DIAGNOSTIC AND TREATMENT METHODS

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METHOD OF FIXING FULL REMOVABLE PROSTHESES ON THE TOOTHLESS UPPER JAW USING SERIES-CLOSED VALVE ZONES

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There has been an increase in the ratio of elderly and senile people to the general population who need prosthetics. At the same time, complete teeth loss leads to various anatomical-topographical changes in the denture bed in the elder age group. Meanwhile, there are insufficient researches aimed at improving the fixation and stabilization of complete removable dentures, which determined the direction of our study. The aim of this research was to increase the degree of retention of complete removable dentures by creating additional valve zones, taking into account the individual anatomical-topographical variability of the denture bed structure of the maxilla. **Material and Methods.** Prosthetics of 115 people aged from 60 to 93 years old with complete teeth loss on the upper jaw was carried out. Prosthetics were performed by the method of determining the locations of individual valve zones in the area of the pliable mucous membrane of the denture bed on the edentulous upper jaw, including the use of a digital model of the denture bed obtained by cone-beam computed tomography (CBCT) with the use of a contrast agent and subsequent analysis in 3D graphics editors. **Results.** Additional retention elements were determined with the individual anatomical-topographical variability of the location of the malleability zones, places of exit of the neurovascular bundles and places with dense mucosa on the upper jaw to improve the retention of the prosthetic structure. At the same time, the obtained results characterize the increase in the efficiency of functional retention of complete removable prostheses due to the creation of consecutive concentrically closed valve zones, which create negative pressure zones medial to the borders of the prosthetic bed. Discussion. The developed method provides conditions for increasing the efficiency of retention and functionality of complete removable plate prostheses on the upper jaw due to accurate determination of individual anatomical-topographical features of the prosthetic bed, thickness of the mucous membrane, places of exit of neurovascular bundles, torus and exostoses. The probability of vascular compression with microcirculation disturbance and traumatization of soft tissues adjacent to the prosthetic structure was significantly reduced. The method minimizes alternating loads in the area of torus and exostoses in the area of maxillary tubercles, which significantly reduces the probability of fracture of the base of a full removable plate prosthesis. **Conclusion.** Our method in case of depressurization of external valve zones increases the degree of retention and stabilization of complete removable orthopedic constructions on the upper jaw during the operation. At the same time, retention is provided by additional internal valve zones located in places where there is sufficient pliability and there are no neurovascular bundles and exostoses.

Keywords: upper jaw, anatomy and topography, complete teeth loss, denture bed, full removable plate prosthesis, retention, prosthetic efficiency.

Introduction. Recently, the ratio of elderly and senile age people to the general population who need prosthetics has increased [1, 2]. The main etiologic factors of tooth loss in these age groups are the prevalence of dental caries and its complications, inflammatory processes of periodontal tissues, which require further improvement of therapeutic and preventive measures [2, 5, 6,]. Meanwhile, tooth loss in the older age group leads to various anatomical-topographical changes in the prosthetic bed area, which are associated with significant atrophy of the alveolar processes and their changing relations with the maxillary sinuses and the base of the pear-shaped hole, mandibular canal, making it difficult to plan and manufacture prosthetic structures. At the same time decompensated forms of general medical pathologies make the use of dental implants impossible. Meanwhile, production of removable prostheses is the main method of medical and social rehabilitation of patients in these clinical cases. In this regard, orthopedic rehabilitation of patients with the complete removable plate prostheses requires an individual approach taking into account the above-mentioned changes in the alveolar process and oral mucosa [7, 8]. Today, there are no researches improving prostheses fixation and stabilization, which determined the direction of our study.

The research objective is to increase the degree of retention of complete removable plate prostheses by creating additional valve zones taking into account the individual anatomical-topographical variability of the structure of the maxillary denture bed.

Materials and methods. Prosthetics of 116 people aged from 60 to 93 years old, males - 23,53±1,38% (27) and females - 76,47±0,43% (89) with complete upper jaw teeth loss was carried out. The research was conducted at the clinic of M.K.Ammosov North-Eastern Federal University, the center of radiological diagnostics "Voxel" (Yakutsk) and the dental clinic "Harmony" (Yakutsk).

Prosthetics were performed by the developed method of determining the location of individual valve zones in the area of the pliable mucous membrane of the denture bed on the edentulous maxilla using a digital model of the prosthesis boundaries obtained by cone-beam computed tomography with the use of contrast agent and subsequent analysis in 3D graphics editors (Patent for Invention № 2792541 from 22.03.2023) [4]. For this purpose, a digital model of the prosthesis boundaries was used based on the results of cone-beam computed tomography ("OnDemand 3D Dental" ("KaVo Russia" LLC Ace Dental RUS)) with the

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use of a barium sulfate contrast agent "Barium sulfate" [4]. Bar-VIPS barium sulfate contrast agent (manufacturer LLC Firm VIPS-Med 141190 Russia, Moscow Region, Fryazino, Zavodskoy Str., 3A, Tel (495)22-181-22 internet: www.vipsmed.ru. Registration number in the state Registration number in the state register of medicines R No000178/0, date of registration 18.02.2011) and subsequent analysis in 3D graphics editors ("Blender 2.91 References Manual"). Informed voluntary consent was obtained from all patients during the study.

