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THE ROLE OF PRELIMINARY EXPANSION OF SOFT TISSUES BEFORE GBR

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Abstract:

The deficiency of soft tissues observed in atrophy of the alveolar ridge creates certain difficulties for performing guided bone regeneration (GBR), the success of which to a certain extent depends on the closure of the wound without tension. The study examined the possibilities and the effect of preliminary expansion of soft tissues by an expander directly on microcirculation in the area of administration, and in general on the further results of the GBR.

Keywords: soft tissue expander, osteoplasty, bone atrophy, augmentation, guided bone regeneration (GBR), laser doppler flowmetry (LDF), microcirculation, oral mucosa

INTRODUCTION. Atrophy of the bone tissue of the alveolar process/part of the jaw creates significant difficulties for the successful rehabilitation of patients using dental implants as a support for orthopedic structures. It was found that in 64% of cases, the main cause of alveolar bone atrophy is a prolonged absence of teeth, as well as: traumatic removal – 17%, jaw injuries – 11%, unsuccessful bone grafting – 8%. And also, about 60% of primary patients who have sought dental care have bone atrophy and need preliminary bone reconstruction for the purpose of dental implantation [1, 2, 6].

It is known that the toothless part of the alveolar ridge, which does not experience a chewing load, is a functionally inactive bone. According to E.M.Kelenjeridze (2006), changes also occur in the mucous membrane of the alveolar bone in the atrophy zone. The effectiveness of microcirculation in the gum tissues of a partial dentition defect decreases in the absence of 1 tooth by 12%, in the absence of 2-3 teeth by 21%. This is due to a decrease in the intensity of blood flow by 7 and 37%, respectively, due to the involution of functionally inactive vessels of the microcirculatory bed. With significant atrophy of the bone tissue of the jaws, there is a significant decrease in blood flow, which negatively affects not only the healing processes of soft tissues, but also the process of reparative osteogenesis of the transplanted bone tissue [3, 4, 5, 8].

Along with the lack of bone volume, there is also a shortage of soft tissues during atrophy, which creates certain inconveniences during guided bone regeneration (GBR). It should be noted that Istvan A. Urban and Alberto Monje identified 4 principles of successful guided bone regeneration, among which the primary closure of the wound without tension to minimize the risk of membrane exposure and the creation of space to prevent tension are directly related to the mucous membrane of the recipient zone. These principles require preliminary planning of the shape of the muco-periosteal flap (MPF), and in most cases additional laxative incisions are necessary to avoid tension during wound suturing [7, 9, 10, 11].

Thus, the above factors determine the need to develop optimal methods for increasing the volume of soft tissues in the area of planned osteoplastic surgery.

AIM. To study the effectiveness of using a self-expanding expander to increase the volume of soft tissues before guided bone regeneration.

MATERIALS AND METHODS. The study involved 10 patients with partial secondary adentia and atrophy of the alveolar ridge (more than 4 mm), who applied to the department of surgical dentistry of the clinic of the South Kazakhstan Medical Academy (Shymkent, Kazakhstan). The age of the patients ranged from 38 to 60 (mean age – 48.6±7.2 years).

The criteria for excluding patients from the study were the following: age younger than 18 and older than 75 years, complete adentia of both jaws, significant atrophy of the bone tissue of the jaws (category of atrophy "D" – complete loss of the alveolar process and atrophy of the basal bone, severe atrophy) according to the classification of Misch C.E., Judi K.W.M. (1985), which requires the use of autografts from extraoral donor zones), metabolic

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diseases (uncontrolled diabetes, etc.), pregnancy or breast-feeding, uncontrolled periodontitis, chronic diseases at the stage of decompensation, oncological diseases, radiation therapy in the head and neck, violation of the hemostasis system, anticoagulant therapy, allergy to the materials used, current smoking habit and low level of oral hygiene, ongoing treatment with drugs affecting bone metabolism (bisphosphonate, recombinant parathyroid hormone and denosumab), drug and alcohol dependence, mental illness, taking immunosuppressive drugs and corticosteroids, pronounced bruxism, autoimmune and inflammatory diseases of the oral cavity, AIDS, hepatitis C, tuberculosis.

All 10 patients included in the study had atrophy of the alveolar part of the mandible and needed to increase the height and/or width of the crest by more than 4 mm with insufficient soft tissue. 6 people had an included defect, 1 – terminal unilateral, 1 – terminal bilateral and 2 – combined dentition defect.

After a clinical examination and verification of patients' compliance with the criteria for inclusion in the study, a treatment plan was drawn up. Prior to the osteoplastic surgery, a preliminary soft tissue expansion was performed in the field of reconstruction by introducing a hydrogel-type soft tissue expander (TissueMax, Osstem, South Korea).

