A New Technique for Reconstruction of the Atrophied Narrow Alveolar Crest in the Maxilla Using Morselized Impacted Bone Allograft and Later Placement of Dental Implants

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ABSTRACT

Background: In cases when the alveolar crest is too narrow to host an implant, lateral augmentation is required. The use of autogenous bone blocks harvested from the iliac crest is often demanded. One disadvantage is the associated patient morbidity.

Purpose: The purpose of this study was to clinically and histologically evaluate the use of morselized impacted bone allograft, a novel technique for reconstruction of the narrow alveolar crest.

Materials and Methods: Two patients with completely edentulous maxillae and one partially edentulous, with a mean age of 77 years (range 76–79 years) were included in the study. The alveolar crest width was <3 mm without possibility to place any implant. Bone grafts were taken from a bone bank in Gävle Hospital. Bone from the neck of femur heads was milled to produce bone chips. The milled bone was partially defatted by rinsing in 37°C saline solution. After compression of the graft pieces with a size of 15 mm (height), 30 mm (length), and 6 mm (width), they were then fit to adapt to the buccal surface of the atrophied alveolar crest. One piece was placed to the right and one to the left side of the midline. On both sides fibrin glue was used (Tisseel®, Baxter AG, Vienna, Austria) to stabilize the graft.

After 6 months of graft healing, dental implants were placed, simultaneously biopsies were harvested and in one patient two oxidized microimplants were placed. At the time of abutment connection, microimplants were retrieved with surrounding bone for histology. Fixed screw-retained bridges were fabricated in mean of 7 months after implant surgery. Radiographs were taken before and after implant surgery and after 1 year of loading.

Results: Sixteen implants with an oxidized surface were placed (TiUnite®, Nobel Biocare AB, Göteborg, Sweden). After 1 year of functional loading, all implants were clinically stable. The marginal bone loss was 1.4 mm (SD 0.3) after 1 year of loading. The histological examination showed resorption and subsequent bone formation on the allograft particles. There were no signs of inflammatory cell infiltration in conjunction with the allograft. The two microimplants showed bone formation directly on the implant surface.

Conclusions: This study shows that morselized impacted bone allograft can be used to increase the width of the atrophied narrow alveolar crest as a good alternative to autogenous bone grafts in elderly patients. The histological examination of biopsies revealed a normal incorporation process and no signs of an immunological reaction. Further studies with larger samples are of important to be able to conclude if equal results can be obtained using morselized impacted bone allograft as for autogenous bone graft.

KEY WORDS: allograft, atrophy, dental implants, edentulous maxilla, histology

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INTRODUCTION

Rehabilitation of edentulous patients with dental implants is today a safe and predictable method. However, in some cases bone resorption makes this procedure complicated or impossible. Various augmentation techniques have been described. In most cases, autogenous grafts from the iliac crest and mandibular symphyses, or various bone substitutes have been used as grafting material.[1–8] Although autogenous bone grafts appear to be the ideal material, there are some disadvantages to consider such as the need of general anesthesia and a second surgical site leading to increased postoperative morbidity and treatment costs. Furthermore, many of these patients are old and have diseases that might complicate these procedures, which are factors to take into consideration. Therefore, the use of bone substitutes might be a solution for these patients.

Studies indicate that allogeneic bone graft may be an alternative in maxillofacial reconstruction procedures.[9] An allogeneic graft is defined as tissue from a donor who belongs to the same species but is not genetically related to the recipient. Because of the increase of prosthetic hip replacement procedures, allogeneic bone graft is available in large quantities at low cost. For old patients with severely atrophied narrow alveolar crest in the maxilla and when autogenous bone graft and general anesthesia are not an option, this treatment modality can be an alternative.

The aim of this study was to evaluate the clinical, histological, and radiographic outcome of dental implants inserted after lateral augmentation with allogeneic bone graft.

MATERIALS AND METHODS

Surgical Protocol

This study included three patients (one male and two females, 76 to 79 years of age). Two patients were completely edentulous in the maxilla and one partially edentulous with teeth 24–26. Inclusion criterion was severe atrophy of the maxilla with a width <3 mm. The patients were consecutively included in the study after accepting the treatment protocol and signing the patient information. In all patients, the bone width was too narrow for conventional dental implant surgery.

