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Development of Methods of Surgical Preparation of the Oral Cavity for Orthopedic Treatment

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Abstract.

The article describes an integrated approach to preparing patients with dentition defects living in unfavorable environmental conditions for orthopedic treatment as well as the influence of the integrated approach including special surgical preparation and correction with medicines on the bone tissue. Treatment plan and selection of dental prosthesis were considered in order to preserve the abutment teeth and the bone tissue.



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Problem statement and analysis of the recent research

Nowadays, about 50% of the adult population requires orthopedic treatment worldwide, while in Ukraine orthopedic treatment is desired for 75-80% of the population. 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 dentition defects using teeth with some periapical changes including significant bone atrophy. Many research works carried out to study the aging of bone tissue, osteoporosis and its complications among the population of different regions produced the results confirming the highest rate in western regions of Ukraine. Both genetic and environmental factors play a significant role in aging of bone tissue. According to the Institute of Gerontology NAMS of Ukraine the primary cause of accelerated aging of bone tissue in the population of western regions of Ukraine is living in endemic areas with high levels of fluoride and iodine, and environmentally polluted regions.

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. Considering all the above-mentioned data we have decided to develop, improve and implement into practice highly effective methods of surgical preparing patients suffering from tooth loss and damage to bone tissue for orthopedic treatment aiming at the preservation of the abutment teeth, masticatory function and person's health in general.

A promising direction for our research is the study of causative factors and mechanisms of developing pathological processes in the alveolar process and alveolar ridge occurring due to the action of local and general factors, progression of the dystrophic and resorptive processes in the periodontium and bone tissue. In bone tissue of the alveolar process disturbances in protein and mineral metabolism as well as an imbalance in bone remodeling with a predominance of osteoresorption over the process of osseointegration were observed. Different pathological processes occurring in the alveolar process change bone structure over time and in a worst-case scenario they result in atrophy.

The objective of the research was to improve the effectiveness of orthopedic treatment of patients with dentition defects on the basis of special surgical techniques and correction with medicines.

Materials and methods

110 patients at the age of 20-55 years were examined and treated. They included healthy individuals, patients with dentition defects, patients with dental prostheses (residents of Ivano-Frankivsk and villages of Starunia and Lastivtsi, Bohorodchany district), and those who underwent preoperative preparation using an integrated surgical approach to preparation of the oral cavity for orthopedic treatment. They were divided into three groups.

Group I included 30 healthy residents of Ivano-Frankivsk and surrounding areas (the control group).

Group II consisted of 45 patients living in unfavorable environmental conditions (villages of Starunia and Lastivtsi, Bohorodchany district) being treated with conventional methods of orthopedic treatment.

Group III consisted of 35 patients who underwent preoperative preparation using an integrated approach to preparation of the oral cavity for orthopedic treatment according to special surgical methods and correction with medicines. The study included history taking, physical examination, X-rays of bone tissue, functional analysis of dentition status and periodontium,

collection of oral fluid for biochemical analysis. Saliva collection is simple and non-invasive method used for detecting pathogenic components in the development of oral diseases.

The proposed methods of surgical preparation and complex treatment of patients followed by orthopedic treatment including correction with medicines provided the positive results. The importance of the integrated approach using new methods of surgical preparation (utility model patent No 68245. 2012 March 26) was noted. The instrument proposed by us was a holder of the soft tissues during oral surgery.

Its applied part is spherical ($r=12\text{mm}$) and corresponds to the shape of the alveolar process. The usage of this instrument has obvious advantages: it increases the area of contact with the soft tissues, prevents traumatization while holding and improves the access to surgical field (Fig. 1).

