment. Our task is to maximally preserve bone tissue as well as to restore dentitions using teeth with some dystrophic changes in bone tissue in different areas. Over the past decade this problem has gained a lot of attention among scientists and new methods and materials find their application in dental practice.

On the basis of clinical and experimental studies there was determined the damaging effect of environmental factors and heavy metals compounds on the state of the dentofacial system. Considering the preparation of patients with the given pathology for orthopedic treatment it is advisable to use the combination of osteotropic agents and correction with medicines. In recent years, these problems have been solved by developing new surgical methods using materials being able to restore lost bone volume as well as to improve its regenerative property.

In oral surgery to restore lost bone defects of the alveolar process different osteotropic preparations of both synthetic and natural origin are widely used. Osteotropic bioceramics ("Biohran", "Kerhap", and "Capsept") having an obvious advantage over auto and homogenous bone grafts is often used (Tymofeiev AA, Tsysliuk VP, Blynova VP, 1998). The disadvantages of the latter include the complexity of their production and short-term storage as well as the complexity of their formation and fixation, limited use of their biomechanical properties (resistance to resorption) and the absence of biologically active substances. Due to slow resorption of osteotropic ceramics bone defect is gradually restored and filled with bone tissue. In resorption of hydroxylapatite in the focal area calcium and phosphate ions are released stimulating the processes of tissue regeneration and making ceramics bioactive.

The substitution of bone defects using synthetic hydroxylapatite stimulates the processes of osteoregeneration (Ornovskyi VP, Kurbatov SH, Slyvak ON, 1996). To restore the structure of the alveolar process in generalized periodontitis and bone defects due to odontogenic cysts demineralized freeze dried bone allografts and autotransplants are widely used. To obtain positive results of reparative osteogenesis when substituting bone defect calcium and phosphate ions are required. Therefore, it is important not only to restore the bone structure but also to enrich it with minerals, especially with calcium and phosphorus. Synthetic hydroxylapatite meets all these requirements being widely available and inexpensive preparation.

Synthetic hydroxylapatite is an analogue of the biological one; however, despite their resemblance in chemical structure and perfect biocompatibility there are some differences between synthetic and biological hydroxylapatite. To obtain positive final results preparations influencing the state of bone tissue, restoring bone tissue blood supply and having an effective osteotropic effect should be used (Nykolaiev AN, Tsekov LM, 2003).

Therefore, when selecting the strategy of pharmaceutical treatment structural and functional state of the osseous system is of great importance. In dentition defects with obvious destructive changes in bone tissue and periodontal diseases the study of activity of the bone remodeling processes is of great significance. Therefore, at the stages of selection of and preparation for orthopedic treatment we should attach great importance to pathogenetic treatment, especially when treating patients living in unfavorable environmental conditions.

The combination of preparations having antioxidant and adsorption properties which reduce the level of endogenous intoxication as well as osteogenesis-stimulating properties and the usage of adaptogens are of great practical importance.

Our research is a part of a wider research of the Department of Dentistry of Postgraduate Medical Education Faculty, IFNMU – "The Study of Oral Health among the Population of Western Ukraine and Development of Proposals for its Preservation and Improvement" (state registration

number 0107U004631). We have carried out experimental and clinical studies on a comprehensive approach to preparation of the oral cavity for orthopedic treatment.

***The objective** of the research was* to improve the effectiveness of preparing the oral cavity for orthopedic treatment on the basis of advanced surgical technique and correction with medicines.

Materials and methods

125 patients at the age of 20-55 years were examined and treated. They included healthy individuals, patients with Kennedy class III dentition defects, patients with dental prostheses (residents of Ivano-Frankivsk region and polluted area of Bohorodchany district - villages of Starunia and Lastivtsi). They were divided into three groups.

Group I included 25 healthy residents of Ivano-Frankivsk and surrounding areas (the control group).

Group II consisted of 40 patients living in unfavorable environmental conditions being treated with conventional methods of orthopedic treatment.

Group III consisted of 60 residents of Ivano-Frankivsk region who underwent preoperative preparation using a comprehensive approach to preparation of the oral cavity for orthopedic treatment.

Group III was divided into three subgroups.

Subgroup IIIa consisted of 20 patients living in environmentally polluted regions who were previously prepared for orthopedic treatment using osteotropic preparations of synthetic origin (bioceramics “Biohran”, “Kerhap”) and underwent orthopedic treatment.

Subgroup IIIb included 20 patients who were previously prepared for orthopedic treatment using osteotropic preparations of natural origin (bioceramics “Collapan-L”, “Osteoplast-K”) and underwent correction with medicines.