All patients were given antibiotics at the time for grafting and implant surgery (Kåvepenin®, AstraZeneca, Södertälje, Sweden), 1 g, twice daily for 7 days as a prophylactic measure. Surgery was done under sedation with Midazolam/Dormicum (Roche, Stockholm, Sweden), 5–10 mg was given 30 minutes preoperatively.

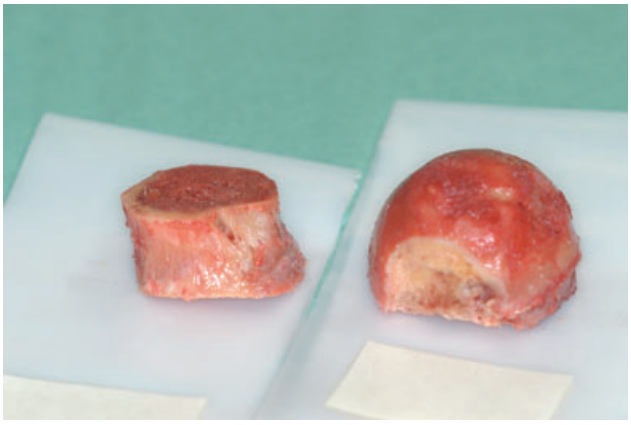

Figure 1 Showing a femur allograft from the bone bank of Gävle Hospital, Sweden.

An alveolar crest incision, vertically released in the posterior maxilla, was made and a mucoperiostal flap was elevated laterally.

Fresh-frozen allogeneic bone (–70°C) was taken from a bone bank at Gävle Hospital (Figure 1). The neck of femur head was milled to produce bone chips. The milled bone was then partially defatted by rinsing in 37°C saline solution, to be able to improve graft stability.[10] After compression of the graft, it was formed into pieces with the size of 15 mm (height) × 30 mm (length) × 6 mm (width) (Figure 2, A and B). Before placement of the graft, small buccal perforations of the alveolar crest were made (Figure 3). Two pieces, one on each side of the midline, were placed as a buccal onlay on the narrow alveolar crest. Fibrin glue (Tisseel®, Baxter AG, Vienna, Austria) was used to further stabilize the graft.

The graft was covered with a resorbable membrane (Bio-Gide®, Geistlich Pharma AG, Division Biomaterials, Wolhusen, Switzerland) (Figure 4). After 6 months of graft healing, 16 implants (TiUnite®, Nobel Biocare AB, Göteborg, Sweden) were placed.

Implants in different lengths (8.5–13 mm) were used (Table 1). A two-stage procedure was utilized and abutments (Multi-Unit Abutments®, Nobel Biocare AB) were connected after 3 to 5 months of implant healing.

Prosthetics and Follow-up

After the grafting procedure, all patients were advised to refrain from use of their dentures for 4 weeks. Dentures

A

B

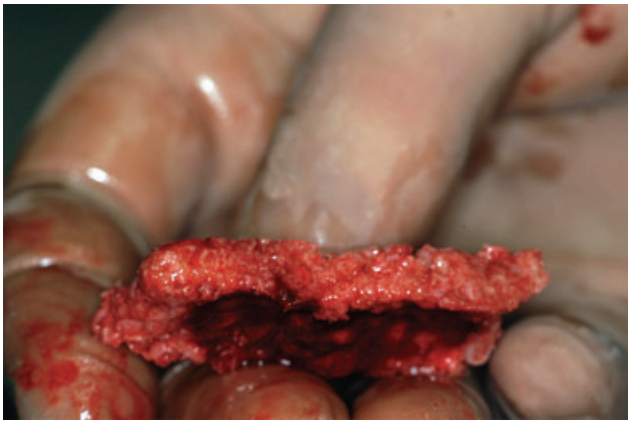

Figure 2 *A* and *B,* Showing the milled, defatted, and compressed allograft ready to be used.

were then relined with a soft material to fit during the healing period. In mean 7 months (range 6 to 8 months) after implant surgery, permanent screw-retained bridges were fabricated. Orthopantomographs, photos, and periapical radiographs were taken before and after implant surgery and after 1 year of loading (Figures 5–7).

