Comparative evaluation of the effectiveness of methods of alveolar bone preservation before dental implantation

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Abstract

One of the fundamental factors for the success implantation is the sufficient alveolar bone. The required initial volume of bone tissue before implantation ensures predictability of surgical treatment, reduction of possible complications, and the absence of repeated operations. Was developed, the concept, of preserving the initial volume of the alveolar bone tissue in the area of the future implantation without the use of bone grafts and stimulating the biological potential of own tissue. To improve the regeneration processes, protect the postoperative area, prepare the prosthetics place, and for psychological comfort of patients, was selected a group of patients who used the developed method of bone preserving before implantation by using direct immediate prosthetics. This article presents comparative results of the developed concept with the use of a direct immediate prosthetics and a group where the postoperative period was managed without it. The concept of bone preservation before implantation allows not only to preserve the volume of its own tissues, but also prevents the development of complications characteristic of traditional methods of bone augmentation.

Key words: implantation, bone augmentation, bone preserve, biological potential.

Introduction

In the modern dentistry, patients have a high demand on the treatment. First of all, for patient, become important not only functional qualities and characteristics, but also esthetics aspects of dental prosthetics, also no impact of treatment on quality of life (Abbott & Abbott, 2015; Śmielak & Andruch, 2018).

As we know, after tooth extraction, atrophy of bone tissue from initial values occurs by at least 30-40%. In the future, for successful implantation, we need enough bone volume in the area of the planned operation (Ikbal, Mude, Dammar, & Ekayani, 2020; N.M & Ryzhova, 2020; Tan, Wong, Wong, & Lang, 2012).

Methods of the alveolar bone preserving in the surgical area can reduce bone resorption, and the effectiveness depends on some factors (Guluyk, Varzhapetjan, Lepskiy, Gulyuk, & Taschjan, 2015; Moussa & Dym, 2020; Pogosian, Novozhilova, Gabov, & Ryzhova, 2019; Radović, Obradović-Đuričić, Čairović, Glišić, & Đurišić, 2016). One of the main conditions for the success of surgical treatment by the method of guided bone regeneration is the protection of the postoperative area and the prevention of exposure to the materials used.For realization this, most doctors to use the direct prosthetics (Bonartsev, Muraev, Deyev, & Volkov, 2018; Kim et al., 2013; Mihailovskii, Kulakov, Korolev, & Vinnichenko, 2014). A direct prosthetic is a pre-made prosthesis that is applied to the postoperative area, no later than 48 hours after the treatment (Trezubov., Bulycheva., Azarin., & Volkovoy., 2017; Velichko & N.V, 2014).

Most authors have a different opinion for use direct prosthetics after surgical treatment. But undeniable advantages of direct prosthetics are the faster and less painful recovery postoperative area, decrease rate of bone atrophy, elimination of psychological trauma after tooth extraction, restoration of appearance, prevention of disorders of muscle activity and function of the temporomandibular joint (Radović et al., 2016; Zhakupbekova, Sakenov, Aubakirov, Myltykbaev, & Asanidze, 2015).

Using direct prosthetics is highly increase effectiveness of prosthetic treatment. Because it significantly reduces the time of reparative processes in the alveolar bone of post extraction tooth and contribute to the restoration of the necessary bone density and better adaptation of the patient to the future prosthesis (Gvetadze, Arzhantsev, Perfil'ev, & Sharova, 2013).

The purpose of this study is to evaluate the effectiveness and role of using direct prosthetics after surgical treatment according to the developed method.

Material and Methods

In the dental clinic "Studiya S" in Ekaterinburg city, a study was conducted of three groups of patients aimed of tooth extraction before implantation.

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There was examination about 75 patients in age 25-59, 47 (47%) of them woman and 28 (28%) man. All patients had a good health without any somatic diseases. The criteria for inclusion of patient groups were caries and non caries lesion of tooth, tooth trauma.

To assess the role of the use of direct prosthetics, a comparison was made between the results obtained between the two groups, where the basis for the surgical preparation of the alveolar bone before implantation was the developed concept using replantation of a fragment of one's own tooth. Also, the results of the questionnaire were analyzed, which was carried out on the 3.7th day after surgical treatment and after 1 and 3 months.

In the 1st group of patients, the preparation of the alveolar bone in the area of the extracted tooth was carried out, according to the developed technique (Patent No. 2680797).

In the 2nd group of patients, the alveolar bone was prepared in the area of the extracted tooth using the developed technique (Patent No. 2680797) and the subsequent imposition of a pre-fabricated direct prosthesis in the form of a small removable prosthesis. The first stage of the treatment was taking an impression with the Upeen alginate impression material, preparation of a plaster model, with preliminary removal of the causal tooth on the model, and setting up an artificial tooth followed by making a small removable plate prosthesis.

