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Changes in volume during the four months' remodelling period of iliac crest grafts in reconstruction of the alveolar ridge

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Abstract

Our aim was to assess the four months' resorption rates of onlay iliac crest grafts in atrophic jaws prospectively, and to identify factors that influence them. Twenty-four patients had reconstructions of the alveolar ridge with iliac crest onlay grafts at 30 sites on the mandibles and maxillas. The augmentation volumes were measured on cone-beam computed tomographic (CT) data-sets directly after augmentation (V_1), and after four months' remodelling (V_2). Statistical analysis allowed identification of potential influences from the recipient sites, volume of the graft, and the patients' smoking behaviour. The mean (range) initial onlay graft volume (V_1) was 2.82 (0.66 to 6.41) ml. After four months, the mean measured onlay graft volume (V_2) was 2.39 (0.47 to 6.21) ml. Mean iliac crest onlay graft volume resorption after four months of remodelling was 0.43 (-0.15 - 1.78) ml (15%). We found no significant differences in the resorption rates of iliac crest onlay grafts between different recipient sites (maxilla and mandible) or in dependence on the volume of iliac crest grafts. Smokers tended to have a higher rate of resorption, but not significantly so ($p = 0.056$). The results of this study indicate the most favourable resorption rates for iliac crest onlay grafts that we know have seen published to date.

Keywords: alveolar ridge augmentation; bone resorption; grafting; iliac crest transplants

Introduction

Autologous bone grafting is an adequate way to treat severe atrophy of the jaw when implant-mounted oral rehabilitation is otherwise not possible. For extensive augmentation of the alveolar ridge, the calvarium and iliac crest area are particularly recommended.[1] Extensive bony resorption can lead to insufficient quality and quantity of bone and can hamper subsequent planned insertion of implants. Studies of the rates of volume resorption of autologous bone grafts should reliably identify possible factors that may influence the results. Prospective data with metrically accurate measurements of augmented volume of bone and meticulous protocols are scarce.

The aim of this prospective study was to report reliable data about resorption of iliac crest onlay grafts during the remodelling period of four months based on a standard

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surgical protocol and study design, which allows for assessment of factors that may contribute to optimal results.

Material and Methods

Twenty-four patients had 30 augmentation sites treated with iliac crest onlay grafts that combined monocortical bony strips and interposition of trabecular bone. Fourteen of the augmentation sites were in the mandible, and 16 in the maxilla. For the planning of diagnosis and treatment, we classified resorption of the jaw bone according to Cawood and Howell's scale.[2] The patients all came from resorption classes IV to VI, where no insertion of an implant was feasible without augmentation of the bone first. In all patients the residual crests were less than 7 mm high, or less than 6 mm wide, or both, so that horizontal or vertical augmentation, or both, was necessary.[3,4]

Smoking at the time of surgery was recorded: 19 patients (with 23 grafted areas) claimed to be non-smokers and three patients (with 5 grafted areas) smoked between 15 and 20 cigarettes/day during the observation period of four months. We did not know whether two patients smoked or not.

Surgical protocol

Bone was harvested from the iliac crest using the protocol described by Grillon et al[5] where, after incision of the skin and separation of the inserting abdominal muscles and periosteum, several parallel, vertical monocortical cuts were made on the inner cortical plate of the iliac crest with an oscillating saw. After an additional longitudinal crestal cut, multiple parallel cortical strips of bone could be harvested with a chisel. Trabecular bone was gathered from the internal aspect of the iliac ala.

The recipient site was grafted as described by Triplett and Schow,[6] with slight modifications in the preparation of the flap, our aim being to build mucomusculo- periostal flaps to enable tension-free coverage of the augmented areas. Instead of midline incisions on the atrophied alveolar ridge, highly vestibular incisions were made in the mobile vestibular gingiva. The layer of muscle was cut about 3 mm closer to the crestal bone than the initial incision.

Finally, the periosteum was incised as distally as possible from the margin of the crestal ridge. Monocortical strips were adapted cortical side-out to the ridge and fixed with two titanium miniscrews 2.0 mm in diameter. Trabecular bone was interposed between cortical strips and the alveolar ridge. The mucomusculo-periostal flaps were then repositioned, and sutured stepwise to enable complete tension-free coverage. Antibiotic prophylaxis was with either an aminopenicillin with a beta-lactamase-inhibitor, or clindamycin.

Acquisition of images

Cone-beam computed tomographic (CT) scans were taken with the GALILEOS® cone-beam CT device (Sirona, Bensheim, Germany) at512 pixels and a resolutionof 300 μm or 2.5 line pairs/ mm.

Patients had three cone-beam CT scans: one preoperatively for diagnosis two weeks before augmentation, a second one to three days postoperatively, and the third four months after grafting.

Volumetric measurements

Cone-beam CT DICOM datasets were imported to open-source software (SKY-PlanX, Bredent, Senden, Germany), which allowed for similar uploads of two datasets from each patient. The datasets were then superimposed by anatomical alignment, also known as registration. The failures of registration were automatically calculated by the software, and accepted only if they were smaller than 0.4 mm. After registration the augmented bony area could be visualised exactly, and calculated for each axial slice (Fig. 1). The areas were multiplied over the height for calculation of the primarily grafted volume of bone (V_1), and after four months of remodelling (V_2).

Statistical analysis

Data were stored in Excel sheets (Microsoft Excel 14.0, Redmond, USA) and the significance of differences analysed with the aid of IBM SPSS Statistics for Windows software (version 20.0, IBM Corp, Armonk, NY, USA). Normality of distribution was tested using the Kolmogorov–Smirnov test, after which we used unpaired *t* tests, paired *t* tests, or the Mann–Whitney *U* test, as appropriate. Volumes of augmented graft were divided into three groups –small (0-2 ml), medium (2-3.5 ml), and large (3.5 ml or more). The significance of differences in the percentage losses of volume for the three groups was assessed with the univariate analysis of variance (ANOVA).

The study was approved by the hospital local ethics committee (approval no. 10-163) and all participants signed an informed consent before examination and treatment.

Results

We assessed 24 patients with 30 reconstruction sites in the alveolar ridge grafted with iliac crest. Seven of the patients were male and 17 female, with a mean (SD) age of 59 (12) years. Sixteen augmentation sites were in the maxilla, and 14 in the mandible and the mean (range) volume (V_1) was 2.82 (0.66 - 6.41) ml, while after four months of remodelling it (V_2) was 2.39 (0.56 - 6.21) ml, corresponding to a mean (SD) percentage reduction in volume of 0.43 ($\pm$0.37) ml (15%).