

# COMPARATIVE EVALUATION OF CLINICAL APPLICATION OF MONOLITHIC AND FOLDING IMPLANTS IN REHABILITATION OF ELDERLY PATIENTS WITH VARIOUS DEGREES OF ATROPHY OF ALVEOLAR PROCESSES

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## ABSTRACT

**The aim:** Comparative evaluation of long-term results of clinical application of one- and two-stage surgical protocols of dental implantation with the use of monolithic and collapsible implants in the rehabilitation of elderly patients.

**Materials and methods:** Under clinical observation were 46 patients with various clinical diagnoses of dentition defects aged 60 to 70 years. The following methods were used in the study: one - stage surgical protocol of dental implantation operation with non - detachable implants of ART IMPLANT system with subsequent temporary splint fixed prosthesis and immediate occlusive functional load, mechanical oscillatory - resonance method, questionnaire and statistical analysis.

**Results:** The duration of surgical stages of treatment and complete rehabilitation showed statistically significant differences ( $p < 0.05$ ) and was significantly less when using a single-stage protocol of dental implant surgery and non-detachable implants and averaged  $3.9 \pm 0.8$ ,  $p < 0.05$  months against  $7.3 \pm 1.2$ ,  $p < 0.05$  months in implants according to the two-stage protocol. Assessment of patient satisfaction with the treatment was directly correlated with his timing.

**Conclusions:** Thus, it should be noted that the clinical use of one-stage surgical protocol of implantation and non-detachable (monolithic) dental implants of the system «ART IMPLANT» in the rehabilitation of elderly patients with varying degrees of atrophy of the alveolar processes of the jaws is clinically justified.

**KEY WORDS:** monolithic implants, single-stage implantation, elderly patients, stability index, ART IMPLANT system

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## INTRODUCTION

Studies by the World Health Organization (WHO) indicate that there is a huge unmet need for restorative dental care, especially among the elderly [1,2]. And one of the difficult problems of dentistry is still the problem of prosthetics for elderly and senile patients who have completely lost their teeth. Atrophic processes occurring in the jaws often lead to such unfavorable clinical conditions in the oral cavity, in which rehabilitation of this group of patients by traditional methods is not always possible. It should be noted that the share of elderly and senile people in our country is quite large and is in different regions up to 30% of the total population [1-17]. Due to the trend of steady aging of the population in the developed world and due to the accumulation of unmet needs for dental restoration, many researchers see the opportunity to develop these promising and sophisticated methods of dental care. According to research by leading analytical agencies in Europe and the United States, the demand for orthopedic structures on implants exceeds the demand for all other types of dental care. And the market for dental implants and bone and plastic materials is the fastest growing segment in the field of dental. Today,

implantology is one of the most dynamically developing areas of modern dentistry, the use of modern technologies has allowed to approach the problem of treatment of complete and partial absence of teeth at a new level. The vast majority of modern dental implant designs are collapsible. The collapsible structure is always less durable than the monolithic one, and the joint area is a constantly infected area. A significant amount of modern research has been devoted to the problem of connecting the intraosseous and extraosseous parts of the implant and ways to increase its strength and sealing. At the same time, the classic two-stage method of dental implantation has a number of significant disadvantages, the negative consequences of which may not be detected immediately, but in the long term after treatment. To date, a well-established and increasingly widespread in world practice single-stage surgical protocol using new one-component designs of dental implants, which allows their use in cases of insufficient volume and quality of bone tissue. Installation of single-stage monolithic implants in the treatment of patients with atrophy of the alveolar processes of the jaws is recognized by various authors as the best, simplest and most gentle, with a high percentage of long-term

