

social'noi' neobhidnosti ta ekonomichnoi' docil'nosti reformuvannja ta planuvannja stomatologichnoi' ortopedychnoi' dopomogy molodi Ukraïny. Architecture Medical Science Technical Science. 2020;30(82):41-48. Cressi. [Warszawa, in Poland]

10. **Semenov E.Y., Sennykov O.N.** Nuzhdaemost' y obespechennost' molodogo naselenija Ukraïny v stomatologicheskij pomoshhy. Visnyk stomatologii'. 2016;3:45-47. [in Ukrainian]

11. **Labunec' V.A.** Rozrobka naukovyh osnov planuvannja stomatologichnoi' ortopedychnoi' dopomogy na suchasnomu etapi iï rozvytku: avtoref. dys. na zdobuttja naukovogo stupenja d-ra medychnyh nauk. Kyïv; 2000:37. [in Ukrainian]

The article was submitted to the editorial office 17.02.21



DOI 10.35220/2078-8916-2021-39-1-24-30

UDC 616-036.8+616-083.28/.29:616.716.4

S.A. Sapalov

Zaporizhzhya State Medical University,
Department of Propaedeutic and Surgical Dentistry

CLINICAL EFFICIENCY OF DIFFERENT TYPES OF PROSTHETICS OF EDENTULOUS MANDIBLE DEPENDING ON THE TYPE OF ITS ATROPHY

ABSTRACT

The article presents the results of the comparative clinical and functional study of the effectiveness of prosthetics in 300 patients with edentulous mandibles depending on the type of atrophy and design of denture fixation (by using closing valve or due to fixation on locator- and ball-abutments). It has been established that the use of "classic" complete removable dentures is the most effective in type I of the edentulous mandible, when under the condition of satisfactory function of dentures it is possible to prevent progressive atrophy of the bone tissue of the prosthetic bed. Whereas, in types II, III and IV, a similar clinical effect is possible only due to additional mechanical fixation on implants. The obtained data correspond to the results of previous studies of stress-strain states.

Keywords: complete absence of teeth on mandible, alveolar bone atrophy, complete denture prosthesis, dental implantation, clinical efficiency.

С. О. Сапалов

Запорізький державний медичний університет,

КЛІНІЧНА ЕФЕКТИВНІСТЬ РІЗНИХ ВИДІВ ПРОТЕЗУВАННЯ БЕЗЗУБОЇ НИЖНЬОЇ ЩЕЛЕПИ В ЗАЛЕЖНОСТІ ВІД ТИПУ ЇЇ АТРОФІЇ

АНОТАЦІЯ

В статті представлені результати порівняльного клініко-функціонального дослідження ефективності

протезування 300 хворих з повною відсутністю зубів на нижній щелепі в залежності від типу її атрофії та виду фіксації протезу (за рахунок клапану, що замикає, або завдяки фіксації на локатор- та бол-абатментах). Встановлено, що застосування «класичних» повних знімних конструкцій найбільш ефективно при I типі нижніх беззубих щелеп, коли за умови задовільної функції зубних протезів вдається запобігти прогресуючій атрофії кісткової тканини протезного ложа. Тоді як подібний клінічний ефект при II, III та IV типах можливий лише завдяки додатковій механічній фіксації протезів з опорою на імплантати. Отримані дані відповідають результатам попередніх досліджень напружено-деформованих станів.

Ключові слова: повна відсутність зубів на нижній щелепі, атрофія альвеолярної частини, повне знімне протезування, дентальна імплантація, клінічна ефективність.

Dental implantation, which is now widely used in dental practice, has to some extent solved the main problem of prosthetic treatment of patients with complete absence of teeth that is the difficulty of fixation, stabilization and balance of dentures [1]. However, it is not a panacea for edentulous patients, because the wide use of intraosseous implants is hampered by the very common among the elderly and senile persons significant atrophy of the residual ridge and reduced bone mineral density of alveolar bone caused by involution processes [2]. At the same time, according to our clinical observations, on the one hand removable dentures with fixation on implants provide greater effectiveness of prosthetic treatment in terms of quality of life, fixation of dentures and functional efficiency, on the other hand they are a reason of atrophy of the distal alveolar parts of mandibles, that worsens the anatomical and topographic conditions for re-prosthetics [3].