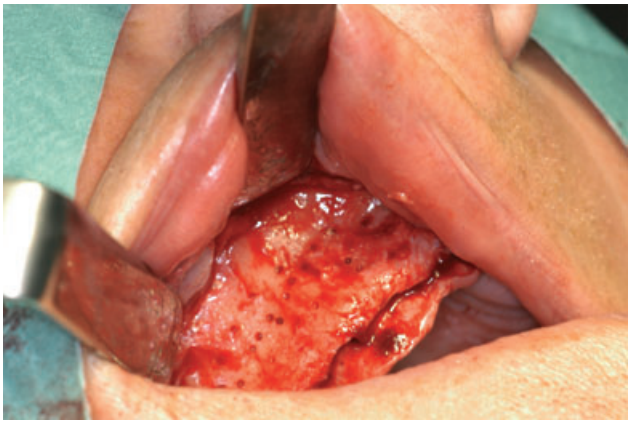

Figure 3 Showing a thin maxillary alveolar crest with drilled buccal perforations before the allograft is placed.

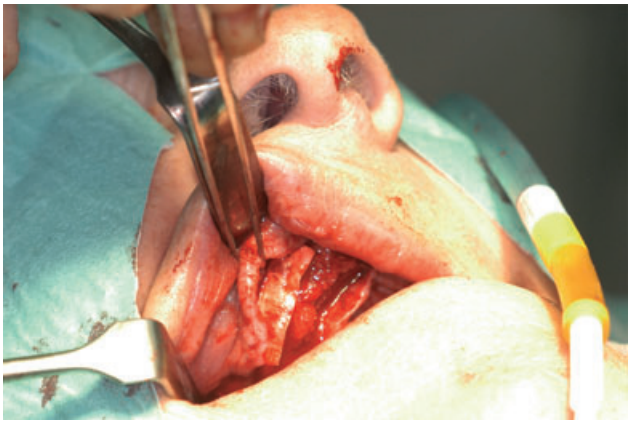

Figure 4 Showing allograft material covered with a resorbable collagen membrane (Bio-Gide).

Histology

Bone biopsies from the grafted areas were harvested in three patients at the time of implant surgery (6 months), and in two patients, a second biopsy was taken at abutment connection (9 months after grafting). One patient also received two microimplants with an oxidized surface (2 × 5 mm) at implant placement surgery which were retrieved with surrounding bone using a 3-mm trephine at the time for abutment connection (Figures 6 and 8). The retrieved microimplants were fixed by immersion in 4% buffered formaldehyde solution. The fixed biopsies were then dehydrated in a graded series of ethanols and embedded in plastic resin (Technovit® 7200 VCL, Kulzer, Wehrheim, Germany). Sections were cut and ground to a thickness of 150 µm by means of exact cutting and grinding equipment (Exact Apparatebau, Norderstedt, Germany). The ground sections were further ground to a thickness of about 10 µm and strained with 1% toluidine blue and 1% pyronin-G. The

TABLE 1 Implant Lengths

Implant Length (mm)	No. of Implants
8.5	4
10	5
11.5	2
13	5
Total	16

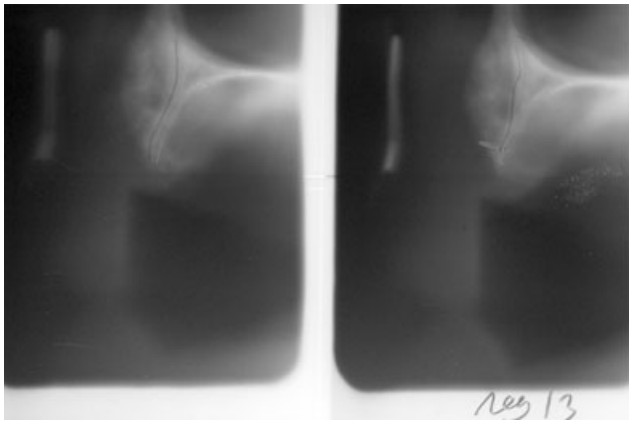

Figure 5 Radiograph showing severe atrophy of the maxillary width and the onlay allograft after 6 months of healing.

Figure 8 Showing an oxidized titanium microimplant 2.3 × 5 mm in size.

sections were viewed and photographed in a Leitz Orthoplan microscope equipped with a Microvid morphometric system (Leitz, Wetzlar, Germany) connected to a personal computer. The area of mineralized bone tissue in relation to the total specimen area was measured with histomorphometry.