Subgroup IIIc consisted of 20 patients who were previously prepared for orthopedic treatment using osteotropic preparations of natural origin (bioceramics “Collapan-L”, “Osteoplast-K” and ““Osteoplast-Dent”) in combination with platelet-rich autoplasma, correction with medicines (antibiotic treatment, hyposensitization and anti-inflammatory therapy), adsorbent “Enterosgel”, antioxidant “Enoant”, adaptogen “Biotryn-Dent”, and complex preparation “Osteoplus”.

The examination and treatment of patients, functional investigation and sample collection were conducted at the clinic of Postgraduate Medical Education Faculty, IFNMU and dental office in Starunia village, Bohorodchany district. To determine the state of dentition and effectiveness of treatment an assessment of dental status was made and screening records developed by us were filled. Clinical research included medical history, physical examination, instrumental investigation, determination of parameters and sample collection (oral fluid).

The use of osteotropic agents allows us to achieve effective results when treating dentition defects as well as to prevent progressive bone resorption and stimulate the processes of reparative regeneration.

During surgical reconstruction of large bone defects we have used platelet-rich autoplasma in combination with osteotropic agents. The combination of autoplasma and bioceramics “Collapan-L”, biomaterials “Osteoplast-K” and “Osteoplast-Dent” which improve angiogenesis, migration and attachment of stromal stem cells as well as their differentiation into osteoblasts in reparative osteogenesis was used to fill bone defects.

To obtain platelet-rich and protein-rich fibrinous autoplasma we have used the method proposed by a group of scientists (Adda F, Chuokrouk Y, Schleicher R, 2000). It consists in collection of 9.0 ml of blood from the median cubital vein into sterile vacuum centrifuge tubes; then, single and vibration-free centrifugation using EBA-21 centrifuge (Hettich, Germany) is done. Rotational speed is

2,400 rev/min; centrifugation time – 12 min. The resulting material is a gel-like clot of two fractions: erythrocytes (lower part of the clot) and plasma proteins (upper part of the clot).

Morphologically, it is a tetra-stratified substrate: the first layer – erythrocytes, the second layer - platelet concentrate, the third layer – fibrin, the fourth layer – plasma proteins.

To obtain the platelet concentrate a gel-like clot was separated into two parts using sterile scissors. Platelet and erythrocyte layer was obtained (about 1.0 ml of growth factor).The second layer was plasma proteins layer. It is an effective material for substituting the volume of the membrane which sometimes is not enough for surgical operations.

An X-ray examination including periapical X-rays, dental panoramic X-rays and computer-aided 3D diagnostics provided the data on the state of bone tissue at the current time and in dynamics of orthopedic treatment in case of dentition deformations. A survey was performed during treatment and 6 months after. The T-Scan III Occlusal Analysis system is one of the most effective functional techniques for diagnosing occlusal relationships. It allows us to determine accurately areas of the premature contacts at the stage of the fitting of bridges and removable partial denture, as well as to monitor their fixation and further use of prostheses. The laser Doppler device LACC-02 was used to measure blood circulation velocity in periodontal tissues. Biochemical investigations were conducted to study the violations of bone and collagen metabolism as well as pro-oxidant and oxidative changes in the oral cavity.

Results and discussion

The use of osteotropic agents allows us to achieve effective results when treating dentition defects as well as to prevent progressive bone resorption and stimulate the processes of reparative regeneration.

All the above-mentioned osteotropic agents in combination with platelet-rich autoplasma improve reparative regeneration of all tissues, reduce the risk of developing postoperative complications and allow us to receive optimal conditions for improving the preparation for orthopedic treatment and rehabilitation.

The results of advanced surgical preparation using medicines in case of dentition defects were evaluated determining antioxidant changes in the body. These changes were investigated in antioxidant defense (AO) system by changes in protein peroxidation (PPO) in the oral fluid.

To reduce the processes of PPO we used a comprehensive approach to the preparation for orthopedic treatment; positive results were observed in patients of Group III, subgroup IIIc in particular.

In patiens who underwent advanced surgical preparation using osteotropic preparations of natural origin (bioceramics “Osteoplast-K”, “Collapan-L”, and “Bioplast-Dent”) in combination with platelet-rich autoplasma, correction with medicines (antibiotic treatment, hyposensitization and anti-inflammatory therapy), adsorbent “Enterosgel”, antioxidant “Enoant”, adaptogen “Biotryn-Dent”, and complex preparation “Osteoplus” protein oxidation parameters reduced.