To study this contradiction, we conducted studies of the distribution of stress-strain states in prosthetics of complete defects of the lower dentition with "classic" removable lamellar dentures and overdentures supporting on intraosseous implants [4]. It was found that the distribution of stresses and strains is determined by the shape of the alveolar part, which is described in Keller's classification. Additional fixation of removable dentures on intraosseous implants leads to a significant increase in stress in the alveolar bone. This is in line with the result of the research [5], where they demonstrated a significant increase in stresses and strains in the simulation model of the mandible in the manufacture of overdentures supporting on implants. According to the authors' data it leads to progressing bone resorption.

Our data about the peculiarities of the distribution of stress-strain states depending on the type of mandible atrophy allowed us to create recommendations for differentiating the tactics of prosthetic treatment of patients with complete absence of teeth. Thus, according to the calculations, the use of complete removable dentures without additional support on implants is most indicated in type I of the edentulous mandible. This type of prosthetic treatment avoids progressive atrophy of the distal parts of the residual ridge of the mandible. In type II, significant uniform atrophy of the alveolar part of the mandible is an indication for dental implantation. From the standpoint of biomechanics, in types III and IV of atrophy of the edentulous mandible, it is better to place implants in areas of low or absent residual ridge. In general, to prevent atrophy of the distal parts of the alveolar bone in all types of edentulous

mandibles, it is advisable to consider the possibility of increasing the number of support implants.

To confirm the biomechanical patterns established as a result of computer modeling, we conducted a clinical study, the results of which are presented in this article.

Thus, *the aim of the study* was to evaluate the clinical effectiveness of different types of prosthetics of the edentulous mandible depending on the type of its atrophy.

Materials and methods. In the research there was a dynamic observation of 90 patients with complete absence of teeth on the mandible (distribution by type of edentulous mandible and type of fixation of a removable denture is given in Table 1). It should be noted that in experimental patients, two intraosseous implants were used as a support.

Table 1

The composition of the research groups by sex, by Keller's type of edentulous mandible and by the design of the prosthetics

Types of prosthetics		Total number	Keller's type of edentulous mandible							
			I		II		III		IV	
			m	f	m	f	m	f	m	f
			total		total		total		total	
"Classic" complete removable dentures		30	5	5	3	5	4	3	2	3
			10		8		7		5	
Removable dentures supported on implants	with ball-abutments	30	4	3	3	4	5	4	4	3
	with locator-abutments	30	7		7		9		7	
	with locator-abutments	30	5	4	3	3	4	4	3	4

Observations were performed in the remote prosthetics period, which were on average 2-3 years. The groups were formed similar in age and sex composition (Table 1). The mean age of patients was 65.7 ± 4.5 years. The selection criteria were as follows: 1) stable health, namely the absence of severe comorbidities in the anamnesis; 2) absence of injuries and inflammatory processes in the oral cavity; 3) no smoking. Informed consent was obtained from each patient.

For an objective analysis of the results of prosthetics, we, firstly, evaluated the quality of fixation of removable dentures [6], and secondly, determined the indicators of masticatory efficiency by Rubinov [7].

Third, we researched the character of the occlusal relations in the dentures using digital registration of the occlusal pressure distribution OccluSense by Bausch. A disposable flexible electronic sensor with a thickness of 60 microns with a colored coating was used. The pressure distribution at the points of contact in the static state and in the dynamics were registered (Fig. 1). Additionally, the

sensor coating left red marks in the places of interdental contacts (Fig. 2).

Fourth, to determine the degree of atrophy of the residual ridge when using the manufactured dentures, we studied computed tomography made on the device "Planmeca ProMax 3D Classic", using computer software Planmeca Romexis 3D. Measurements were performed in four symmetrical sections. The mandible canal, mental opening and projections of the first molar were used as anatomical landmarks. When determining the height of the residual ridge we made 1-2 mm deviation from these anatomical landmarks or from the top of the alveolar part.

Fifth, the effectiveness of the prosthetic treatment was estimated by the condition of the masticatory muscles and temporomandibular joints in patients. The examination included an extraoral examination, during which the proportionality of the face and the maxillomandibular relationships were studied. In addition, palpation of the masticatory and temporal muscles, as well as temporomandibular joints was performed to determine the synchronicity

of movements and the presence of pain. The condition of the temporomandibular joints was diagnosed using computed tomography «Planmeca Promax 3D», which has been described earlier. The functional state of the masticatory muscles was assessed using the surface electromyography method with

electromyograph Bio EMG III (Bio RESEARCH Associates, Inc., USA) with surface (interference) method. The analysis was performed in a state of physiological rest, with compression of the jaws under the condition of maximum interdental contact and random chewing [8].