Statistical processing was carried out according to standard methods of variation statistics. Calculation of the sample volume and its size (sample size) were carried out by the method of K.A. Otdelnova (1980), which stipulates the necessary volume of clinical material to obtain reliably significant data [3]. At the same time, the research indicators were representative. Correlation analysis of the obtained results was carried out with the determination of the Spearman's coefficient (rs) in the software package "SPSS", version 22 of IBM SPSS license."

Clinical studies were conducted on the basis of the ethical principles of the Helsinki declaration (1964) and the decision of the local ethical committee of Medical Institute of M.K. Ammosov NEFU" (protocol No29 of 08.04.2021).

Results and discussion. The main purpose of the developed method is to increase the retention of complete removable prosthetic constructions taking into account individual anatomical-topographical features of the prosthesis boundaries on the upper jaw. In this case, to determine the optimal locations of the valve zones, CBCT was performed, where tomography was carried out with the use of the contrast agent "Bar-VIPS". For this purpose, the patient's oral cavity was filled with a contrast agent suspension, which is obtained by adding 240 g of powder to 60 ml of boiled water while stirring for 3 min, where the volume of the resulting suspension is 120 ml. The suspension was then held in the mouth by the patient without swallowing and tomographic examination was performed (Fig.1). Processing of the obtained series of images in "Dicom" format was converted into "Stl" format (Fig.2 a, b, c, d) of the digital model of the maxilla, where we identified areas with pliable mucosa with the help of neural network (Fig.3), avoiding the location of the maxillary greater palatine and incisor aperture, and areas of irregularities of the medial palatine suture and maxillary tubercles, where masks were formed in

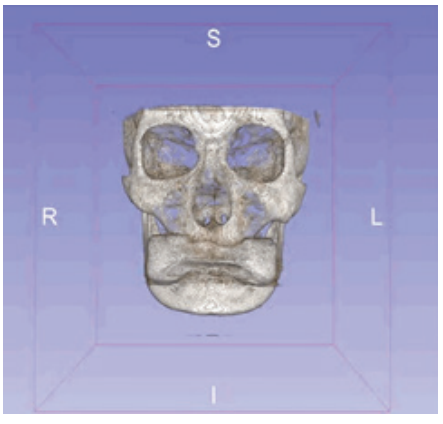
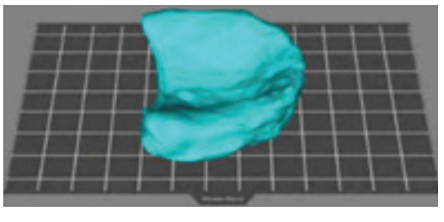
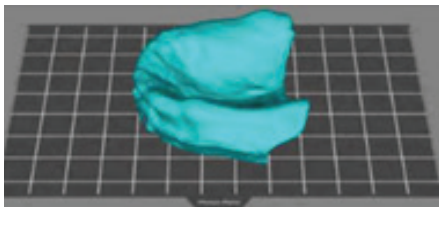


Fig. 1. CT result with contrast agent of the oral cavity in ".dcm" format

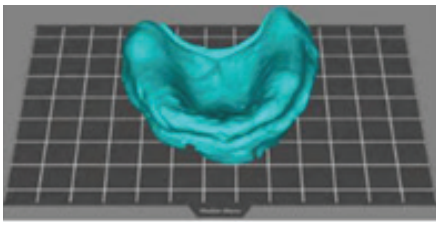
a



b



c



d

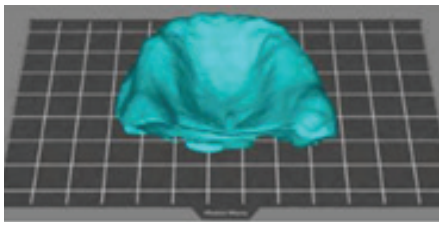


Fig. 2. Obtaining a volumetric digital model of the edentulous maxilla on the basis of cone-beam tomography (a - left view, b - right view, c - front view, d - back view)

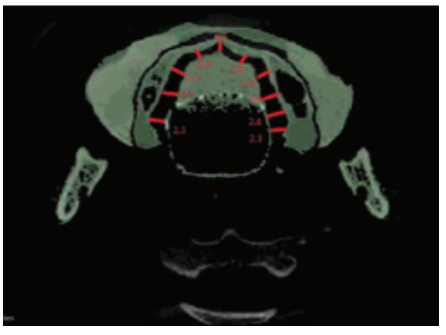


Fig. 3. Zones identification of the supple mucosa of the denture bed in the area of the lateral sections of the middle third of the hard palate