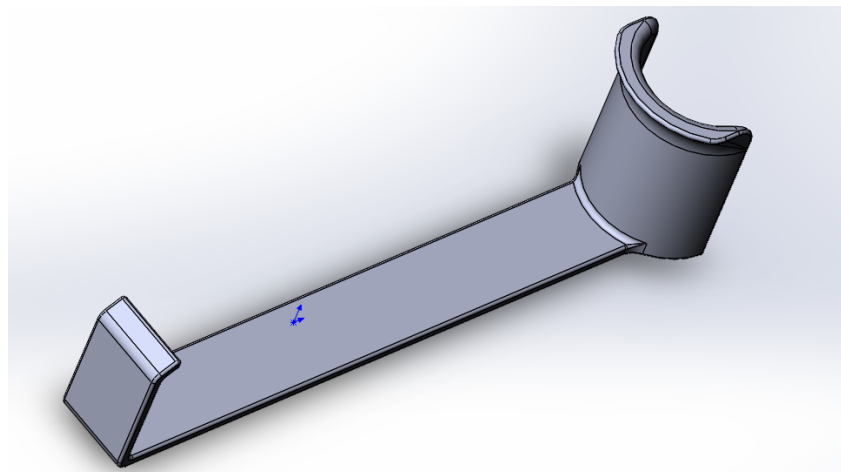


Fig. 1. Holder of soft tissues

The other instrument proposed by us was a “tooth root extractor” for removing tooth roots during the extraction process being the stage of preparing for orthopedic treatment (utility model patent No 84362. 2013 Oct 25). It is a special elevator for the removal of tooth roots the applied part of which is made in the form of the cylindrical rod being smoothly hinged to an external conical thread with a sharp ending for easy entry into the root canal. Tooth root extractor is technically simple and easy to use in surgical dentistry for screwing sharp ending into the root canal and applying light force while removing the tooth root (Fig. 2).

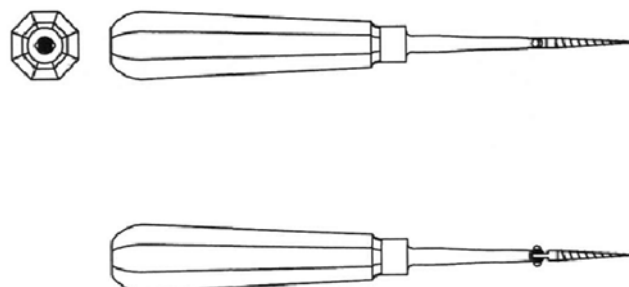


Fig. 2. Tooth root extractor

When using in dental surgery this instrument allows preserving the alveolar process without changing its size and shape, and, in turn, it will be rational and quality approach in the

stages of preparing patients for orthopedic treatment with removable and non-removable dentures.

Modern dental surgery has advanced considerably with the development of less traumatic surgeries including atypical tooth extraction, apicoectomy, cystectomy, flap surgery in periodontal diseases, alveoloplasty (utility model patent No 75915. 2012 Dec 25), instrument for removing the bony prominences and sharp edges of the alveolar processes. Its applied part is a cone-shaped disk with a diameter of 23 mm having a smooth working surface which is smoothly hinged to a rod which, in turn, is attached to the bulb-shaped handle with longitudinal facets. The given type of design allows us to place the applied part of the instrument on any surface and at a certain angle towards the alveolar process (Fig. 3).

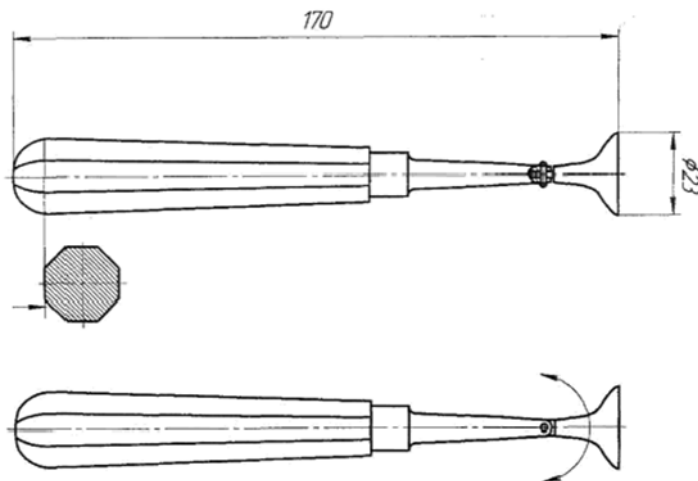


Fig.3. Instrument for removing bony prominences

The goal of using the given instrument was qualitative and quantitative preservation of bone tissue, its anatomic-physiological applicability, autramatic method of removing bony prominences.

