Comparison of different sizes of Iranian bone allograft particles (CenoBone)* in preserving grafted socket dimensions

Abstract Introduction: Teeth are extracted for a variety of reasons, including severe decay, endodontic problems, severe periodontal destruction, inadequate residual crown structure, root resorption, iatrogenic factors such as perforations, injuries due to trauma, and cosmetic problems. Aim of the research: To compare different sizes of Iranian bone allograft particles (CenoBone)* in preserving grafted socket dimensions. Material and methods: It was an experimental study. Twenty healthy patients who had 25 unpreserved single-rooted teeth were included in the study. Patients were randomly divided into two equal groups. In the first group, allograft particles with a size of 150–500 µm and in the second group, particles with a size of 1000–2000 µm were placed in the socket. Then, Iranian resorbable membrane (CenoBone)* was placed on the socket openings and buccal wall and was initially closed by a coronalizing buccal flap. Buccal wall height and ridge width in the two groups were compared immediately after surgery and 4 months after surgery with radiological evaluation (cone-beam computed tomography – CBCT) of the region. Results: In both groups the horizontal dimension was significantly different after treatment

Introduction Teeth are extracted for a variety of reasons, including severe decay, endodontic problems, severe periodontal destruction, inadequate residual crown structure, root resorption, iatrogenic factors such as perforations, injuries due to trauma, cosmetic problems, etc. [1]. Alveolar bone has a variety of functions. Some of its specific functions are: protection and support of teeth, shaping the jaw, ion conversion, storage of calcium and growth factors, gum attachment to teeth and alveolar bone, compensation of root growth and functional wear of teeth, facial growth and replacement of teeth, allowing orthodontic movements, resorption (on the pressure side) and deposition (on the traction side) of bone that decomposes more easily than cement, the defense mechanism of the alveolar bone against mechanical and biological damage, and so on. Alveolar bone resorption is a serious and common problem, especially in edentulous patients, where alveolar ridge atrophy makes it difficult to support any prosthetic appellation. Because the preservation and development of the alveolar bone depends on the presence of teeth, proper function and precise interference can indicate and reflect the functional plasticity of the bone in response to all forms of structural and physiological changes associated with the teeth. Such bone remodeling activity started simultaneously with the evolution of teeth, the mechanical growth and changes of the teeth occur along with the growth of the face, and the slight movements in adaptation to the changing mechanical forces continue throughout life. Following tooth extraction, the empty tooth socket fills with blood clots, and then a cascade of normal events begins to repair the socket with a distinct histodynamic appearance. However, the alveolar bone deteriorates in the empty socket. a few days after tooth extraction, bone resorption begins in the alveolar crest and the region between the roots of the socket. Two months later, when the socket is filled with new bone, most of it is the trabecular bone, which is formed from a collagen network in the early days of the reconstruction of the socket and sometimes begins at the base of the socket. The vertical height of the restored socket and