Fig. 1. Methods of digital registration of occlusal pressure distribution OccluSense by Bausch.



Fig. 2. Painting of occlusal contacts during occlusiography

The obtained data were processed with methods of variation statistics using the MS Excel 2003 software.

Results and discussion. First of all, it should be noted that the extraoral examination did not reveal disorders of maxillomandibular relationships in any patient. Complaints of pain associated with chewing were absent. All patients used manufactured dentures, in particular during eating.

As can be seen from table 2, in patients with type IV edentulous mandibles, good and satisfactory fixation of dentures has been achieved only by applying additional support on implants. On the contrary, in the cases of the type I of edentulous mandibles, the «classic» removable dentures had a high degree of efficiency, while overdentures supported

on implants had poorer fixation; they balanced on the prosthetic bed, especially when using ball-abutments. Worse fixation of removable dentures in this group of patients was associated with disorders of the tightness of the bases of the dentures to the prosthetic bed in the distal areas. At II and III types of atrophy of the mandible's alveolar part, no complete removable denture had a good fixation. At the same time, the support on implants provided sufficient fixation of dentures, with a particularly noticeable difference in the effectiveness of prosthetics in patients with type II mandible atrophy.

Study of masticatory efficiency indicators, which are presented in table 3, proved their greater importance among patients in whom complete defects of the lower dentition were restored by

overdentures supported on implants, mainly with locator-abutments. However, in the case of prosthetics with complete removable dentures in type I atrophy of the edentulous mandibles, the obtained results could be compared with the data for dental implantation ($p>0.05$).

Based on the fact that the peculiarities of the distribution of masticatory pressure on the tissues of the prosthetic bed is determined by the character of the occlusion of artificial teeth in dentures [9], we used the method of occlusal computer diagnostics OccluSense by Bausch. The sensor registered the sequence of occlusal contacts, the distribution of

loads between the right and left sides, and the proportion of masticatory load on the occlusal surfaces of the dentitions in complete removable dentures [10]. During occlusiography, we evaluated the distribution of occlusal load between the left and right sides of the dentitions in the central position (balance of occlusal contacts), the absence of supercontacts in all occlusions. According to the obtained data which is presented in table 4, the indicators of occlusal balance in the vast majority of patients are quite comparable with the quality of dentures' fixation.

Table 2

The degree of fixation of removable dentures using different support elements and depending on the type of atrophy of the mandibles

Types of prosthetics		Keller's type of edentulous mandible	Number	The degree of fixation					
				good		satisfactory		unsatisfactory	
				abs.	%	abs.	%	abs.	%
«Classic» complete removable dentures		I	10	8	80.0	2	20.0	0	-
		II	8	0	-	2	25.0	6	75.0
		III	7	0	-	2	28.6	5	71.4
		IV	5	0	-	1	20.0	4	80.0
Removable dentures supported on implants	with ball-abutments	I	7	0	-	5	71.4	2	28.6
		II	7	5	28.6	2	28.6	0	-
		III	9	4	44.4	4	44.4	1	11.2
		IV	7	2	28.6	5	71.4	0	-
	with locator-abutments	I	9	1	11.1	7	77.8	1	11.1
		II	6	3	50.0	3	50.0	0	-
		III	8	5	62.5	2	25.0	1	12.5
		IV	7	4	57.1	3	42.9	0	-

Table 3

Indicators of masticatory efficiency in patients with complete absence of teeth on the mandible when using different types of denture fixation

Types of prosthetics		Keller's type of edentulous mandible	Number	Indicators	
				masticatory efficiency ($P \pm m_p$, %)	chewing time (sec, $M \pm m$)
«Classic» complete removable dentures		I	10	61.0±5.0	31.7±1.5
		II	8	42.0±4.7°	38.1±2.0°
		III	7	47.0±4.8°	36.2±1.7°
		IV	5	41.0±4.5°	40.0±2.0°
Removable dentures supported on implants	with ball-abutments	I	7	65.0±5.5	30.0±1.3
		II	7	55.0±4.9*	32.0±1.6*
		III	9	51.0±4.7	35.0±1.6
		IV	7	50.5±4.5	35.0±1.8*
	with locator-abutments	I	9	67.0±5.3	28.0±1.6
		II	6	60.0±4.4*	31.0±2.0*
		III	8	55.0±4.7*	33.0±1.7
		IV	7	52.7±4.0*	35.0±2.1°*

Notes. 1. * – $p<0.05$ compared to the values calculated for "classic" complete removable dentures. 2. $p>0.05$ between the values of the indicators calculated for different types of abutments. 3. ° – $p>0.05$ between the values of different types of atrophy of the edentulous mandibles obtained for the same type of prosthesis, compared with the type I.