The technique of replantation of a fragment of an extracted tooth includes atraumatic removal of the causative tooth, the introduction of the obtained platelet mass PRF into the socket of the extracted tooth. Preparation of a fragment of an extracted tooth using a surgical cutter. After antiseptic treatment the fragment was inserted into the socket of the extracted tooth to a depth of 2 mm, fixed with non-absorbable suture material. Imposition of a prefabricated removable denture in the form of a small removable denture.

Dynamic observation of patients included clinical examinations on days 1,3,7 after performed surgical preparation (pre-implantation period) and after implantation in the prepared area (post-implantation period). The main criteria of the clinical examination were the collection of complaints, examination with an assessment of the state of the postoperative wound, the level of oral hygiene, the presence of inflammatory processes in the intervention area, the stability and integration of the fitted fragment, the effect of the direct prosthesis on the postoperative wound.

Patients were also offered to undergo a written questionnaire, which included the following questions: the presence of pain during the healing of the hole, a feeling of discomfort due to the absence of a tooth, difficulties in talking and communicating with people, what difficulties they experienced while wearing a direct prosthesis, how quickly the adaptation to the direct prosthesis went.

X-ray and densitometric studies were performed 1 and 3 months later in each period using a Planmeca ProMax3D cone-beam tomography. The state of the bone tissue, the volume of the alveolar bone in width and height, as well as the quality and degree of bone mineral density in the intervention area were assessed.

Results and Discussion

The results of the clinical trials

All stages of the treatment included a clinical examination after surgical preparation and implantation on the 1,3,7 days after surgery and after 1,3 months.

In the 1st group of patients, which included 26 people, as a result of collecting complaints, it was found that 30% (8) of patients noted psychological discomfort due to the absence of a tooth, in particular, during communication with people.

10% (3) patients, during the clinical examination in the pre-implantation period, on the 7th day after the surgical preparation, noted deterioration in the level of oral hygiene, as well as the presence of areas of hyperemia in the replant area. The participants in this group received an additional training on the correction of individual oral hygiene and re-examination after 7 days. Re-examination revealed improved hygiene and the absence of an inflammatory component in the area of the fixed graft. Also, according to the results of the questionnaire, it was revealed that 20% (6) of patients noted pain after tooth extraction, and during the healing period after surgical treatment. 5% (2) of patients noted deterioration in the effectiveness of chewing during meals.

In the 2nd group, patients (15 people), during the clinical examination, collection of complaints, and according to the results of the questionnaire, noted the absence of changes in social activity and discomfort due to the removal of the causative tooth. 20% (3) of patients complained of a feeling of discomfort and pain in the area of adhesion of the direct prosthesis.

Correction and additional clinical relocation of the small removable denture were carried out, after which the patients did not present any more complaints. Patients in this group noted the absence of any kind of pain after tooth extraction, as well as in the postoperative period. 10% (2) of patients noted difficulties during a conversation due to the presence of a removable prosthesis in the oral cavity, but in 2 weeks, after the correction and subsequent adaptation, the complaints were no longer presented. There were no changes in the level of hygiene of the 2nd group of patients.

X-ray diagnostics with usage of a cone-beam tomograph was carried out 1 and 3 months later in

the pre-implantation and post-implantation periods. The purpose of this study was to evaluate the results obtained in the intervention area in comparison with the initial data in the pre-implantation period, and the dynamics of maintaining the result after the implantation. The main criteria were the assessment of the width and height of the alveolar bone in the area of the causative tooth and, subsequently, the alveolar bone in the area of the extracted tooth after surgical preparation.

The results of the obtained data of X-ray diagnostics are presented in Table 1.

Table 1 The results of the computed tomography data obtained in the study area after the performed surgical preparation

№ of group	The initial volume of the alveolar bone before tooth extraction		The volume of the alveolar bone after 1 month		The volume of the alveolar bone after 3 months	
	Width (mm)	Height (mm)	Width (mm)	Height (mm)	Width (mm)	Height (mm)
1	6.31±0.35*	6.43±0.40*	6.53±0.25	7.12±0.33*	7.03±0.22*	7.47±0.3*
2	6.52 ±0.40*	6.12±0.32*	6.90±0.45	6.84±0.23*	7.45±0.31*	8.01±0.3*

*- statistically significant differences at p≤0.5

To assess changes in the quality of bone tissue in the area of the causative tooth after the performed surgical preparation, a densitometric study was performed with the analysis of images obtained on a Planmeca ProMax3D cone-beam computed tomograph. The level of mineral density was determined in the projection zone of the apex of the studied tooth and, subsequently, the alveolar bone. The unit of measure for bone density is - Hu (Hounsfiel). The results are shown in Table 2.

