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RESULTS OF GUIDED BONE REGENERATION AFTER PRELIMINARY SOFT TISSUE EXPANSION

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Abstract
Bone atrophy of the alveolar process/part of the jaw poses a significant challenge for the successful rehabilitation of patients using dental implants as a support for prosthetic constructions. Clinical studies confirm that bone resorption in the edentulous jaw region continues until it reaches the body of the jaw and is associated with a lack of internal loading. The edentulous part of the alveolar ridge that is not under chewing pressure is functionally inactive bone. The alveolar ridge mucosa in the atrophy zone also undergoes changes.

Keywords: soft tissue expander, osteoplasty, bone atrophy, augmentation, guided bone regeneration (GBR), echoosteometry, muco-periosteal flap (MPF)

Introduction

Currently, dentists are increasingly faced with the problem of bone deficiency, which requires additional interventions to replenish the necessary bone volume for subsequent dental implantation. 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 effectiveness of the use of the method of preliminary expansion of soft tissues before the GBR and the long-term results of subsequent installation of dental implants and orthopedic construction.

Tan W.L. et al (2012) found that 6 months after extraction, horizontal bone loss (3.79±0.23 mm) was greater than vertical bone loss (1.24±0.11 mm in the cheek region, 0.84±0.62 mm mesially and 0.80±0.71 mm distally). The percentage change in vertical dimensions during this period was 11-22%. The percentage change in horizontal dimensions after 3 months was 32% and 29-63% after 6-7 months. Soft tissue changes showed a 0.4-0.5 mm increase in thickness after 6 months on the cheek and lingual sides. Horizontal changes in hard tissue and soft tissue dimensions (0.1-

6.1 mm loss) were more significant than the vertical changes (from 0.9 mm loss to 0.4 mm increase) during follow-up periods up to 12 months.

In addition to the lack of bone volume, soft tissue deficits can be observed in atrophy, which makes guided bone regeneration (GBR) very inconvenient. Note that Istvan A. Urban and Alberto Monje identified 4 principles for successful guided bone regeneration, among which primary closure of the wound without tension to minimise the risk of membrane exposure and creating space to prevent tension are directly linked to the mucosa of the recipient area.

Reconstructive surgery to correct bone volume deficits involves an incision in the middle of the alveolar ridge with a wide peeling of the mucosal-periosteal flap. It should be noted that the minimal incision and shape of the flap (to preserve the integrity of the periosteum) affects the healing process of the bone on the receiving side of the bed. Therefore, when improving the above techniques for alveolar ridge remodelling, the focus is on the incision design and shape of the mucosal-periosteal flap as well as soft tissue plastics to increase the effectiveness of bone grafting, prevent postoperative complications and achieve the most aesthetically pleasing result. These principles require planning of the shape of the mucosal-periosteal flap (MPF) beforehand, and in most cases additional indentations are necessary to avoid tension during suturing.

Thus, the factors described above necessitate the development of optimal soft tissue augmentation techniques in the area of the planned osteoplastic surgery.

Objective of the Study

To study the effectiveness of the self-expanding expander for soft tissue augmentation prior to guided bone regeneration.

Materials and Methods

60 patients with partial secondary adentia and alveolar ridge atrophy were examined and were treated in the surgical dentistry department of the South Kazakhstan Medical Academy clinic (Shymkent, Kazakhstan) in 2021-2022. Among those studied there were 25 (41.7%) males and 35 (58.3%) females. Patients ranged in age from 20 to 75 years, with a mean age of 45.16±0.68 years without regard to gender.

Exclusion criteria were as follows: age under 18 and over 75 years, complete edentulism, significant jaw bone atrophy ("D" for complete loss of alveolar process and basal bone atrophy, severe atrophy) according to Misch C.E. classification, Judi K.W.M. (1985), which requires the use of extraoral donor sites), metabolic diseases, pregnancy or lactation, uncontrolled periodontitis, chronic diseases in

decompensation, cancer, haemostasis disorders, anticoagulant therapy and allergies to the materials used, Smoking and poor oral hygiene, bisphosphonates, recombinant parathyroid hormone and denosumab, drug and alcohol dependence, mental illness, immunosuppressants and GCS, severe bruxism, autoimmune and inflammatory oral diseases, AIDS, hepatitis C, tuberculosis.

Complaints and anamnesis were studied and analysed. The etiology of the defects, the chronology of the therapeutic and orthopaedic care, and previous illnesses were identified.