The usage of advanced surgical procedures and correction with medicines allowed us to maximally preserve bone tissue and most abutment teeth as well as to improve orthopedic treatment. During surgery and postoperative period we have used a number of medicines to correct and improve tissue regeneration and bone remodeling. The usage of osteotropic preparations bioceramics "Biohran" and "Kerhap", "Collapan-L", "Osteoplast-K" and "Paradontokol" and correction with adsorbents "Ultrisorb" and "Enterogel", adaptogens "Enoant" and "Biotryn-Dent" including complex preparation "Osteoplus" allowed us to improve the design of dental prosthesis, effectiveness of its use and period of service (Fig. 4).

The state of bone tissues of the alveolar process was studied by means of a cone-beam computed tomograph Morita (J. Morita Manufacturing Corporation) which combines the methods of orthopantomography, conformal radiotherapy and spot-film radiography (Fig. 5).

Results and discussion

In patients with dentition defects and periodontal diseases various changes in all systems including bone tissue detected when examining oral fluid were observed. Copper and zinc were proven to play an important role in the body organism affecting calcium and phosphorus metabolism in bone tissue without which osteoblastic differentiation is impossible.

When analyzing the indicators presented in Table 1 it was revealed that copper levels in patients of Group II and Group III increased significantly compared to healthy persons.

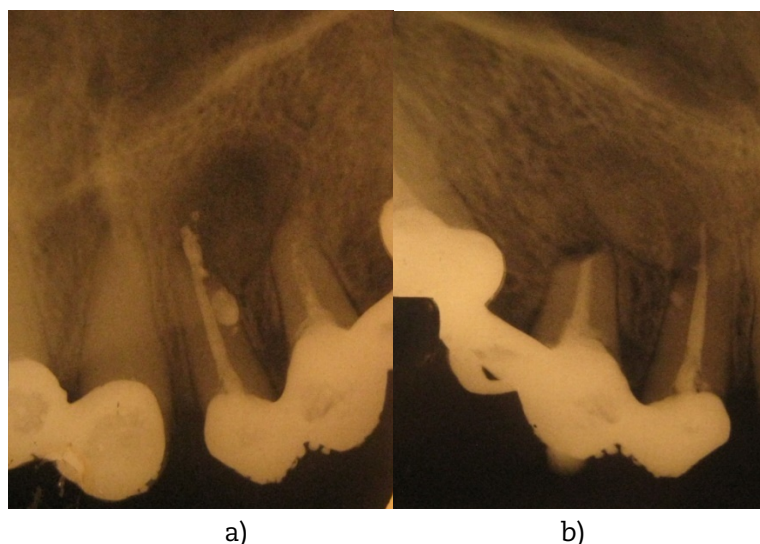


Fig. 4. State of bone tissue of the alveolar process
 a) before treatment;
 b) 6 months after treatment.