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its bony contour never reaches its original size. This alveolar bone resorption continues at a slower rate throughout life and may extend to the anterior apex of the tooth root. Pattern and timing of alveolar bone resorption following tooth loss are classified for the completely toothless maxilla and mandible during the first 6 months. This condition has a significant effect on the performance and beauty of the treatment results, so the preservation of the bone after tooth extraction provides ideal conditions for the clinician to place the implant. It has been reported that preserving the socket immediately after tooth extraction prevents 60–40% of alveolar bone atrophy. Many attempts have been made to deal with the resorption of the residual socket and ridge, including tooth socket grafting with bone replacements or immediate placement of implants. Although none of these methods prevent resorption, by socket grafting, changes in width and height are reduced [2, 3]. Socket preserving techniques can reduce dimensional changes following tooth extraction, although some degree of vertical and horizontal bone resorption is expected [4]. Various materials including autogenous bone, allografts, xenografts and synthetic materials were studied for this purpose. Allografts are materials made from another individual of the same species but with a different genotype. These materials do not require a secondary donor site, are extracted from corpses, are available in the required amount and are relatively inexpensive. Allografts are divided into two categories: freeze-dried bone allograft (FDBA) and demineralized freeze-dried bone allograft (DFDBA). Some researchers believe that DFDBA has osteoinductive properties, but it has recently been shown that this material does not have enough (bone morphogenic protein – BMP) to induce bone formation. DFDBA has more resorption and shrinkage than FDBA and therefore its use is limited. These two types of allografts work by different mechanisms. The FDBA produces an active scaphoid osteochondral. DFDBA also provides an osteoconductive substrate, and also has sources of osteoinductive factors. FDBA and DFDBA have been widely used in the treatment of periodontal lesions and there have been no reports of disease transmission during their 30 years of use. FDBA has been used to treat lesions of three walls adjacent to implants, maxillary sinus augmentation, alveolar ridge augmentation and treatment of periodontal lesions alone or in combination with platelets, and enamel matrix proteins or types of membranes. Bone allograft demyelination causes exposure of BMPs in the bone matrix. These proteins induce a series of cascading events that lead to cellular affinity and bone nnnn,m by differentiating polyvalent cells into osteoblasts. When DFDBA is used as a particulate, their particle size is an important variable in determining the success rate of DFDBA as an osteoactive substance. Particles with a size of 125–1000 µm have a higher osteogenic potential than particles with a size of less than 125 µm. The appropriate size for particles is 200– 300 µm. This issue is related to the amount of surface area and packing density. Very small sizes of DFDBA stimulate the macrophage response and degrade rapidly without causing bone formation. The degree of mineralization of DFDBA varies between different tissue banks and affects its clinical regeneration potential. The remaining 2% of calcium caused the highest alkaline phosphatase activity in tissue culture of human periosteal cells, which is a desirable amount for osteoactive properties. In previous studies, Toloue et al. examined mineralized FDBA to preserve socketdimensions after tooth extraction. The results of this study showed that this material is effective in preserving the dimensions of the socket [5]. Azimi et al. in a study examined radiographically allograft material to prevent alveolar bone resorption after tooth extraction. They eventually concluded that the material was suitable for filling bone defects and reduced the rate of socket resorption after tooth extraction [6]. In Italy, Marconcini et al. compared implants in a socket

grafted with collagenated cortico-cancellous porcine bone and ungrafted. In their 4-year follow-up, in the group with implants placed in grafted sockets and marginal bone better aesthetic results were observed [7]. Amoian et al. in Iran examined the histology of CenoBone* (Aiiograft Derived Matrix) and ITB-MBA (Iranian Tissue Bank) in open sinus lift. They divided twenty patients into two groups and randomly used CenoBone* and ITB-MBA. Finally, it was observed that there was no significant difference in terms of inflammatory processes, trabecular bone thickness, residual biomaterial content, blood vessel density and the amount of bone formed [8]. Araujo et al. in Brazil examined ridge changes following socket tooth extraction. They studied 28 incisors or canines or premolars and randomly divided them into test and control groups; in the test group, Bio-Oss was used for socket grafting and collagen membranes were placed on it. Immediately after grafting and 4 months later, CBCT was prepared and ridge changes were measured. They reported that socket grafting did not prevent buccal and palatal bone resorption, but the width of the ridge was more conserved in the test group [9]. Abolfazli et al. in Iran studied DFDBA (CenoBone)* with autogenous bone in intraosseous lesions of two walls and three walls and observed that both materials improved clinical parameters and there was no significant difference between the groups, and due to the limitation of autogenous bone, it is better to use DFDBA (CenoBone)* allograft [10].

Aim of the research

The main purpose of this study was to compare the effect of bone allograft particle size (CenoBone)* on preserving the dimensions of the grafted socket by CBCT evaluation. This study also sought to answer these two questions: 1. How is CenoBone* with small particle size in terms of preserving socket dimensions? 2. How is CenoBone *with large particle size in terms of preserving socket dimensions? It has not been studied in this case so far.