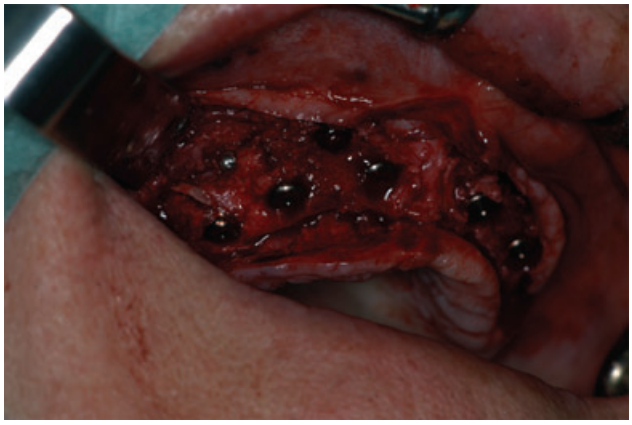

Figure 6 Showing the alveolar crest with implants and microimplant at the time of abutment surgery.

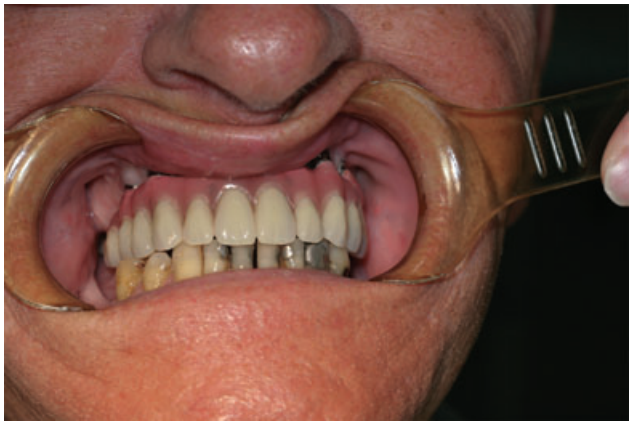

Figure 7 Showing a patient with fixed bridge after 1 year of functional loading.

RESULTS

In two patients, perforation of the mucosa and migration of allograft particles occurred during graft healing, probably due to mechanical trauma from the dentures. After 6 months of graft healing, at the time of implant placement, the bone was quite soft and the stability of the placed implants was moderate. All implants were left to heal for 4 months before abutment surgery. During the impression procedure, one implant showed symptoms of tenderness and was left for an additional period of 8 weeks before prosthetics was finished. No other complications occurred.

All three patients attended the 1-year recall. None of the 16 implants had been lost. The marginal bone loss during 1 year of loading was 1.4 mm (SD 0.3).

Histology

Light microscopy of the 6-month specimens showed presence of allograft particles in the biopsies (Figure 9). The interparticle space was occupied by a loose connective tissue rich of vessels and cells. Some of the particles showed empty osteocyte lacunae while others showed the presence of osteocytes. The particles had undergone resorption as indicated by the presence of scalloped areas (Figure 10). Woven bone, osteoid, and osteoblast seams as well as lamellar bone were seen on the surface of the allograft particles (Figures 9 and 10). All allograft particles showed signs of bone formation on their surfaces. There were no signs of inflammatory cell infiltration in conjunction with the particles. The 9-month

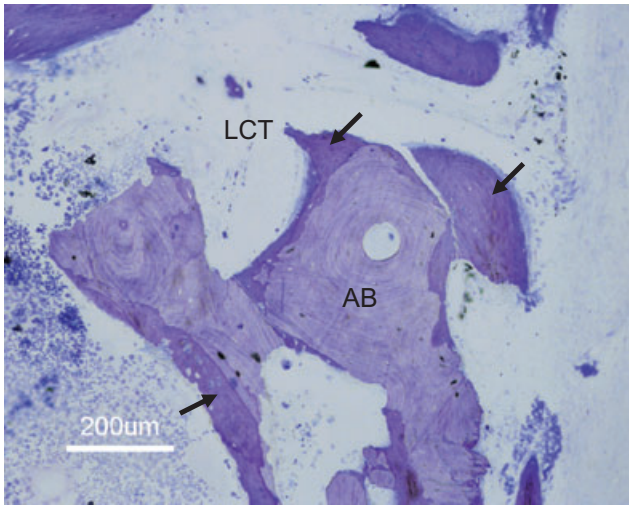

Figure 9 Light micrograph of a 6-month biopsy. Allograft bone particles (AB) with newly formed bone (arrows) on the surface are seen in a loose connective tissue (LCT). Toluidine blue.