Table 4

The character of occlusal relations on dentures according to the results of OccluSense by Bausch when using different types of fixation

Types of prosthetics		Keller's type of edentulous mandible	Number	Occlusal balance					
				50%-50%		40-60%		70%-30% and more	
				abs.	%	abs.	%	abs.	%
«Classic» complete removable dentures		I	10	1	10.0	6	60.0	3	30.0
		II	8	0	-	3	37.5	5	62.5
		III	7	0	-	2	28.6	5	71.4
		IV	5	0	-	2	40.0	3	60.0
Removable dentures supported on implants	with ball-abutments	I	7	0	-	4	57.1	3	42.9
		II	7	1	14.2	3	42.9	3	42.9
		III	9	0	-	5	55.6	4	44.4
		IV	7	0	-	4	57.1	3	42.9
	with locator-abutments	I	9	1	11.1	5	55.6	3	33.3
		II	6	1	16.7	3	50.0	2	33.3
		III	8	0	-	4	50.0	4	50.0
		IV	7	0	-	4	57.1	3	42.9

Table 5

The results of measurements of bioelectrical activity of the masticatory and temporal muscles when using removable dentures with different types of fixation (mcV, M±m, p>0.05)

Types of prosthetics		Keller's type of edentulous mandible	Number	Muscles			
				masticatory		temporal	
				left	right	left	right
«Classic» complete removable dentures		I	10	218.6 ±73.1	269.2 ±85.5	283.9 ±94.3	332.5 ±111.2
		II	8	301.8 ±92.4	341.2 ±114.3	362.2 ±123.9	478.3 ±144.2
		III	7	290.3 ±96.5	330.0 ±109.2	357.2 ±118.4	410.4 ±129.0
		IV	5	323.8 ±100.3	362.5 ±120.5	378.3 ±111.4	425.5 ±136.4
Removable dentures supported on implants	with ball-abutments	I	7	255.2 ±81.3	292.0 ±90.0	327.0 ±114.4	381.5 ±113.4
		II	7	244.7 ±80.0	287.4 ±95.0	310.0 ±90.6	351.8 ±109.2
		III	9	232.6 ±65.4	280.0 ±91.0	300.2 ±95.5	350.0 ±92.9
		IV	7	242.9 ±73.2	300.9 ±87.0	310.4 ±100.0	341.0 ±110.0
	with locator-abutments	I	9	275.1 ±85.5	318.8 ±104.4	340.0 ±112.1	390.0 ±130.0
		II	6	232.1 ±65.7	287.5 ±95.0	278.7 ±93.6	361.6 ±121.5
		III	8	210.2 ±76.2	263.3 ±88.6	268.5 ±90.5	300.4 ±96.4
		IV	7	208.7 ±63.2	252.4 ±92.8	257.9 ±73.1	280.8 ±90.0

Occlusal disharmony, described by the uneven distribution of interdental contacts on the right and left sides, has been established in cases of uneven atrophy of the alveolar part when using both complete dentures and overdentures supported on implants. Uniform distribution of occlusion contacts can be

achieved only in the cases of uniform atrophy of bone tissue. The best results were registered for type I edentulous mandible with complete removable prosthetics and for type II – with additional fixation on implants. In general, more uniform contact of artificial teeth on dentures can be achieved by means

of implant prosthetics.

The type of the occlusal relations is determined by the peculiarities of the functioning of the masticatory muscles and temporomandibular joints. No significant abnormalities were found in experimental patients with masticatory muscle electromyography. Symmetry was observed in the work of the masticatory muscles. The synchronicity of the activity was also at a sufficient level. No disturbances of alternating periods of bioelectrical activity and rest during chewing were registered.

The results of measurements of bioelectrical activity of the masticatory and temporal muscles, depending on the type of prosthesis, are presented in table 5. We would like to note that this method of research was low-impact, given the lack of significant differences between the indicators of the research groups ($p > 0.05$). «Jumps» of bioelectrical activity of masticatory muscles, which indicate complications of prosthetics, were not recorded among the patients. According to the features of the functioning of the temporomandibular joints describing

computer tomography, all examined patients had a normal relative position of their elements. It was found the involution changes in the width of the joints slits correspond to age, but no significant violation of the position of their heads.