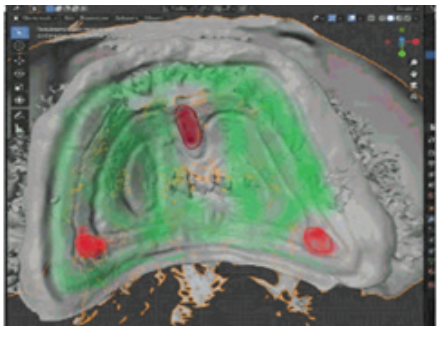


Fig. 4. Formed consecutive closed valve thickenings of the custom tray surface facing the denture bed (red color indicates places in the area of exit of neurovascular bundles and places with thinned mucosa, green color - places favorable for the formation of valve zones).

Fig. 5. Finished prosthesis made on the model obtained by impression with formed consecutive valve zones, taking into account individual anatomical variability of the topography of the soft tissues of the prosthetic bed

the "Stl" array of the model, in places of sufficient mucosa suppleness of the denture bed mucosa, medial to the external borders of the denture bed. Based on the masks, 3D modeling of the individual spoon was performed in the 3D graphics editor ("Blender 2.91 References Manual"). Then, at a distance of 2-5 mm towards the center of the denture bed from the attachment of the soft palate curtain

a

b

c

Fig. 6. View of the finished denture in the oral cavity (a – palatal surface, b – front view, c – view of the upper complete denture in bite position)

and the center of the alveolar process apex, "in the projection of the mask allowing compression, a roughness was placed on the surface of the spoon in the form of a roller with a height of 0.1 to 0.8 mm, where the height of the valve depended on the thickness of the mucous membrane, 2-5 mm away from the mask prohibiting compression in the area of the vessels and irregularities of the bone base of the denture bed. If the mask allowing compression was of sufficient size, the area with the valve zone was located again at a distance of 2 to 5 mm from the previous one. In the area of the mask prohibiting compression, decompression technological openings were designed in the areas of adhesion of the thinning mucosa, torus and exostoses (Fig. 4). Then the individualized spoon was printed using additive technologies, followed by fitting in the patient's oral cavity. Further stages of producing of complete removable orthopedic constructions were carried out according to generally accepted technologies.

Clinical case: Patient P., 68 years old, came to the Clinic of the North-Eastern Federal University named after M.K. Ammosov with the diagnosis: complete loss of teeth due to chronic periodontal disease of the upper jaw. Schroeder class 2, Supple class 1. From the anamnesis he had been previously prosthetized with full removable prosthetic constructions, for the last six months he notes unsatisfactory fixation of removable prosthesis, violation of food intake. Two days ago, while cleaning the denture, the patient dropped the denture, resulting in a fracture of the base.

After dental examination, the patient was offered to produce a full removable plate prosthesis according to our new method, where the patient's consent to participate in a scientific clinical study was obtained. Then the patient underwent CBCT with Bar-VIPS oral contrasting. Further, after the analysis of the prosthetic bed, taking into account his individual anatomical-topographical variability, three consecutive valve zones and three areas where the prosthetic bed is not in contact with the surface of the mucous membrane of the upper jaw in the area of exit of neurovascular bundles were formed (Fig. 5). After that, a digital model of the individual spoon was formed and then printed by the stereolithographic printer "Anycubic". The subsequent stages of producing of a complete removable orthopedic structure were carried out according to the well-known technology. At the same time dynamic control of the patient during 5 months characterizes the absence of necessity of prosthetic bed correction. In addition, the patient reports satisfactory fixation of the prosthesis and absence of discomfort on the upper jaw (Fig. 6 a, b, c).

Conclusion. The developed method of determining consecutively located concentrically closed valve zones with contrasting of the oral cavity provides the increase of fixation efficiency and function of complete removable plate prostheses on the upper jaw with a personalized approach of anatomical-topographical features of the prosthetic bed, thickness of the mucous membrane, places of exit of neurovascular bundles, torus and exostoses. At the same time the probability of vascular compression with microcirculation disturbance and traumatization of soft tissues to which the prosthetic construction adjoins is significantly reduced. In addition, the developed method minimizes alternating loads in the area of torus and exostoses in the area of maxillary tubercles, which significantly reduces the probability of fracture of the base of the full removable plate prosthesis. The sequential arrangement of the valve zones reduces the likelihood of tipping of the prosthesis in the event of a breach of the tightness of the external valve zones, since concentric sequential valve zones are provided inside the borders of the prosthetic bed, which preserve retention. It improves the quality of dental care and increases the living standard of patients.

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