The soft tissue expander consists of methyl methacrylate and 1-vinyl-2-pyrrolidone in a silicone shell. Osmotic expansion of tissues occurs due to hydrogel, which increases its volume due to the osmotic effect. The expander is based on a semi-permeable silicone membrane containing a hypertonic sodium chloride solution. The osmotic gradient ensures a continuous flow of tissue fluid into the expander. As a consequence, the volume of the expander increases with the concomitant growth of soft tissues.

Depending on the required volume of soft tissue expansion, 3 types of expander were used, differing in volume and design. The final expanded volume was received after 28 days.

The study of the mucous membrane of the recipient zone was carried out during control examinations – a visual assessment of the severity of collateral edema, hyperemia and hyperthermia of soft tissues was carried out. Instrumental methods (ultrasound, LDF, 3D scanning) were also used to more accurately assess changes in the volume of soft tissues, the state of microcirculation, etc.

Ultrasound examination of the expander insertion area was performed using the E-CUBE 9 Diamond imaging system (Alpinion medical systems®, South Korea). To assess the thickness of the attached gum, an intraoral sensor IO3-12 (frequency 3~12 MHz) was used. Changes in the volume of the tissue expander and the thickness of the gum above the expander were measured by estimating the height and width during expansion at intervals of 3-5 mm; then their average values were calculated.

Alginate impressions were obtained in all patients and models of recipient zones were made at the initial stage (preoperative, during the initial examination) and at the end of soft expansion. The casts were scanned using a Cerec 3D optical scanner (Sirona Dental Systems GmbH, Germany), and the resulting images were imported into the CAD Geomagic Studio® 2013 software (Raindrop Geomagic, North Carolina, USA) to assess changes in the size of soft tissues.

To study the state of microcirculation of the mucosa of the alveolar ridge in the area of the planned implantation and on the symmetrical side, the method of laser Doppler flowmetry (LDF) was used on the laser analyzer of tissue blood flow "LAKK-02" ("Lazma", Russia).

Statistical data processing was carried out in the traditional way and included the control of the collected material for compliance with the objectives of the study, grouping the data obtained, bringing them into statistical tables, calculating statistical indicators, evaluating and analyzing them. A software package for biomedical research was used. The data were entered into specially compiled tables in the Microsoft Office Excel 2010 program for the Windows XP operating system, as well as the statistical software package Stat Soft Statistica v6.0. The same programs were used to construct graphs and diagrams to illustrate the changes and interrelation of the statistical data of the study.

RESULTS OF THE STUDY. The soft tissue expander was administered under local anesthesia (4% articaine hydrochloride with adrenaline 1:100000). An expander of a suitable size was pre-selected using a special surgical template corresponding to the initial and final volumes of the expander.

Next, vertical incisions were made 5-10 mm long from the crest to the buccal side on each mesial and distal side of the defect. Then a tunnel of the appropriate size under the periosteum was prepared with a special elevator. The expanders were inserted into a subcostal "pouch" prepared under local anesthesia and monitored using a special surgical template to make sure that the expander was placed without tension in the prepared place. The expander

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was fixed with screws on each side to prevent displacement or displacement. The incisions were sewn with monofilament nylon suture material Dermalon® 4-0 or 5-0. Daily mouthwashes with chlorhexidine solution were prescribed to minimize the possibility of infection. Any divergence of wounds, perforations, inflammation, infection or postoperative complications were recorded at each visit.