Material and methods

This experimental study has a code of ethics No. U-97095 from the Vice-chancellor for Research and Technology of Ahvaz Jundishapur University of Medical Sciences, and was performed in the Department of Periodontics, School of Dentistry of this university. In order to determine the sample size, Al Qabbani's study was used due to the similarity in the method [11]. The sample size was 20 people, but due to the possibility of excluding a number of samples from the study, 25 people were included in the study. Twenty patients (13 males and 7 females) who had a total of 25 unmaintainable single root teeth were included in the study. The following criteria were evaluated in selecting research samples: age group 18 to 60 years old, nonsmoker, interproximal bone of the mentioned tooth has a bone resorption less than 3 mm, buccal wall thickness less than 2 mm, teeth cannot be preserved due to severe caries or endo problems. Also patients with systemic or pregnant problems or those taking drugs that affect bone metabolism were excluded. The variables of ridge width and the height of the buccal wall were measured and reported in this study.

Used materials

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Iranian allograft (CenoBone)* is available in sizes 150–500, 150–2000, 500–1000, 1000–2000 and 150–1000 µm; in this study, the smallest and largest sizes were used for comparison. (Particles with a size of 150–500 µm were compared with particles with a size of 1000–2000 µm). CenoBone* (Tissue Regeneration Co., Kish, Iran) with particle size 1000–2000 and 150–500 µm. Cenomambrane* (resorbable collagen membrane) (Tissue Regeneration Co., Kish, Iran) 0.6–0.2 mm with size 10 mm * 20 mm.

Surgical procedure

After selecting the patients from among those referred to the Department of Periodontics, School of Dentistry of Ahvaz Jundishapur University of Medical Sciences with the mentioned characteristics and obtaining ethical and informed consent from the patients, infiltration anesthesia with lidocaine was injected. The tooth was extracted with minimal trauma using a periotome and the flap with full thickness was lifted in the buccal region. In the palatal region, the flap with full thickness was lifted so that the membrane was placed below the palatal and buccal flaps. A periosteal incision was made in the buccal flap and then the buccal flap became coronal to close the surgical site initially. Postoperative management included the use of a cold compress on the first day and the necessary medications including analgesics (ibuprofen 400 mg every 6 h) and antibiotics (amoxicillin 500 mg every 8 h for 7 days) and chlorhexidine mouthwash 0.2 were prescribed to clean the surgical site. The patient was advised not to eat on the side where the surgery was performed. The stitches were removed after 2 weeks and the patients were examined every 2 weeks in the first month. After the surgery, CBCT was prepared from this region and after 4 months, CBCT was repeated again, and then implant placement surgery was performed. Mesiodistally, the socket center was determined on the CBCT (corresponding to the mid-buccal point of the extracted tooth) and thus the initial CBCT was examined with the CBCT taken in the fourth month for ridge width changes and changes in the buccal and palatal wall lengths. Ridge width changes were also reported as the mean and standard deviation. Also, changes in buccal wall height were reported as the mean and standard deviation.-

Analysis

The mean and median were used to describe the central tendency of data in quantitative variables, and standard deviation and interquartile range were used to describe the data scatter. In qualitative variables, frequency and percentage were used to describe the data. The normality of the data was checked using the Shapiro-Wilk test and Q-Q plot. Wilcoxon and MannWhitney tests were used for univariate data analysis, and multiple linear regression was used for multivariate data analysis. The significance level was considered 0.05 and all analyses were performed using SPSS software version 22.

Results

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After analyzing the data in a univariate manner, the following results were obtained: the mean and standard deviation of the horizontal dimension in the group with a particle size of 150–500 µm before treatment were 8.15 and 0.75 µm and after treatment were 6.69 and 1.13 µm, which was statistically significant (p = 0.002). The mean and standard deviation of the horizontal dimension in the group with particle size of 1000–2000 µm before treatment were 7.67 and 0.98 µm and after treatment were 6.25 and 0.87 µm, which was statistically significant (p = 0.002). There was no statistically significant difference between the two groups before treatment (p = 0.270). Also, there was no significant difference between the two groups compared after treatment (p = 0.347) (Table 1). The mean and standard deviation of the vertical height dimension in the group with particle size of 150–500 µm before treatment were 11.31 and 1.52 µm and after treatment were 9.42 and 1.22 µm; this difference was statistically significant (p = 0.001). The mean and standard deviation of the vertical height dimension in the group with particle size of 100–2000 µm before treatment were 12.29 and 1.30 µm and after treatment were 10.21 and 1.44 µm; this difference was statistically significant (p = 0.003). There was no significant difference between the two groups before treatment (p = 0.123). Also, there was no significant difference between the two groups after treatment (p = 0.168) (Table 2). After the multivariate data analysis, these results were obtained: by controlling the data in the vertical dimension before treatment, there was no significant difference between the two groups (p = 0.650). There was no significant difference between the two groups by controlling horizontal data before treatment.