Immediately after treatment the level of oxidized and modified proteins (OMP) in subgroup IIIc was (0.044±0.002) being almost the same that that in healthy individuals (P_1>0.001), compared to subgroup IIIa where it was 1.28 higher before treatment and its reduction six months after treatment was insignificant (P_2>0.05), and the difference before treatment was statistically significant (P_1<0.005, P_2 <0.01).

The levels of OMP at a wavelength of 370 nm in healthy persons before treatment (0.047±0.0004) c.u., patients of subgroup IIIa before treatment (0.0061±0.003) c.u. and in patients of subgroup IIIc (0.063±0.0003) were very close to the levels of OMP at a wavelength of 356 nm. Under the influence of advanced surgical preparation and correction with medicines PPO processes decelerated and in patients of subgroup IIIa parameters of OMP_{370} 6 and 12 month after treatment

reduced by 1.21, 1.40, 1.38, respectively (P_1<0.05); in patients of subgroup IIIc they were 1.04, 1.14, 1.21, respectively (P_1=0.001), (P_1>0.001) ,(P_1>0.005).

A significant reduction in the number of OMP_{430} was observed in patients of subgroup IIIc - (0.013±0.002) c.u., where P_1=0.001; in patients of subgroup IIIa the parameters were slightly higher - (0.015±0.002) c.u., P_1>0.005. The obtained results were preserved in the remote period of follow-up (0.015±0.002) c.u., P_1>0.001, P_1>0.01, P_1>0.005.

Summing up it can be noted that there was no significant difference in the number of PPO products between patients of subgroup IIIc and healthy persons (P_2>0.05).

Table 1

Regulation of OMP parameters in oral fluid after preparation of the oral cavity for orthopedic treatment

Parameters	Healthy persons N=25	Subgroup IIIa				Subgroup IIIc			
		before treatment N=20	immediately after treatment N=20	6 months after treatment N=20	12 months after treatment N=20	before treatment N=20	immediately after treatment N=20	6 months after treatment N=20	12 months after treatment N=20
OMP 356 c.u.	0.042± 0.002	0.061± 0.004	0.054± 0.003 P_1<0.001 P_2>0.05 P_3>0.05	0.054± 0.002 P_1<0.001 P_2>0.05 P_4>0.05	0.058± 0.003 P_1<0.005 P_2>0.05 P_5>0.05	0.063± 0.004	0.044± 0.002 P_1=0.001 P_2>0.05	0.049± 0.002 P_1>0.005 P_2>0.05	0.052 ±0.003 P_1<0.01 P_2>0.005
OMP_{370} c.u.	0.047± 0.002	0.067± 0.003	0.057± 0.003 P_1<0.001 P_2>0.05 P_3>0.05	0.066± 0.003 P_1<0.005 P_2>0.05 P_5>0.05	0.065± 0.003 P_1<0.005 P_2>0.05 P_5>0.05	0.070± 0.003	0.049± 0.002 P_1=0.001 P_2<0.05	0.054± 0.003 P_1>0.001 P_2>0.05	0.057± 0.002 P_1>0.005 P_2>0.05
OMP_{430} c.u.	0.012± 0.001	0.019± 0.002	0.015± 0.002 P_1<0.001 P_2>0.05 P_3>0.05	0.016± 0.002 P_1<0.005 P_2>0.05 P_5>0.05	0.019± 0.001 P_1<0.005 P_2>0.05 P_5>0.05	0.017± 0.001	0.013± 0.002 P_1=0.001 P_2<0.05	0.015± 0.002 P_1>0.005 P_2>0.05	0.015± 0.002 P_1>0.005 P_2>0.05

Notes: probability of differences is indicated:

P_1 – between the parameters before treatment;

P_2 – between the parameters of healthy people;

P_3 – between the parameters of subgroup IIIc immediately after treatment;

P_4 – between the parameters of subgroup IIIc 6 months after treatment;

P_5 – between the parameters of subgroup IIIc 12 months after treatment.

Microcirculation changes in the periodontal tissues were studied using the method of laser doppler flowmetry (LDF) which allowed us to assess the influence of complex treatment on its results (Fig.1).