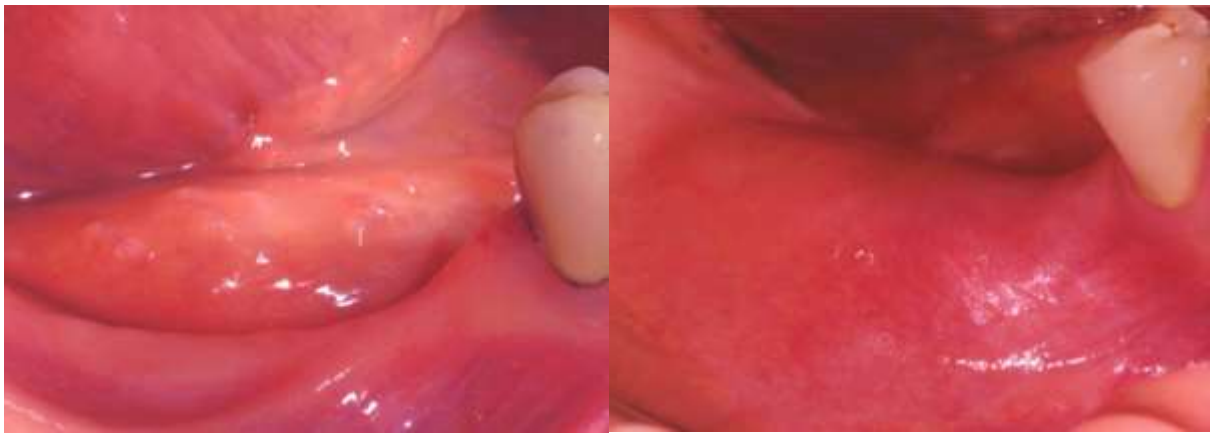

Fig. 1. Initial state and the final result of soft tissue expansion (on day 28)

During control examinations, patients had no complaints of discomfort, pain or redness of the mucous membrane in the area of expander insertion. The expansion of soft tissues passed without cases of inflammation, rupture or damage.

Ultrasound examination of the gum thickness above the dilators showed that the mucous membrane did not thin after tissue expansion. Thus, the value of this indicator before the expansion was equal to 1.52 ± 0.12 mm, and after the expansion – 1.45 ± 0.24 mm, which indicates a minimal clinical risk of divergence and injury of tissues during the expansion.

Soft tissue changes after a 28-day expansion period were quantified as 6.84±1.52 mm vertically (measured in the vestibular region) and 6.58±1.46 mm horizontally (measured 2 mm below the cement-enamel joint). Since in all cases the injection was carried out through the buccal access, the increase in the volume of soft tissues from the lingual side was much less.

According to the results of the digital analysis of the models, the increase in the volume of soft tissues after expansion by the expander was 1243.7 ±5.6 mm3.

The results of LDF before the introduction of the expander indicated an increase in passive modulation of tissue blood flow and obstructed venous outflow in the microvascular bed (an increase in pulse fluctuations by 10%). Vascular tone was reduced compared to the symmetrical side, which indicates vasoconstriction. In the mucous membrane of the alveolar ridge, there was a decrease in the level of microcirculation due to a decrease in the masticatory load in these areas. These parameters were re-measured on the 3rd day after the introduction of the expander. The values indicated the development of hyperemia in response to surgery. LDF, performed 28 days after the introduction of the soft tissue expander, characterized the preservation of slight hyperemia in microvessels in response to stretching; positive shifts in microcirculation indicators of the studied area of the mucosa of the alveolar ridge were noted.

In addition, the parameters (length, width, volume) were compared with the manufacturer's data for each expander size used in the study (Table 1).

Table 1

Comparative characteristics of changes in the size of soft tissue expanders after expansion, (M±m)

Types	L, mm		D, mm		V, mm^3	
	clinic	manufac	clinic	manufac	clinic	manufac
TEX 007 (n=5)	17,8 ±0,66	20	6,26 ±0,3	7	624,6 ±3,87	700
	89%		**89,4%**		**89,2%**	
TEX 010 (n=4)	19,4 ±0,26	22	8,4± 0,18	9	1170± 6,5	1300
	88,2%		**93,3%**		**90%**	
TEX 021 (n=4)	22,2 ±0,19	24	10,2 ±0,16	11	1947, 3±6,5	2100
	92,5%		**92,7%**		**92,7%**	

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Based on the data, an expansion of the soft tissues of the recipient zone was obtained to some extent smaller in size compared to the parameters specified by the manufacturer. The largest increase in volume was observed in expanders of the TEX 021 type (92.7% of the manufacturer's volume). On average, the size of the expanded expander was 90% of the parameters stated in the instructions for each of the models, which should be taken into account when planning treatment.

When performing the GBR using the traditional method (with "open" surgical access), after the stage of bone augmentation and membrane fixation, suturing was easily achieved without tension and without additional laxative vertical incisions.

CONCLUSIONS. Thus, the use of self-expanding expanders for preliminary expansion of soft tissues in the area of the planned GBR allows for sufficient tissue growth, which, in turn, has a beneficial effect on the further stages of treatment of partial secondary adentia with atrophy of the alveolar ridge. It should be noted that the short period of stay under the periosteum and gum of the hydrogel-type soft tissue expander avoids the formation of a connective tissue capsule around the expander. The above-described technique of increasing the volume of soft tissues helps to increase the efficiency of the GBR and reduce the frequency of complications, because it allows you to optimally form a muco-periosteal flap, apply sutures without tension, and there is also no need to perform laxative incisions, thereby eliminating the factor of additional traumatization of surrounding tissues.

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