Patients were divided into 3 groups by random sampling depending on the tactics and osteoplastic materials used in NCD ("open" surgical access):

Group 1 - 20 patients - Bone-D XB (MedPark, South Korea) xenograft was used in ECD;

Group 2 - 18 patients - autograft from the retromolar region of the lower jaw was used;

Group 3 - 22 patients - a mixture of autograft (bone shavings) from the retromolar region and Bone-D XB (MedPark, South Korea) in a 1:1 ratio was used. This group of patients was divided into 2 subgroups depending on the method of mucosal-periosteal flap (MPF) formation:

3a - 12 patients - SLF was formed by the traditional method: making a trapezoidal incision in the reconstruction zone;

3b - 10 patients - preliminary soft tissue expansion of the recipient area by introducing a soft tissue expander of the hydrogel type (TissueMax, Osstem, South Korea) was performed. The soft tissue expander consists of methyl methacrylate and 1-vinyl-2-pyrrolidone in a silicone sheath. The osmotic expansion of the tissue is due to the 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. An osmotic gradient ensures a continuous inflow of tissue fluid into the expander. As a consequence, the volume of the dilator increased with concomitant soft tissue growth. Depending on the amount of soft tissue expansion required, 3 types of expanders were used, differing in volume and design: TEX007, TEX010, TEX021. The expanders were inserted into a subperiosteal "pouch" prepared under local anaesthesia and controlled using a special surgical template to ensure that the expander fit into the prepared position without tension. The final dilated volume was obtained after 28 days.

Postoperative pain, local hyperemia and collateral swelling were assessed during follow-up examinations. Bone volume was recorded using a Gendex GXCB-500 CT scanner (KavoDental, Germany) at the initial examination (before surgery), 2 weeks

and 6 months after the NCD (before dental implantation) and, if necessary, after prosthetics with the support of implants placed.

Bone density in the study was investigated using CLCT as well as echosteometry. Echosteometry was performed using an EOM-02 diagnostic device, which uses a pulsed method to measure the velocity of ultrasonic vibrations in tissues.

A total of 158 TS III SA® (Osstem, South Korea) dental implants were placed. Osstell ISQ determined the stability of the dental implants at the stage of their placement (primary stability), during the gingival former fixation (secondary stability), at the stages of prosthetic treatment - during withdrawal of impressions, fixation of constructions.

IO3-12 intraoral transducer (frequency 3~12 MHz) was used to estimate the thickness of the attached gingiva. Changes in tissue expander volume and gingival thickness above the expander were measured by estimating the height and width during the expansion at 3-5 mm intervals; their average values were then calculated.

Statistical data processing was carried out in Microsoft Office Excel 2010 for Windows XP and Stat Soft Statistica v6.0 statistical software package. The same programmes were used to construct graphs and charts to clearly illustrate the changes and interrelationship of statistical data in the study.

Results of the study. Total 73 NCD operations were performed: in the 1st group - 24, in the 2nd group - 21, in the 3rd group - 15 and in the 3rdb group - 13 operations.

In 52 cases of ICH of the patients in 1, 2 and 3a groups after a flap was put in its place, the periosteum was dissected at the base of the SNL in staggered order in order to close the wound without tension. In patients in group 3b, the traditional method (with "open" surgical access) of performing RCD after the stage of bone augmentation and membrane fixation, suturing was easily achieved without tension and without additional loosening of the vertical incisions. A similar dynamics of pain syndrome was observed in all groups - pain intensity values close to the average on the day of surgery, an increase in its severity on the 3rd day after ICD and a gradual decrease to complete absence 2 weeks after surgery. It should be noted that in Group 3b, which had preliminary soft tissue expansion, the pain disappeared on the 10th day after the operation, while Group 1 still had slight pain on the 14th day after ICD.

The high severity and duration of the pain syndrome when using the traditional method of bone grafting without prior soft tissue expansion led to the need to prescribe analgesics. This phenomenon is associated with the performance of additional loosening incisions during the NCD. The need for them arose on day 3, when the pain syndrome was most pronounced, and persisted for the next 3-4 days. At the same time, there was no need for analgesics in group 3b patients. Collateral