Discussion

The main purpose of this study was to compare the effect of bone allograft particle size (CenoBone)* on preserving the dimensions of the grafted socket by radiological evaluation (CBCT). This study also sought to answer these two questions: 1. How is CenoBone* with small particle size in terms of preserving socket dimensions? 2. How is CenoBone* with large particle size in terms of preserving socket dimensions? The buccal wall height in both groups of 150–500 µm and 1000–1000 µm after treatment was significantly reduced compared to the initial height of the samples; these results are consistent with the results of the Araujo study [12]. Buccal wall resorption occurs in all conditions, but its amount can vary. According to the study, tooth socket grafting reduces this resorption but does not prevent the buccal wall from being resorbed. Also, the particle size of bone graft material does not reduce the resorption. Our study also proved that alluvial materials with particles of different sizes have osteoinductive properties and the size of particles is not a critical factor. The crystal areas mostly contain bundle bone, which is dependent on the presence of the tooth and is resorbed by osteoclasts after tooth extraction, and tooth socket grafting does not prevent this process [13]. The width of the ridge also decreased, which was statistically significant in both groups, but there was no significant difference between the groups; this is consistent with other studies that showed that socket grafting reduces hard tissue contraction but does not prevent it [13]. In general, there was no difference between the two groups in terms of preserving the socket in the dimensions of the width and height of the buccal wall, which is consistent with the study of Hoang et al., which compared two sizes of DBM and putty and concluded that there no statistically significant differences in the different sizes of allograft material in terms of ridge dimensional changes, vital bone formation, residual graft particles and allograft particle

resorption in socket tooth grafting [14]. Kon et al. examined different sizes of autogenous bone in the rabbit cranial model. In the small group, bone resorption was faster, but in the larger group, bone resorption was later and acted as a scaffold for bone for mation. In general, they recommended that large size be used for augmentation [15]. In the study, Shapoff et al. examined different size particles of allografts mixed with autogenous bone and concluded that the smaller size of allografts has more osteogenic properties [16]. de Molon et al. examined two different sizes of deproteinized bovine bone mineral (DBBM) in sinus grafts and concluded that there was no statistically significant difference between the groups in terms of new bone formation, residual material content, osteocalcin (OCN), vascular endothelial growth factor (VEGF), and tartrate-resistant acid phosphatase (TRAP), and both particle sizes can be used effectively [17]. There is a controversy between different studies on the appropriate particle size for the bone grafting process in different processes (such as socket grafting, maxillary sinus grafting, etc.). In the present study, there was no difference in the width dimension of the ridge and the height of the buccal wall in the two groups and it suggested that each size of the allografts is suitable for preserving the socket and both sizes provide good osteoconductive and scaffolding properties for new bone growth in the space between the particles. It is recommended that particles of different sizes be used in different socket grafting techniques and in other bone grafting techniques and from various aspects such as histological examination. In general, there is no particular advantage for different biomaterials and sizes, and according to clinicians, each of them can be used [18]. Chackartchi et al. examined the effect of BBM particle sizes on sinus graft and concluded that the particle size had no
effect on the vertical height grafted and the amount of newly formed bone and was not statistically significant, which was consistent with our study [19].

Conclusions

Allografts have long been used as bone substitute materials and as scaffolds in ossification. From the results of this study, it is concluded that allografts with fine and coarse particles can be used in socket grafting and there is no difference between them in terms of preserving the dimensions of the tooth socket. It is suggested that this study be evaluated with more samples and with different socket grafting techniques. It is also suggested that the durability and success of implants placed in both groups be evaluated for a long time.

Ethics approval and consent to participate

This study was supported by Deputy of research in Ahwaz Jundishapur University of Medical Sciences, and was approved by independed Ethics Committee of Ahwaz Jundishapur University of Medical Ahwaz Jundishapur University of Medical with code of IR. AJUMS.REC.1397.338

Conflict of interest

The authors declare no conflict of interest.

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