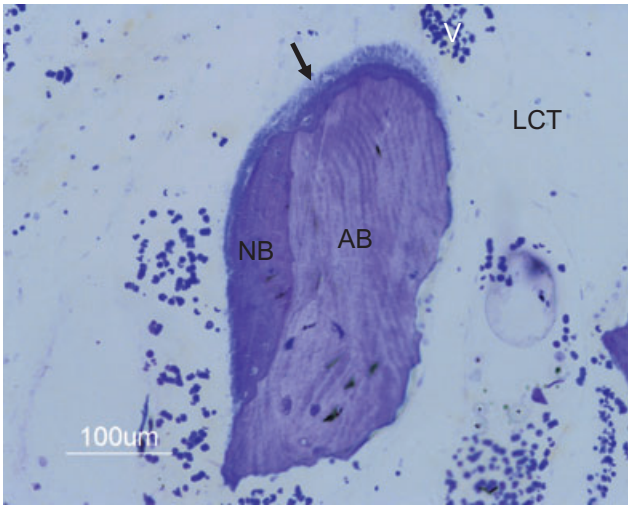

Figure 11 Light micrograph of a 9-month biopsy showing an allograft bone particle (AB) incorporated in new lamellar bone (NB). Arrow is pointing on active bone formation areas. Vessels (V) with red blood cells in the loose connective tissue (LCT) are seen near the particle. Toluidine blue.

specimens showed a similar picture as the 6-month specimens (Figure 11). The two microimplants showed bone formation directly at their surface (Figure 12). A direct contact between allograft bone and the implant surface was occasionally seen (Figure 13). In these sites, new bone had been formed at both the allograft bone and the implant surface (Figure 13).

The biopsies without microimplants showed a mean bone content of 31.8% (SD 26.8) (range 13.4–96.2%) (Table 2).

DISCUSSION

Treatment with titanium dental implants in the edentulous maxilla is today considered a predictable method. However, in some cases the edentulous maxilla is too resorbed for conventional implant surgery and therefore various augmentation techniques have been proposed.[1–8] Although autogenous bone grafts is considered gold standard, there are drawbacks, such as the need for a second surgical donor site and the risk of postoperative

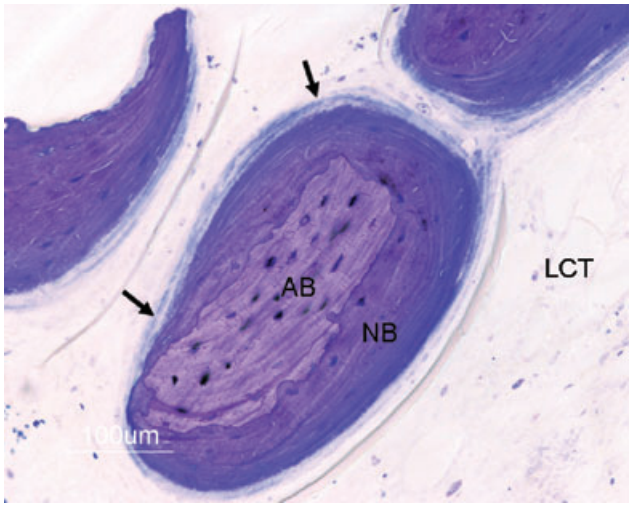

Figure 10 Light micrograph of a 6-month specimen showing an allograft bone particle (AB) with an area of newly formed bone (NB). Arrows are pointing to an area with active bone formation as indicated by the presence of osteoblasts and osteoid. LCT = loose connective tissue. Toluidine blue.

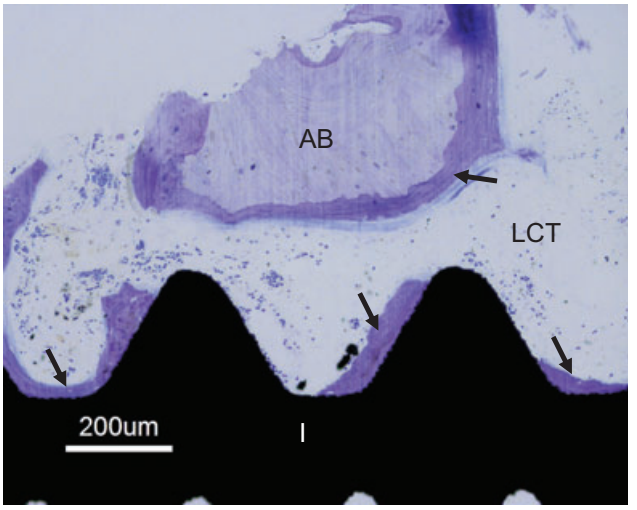

Figure 12 Light micrograph of a microimplant after 3 months of healing showing bone formation on the surface (arrows). An allograft bone particle (AB) with new bone formation (arrow) is seen at a distance from the implant. LCT = loose connective tissue. Toluidine blue.