survival [13,14,18,19]. The use of single-stage implants can reduce the duration of prosthetics from 1 to 30 days with immediate implantation and reduce atrophy of the alveolar process after tooth extraction. 97.8% of patients maintained a long-term good functional result of prosthetics, and the success of osseointegration of direct and delayed loading of implants depended on the primary stability during their installation [1,3-5,20]. In modern implantology, the requirements for the formation of stable secondary stability of dental implants (osseointegration) have been studied in detail, which allows to predict with a high level of confidence a satisfactory result of prosthetics. At the same time, the primary stability of the installed implants is one of the main (if not the main) conditions for the success of their osseointegration [6-8,21,22]. In recent years, the most important indicators of the effectiveness of dental treatment are the criteria of quality of life based on the patient's emotional perception of the results of treatment. The use of these indicators in dentistry is becoming an urgent strategic task. Traditional dental examination does not allow to assess how the result of dental treatment affects the mental and emotional well-being of the patient [9,10,12]. The use of questionnaires at the dental reception allows doctors to optimize the choice of treatment, monitor and evaluate the treatment process, which increases the effectiveness of rehabilitation. In accordance with the requirements of the International Association for the Assessment of Quality of Life (IQOLA), the choice of dental questionnaire should be mediated by a personalized clinical situation. Therefore, the rehabilitation of elderly patients with partial and complete defects of the dentition with varying degrees of atrophy of the alveolar processes using single-stage protocols and one-component dental implants is today an important and priority medical and social task.

## THE AIM

Comparative evaluation of long-term results of clinical application of one- and two-stage surgical protocols of dental

implantation using monolithic and collapsible implants in the rehabilitation of elderly patients with dentition defects and varying degrees of atrophy of alveolar processes.

## MATERIALS AND METHODS

The clinical study was conducted on the basis of the Department of Postgraduate Dentistry, Uzhhorod National University and the Dental Clinic Art Dentistry (Zaporizhzhya, Ukraine). 46 patients with various clinical diagnoses of dentition defects were under clinical observation. At diagnosis the generally accepted classification MKH-10 was used. The first group (table I) of the study included: 15 patients (32.61%) with dentition defects with sufficient bone volume, who used a one-stage surgical protocol of dental implant surgery with non-detachable implants Solidum system "ART IMPLANT" followed by temporary splinting fixed prosthesis and immediate occlusive functional load [18,23,24]. The Solidum implant is a monolithic self-tapping implant ( $d = 3.2-4.5$  mm). Due to its design features, this implant is installed subcrystalline in a wide alveolar ridge. In the process of bone remodeling, it forms the effect of a "displaced wound canal", which prevents precervical resorption of the cortical bone and recession of the mucous membrane. The second group included patients with dentition defects with insufficient bone volume, who used a one-stage surgical protocol of dental implant surgery with non-detachable Simplex implants of the ART IMPLANT system, followed by a temporary splint fixed prosthesis and immediate occlusive function. Simplex implant is a monolithic self-tapping cone-shaped implant ( $d = 2.8$  mm), allows to use this implant in conditions of insufficient bone volume in a narrow alveolar ridge by minimally invasive protocol and cylindrical narrow heat-treated neck. This group included 15 people (32.61%). The third (comparative) group included patients with dentition defects with insufficient bone volume, who used the traditional two-stage surgical protocol of dental implant surgery with a detachable implant Virtus ( $d = 3.5-5.0$ ) system "ART IMPLANT"). This group also included 16 people (34.78%). The distribution of patients into groups was carried out randomly and was not fundamental.

**Table I.** Distribution of patients by age, gender and type of surgical protocol

INDEX		QUANTITY (abs.,%)
<b>Total patients</b>		<b>46</b>
Sex	Men	23 (50%)
	Women	23 (50%)
Age (years)		60 – 70
Study groups of patients		3
Main research groups:		
One-stage surgical protocol with occlusal functional load		2 groups
The first group (sufficient bone volume), "Solidum"		15 (32,61%)
Second group (insufficient bone volume), "Simplex"		15 (32,61%)
Two-stage surgical protocol		1 group
Third (insufficient bone volume), "Virtus"		16 (34,78%).

**Table II.** The results of the assessment of the mobility index of installed dental implants in the study groups at different control times

Research groups	Implant Mobility Index (IMI)							
	Post-operative	1 week	2 weeks	4 weeks	8 weeks	3 months	6 months	12 months
The first group (sufficient bone volume, one-stage surgical protocol "Solidum")	-6,4	+0,1*	+1,2*	-2,6*	-5,5	-6,4	-6,6	-6,8
The second group (insufficient bone volume, one-stage surgical protocol "Simplex")	-2,8	+1,6*	+2,2*	+1,8*	-0,7	-2,2	-2,6	-3,1
Third (insufficient bone volume, two-stage surgical protocol "Virtus")	+1,7	+5,9*	+8,7*	+4,1*	+3,8*	+1,1	-1,1	-1,5*

\*Note.  $p \leq 0.05$  statistically significant changes relative to the original data.