Table 2 The results of the study of bone mineral density after performed surgical preparation

№ group	Bone density before tooth extraction, Hu	Bone density after 1 month , Hu	Bone density after 3 months , Hu
1	540 ±102*	370 ±107*	645 ±95
2	662 ±100*	383 ±106*	756 ±103*

*- statistically significant differences at p≤0.05

As a result of the analysis of the obtained data of a computer study carried out before and after the surgical preparation of the alveolar bone in the area of the causative tooth (pre-implantation period), the following results were obtained. In the first group of patients, where the alveolar bone was prepared using the developed method, without replacing the missing tooth with a direct prosthesis, the height of the alveolar bone was restored by 0.69 mm (9.69%) after 1 month, and by 1.04 mm (13, 92%) 3 months after surgical preparation from the initial level.

In the width of the alveolar bone, restoration of the bone tissue volume was also achieved by 0.22 mm (3.37%) 1 month after surgical preparation, and by 0.72 mm (10.24%) after 3 months. According to the results of densitometric studies, after 1 month, there was a decrease in bone density by 170 Hu (45.95%), but after 3 months, an improvement in the quality of bone tissue was obtained by 105 Hu (16.28%) from the initial data.

In the second group of the study, where the socket of the extracted tooth was prepared by the developed method with direct prosthetics, according to the results of the data obtained by the computed tomography method, it was noted that the height of the alveolar bone was restored by 0.72 mm (10.53%) 1 month after the surgical preparation, and 1.89 mm (23.6%) after 3 months. The restoration of the width of the alveolar bone was also achieved by 0.38 mm (5.51%) after 1 month, and by 0.72 mm (10.53%) after 3 months after the treatment from the initial level.

After reaching the optimal volume of bone tissue in the area of the extracted tooth, all patients of the study groups underwent implantation. After 1 month and 3 months, the analysis of X-ray images obtained by the method of computed tomography, as well as densitometric studies, was carried out. Changes in the quality and quantity of bone tissue in the area of the installed implant, as well as the dynamics of the results obtained were assessed.

The results of the computed tomography data obtained after the implantation (post-implantation period) are presented in Table 3.

Table 3 Results of the computed tomography data obtained in the study area after performed implantation

№ of group	Initial volume of alveolar bone before implantation		Volume of alveolar bone after 1 month		Volume of alveolar bone after 3 month	
	Width (mm)	Height (mm)	Width (mm)	Height (mm)	Width (mm)	Height (mm)
1	7.03±0.22*	7.47±0.3*	6,24±0,42	7.47±0.3	6,33±0,26*	7.47±0.3*
2	7.45±0.31*	8.01±0.3	6,98±0,32*	8.01±0.3	7,12±0,36	8.01±0.3

Note: statistically significant differences at p≤0.5

The results of the dynamics of changes in the quality of bone tissue in the study area after implantation are presented in Table 4.

Table 4 Results of the study of bone mineral density after performed implantation

№ of group	Bone density before implantation, Hu	Bone density after 1 month, Hu	Bone density after 3 months, Hu
1	645 ±95	450±110*	601±120*
2	756 ±103	560 ±102*	712±101*

*- statistically significant differences at p≤0.5

As a result of the analysis of the data of X-ray and densitometric studies after the implantation (post-implantological period), the following results were obtained. In the 1st group of patients, after implantation, there was a decrease in the width of the alveolar bone after 1 month by 0.79 mm (12.6%) and by 0.7 mm (11.06%) in comparison with the initial data. There were no changes in the height of the alveolar bone. Analysis of bone mineral density shows a decrease in bone mineral density 1 month after implantation by 195 Hu (43.31%), and by 44 Hu (7.32%) from the baseline data after 3 months.

In the 2nd group of patients, there was a decrease in the width of the alveolar bone by 0.47 mm (6.73%) 1 month after the implantation, and by 0.33 mm (0.53%) 3 months after implantation, compared with initial data. Bone mineral density decreased by 186 Hu (35%) 1 month after implantation, and 44 Hu (6.18%) after 3 months compared with the initial data.

Conclusion

The developed concept of bone tissue restoration with replantation of a fragment of an extracted tooth allows preserving the alveolar bone without loss in a short period of time without the use of bone grafts and repeated surgical interventions. The use of a direct prosthesis after a surgical intervention can significantly accelerate the reparative processes in the area of the extracted tooth, protect the surface of the postoperative wound, adapt the patient in psycho-emotional terms and reduce the discomfort associated with the surgery, as well as a probabillity of an inflammatory process. Patients in this group noted the absence of pain after surgical interventions, better adaptation to subsequent orthopedic treatment, as well as the absence of discomfort while eating, communicating with people. Patients in this group were socially adapted throughout the study, which clearly improved the quality of life.

Analyzing the results of the data obtained by the method of computed tomography and densitometry, in the group where a direct prosthesis was used, it can be noted the effectiveness of direct prosthetics not only on the quality and quantity of bone tissue compared to the group without prosthetics, but also social adaptation, which makes it possible to reduce the stress for the body.

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