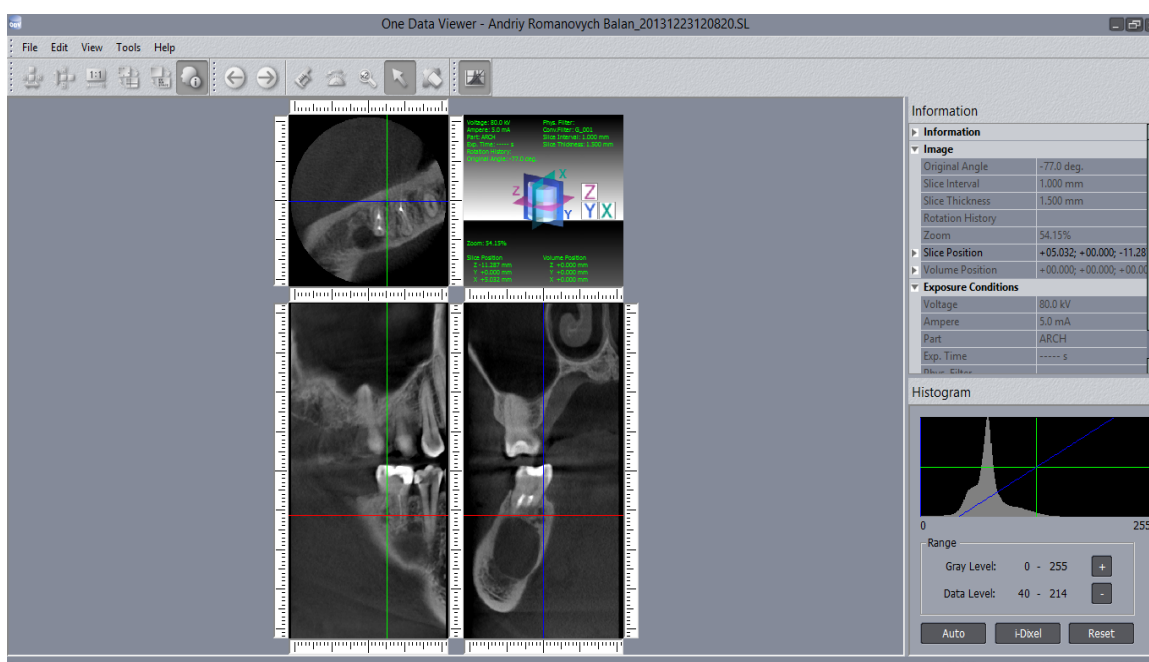


Fig. 5. Study of the state of bone tissue in patients using cone-beam computed tomograph Morita

The increase in copper levels was particularly evident in Group III 1 year after treatment – 110.27 ± 2.63 compared to the control group 81.25 ± 2.76 being 1.35 times higher ($p_1 < 0.001$). In patients of Group II copper levels 129.13 ± 5.14 increased by 1.6 times compared to the control group 81.25 ± 2.76 ($p_1 < 0.05$); the comparison of copper levels in studied groups was significantly different from zinc levels in saliva. Zinc was proven to be closely related to calcium and copper as well as to be able to compete with calcium in the crystal lattice. The level of zinc in saliva of studied patients decreased sharply. The levels of zinc in saliva of patients of Group III and Group I differed from 399.17 ± 12.18 to 498.27 ± 13.21 being 1.24 times less ($p_1 < 0.05$), and the difference between groups was unreliable.

Table 1

Level of trace elements in saliva

Indicators	Group I (healthy persons)	Group II (main group)	Group III (control group)	
			6 months after treatment	1 year after treatment
Copper, μg/l	81.25±2.70	129.13±5.14 p ₁ <0.001	95.18± 4.24 p ₁ <0.01	110.27±2.63 p ₁ <0.001 p ₂ <0.05 p ₃ <0.001
Zinc, μg/l	498.27±13.21	389.23±5.14 p ₁ >0.05	470.67±11.19 p ₁ <0.05	399.17±12.18 p ₁ <0.05 p ₂ >0.05 p ₃ <0.001

After advanced surgical preparation and correction with medicines we performed orthopedic treatment replacing dentition defects with non-removable porcelain-fused-to-metal prostheses and metal-on-plastic prostheses. These methods were used when treating patients of Group III (35 patients) constantly being under our observation (Fig. 6).