**Table III.** Duration of surgical treatment and complete rehabilitation depending on the types of dental implants and surgical protocols used

Average terms of treatment of patients (months)	One-stage implantation protocol		Two-stage implantation protocol
	Non-detachable implants "Solidum" (group 1)	"Simplex" non-demountable implants (group 2)	Collapsible implants "Virtus" (group 3)
Surgical stages of treatment	3,9±0,8**	4,4±0,9*/**	7,3±1,2
Duration of complete rehabilitation	4,5±0,9**	5,5±1,3*/**	9,8±1,4

Note. \*  $p < 0.05$  statistically significant difference between non-detachable and collapsible implants. \*\*  $p < 0.05$  statistically significant differences between one- and two-stage implantation protocol.

**Table IV.** Assessment of patients' satisfaction with the treatment depending on the types of installed dental implants, the timing of complete treatment and the methods of dental implantation used

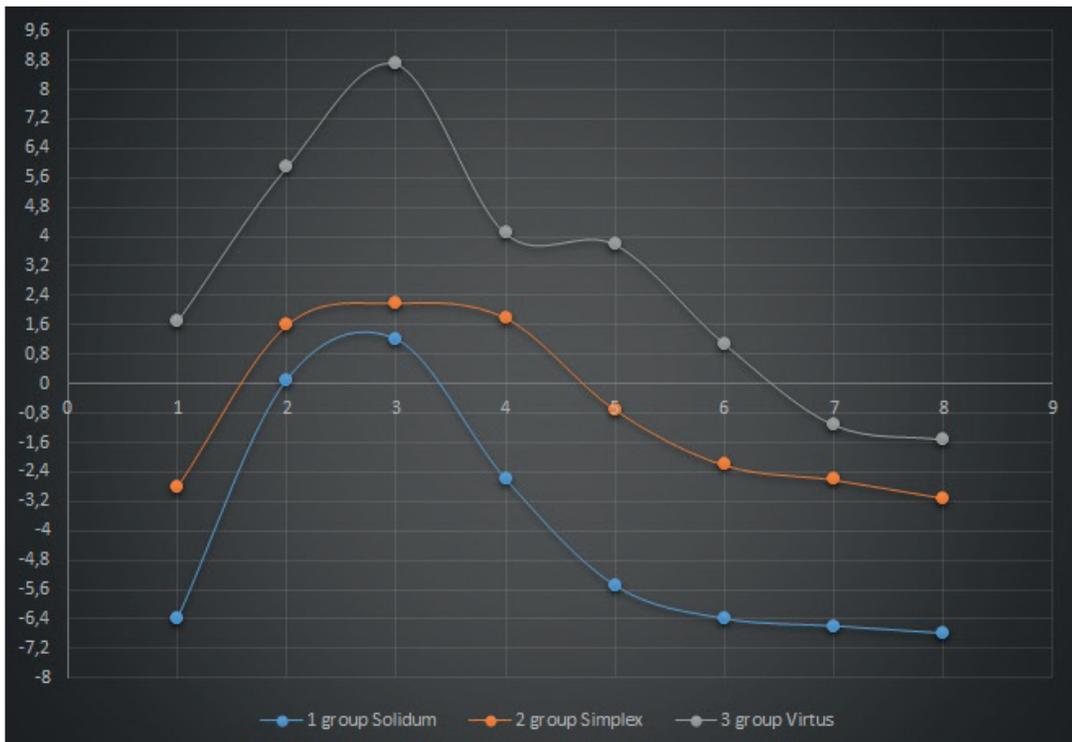
Surgical protocol	Type of implant system "ART IMPLANT"	Patient satisfaction with the treatment				Average rating
		Unsatisfactorily	Satisfactorily	Good	Excellent	
One-stage implantation protocol	Solidum	-	-	4 (8,7%)	11 (23,91%)	4,73±0,14, $p < 0,05$
	Simplex	-	1 (2,7%)	5 (10,87%)	9 (19,56%)	4,53±0,12, $p < 0,05$
Two-stage implantation protocol	Virtus	6 (13,05%)	3 (6,52%)	6 (13,05%)	1 (2,7%)	3,69±0,11, $p < 0,05$
TOTAL:		6 (13,05%)	4 (8,69%)	15 (32,62%)	21 (45,64%)	4,32±0,12, $p < 0,05$