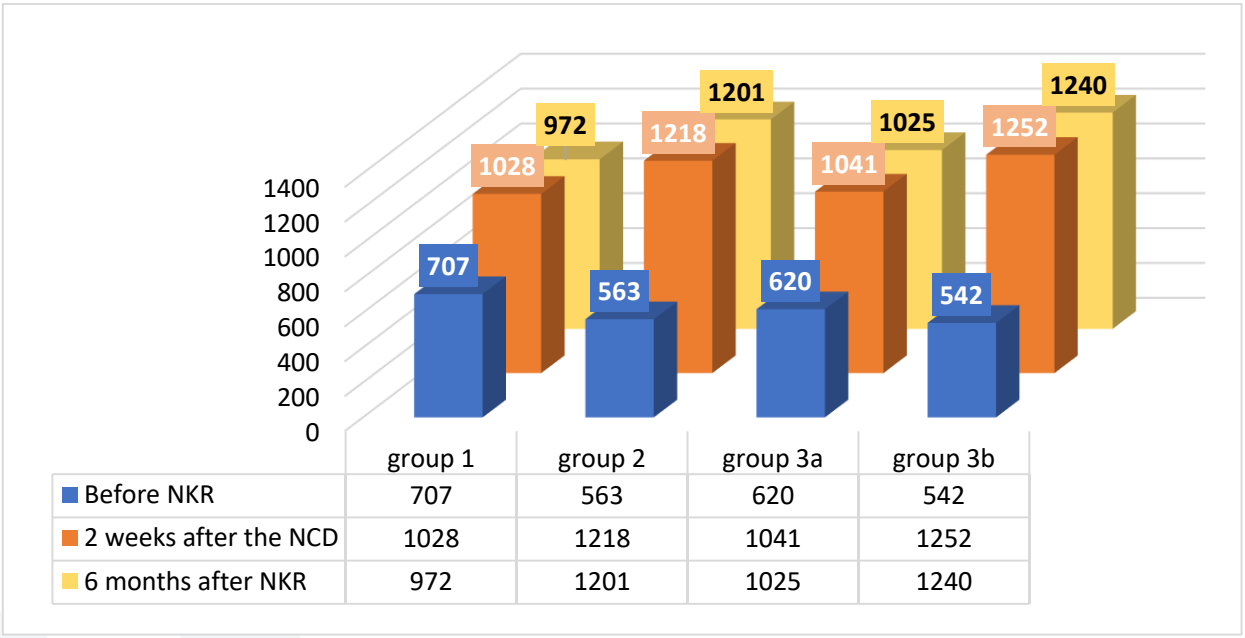
oedema was present in all subjects, but to varying degrees. There was a similar severity of collateral edema in all groups, with values close to the mean on the day of surgery, an increase in the severity of edema on the 3rd day after ICD and a gradual decrease until it disappeared two weeks after surgery. In group 3b with preoperative soft tissue expansion, the swelling disappeared as early as day 10 after surgery and was more often localised in one anatomical area, whereas in the remaining groups, the swelling spread to neighbouring anatomical areas in the majority of subjects. Less soft tissue trauma in NCD in group 3b contributed to less postoperative swelling, which was not only less severe but also less prolonged compared to patients in the other groups. A few Group 1 cases still had mild swelling on the 14th day after ICD.

The timing of wound healing after ICD was monitored and was similar in all patients. Healing was somewhat faster in Group 3b patients than in the rest of the groups: by the 10th day of observation the percentage of patients with a complete healing was 40%, but in other groups the average figure was 18%. The mean healing time was 14.5±0.5 days in groups 1, 2 and 3a, and 12±0.5 days in group 3b.

The vast majority of patients had a favourable postoperative period, but some of them experienced suture loosening on day 7-8. The proportion of these postoperative complications varied in the study groups. There were no obvious signs of inflammation. Some patients had moderate neurosensory disturbances: decreased skin sensitivity in the area of the chin, half of the lip and the corner of the mouth on the side of the operated lower jaw area. These abnormalities appeared from 4-5 days after ICD and completely disappeared by the 2nd month. One patient in group 3b showed reduced skin sensitivity in the chin area on the 3rd day after ICD and disappeared on the 12th day. Soft tissue ischemia due to collateral edema was the most likely cause of these neurosensory disturbances.

A decrease in the height and width of the alveolar ridge of the jaw was detected 6 months after ICD. This phenomenon was associated with the process of bone remodelling of the graft and the loss of partial bone volume. At the stage of dental implants placement, the increment of the alveolar ridge height of the maxilla in group 1 was 11.9%, in group 2 - 15.5%, in group 3a - 15.9% and 33.7% in group 3b patients. The increment on the lower jaw was 15.1%, 18.5%, 18.6% and 56.8%, respectively. A comparative evaluation of the height and width of the bone tissue revealed that the growth rates were higher in patients after preliminary soft tissue expansion (group 3b) - 4.21±0.03 mm on the upper jaw and 4.52±0.03 mm on the lower jaw, 5.81±0.23 mm and 5.7±0.03 mm respectively. The density of the bone regenerate was determined in the course of treatment. The greatest increase in 2 weeks after the bone grafting surgery was observed in the test group 3b (710±21.6 HU), the least one - in

the group 1 (321±15.2 HU), which is likely to be related to the use of autograft in these patients. Densitometry after 6 months showed some reduction in density associated with remodelling processes. The lowest density loss was observed in group 3b patients with an increase of 698±14.8 HU (Figure 2).



	group 1	group 2	group 3a	group 3b
Before NKR	707	563	620	542
2 weeks after the NCD	1028	1218	1041	1252
6 months after NKR	972	1201	1025	1240

Fig. 2. Comparative characterisation of changes in bone density over time

Group 3b patients had a higher primary implant stability score of 70±15 conventional units. The limit of variation was as follows: the minimum value was 55 conventional units, and the maximum value was 85 conventional units. The lowest values were found in Group 1 patients - 60±6 conventional units. The indices in the patients of the 2ndand 3rd groups were practically identical: 68±15 conventional units and 65±12 conventional units respectively.

