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Particulate vs. block bone grafts: Three-dimensional changes in graft volume after reconstruction of the atrophic maxilla, a 2-year radiographic follow-up

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ABSTRACT

Background: Extensive alveolar bone resorption in the maxilla limits the possibility of successful placement and osseointegration of endosseous implants for future prosthetic rehabilitation. Autogenous bone from the iliac crest may be used as lateral onlays in the atrophic maxilla, both as block and particulate bone. To our knowledge, there is no three-dimensional 2-year follow-up study measuring the volumetric reduction of the augmented areas comparing particulate and block bone grafts.
Purpose: The aim of this study was to conduct a radiographic 2-year follow-up study, using computed tomographic (CT) images in order to evaluate and compare the extent of bone graft resorption in the frontal maxillae augmented by particulate (test) and block bone (control).
Material and methods: Eleven patients treated with iliac bone grafts and oral implants in the maxilla were followed with CT examinations directly post grafting and after 2 years.
Result: The volumetric changes after 6 months were extensive. Additionally, the changes in particulate bone tended to be larger after 2 years compared to block bone, using this protocol. However, the difference was not statistically significant.
Conclusion: The present follow-up study showed that there is radiographically complete integration and embedding of implants installed in grafted bone despite extensive initial graft resorption. There was no significant difference in the amount of volumetric reduction between particulate bone and block bone grafts.

1. Introduction

The introduction of endosteal titanium implants has made it possible for many edentulous people to receive fixed prosthetic restorations. However, in order to gain osseointegration of the implants, sufficient bone volume both in height and width is a prerequisite. Clinicians are frequently encountered with situations where the bone volume is either insufficient for conventional implant therapy or the existing bone volume is inadequate to allow placement of implants with sufficient proportions in the aesthetic zone.

According to the literature (Boyne and James, 1980; Burchardt, 1983; Wood and Moore, 1988; Hunt and Jovanovic, 1999; Schliephake et al., 2000) the golden standard procedure for reconstruction of a severely resorbed alveolar crest, is still the use of autogenous bone grafts. There are several methods of bone augmentation using autogenous bone grafts (Keller et al., 1987; Hirsch and Ericsson, 1991; Isaksson, 1994; Isaksson and Alberius, 1992; Tolman, 1995; Nyström et al., 1997; Rasmusson, 1998). The most common procedures today are the use of particulate bone graft for augmentation of the maxillary sinus in order to gain an increase of the height and the use of block bone grafts placed as buccal onlay to increase the width of the alveolar process. Earlier studies have reported quite extensive resorption of the grafted bone both in height and width (Nyström et al., 1995; Johansson et al., 2001). In a prospective clinical study (Thor et al., 2005) the role of platelet-rich plasma in conjunction with particulate autogenous bone graft was evaluated. In the anterior maxilla, particulate bone mixed with PRP (test) was compared with onlay block bone without additional PRP (control). Furthermore, in the posterior part of the maxilla, particulate bone grafts with or without PRP was placed as sinus inlays. PRP and non-PRP sites were evaluated and compared regarding implant survival rate, marginal bone level and implant

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stability using resonance frequency analysis (RFA) during 1 year in function. It was concluded that high implant survival rates could be observed after 1 year of loading. Furthermore, the marginal bone levels were stable, with no statistically significant differences between test and control sites. In a study by Dasmah et al. (2011), the marginal bone level alterations were assessed at abutment connection (6 months after fixture installation) and thereafter at 1 year and 5 years of loading. In general, there was a higher degree of marginal resorption during the first year of loading, compared to the continuing changes of years 2–5, but there were no statistically significant differences between test and control sites.

Different radiographic techniques for assessment of the augmented areas have been reported. Dental or panoramic radiographs allow an estimation of the vertical dimensions of the grafts, but do not provide information about volume changes three-dimensionally (Bloin et al., 1996; Fredholm et al., 1993). Earlier volumetric studies (Nyström et al., 1995) have shown that there is a rapid initial loss of bone height during the first 6 months using autogenous block bone. It was also stated that the loss of vertical bone height of the grafted bone levelled out and became insignificant during the second follow-up year. Johansson et al., 2001 examined the changes in the volume of bone grafts in the atrophic maxilla comparing autogenous buccal onlay and particulate sinus inlay over a 6 months period. It was concluded that the reduction in the volume of bone was the same regardless of the method used for grafting. However, the range was significantly greater in the onlay group.

To our knowledge, there are no studies comparing the volumetric changes of autogenous particulate bone vs. block bone grafts used as lateral onlays. Therefore, the aim of the present study was to conduct a volumetric study, using computed tomographic (CT) scans in order to evaluate and compare alterations in volume of particulate and block bone on the lateral aspects of the anterior maxilla over a period of 2 years.