The study was carried out taking into account the main provisions of the GCP ICH and the Helsinki Declaration on Biomedical Research, the Council of Europe Convention on Human Rights and Biomedicine (2007) and the recommendations of the Bioethics Committee of the Presidium of the NAMS of Ukraine (2002). The age of patients ranged from 60 to 70 years, including men - 23 people (50%), women - 23 people (50%). At the same time, the timing of healing, the condition of dental implants, their stability and satisfaction of patients with the treatment and psycho-emotional well-being in relation to treatment using the method of dental implants were studied. In some clinical cases, patients underwent immediate implantation with passive occlusive loading [18,22,24] according to traditional one-

et al., 2007) under local anesthesia Sol. Articaini 4% with vasoconstrictor 1: 100000. Measurement of the degree of stability of the installed dental implants was performed using a mechanical oscillatory - resonance method using the device Periotest M (Gulden Medizintechnik, Germany). The scale of measurements of the mobility index (IP - PTV) ranges from -8 to +50 and the lower this value, the higher the stability of the implant. Interpretations of values of the mobility index: a) from -8 to 0 good osseointegration, complete immobility: implant and can be loaded; b) from +1 to +9 further clinical observation is required, usually loading is not desirable, but possible at the discretion of the physician in the associated multi-support structures; c) from +10 to +50 osteointegration is insufficient, the implant is mobile and cannot be loaded.



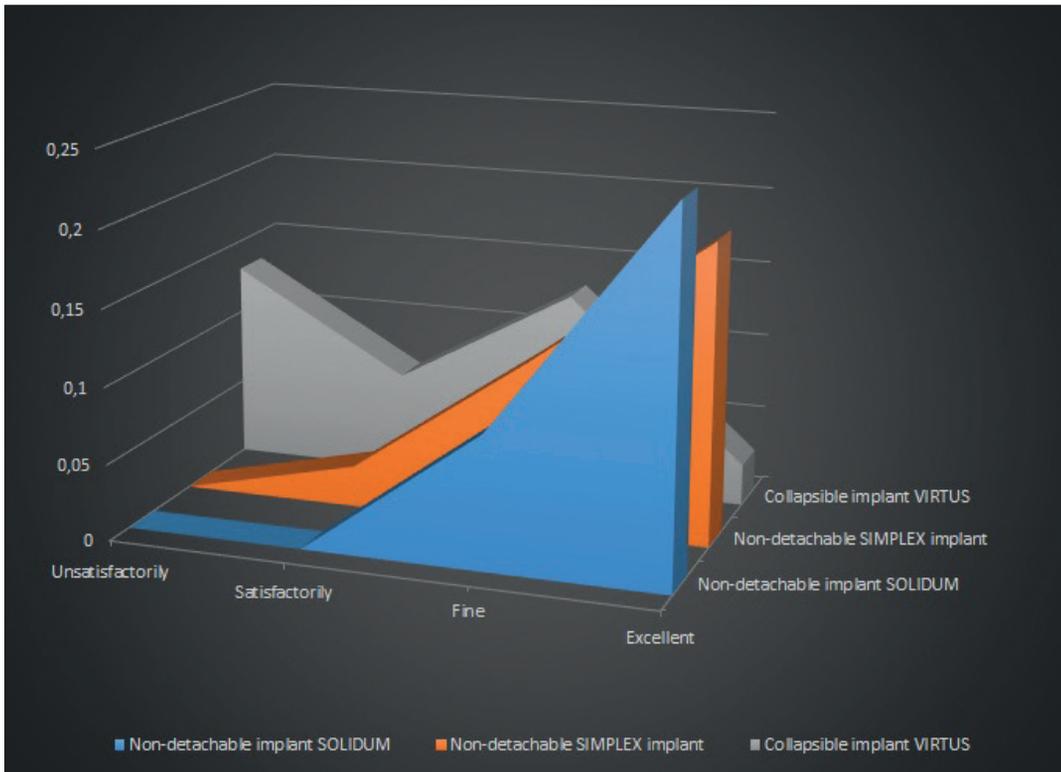
**Fig. 1.** Stages of one-step implantation (Art Implant, Ukraine)