It is possible to assume about complete adaptation of the dental apparatus to the made designs, both at application for their fixing of the "closing valve", and additional mechanical fixing on implants. However, the unevenness of the occlusal contacts detected during the computer diagnostics with OccluSense by Bausch may be due to the presence of the working (usual) side of chewing. Thus, all examined patients were diagnosed with a mixed type of chewing with a predominance of the right side in 64.4 %. Accordingly, the timeliness of dental prosthetics, which provided for the prevention of a significant reduction of the height of the lower third of the face for a long time, avoided anatomical and functional disorders of the temporomandibular joints.

Table 6

The results of measuring the height and width of the residual bone tissue of the alveolar part of the edentulous mandibles in different types of prosthetics (mm, $M \pm m$)

Types of prosthetics		Keller's type of edentulous mandible	Number	Area			
				frontal		lateral	
				height	width	height	width
«Classic» complete removable dentures		I	10	17.0±2.5	9.7±1.5	13.0±2.3	6.5±1.3
		II	8	11.0±1.8°	6.5±1.5	7.6±1.4°	5.2±0.9
		III	7	13.2±1.8	9.1±1.1	7.8±1.2°	5.0±1.0
		IV	5	10.2±1.7°	5.9±1.0°	13.9±2.0	6.8±1.0
Removable dentures supported on implants	with ball-abutments	I	7	16.5±2.5	9.4±1.4	7.7±1.5*	5.6±1.0
		II	7	10.2±1.4°	6.8±1.5	10.0±1.3	6.0±1.0
		III	9	18.5±2.0*	10.0±1.5	7.6±1.4	5.2±0.9
		IV	7	11.0±1.8°	6.2±1.3	14.0±2.5°	6.5±1.2
	with locator-abutments	I	9	16.8±2.2	9.2±1.7	7.0±1.1*	5.2±1.0
		II	6	11.2±1.7°	7.0±1.5	6.8±1.6	4.5±1.0
		III	8	17.8±1.8	9.7±1.4	7.0±1.2	5.2±0.8
		IV	7	11.3±2.1°	6.1±1.3	13.0±2.0°	6.5±1.0

Notes. 1. * – $p < 0.05$ compared to the values calculated for "classic" complete removable dentures. 2. $p > 0.05$ between the values of the indicators calculated for different types of abutments. 3. ° – $p > 0.05$ between the values of different types of atrophy of the edentulous mandibles obtained for the same type of prosthesis, compared with the type I.

In the study of the parameters of the residual bone tissue of the alveolar part of the edentulous mandibles (Table 6), it was found that in patients with type I atrophy with the use of "classic" complete removable dentures had a uniform widespread loss of bone tissue. In turn, the use of implants leads to a significant uneven character of its progress (more expressed loss in the lateral areas according to the height of the alveolar part, $p < 0.05$). In the type II, no significant differences between the grades of the alveolar part atrophy for different types of fixa-

tion of removable dentures were found ($p > 0.05$). In type III of the edentulous mandibles, according to the measurements, atrophic processes occur more intensively in the frontal part when using complete removable dentures ($p < 0.05$), while for lateral parts there is no significant difference was found ($p > 0.05$). In type IV atrophy of the edentulous mandibles, fixation on implants was gentler in preserving the alveolar part in the frontal area. Otherwise, traditional fixation in the lateral parts was more comfortable, but no significant differences between

the indicators of the research groups were calculated ($p > 0.05$). It is important that when using implants, the residual ridge in the lateral areas of type IV atrophy of the edentulous mandible is preserved to a greater extent than in type I ($p < 0.05$). Finally, it should be noted that differences in the size of the residual bone tissue of the alveolar part of the edentulous mandibles with the use of different implants were not registered ($p > 0.05$).

Thus, fixation of overdentures on the mandible by means of intraosseous implants, which increases functional efficiency, simultaneously leads to increased masticatory load on the alveolar part and acceleration of atrophy of prosthetic bed tissues, which is especially pronounced in types I and III atrophy of the edentulous mandibles. It is advisable to agree that the increase in stresses and strains with the use of support implants causes greater masticatory efficiency, and therefore leads to an increase in masticatory load on the edentulous alveolar process [12]. In our opinion, in this situation we can assume the effect of plastic bases of removable dentures on the distal parts of the mandible on the principle of the console. So, the hydrostatic pressure in the mucous membrane exceeds the critical values that cause the development of bone atrophy.