Fig. 6. A 47-year-old patient M. with Kennedy class IV dentition defect

The obtained occlusiograms are an informative method of diagnosing occlusive contacts. The use of traditional techniques to control the occlusal contacts (articulating paper, wax bites, impression materials) when manufacturing dental bridges, did not provide an accurate analysis. When fitting dental bridges the T-Scan III Bite Analysis system was used. It allowed us to determine the nature and order of occurring contacts when fixing the relationships between the upper and lower jaws being of great importance. Occlusal relationships and dental prostheses were corrected according to the results of T-Scan computerized occlusal analysis (when vector of total force was within normal limits, namely in white ellipse). Figures 7a and 7b present an even distribution of load over each group of teeth. Occlusal relationships between the upper and lower teeth obtained at the final stage of orthopedic treatment are preserved for a long time providing long-lasting comfort and in combination with therapeutic treatment extend lifetime of prostheses (Fig 7).

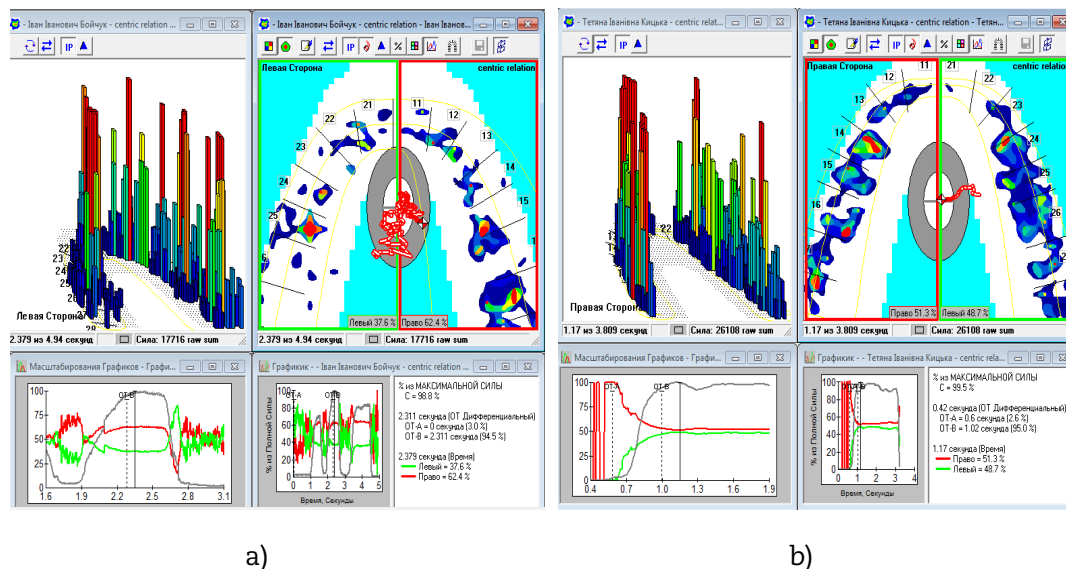


Fig. 7. Percentage distribution of masticatory force (T-Scan III)
 a) data of patient K. with Kennedy class III dentition defect;
 b) data of patient M. with Kennedy class IV dentition defect.

Conclusions

According to the results of our observation advanced surgical methods of preparing the oral cavity for orthopedic treatment using osteotropic preparations of both synthetic and natural origin as well as complex therapy using adaptogens, adsorbents, antioxidants and complex of preparations for strengthening the periodontium of the abutment teeth improved the preparation and treatment as well. Trace elements, namely copper and zinc were proven to play a significant role in the body organism affecting calcium and phosphorus metabolism in bone tissue without which osteoblastic differentiation is impossible. Rational preparation and proper selection of dental prosthesis to preserve masticatory function and patient’s health in general are also of great importance

Prospects for further research

We plan to develop the organizational aspects of medical and diagnostic work in preparing for orthopedic treatment under modern conditions as well as to implement wider special surgical techniques of preparing the oral cavity for orthopedic treatment.

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