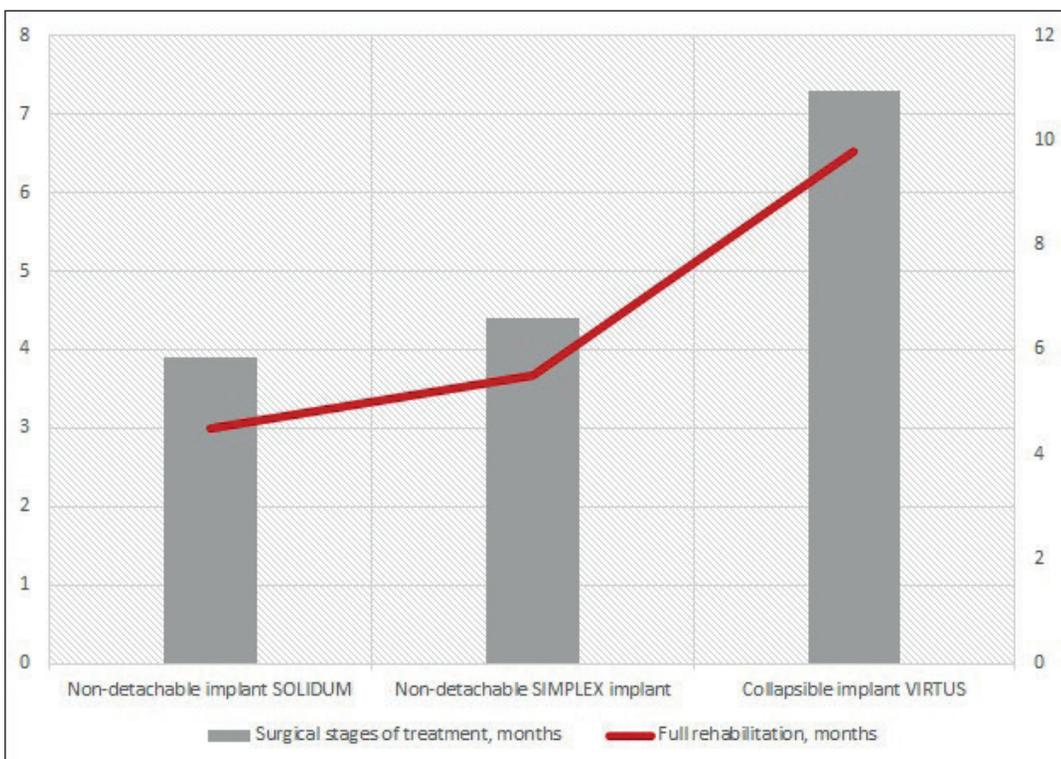
**Fig. 2.** Dynamics of the mobility index of installed dental implants in the studied groups.

A significant increase in the values of the mobility index, in the remote period after implantation, is evidence that the implant is unstable, one of its screws is untwisted or loosened, or there is destruction of peri-implant tissues (peri-implantitis). Therefore, it is recommended to record all the measurements that allow you to control the treat-

ment process in the dynamics. The obtained results were included in the "Questionnaire for assessing the clinical capacity of dental implants" developed by us, compiled on the basis of the above-mentioned criteria, taking into account the features and priorities of the study. The main emphasis was on the stability of the clinical outcome, the timing of



**Fig. 3.** Duration of surgical treatment and complete rehabilitation depending on the types of installed dental implants of the «ART IMPLANT» system



**Fig. 4.** Assessment of patients' satisfaction with the treatment depending on the types of ART IMPLANT dental implants

the surgical stage of treatment and the whole rehabilitation in general, the type of dental implants. To assess the satisfaction and psycho-emotional attitude of patients to the treatment, we used a special questionnaire developed by us with a 5-point scale. The results of laboratory and clinical studies were processed by methods of variation statistics to determine the average value, its errors, Student's t-test for multiple comparisons, using Excel (MS Office 2010,

Microsoft, USA) and STATISTICA 6.0 (StatSoft, USA). Differences in indicators at the level of significance  $p < 0.05$  were considered statistically significant.

