Abstract

Background and aim. Vertical and horizontal bone resorption of the alveolar ridge are common in edentulous jaws. In the distal area of the maxilla, an adequate bone volume is often lacking because of the proximity of the sinus cavities to crestal bone. Sinus floor augmentation is an established way of increasing the height and volume of bone in the posterior region of the maxilla, which increases the stability of dental implants. For this purpose, various materials, including autografts, allografts, alloplasts, and xenografts have been used. The aim of this study was the radiographic and clinical comparison of Algipore with decalcified freeze-dried bone allograft (DFDBA) in the open maxillary sinus lift technique using piezoelectric instruments.

Materials and methods. A total of 20 sinus grafts were performed in 10 patients who had a severely resorbed bilateral maxillary alveolar process with a residual bone thickness of between 1 and 5 mm (mean, 3.6 mm). The operation involved an osteotomy performed on the lateral maxillary wall using piezoelectric instruments, elevation of the sinus membrane, and placement of either of the two bone graft materials in each randomly selected side. Preoperative and postoperative standard radiographs taken at nine months of follow-up were used to compare the outcome of bone height after the maxillary sinus lifting procedure. Changes in radiographic density after sinus grafting were evaluated using densitometry.

Results. The radiographic density was 76.3% on the Algipore side and 72.4% on the DFDBA side (P >0.05). The mean height of newly formed bone in the augmented area was 12.3 mm on the Algipore side and 10.7 mm on the DFDBA side (P >0.05).

Conclusion. After nine months, there were no considerable clinical or radiological differences in outcome between Algipore and DFDBA and both of them were recognized as acceptable materials for sinus lift procedures.

Key words: DFDBA, Algipore, sinus elevation, piezoelectric surgery.
Introduction

Extensive pneumatization of the maxillary sinus can limit the rehabilitation of edentulous maxilla by implants. To meet the basic requirements for implant surgery in such cases, the atrophic ridge must be rebuilt with the aid of reliable techniques.\textsuperscript{1-4} Loss of maxillary molar teeth leads to rapid bone resorption in the alveolar process below the maxillary sinus floor.\textsuperscript{4-5} Conventionally, placement and integration of endosseous implants in patients with such an atrophic ridges requires maxillary sinus floor augmentation. The classic procedure for this augmentation entails the preparation of a trap door to elevate the Schneiderian membrane in the lateral sinus wall. The space created beneath the lifted sinus membrane is then grafted with different fillers, including autogenous bone, bone substitutes, or a mixture of these materials. In general, implants can be placed during the grafting procedure or after a healing period of 9 to 12 months to permit bone regeneration.\textsuperscript{4-8} Various grafting materials have been used for sinus augmentation, including: autologous bone, xenografts such as inorganic bovine bone and coralline calcium carbonate, mineralized and demineralized freeze-dried allografts, and a variety of alloplastic synthetically-derived materials such as Bioglass (US Biomaterials, Alachua, FL), polylactide-polyglycolidematerials, syntheticpolymers, calcium sulfate, and hydroxyapatite.\textsuperscript{9-22} Autologous grafts are considered to be the gold standard agent due to their osteogenic potential. However, they present some disadvantages, such as limited availability of material from the intraoral donor site and morbidity at the bone graft donor site.\textsuperscript{23} To overcome this problem, different substitute materials have been studied and compared in order to introduce the best alternative graft material. There is concern that some biomaterials may cause a foreign body reaction, and the ideal material for sinus floor augmentation with acceptable osteoconductivity, which can be gradually replaced by newly formed bone during remodeling, is still under debate.\textsuperscript{24} Demineralized freeze-dried boneallograft (DFDBA) is readily available and has been used since the 1970s because of its osteoconductive properties.\textsuperscript{11-13} In 1996, it was recognized as a material with fulfilled criteria for promotion of periodontal regeneration.\textsuperscript{14} In recent years, another graft material, Algipore has been used for sinus floor augmentation. Algipore is marine-derived carbonated red alga that is chemically converted into hydroxyapatite (HA).\textsuperscript{25-27} Kirmier et al. Assessed the dimensional stability of grafting with Algipore and other materials after maxillary sinus floor augmentation with computed tomography. They concluded that significant reduction of graft volume took place after maxillary sinus augmentation.\textsuperscript{28} Kuhl et al. used microcomputed tomography to evaluate the 3D structure and remodeling of grafts after sinus floor augmentation. They compared Autogenous bone (AB) alone, AB with beta Tricalcium phosphate (b-TCP), AB and B-TCP/ Hydroxyapatite (HA), AB and Calcium carbonate (Algipore), AB and HA with each other. They found that in all images both bone and substitute material could be identified. Volumetric evaluation such as total bone volume, volume of substitute material, and trabecular thickness and spacing showed differences between the different grafting materials.\textsuperscript{29} Scarano et al. in a case series evaluated histologically and histomorphometrically the specimens from sinuses augmented with Algipore and he found that this biomaterial could be used successfully for sinus floor augmentation.\textsuperscript{30}