The indices of the implant stability in these patients (traditional NCD with autograft) increased and got closer to the indices of the 3b group (NCD with preliminary soft tissue expansion) only 3 months after dental implantation (at the stages of prosthesis) - 76±8 conventional units. The limit of variation ranged from a minimum value of 68 conventional units to a maximum value of 84 conventional units (Fig. 3).

By the end of orthopedic treatment stage (fixation of orthopedic structure), the values of dental implants stability in all groups increased: in group 1 - to 78±8 conditional units, in group 2 - to 82±6 conditional units, in group 3a - to 80±6 conditional units, in group 3b - to 88±5 conditional units. The highest values were obtained in group 3b patients.

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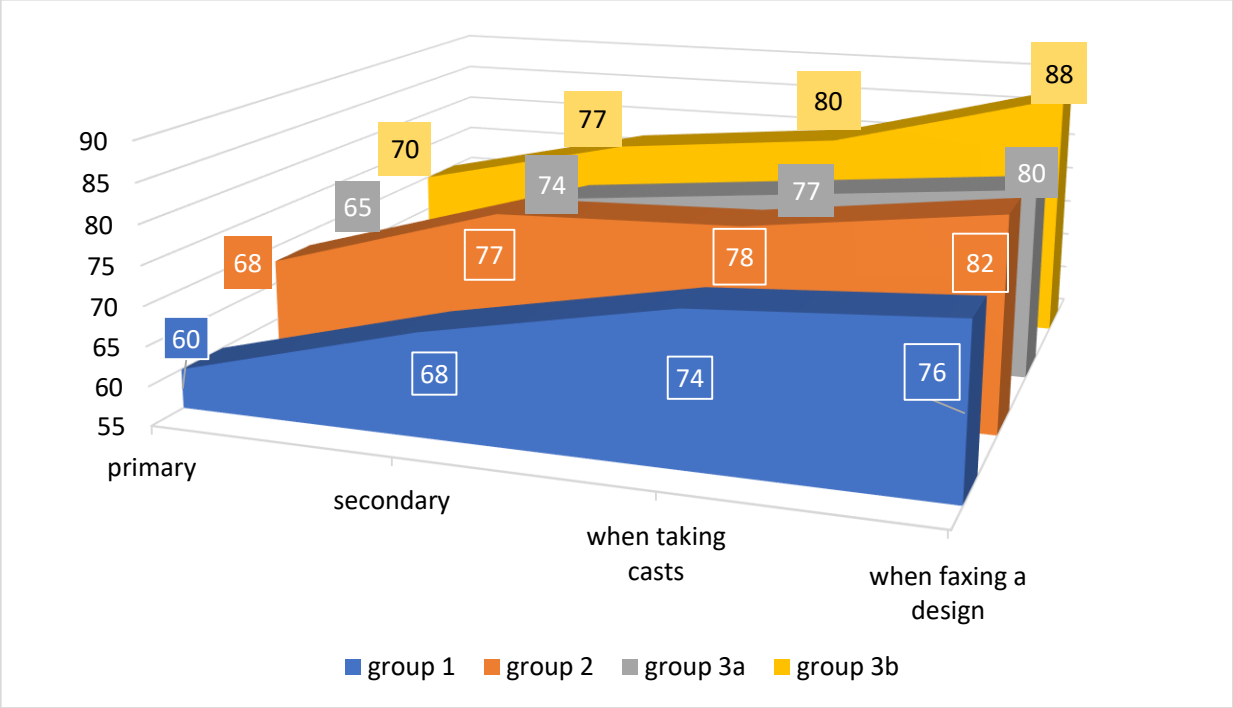

Fig. 3. Stability values of dental implants over time

Conclusions

Thus, according to the results of the study, the most favourable postoperative period was observed in group 3b patients who underwent soft tissue expansion prior to NCD. Radiological examination showed that the parameters of bone height, width and mineral density were also higher in group 3b patients who had undergone soft tissue expansion prior to the HCRC. The values of dental implant stability were significantly higher in this group when studying primary stability, which indicates higher primary osseointegration rates. Patients with conventional autograft-assisted NCR require a longer time (more than 4 months) for osseointegration of the implants, which is confirmed by the indications of this study method.

Application of self-expanding expanders for preliminary soft tissue expansion in the area of the planned ICD allows to obtain sufficient tissue growth, which in turn has a favourable effect on the further stages of treatment of partial secondary adentia with alveolar ridge atrophy.

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