## RESULTS

In the study, one of the indicators of osseointegration and reliability of functional load in patients with atrophy of the

alveolar processes of the jaws was the degree of mobility (stability) of the installed dental implants before the final orthopedic stage. The results of these measurements after the surgical phase and the healing period showed that the index of mobility (IP) of installed dental implants in patients with alveolar atrophy of varying degrees corresponded to that in patients with sufficient bone volume and quality and uncomplicated clinical conditions (Table II).

The mobility index (mobility index) of the installed implants indicated its initial increase within 2 weeks and subsequent gradual decrease. Starting from 4 weeks, the mobility of the implants in all study groups gradually decreased and showed little further regression after 6 months, sometimes there was a slight decrease during 6-12 months (Fig. 2).

In patients of the first group with sufficient bone volume of the alveolar processes of the jaws and the use of a single-stage surgical protocol of implantation of the system «Solidum» all follow-up, starting from the end of the 2nd week. The rate of mobility in this group after 4 weeks showed statistically significant changes compared to baseline and averaged  $-2.6 \pm 0.08$ ,  $p \leq 0.05$  relative units, after 3 months this figure increased 2.5 times and amounted to  $-6.4 \pm 0.06$ ,  $p \leq 0.05$ . Subsequently, there was a slight progressive increase in the level of resistance of dental implants up to 1 year. In patients of the second group of the study with insufficient bone volume of the alveolar processes of the jaws and the use of a single-stage surgical protocol of implantation of the system «Simplex», also from 2 to 4 weeks we observe an increase in  $\pm 1.02$ ,  $p \leq 0.05$  relative units, after 3 months this indicator increased 3 times and amounted to  $-2.2 \pm 0.08$ ,  $p \leq 0.05$ . Subsequently, there was a slight progressive increase in the level of resistance of dental implants up to 1 year. In patients of the third group of the study with insufficient bone volume of the alveolar processes of the jaws and the use of two-stage surgical protocol of implantation of the system «Virtus» only 3 months there is a positive dynamics of stability of dental implants, which after 6 months averages  $-1.1 \pm 0.09$ ,  $p \leq 0.05$  and slightly increases up to 1 year  $-1.5 \pm 0.08$ ,  $p \leq 0.05$ . When assessing the duration of treatment of patients based on the analysis of implantation maps, there was a statistically significant difference between non-detachable and collapsible implant structures, as well as between one- and two-stage surgical implantation protocol in favor of non-detachable (monolithic) implants and one-stage surgical protocol.

In patients of study group 1 with sufficient bone volume and the use of non-detachable implants, the duration of surgical stages of treatment was  $3.9 \pm 0.8$ ,  $p < 0.05$ , which is 1.9 times shorter than the study group 3 with insufficient bone volume and using a collapsible implant, where the duration of the surgical stages of treatment was  $7.3 \pm 1.2$ ,  $p < 0.05$ . Regarding the duration of complete rehabilitation, it is 2.2 shorter in the first group of study  $4.5 \pm 0.9$ ,  $p < 0.05$ , than in the third  $-9.8 \pm 1.4$ ,  $p < 0.05$ .

Based on the study, there is a direct relationship between the timing of treatment and the degree of satisfaction of patients with the used protocol of dental implant surgery

and the type of dental implants (table 4). A comparative assessment of patients' satisfaction with the treatment showed a statistically significant difference in the assessment of treatment as «excellent» in the group of patients who used a one-stage surgical protocol of dental implant surgery. The lowest number of higher assessments of patient satisfaction with the treatment was found in the group of patients who used a two-stage surgical protocol of dental implant surgery (Fig. 4).