The aim of this study was to compare the use of Algipore with DFDBA in open sinus floor augmentation using a piezoelectric surgical device by radiography and clinical observations.

Materials and Methods

This was a randomized controlled clinical trial performed on 10 male patients who needed bilateral maxillary sinus augmentation prior to implant placement. The mean age was 59 years (range, 29 to 72 years). The patients were treated at Mashhad Dental School for implant rehabilitation after signing an informed consent. The protocol was approved by ethical committee of Mashhad University of Medical Sciences. This trial was registered at http://www.clinicaltrial.gov and the clinicaltrial.gov identifier was NCT01735721. All patients were physically healthy without any past medical history of systemic or localized diseases that were contraindications for sinus or implant surgery, their blood parameters were also normal. An important inclusion criterion was a ridge bone height of less than 5 mm. Preoperative and postoperative standard radiographs were taken after 9 months of follow-up in order to compare the bone height after maxillary sinus augmentation.
Surgical procedure

First-stage surgery

All patients had a severely resorbed maxillary alveolar process with a bone height of between 1 and 5 mm (mean, 3.6 mm). The available bone was slightly less than Class C according to the site classification proposed by Jensen,27 which is comparable with Class D on the classification of Simion31 et al. The operative approach was via an entrance to the perform recess, as described by Boyne and James,7 Tatum,33 and Loukota et al.33

A crestal incision was made on the mucosa of the edentulous ridge. The flap was elevated carefully and extended labially to expose the bone. A vertical releasing incision was made in the mesialend of the flap as needed. The mucoperiosteal flap was extended to expose the alveolar ridge and the lateral wall of the maxillary sinus. Then, a window was prepared using the piezoelectric device (Mectron, Italy); the Schneiderian membrane was then elevated conservatively according to the technique described by Vercellotti.34

The sinus membrane was meticulously detached and pushed superiorly to allow for the placement of bone graft material. In each patient, one sinus was chosen at random and filled with DFDBA (Tissue Regeneration Corporation, Iran). The contra lateral sinus was filled with Algipore (Dentsply, USA). The window was then covered by a resorbable collagenous membrane (Bioguide, Geistlich, Swiss). The flap was replaced and sutured using braided silk suture (Supa, Iran). All patients were instructed to follow their usual routine oral hygiene procedures. Antibiotics (co-amoxiclav, 625 mg/tds) and analgesic (ibuprofen, 400 mg/qds) were prescribed for all patients for at least one week. The preoperative and postoperative (after nine months of follow-up standard radiographs were taken using a plastic film holder (XCP; Rinn, Elgin, USA) and were used to assess changes in bone height. All the radiographic analysis were performed by an oral radiologist who was blinded to the type of material used in each site. Pain after surgery in each side was recorded using a self report scale (mild, moderate and severe) and presence or absence of swelling following surgery was examined after each operation.