2. Material and methods

2.1. Patients and surgical procedure

The present study comprises 11 edentulous patients with severe resorption of the maxilla. All the patients were female in this study. The patients were reconstructed with autogenous iliac bone grafts and dental implants (Astra Tech AB, Mölndal, Sweden) in a two-stage procedure. The available bone volume was examined using computed tomographic scans. Inclusion criteria were anterior crestal width of <3 mm and/or height of <7 mm and posterior vertical dimension of <5 mm. All patients underwent bilateral sinus inlay and onlay bone grafting procedures. Both maxillary sinuses were grafted with particulate autogenous bone. The left side of the anterior maxilla was also grafted with particulate bone graft (test), whereas the right side was augmented by blocks of bone (control). Half of the harvested cortico-cancellous bone was used as block and the other half was milled into particulate bone. There was no randomization carried out. The patients were not allowed to use dentures for a minimum of 1 month. New dentures were carefully adjusted so that only limited pressure was affecting the crests and no extending lateral parts were in contact with the grafted areas. Dental implants were placed after 6 months of healing and abutment surgery was performed after additional 6 months.

2.2. Pre-surgical care

Antibiotics were given perioperatively and during 24 h after the grafting surgery either as benzylpenicillin (3 g × 3) or clindamycin (600 mg × 3). Patients received 2 g of phenoxymethylpenicillin preoperatively at the time of implant installation as a single dose. One patient received clindamycin 300 mg because of a previous allergic reaction.

2.3. Harvesting of the bone graft and the grafting procedure to the anterior maxilla

Under general anaesthesia, cortico-cancellous bone graft was harvested from either the right or left anterior iliac crest. A bone mill (Tessier Osseous Microtome, Stryker Leibinger, Freiberg, Germany) was used in order to particulate the harvested bone graft which was mixed with PRP before delivery to the recipient sites.

The left anterior part of the maxilla (test) was freed from the periosteum and prepared with a round bur until small spots of bleeding were noted. Then a moldable mixture of bone with PRP was placed onto the buccal part of the maxilla.

The right side of the anterior maxilla (control) was prepared in the same way as the left side. The block grafts were then adjusted to fit the anatomy of the crest and were secured to the underlying recipient bone by a minimum of two 1.7 mm titanium screws (6–13 mm length) without any possibility of micromovement. Then the buccal flap of soft tissue was elongated through small incisions of the periosteum to gain full and tension-free coverage of the grafted areas. The incisions were closed with resorbable sutures (Vicryl®, Johnson & Johnson AB, Sollentuna, Sweden) Fig. 1.

2.4. Particulate graft preparation

The particulate graft material, in sinuses and for the left side of the anterior maxilla was mixed with platelet-rich plasma (PRP). The preparation of PRP was performed using a Sequestra 1000® gradient density cell separator (Medtronic, Minneapolis, MN, USA) in the operating room. After withdrawal of 450 ml whole blood, 63 ml Citrate phosphate dextrose (Terumo Corp, Tokyo, Japan) was added in order to achieve anticoagulation. The blood was then separated into PRP and red blood cells and platelet poor plasma (PPP) as described by (Marx et al., 1998).

The PPP with the red blood cells were transfused back to the patients. In order to obtain autologous thrombin, CaCl was added to the anticoagulated PRP and a gel mass was formed. The gel was than gently squeezed and the solution extracted from it was used as autologous thrombin. Finally PRP was mixed with autologous thrombin in a syringe that produced a gel which could be used with the bone graft.

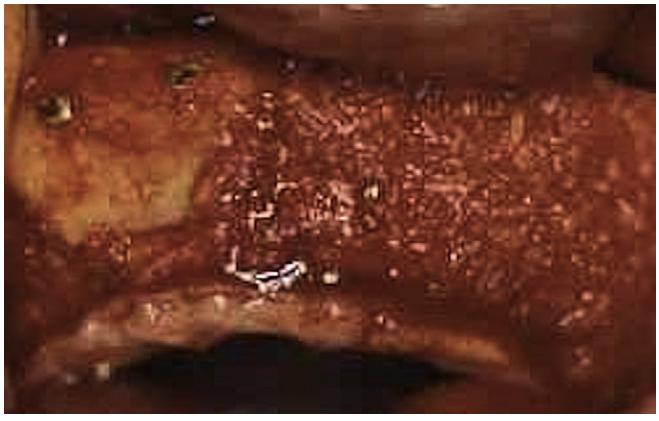

Fig. 1. Clinical image showing the transplanted bone graft.