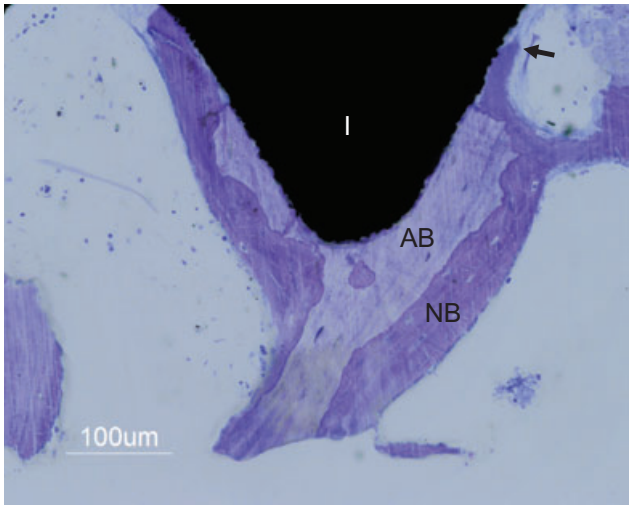

Figure 13 Light micrograph of a microimplant showing contact with allograft bone (AB) and newly formed bone (NB). Arrow is pointing at an area with active bone formation. Toluidine blue.

morbidity. Surgery under general anesthesia also leads to higher treatment costs and increased medical risks for older patients. Therefore the use of bone substitutes has increased and has been recommended.[11]

In the following study, impacted bone allograft was used without any severe complications. However, during the healing of the graft, two patients had small perforations of the mucosa with emigration of small pieces of grafting material, probably due to mechanical trauma from the dentures.

In orthopedic surgery, allogeneic bone grafts have been in use for several decades. Studies have also shown that allogeneic bone grafts were incorporated and revascularized in the recipient site and there was no immunological response in an onlay grafting procedure.[12] The major disadvantage with allogeneic bone grafts is the risk of transmitting blood-borne diseases like hepatitis, HIV, and Creutzfeldt–Jacobs disease. Bone banks require screening and testing before donor selection. Therefore with processing and sterilization, the risks are minimal.

TABLE 2 Results from Histomorphometry

	Bone Area in Biopsy (%)	Time of Healing (months)
Patient 1	21.3	6
	20.1	6
	26.8	9
	96.2	9
Patient 2	17.4	6
	34.1	6
Patient 3	25.1	6
	13.4	9
Mean	31.8% (SD 26.8)	

After the grafting has been performed, results show that delayed placement of dental implants after grafting allows for maturation of the extraction site with good survival rates of implants placed into these grafted sites.[13] Other studies show that human mineralized bone allograft could be successfully used in sinus lifting procedures before placement of implants.[14]

The use of an ideal graft material should result in the formation of a high percentage of vital bone after graft maturation. The literature shows varying results for different grafting materials, with vital bone content from 14 to 44%. Using mineralized cancellous bone allograft in a sinus augmentation procedure demonstrated a vital bone content of 25.2%.[15] Although the nature of the newly formed bone was soft at the time of implant placement, the histology of the biopsies taken in the present patients indicated a normal incorporation of the allograft particles. There were no signs of any immunological reactions to the allograft bone. Morphometry demonstrated that on average 31.8% of the specimen area were occupied by mineralized bone, which was an admixture of allograft and newly formed bone. Our figure is in line with those previously reported in the literature.

In the following limited study of three edentulous patients, a new technique for reconstruction of the alveolar crest using bone allograft with delayed implant placement was evaluated. After 1 year of functional loading of the dental implants, the survival rate was 100%. However, it is obvious that further studies with larger samples are important to be able to conclude if this method is comparable with other existing methods.

CONCLUSION

This study shows that morselized impacted bone allograft can be used to increase the width of the atrophied narrow alveolar crest as a good alternative to autogenous bone grafts in elderly patients. The histological examination of biopsies revealed a normal incorporation process and no signs of an immunological reaction. Further studies with larger samples are

important to be able to conclude if equal results can be obtained using morselized impacted bone allograft as for autogenous bone graft.

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