Image analysis

Baseline and 9 months standard radiographs were scanned with an Agfa scanner at 1200 dpi with a 12-bit grayscale and stored in JPEG format. Changes in bone height were calculated in each case. Two reference points, one at the lowest part of the ridge crest and the other at the highest part of sinus floor, were selected in two radiographs (baseline and after 9 months) and their distance was calculated in 0.1mm scale using computer. Changes in radiographic density after sinus grafting were evaluated using densitometry.

Statistical analysis

The Wilcoxon signed rank test for paired samples was used to calculate two-sided statistical differences. Probabilities of less than 0.05 were regarded as significant.

Results

During the course of healing, there were no differences between the bone materials with regards to local complications at the recipient site. No patients developed sinusitis or other complications. The amount of available bone increased significantly after sinus lift augmentation with either Algipore or DFDBA. Mean change in Algipore side was 8.75 mm and in DFDBA side was 10.3 mm (in both P=0.01).

With regards to pain levels, seven days postoperatively, 40% of patients reported low levels of pain on the side with Algipore and 60% reported moderate pain levels on that side. On the side that received the DFDBA augmentation, 60% of patients had low levels of pain and the remaining patients experienced moderate pain levels on the DFDBA side. However, this difference was not significant (P > 0.05). The degree of swelling one week postoperatively was low to moderate in patients on the Algipore side, and was low or non-existent in the patients on the DFDBA side. This difference was not clinically significant.

The mean radiographic density of newly-formed bone was 76.3 ± 3.89% on the Algipore side and 72.4 ± 4.93% on the DFDBA side. The difference between the two groups was not significant (P =0.62).

The mean height of newly-formed bone in the augmented area was 12.3 ±2.49 mm on the Algipore side and 10.7 ± 1.60 mm on the DFDBA side. This difference was also not significant (P =0.6). (Figures 1 and 2)

Discussion

Implant insertion in severely atrophic maxillae is a difficult challenge in the field of implantology. The posterior maxilla is particularly compromised by sinus pneumatization, bone resorption after tooth loss, or a combination of both. In recent years, the “sinus lift” procedure has become a viable treatment for patients who are partially or completely edentulous with atrophy of the posterior maxilla. This procedure
requires the use of bone or biomaterial grafts or a combination of both. Autologous bone appears to be the best type of graft used in orthopedic surgery, and it remains the most predictable and successful available material.

Due to limited amount of available autologous bone, many other types of materials have been used as substitutes. Demineralized freeze-dried bone has been widely used; it is a biocompatible, osteoconductive, and slowly resorbable graft material.

In the study conducted over a period 4.5 yr by Ewers et al., Bio-oss did not show a good level of remodeling compared with Algipore, which showed significantly more bone remodeling after the sinus lift procedure. The review by Darryet al. mentioned that there are no significant differences between survival rates of autogenous bone, HA and DFDBA in sinus lift method. Another research indicated that calcium sulfate could be successfully used in combination with DFDBA for sinus lift procedures and that possible residues of DFDBA could be found within newly generated bone. Landi L et al who evaluated the osteoconductive potential of bovine-derived porous hydroxyapatite (HA) in combination with demineralized freeze-dried bone allograft (DFDBA) as an alternative to autogenous grafting in the maxillary sinus showed that The combination of Osteograft HA and DFDBA appeared to be osteoconductive and might be considered a valid alternative to autologous bone grafts in sinus lift procedures.

This was the first report to compare Algipore and DFDBA in the open maxillary sinus lift technique using piezoelectric instruments with regards to their effect on new bone formation in the maxillary sinus. In conclusion, no significant clinical and radiological difference was found between Algipore and DFDBA for sinus floor augmentation. Further researches on bone substitutes in sinus lifting are suggested.

Acknowledgments

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References

6 Ghanbari et al.