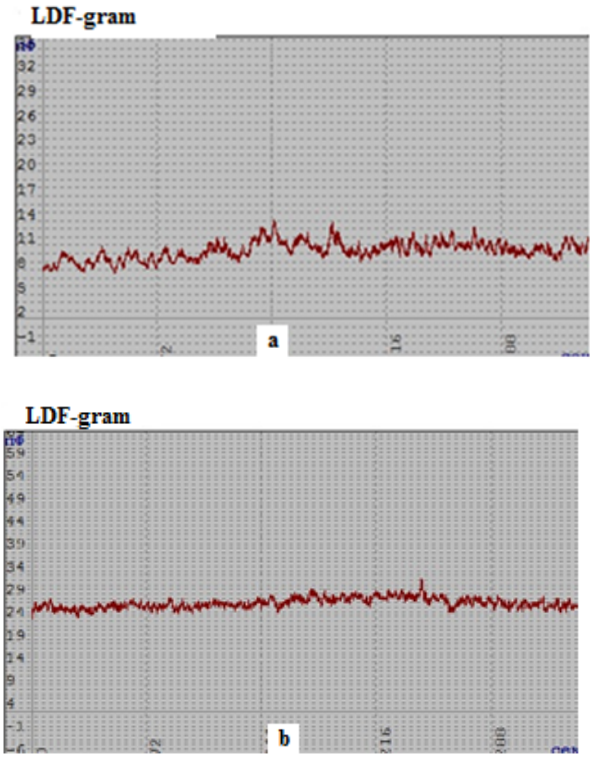

Fig.1. LDF-gram of a 43-year-old patient with Kennedy class III dentition defect:
a – before treatment;
b – after treatment

The use of LDF to measure capillary blood flow allows us to assess the influence of treatment on the microcirculation in the periodontal tissues. On the basis of the investigations carried out by the microcirculation parameter (MP) which characterizes the value of the average blood flow over the time interval of registration the root-mean-square value of the MP before treatment (Table 2) reduced by 1.39 (P_1<0.001); after surgical treatment and correction with medicines it increased sharply by 1.66 (P_2<0.001) in patients of Group III; then, it corresponed to that in healthy persons increasing by 1.12 (P_1<0.001).

Table 2

Hemodynamic parameters in periodontal tissues in case of dentition defects after preparing and treating the oral cavity

Parameters	Healthy persons	Main group				Control group			
		before treatment	immediately after treatment	6 months after treatment	12 months after treatment	before treatment	immediately after treatment	6 months after treatment	12 months after treatment
MP perfusion units	18.19±0.17	17.09±0.32 P_1<0.001	19.43±0.71 P_1<0.001 P_2<0.001	18.01±0.41 P_1<0.001 P_2<0.001 P_3<0.001	17.92±0.38 P_1>0.05 P_2<0.001 P_3<0.001 P_4<0.001	13.61±0.41 P_1<0.001 P_5>0.05	15.19±0.58 P_1<0.001 P_2<0.001 P_6<0.001	14.12±0.39 P_1>0.05 P_2<0.001 P_3<0.001 P_7<0.005	13.59±0.52 P_1>0.05 P_2<0.001 P_3<0.001 P_4<0.001 P_8<0.001

δ perfusion units	2.68±0.52	1.30±0.05 P_1<0.001	3.02±0.19 P_1<0.001 P_2<0.001	2.91±0.81 P_1 >0.05 P_2<0.001 P_3<0.001	2.87±0.93 P_1>0.05 P_2<0.001 P_3<0.001 P_4<0.05	1.73±0.43 P_1<0.001 P_5>0.05	2.73±0.33 P_1<0.05 P_2<0.001 P_6<0.001	2.55±0.96 P_1>0.05 P_2<0.001 P_3<0.001 P_7<0.005	1.88±0.73 P_1<0.001 P_2<0.001 P_3<0.005 P_4<0.005 P_8<0.001
Kv% **v**	13.18±0.45	11.85±0.63 P_1<0.001	13.09±0.67 P_1<0.001 P_2<0.001	12.03±0.40 P_1>0.05 P_2<0.001 P_3>0.05	12.45±0.99 P_1>0.05 P_2<0.001 P_3<0.001 P_4>0.05	12.45±0.72 P_1<0.001 P_5>0.05	9.01±0.55 P_1>0.05 P_2<0.001 P_6>0.05	12.13±0.71 P_1>0.05 P_2<0.001 P_3<0.001 P_7<0.005	11.08±0.29 P_1<0.005 P_2>0.05 P_3<0.01 P_4>0.05 P_8<0.05

Notes: probability of differences is indicated:
P_1 – between the parameters of healthy people;
P_2 – between the parameters before treatment (the main group);
P_3 – between the parameters immediately after treatment;
P_4 – between the parameters of the main group 6 months after treatment;
P_5 – between the parameters of the main group before treatment;
P_6 – between the parameters of the main group immediately after treatment;
P_7 – between the parameters of the main group 6 months before and after treatment;
P_8 – between the parameters of the main group 12 months after treatment.