## DISCUSSION

Due to the widespread use of dental implantation in outpatient practice and the high frequency of atrophy of the alveolar processes of the jaws in elderly patients, much attention is paid to the problems of using this technique in complex anatomical conditions. Despite some successes in the use of various osteoplastic techniques and materials, one of the most difficult problems of such interventions remains complexity, trauma, unpredictability of results and duration. At the same time, the patient's satisfaction with the treatment is directly dependent on these factors and the degree of restoration of masticatory function and aesthetics. Currently, extensive clinical experience in the use of single-stage (monolithic) intraosseous dental implants. Numerous experimental studies of different types of surface and design of the intraosseous part of implants, biomechanical interactions of the implant with the surrounding bone tissue, large-scale randomized studies of long-term results and their condition. Since the patients were carefully selected, and the surgery was performed by the same operator under standard conditions, the higher MBL around implants installed through a two-stage approach can be attributed to the histological process of bone repair after trauma and the surgical procedure done for submerge fixtures [Sharon M Compton, Danielle Clark, Stephanie Chan, Iris Kuc, Berhanu A Wubie, Liran Levin]. The analysis of clinical and experimental studies allows us to conclude that the use of single-stage dental implants in the rehabilitation of patients with atrophy of the alveolar processes of the jaws of various degrees is a reasonable method and creates favorable conditions for functional prosthetics. However, the complex of factors influencing the duration of permanent prosthetics after single-stage dental implantation in this category of patients, in particular the condition of the surrounding bone and soft tissues, the degree of stability (mobility) of implants and its dynamics, the objective duration of treatment and its criteria, the degree of patient satisfaction with treatment [11]. One of the tasks of improving the effectiveness of rehabilitation of patients is to clarify the clinical indications for the use of single-stage dental implantation in the treatment of patients with dentition defects and varying degrees of atrophy of the alveolar processes of the jaws [Cavallaro JS Jr, Greenstein G.]. In this regard, we studied the long-term results of treatment after surgery based on observation of patients. Improving the effectiveness of rehabilitation of patients using the

method of dental implantation is the formulation of the principles of postoperative management and rehabilitation of patients using the method of single-stage implantation. It was found that the main condition for a favorable prognosis of treatment is sufficient primary stability of the installed dental implant, the index of mobility, measured using a mechanical oscillatory-resonance method with the device Periotest M, and should not exceed +10. 97.8% of patients maintained a long-term good functional result of prosthetics, and the success of osseointegration of direct and delayed loading of implants depended on the primary stability during its installation (Yaremenko AI et al., 2013; Testori T., Bianchi F. et al., 2003; Ersanli S., Karabuda C. et al., 2005; Fischer K., Stenberg T., 2006; Zhou W., Han C. et al., 2009). It was found that the reduction in the number of stages and duration of treatment is directly related to increasing patient satisfaction with treatment. As a result, we performed the task of developing and implementing in clinical practice an algorithm of treatment using the methods of single-stage dental implantation in the treatment of patients with varying degrees of atrophy of alveolar processes. The duration of surgical stages of treatment and complete rehabilitation showed statistically significant differences ( $p < 0.05$ ) and was significantly less when using a single-stage protocol of dental implant surgery and non-detachable implants and averaged  $3.9 \pm 0.8$ ,  $p < 0.05$  months against  $7.3 \pm 1.2$ ,  $p < 0.05$  months in implants according to the two-stage protocol. Assessment of patient satisfaction with the treatment was directly correlated with his timing. Collapsible dental implants did not statistically show patient satisfaction with the treatment ( $p > 0.05$ ) compared with the installed non-collapsible dental implants (mean score  $3.69 \pm 0.11$ ,  $p < 0.05$  vs.  $4.63 \pm 0.13$ ,  $p < 0.05$  on a five-point scale).

## CONCLUSIONS

Thus, it should be noted that the clinical use of one-stage surgical protocol of implantation and non-demountable (monolithic) dental implants of the ART IMPLANT system in the rehabilitation of elderly patients with varying degrees of atrophy of the alveolar processes of the jaws demonstrates implants, reduces the waiting period for permanent prosthetics, as well as reduce the duration of the entire treatment, which ultimately leads to increased optimization of treatment effectiveness and patient satisfaction. The use of single-stage conception and single-stage implants is an alternative to the generally accepted two-stage protocol technique and allows in many clinical cases to successfully avoid bone grafting, which is quite traumatic, lengthy, expensive and unpredictable procedure. One-stage (monolithic) implants are free from the disadvantages of two-stage (collapsible), simpler in prosthetics, but at the same time, require a more accurate positioning from the doctor during the operation. They are not an expensive choice, especially in complex clinical cases that require simple solutions.

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#### Conflict of interest:

*The Authors declare no conflict of interest.*

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