On the contrary, in type II of edentulous mandibles, the use of implants gives good fixation and does not cause great progression of bone loss.

Also, it should be taken into account that according to the results of biomechanical calculations, the greatest stresses are observed in the area of the marginal bone at the location of the implants, which coincides with the results of previous studies. The highest stresses occur around one implant, regardless of the type of bone tissue by Mish, but decrease with increasing number of implants to two [11].

Conclusions. It is established that the use of «classic» complete removable dentures is most effective in type I of the edentulous mandibles, when under the condition of satisfactory function of dentures it is possible to prevent progressive atrophy of the bone tissue of the prosthetic bed. Whereas, in types II, III and IV, a similar clinical effect is possible only due to additional mechanical fixation of overdentures on implants. At the same time, ball-abutments are more comfortable for the bone tissue of the prosthetic bed. The obtained data correspond

to the results of previous studies of stress-strain states.

REFERENCES

1. Novozemtseva T. N., Remizova A. A., Uzunyan N. A. i dr. *Vozmozhnosti vnutrikostnoy implantatsii dlya uluchsheniya fiksatsii s'emnykh protezov pri polnoy adentii*. Rossiyskiy stomatologicheskii zhurnal. 2016;20(5):257-259. [In Russian]
2. Malkarova I. V., Kaplan M. Z., Kaplan Z. M., Tigranyan Kh. R. *Polnye s'emnye protezy s oporoy na vnutrikostnykh implantatakh. Zdorov'e i obrazovanie v KhKhI veke*. 2016;2(18):255-257. [In Russian]
3. Fastovec' O. O., Sapal'ov S. *OPorivnjal'na kliniko-funkcional'na ocinka efektyvnosti protezuvannja hvoryh z povnoju vidсутnistju zubiv na nyzhnij shhelepi povnymy znimnymy protezamy ta znimnymy protezamy z oporoju na implantaty*. Visnyk stomatologii'. 2019;1(31): 64-68. [in Ukrainian]
4. Fastovec' O. O., Sapal'ov S. O., Shtepa V. O. *Rezultaty doslidzhennja napruzhenno-deformovanyh staniv pry protezuvanni riznyh typiv atrofii' nyzhn'oi' bezzuboi' shhelepy*. Medychni perspektyvy. 2020;XXV,4:146-158. [in Ukrainian]
5. Alsrouji M. S., Ahmad R., Abdul Razak N. H. et al. *Premaxilla stress distribution and bone resorption induced by implant overdenture and conventional denture*. Journal of Prosthodontics. 2019;28 (2): 764-770. doi: 10.1111/jopr.12954.
6. Lebedenko I. Ju., Kalivradzhijana Je. S., Ibragimova T.P. *Rukovodstvo po ortopedicheskoy stomatologii. Protezirovanie pri polnom otsutstvii zubov*. Moskva. MIA; 2005:400 [In Russian]
7. Lebedenko I. Ju., Ibragimov T. I., Rjahovskij A. N. *Funkcional'nye i apparaturnye metody issledovaniya v ortopedicheskoy stomatologii*. Moskva. MIA; 2003:128. [In Russian]
8. Janishen I. V., Djudina I. L., Tomilin V. G. y dr. *Provedennja elektromiografichnogo doslidzhennja v ortopedychnij stomatologii'*. H.: HNMU; 2017:114. [in Ukrainian]
9. Postić S. D. *Influence of balanced occlusion in complete dentures on the decrease in the reduction of an edentulous ridge*. Vojnosanit Pregl. 2012; 69 (12):1055-1060.
10. Fastovec' O.O., Glazunov A.O. *Ocinka klinichnoi' efektyvnosti povnyh znimnyh proteziv, vygotovlenyh za vdoskonalenoju metodykoju funkcional'nogo vidbytkva*. Visnyk mors'koi' medycyny. 2017;1:122-128. [in Ukrainian]
11. Cheng H. C., Peng B. Y., Chen M. S. et al. *Influence of deformation and stress between bone and implant from various bite forces by numerical simulation analysis*. BioMed Research International. 2017. doi: 10/1155/2017/2827953.
12. Lahoti K., Pathrabe A., Gade J. *Stress analysis at bone-implant interface of single- and two-implant-retained mandibular overdenture using three-dimensional finite element analysis*. Indian Journal of Dental Research. 2016;27(6):597-601. doi: 10.4103/0970-9290.199587.

The article was submitted to the editorial office 18.01.21