Elevated MP indicated increased periodontal tissue perfusion. This parameter reduced slightly 6 months after treatment, however the difference between data before treatment remained statistically significant (P_2<0.001); 12 months after treatment the MP corresponded to that in healthy people (P_1<0.05).

Numerical values of the MP after treatment in patients of the control group were close to those in patients of the main group; however, the difference between them was not statistically significant (P_5<0.001; P_6<0.001; P_2<0.005; P_8<0.001). There was a significant difference in the parameters between two groups 12 months after treatment (P_1<0.001).

The parameter **δ** which is the average fluctuation of perfusion in relation to the mean value of blood flow being calculated by the formula for mean root square deviation reduced with the reduction in the MP; after complex treatment it increased by P_2<0.001.

The obtained value **δ** was insignificant compared to the data of healthy persons P_1<0.05; when compared to the data before treatment it remained P_2<0.001. It indicated the achievement of complete normalization of the functional state of the microcirculation under the influence of therapeutic complex developed by us.

In patients of the control group normal blood flow in the periodontal tissues was not restored over a 6-month period. However, 12 months after treatment the parameter was higher compared to that before treatment, (P_2<0.001) reduced significantly compared to healthy persons, and the difference was statistically significant (P_1<0.001).

Elevated value of the parameter K**v** which characterizes vasomotor activity of blood vessels also reflects the improvement of the functional state of the microcirculation. In patients of the experimental group P_2<0.001 increased. In contrast to numerical values of the MP and **δ**, the parameter K**v** reached that in healthy persons and was slightly higher, but not for long (P_1<0.05). This regularity was observed in the remote period after treatment: there was a statistically significant difference between the parameter and data before treatment (P_2<0.001) and there was an

insignificant difference between the parameter Kv in patients of the experimental group and parameters of healthy people (P_1<0.05).

Treatment using traditional methods regulated vasomotor activity of blood vessels as well and the parameter Kv increased immediately after treatment (P_2<0.001). The difference between the data before and 6 months after treatment reduced by 1.34 times; 12 months after treatment it reduced by 1.22 times only being not statistically significant (P_2<0.05). The difference between the parameters obtained 12 months after treatment and those in healthy persons became significant (P_2<0.005). Thus, long-term regulation of vasomotor activity of blood vessels in the control group was not detected.

Noticeable increase in the parameter K*v* was observed in the main group; immediately after treatment vasomotor activity of blood vessels was slightly higher, however, 6 and 12 months after treatment it was close to the data of healthy persons P_1<0.05. The parameters of the control group did not reach the parameters of healthy persons in any time of the observation. The obtained results indicated the advisability and positive results of comprehensive approach at the stages of preparation for surgery and high-quality orthopedic treatment.

To study micro hemodynamic processes occurring in the periodontal tissues comprehensive surgical approach using osteotropic agents in combination with autoplasma and mandatory correction with medicine were applied.

Conclusions

The application of comprehensive approach at the stages of the preparation for orthopedic treatment affected the PPO regulation in patients of Group III. In all groups immediately after treatment the level of OMP_{356}, OMP_{370} and OMP_{430} reduced and the degree of reliability was from P_1<0.005 to P_1<0.001. The obtained results preserved over a period of 1 year; the difference between the obtained results and the initial data was statistically significant; P_1 was within the range of (P_1<0.05 – P_1=0.01).

We can state that in patients with dentition deformity and periodontal disease the level of OMP increased indicating the impairment in the prooxidant and antioxidant interactions in the body.

It indicates the fact that the stages of the preparation of the oral cavity for orthopedic treatment being developed by us are more effective for the improvement of the prooxidant parameters than generally accepted ones. In patients (subgroup IIIc) who underwent advanced surgical preparation of the oral cavity and correction with medicines before orthopedic treatment, continuous and reliable reduction in the processes of PPO, regulation of microcirculatory processes in the periodontal tissues of all patients, possibility of effective restoration of dentition defects and improvement of overall health were observed.

Prospects for further research

We plan to improve the methods of the diagnosis and treatment in preparing for orthopedic treatment under modern conditions. Unfavorable environmental conditions should be considered; advanced surgical techniques of preparing the oral cavity for orthopedic treatment and mandatory correction with medicines should be implemented.

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