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Clinical Paper
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Tomographic follow-up of bone regeneration after bone block harvesting from the mandibular ramus

G. F. Diez[1], F. N. G. K.Fontão[2], A. P. F. Bassi[3], J. C. Gama[4], M. Claudino[2]

[1]Department of Oral Surgery, University of Planalto Catarinense (UNIPLAC), Lages, Santa Catarina, Brazil; [2]Postgraduate Department, Latin American Institute of Dental Research and Education (ILAPEO), Curitiba, Paraná, Brazil; [3]Department of Oral Surgery, State University of São Paulo (UNESP), Araçatuba, São Paulo, Brazil; [4]Latin American Institute of Dental Research and Education (ILAPEO), Curitiba, Paraná, Brazil

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Abstract. Autogenous bone is still considered the gold standard, and the applicability of autogenous bone grafts is well established. However, the possibility of second harvesting from the same donor region remains unclear. The aim of this study was to perform a prospective evaluation of hard tissue deposition in the mandibular ramus after bone block harvesting using cone beam computed tomography (CBCT). Twenty-two patients with indications for augmentation procedures using autogenous bone from the mandibular ramus were selected. Three CBCT scans were performed with a tomographic guide before bone harvesting (T1) and at 14 days (T2) and 6 months (T3) after the surgical procedures. Measurements were obtained in 2D (area, mm^2) and 3D (volume, mm^3), and were subsequently compared. In the 2D analysis, the mean bone formation rate was 56%, while for the 3D analysis the mean rate was 9.7%. Despite this difference, there was a significant correlation between area and volume measurements. Our findings demonstrated the presence of hard tissue in the mandibular ramus at 6 months after bone harvesting, which suggests that it would be possible to reuse the same region for a second block harvesting. However, the second bone harvesting would involve less bone for transplantation when compared to the first bone harvesting.

Key words: bone transplantation; cone beam computed tomography; bone regeneration.

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Dental implants are considered a safe and predictable treatment for replacing missing teeth and to restore function in partially or completely edentulous patients. However, the success of this treatment is strictly influenced by both the density and volume of available bone for implant placement.[1,2] Insufficient height and width of the alveolar bone is a contraindication to the conventional placement of dental implants. In order to improve the conditions for implant placement, reconstruction and augmentation of severely resorbed alveolar ridges have been performed using different grafting materials and techniques.[3–6] It is widely accepted that autologous bone is the most appropriate grafting material due to its osteoconductive, osteoinductive, and osteogenic properties.[7,8] Previous studies have demonstrated the occurrence of bone remodelling and revascularization or neovascularization in autologous bone grafts and have shown how this provides an ideal site to support the occlusal forces of an implant-supported prosthesis.[9,10] In addition, bone graft augmentation is associated with a reduction in financial costs and has a

faster healing period when compared with others bone substitutes.[1]

Autogenous bone can be obtained from extraoral sites such as the calvarium, iliac crest, and tibia. Moreover, bone blocks can be harvested from intraoral sites, including the retromolar region, zygoma, maxilla, and mandible.[11,12] Intraoral grafting has several advantages when compared with extraoral donor sites, such as proximity of the donor site to the graft site, convenient surgical access, a shorter operative time, lower morbidity, and ease of carrying out the procedure in an office setting. The intraoral surgical procedure can be performed in the office, and general anaesthesia is optional.[7,13] The major limitation of using intraoral donor sites is the smaller quantity of graft obtainable when compared with extraoral donor sites such as the iliac crest and calvarium.[13,14]

The amount of bone harvested from intraoral sites is often adequate for dental implant placement. However, in some cases, additional augmentation procedures may be required, so bone must be harvested from other sites, or the same area may be reassessed.[15] Second harvesting from the mandibular ramus and symphysis in augmentation procedures has been described previously by some authors.[16,17] However, the bone repair process at the donor site remains poorly described.

Therefore, a tomographic evaluation of the repair process at the donor site after bone block harvesting would be very useful for clinical practice, considering that computed tomography (CT) is a highly reliable method for assessing bone changes, especially when compared to radiographs. The aim of this study was to carry out a prospective evaluation of hard tissue deposition in the mandibular ramus after bone block harvesting using cone beam CT (CBCT). The null hypothesis tested was that there would be no significant hard tissue deposition in the mandibular ramus at 6 months after autogenous bone block harvesting.

Materials and methods

Twenty-two patients, 14 women and eight men, ranging in age from 28 to 73 years, were included in the sample. The study took place between 2010 and 2012. The study patients were referred to the clinic as candidates for bone grafting because they presented with atrophied maxillae. The selection criterion was a requirement for alveolar bone ridge augmentation with autogenous bone harvested from the mandibular ramus. Patients were not included if they had a metabolic bone disease or an unstable systemic condition, such as uncontrolled diabetes or untreated hypothyroidism. In addition, smokers and patients who had undergone radiation therapy or who had received chemotherapy were not included in the study. All patients signed an informed consent form to participate in the study. The study was carried out with the approval of the necessary ethics committee.

Surgical procedures were initiated with a mucoperiosteal flap in the anterior region in order to measure the amount of bone tissue to be harvested. A linear incision was made over the external oblique line and a full-thickness flap was reflected, allowing access to the harvest site. After reflection of flaps and exposure of the mandibular ramus, the osteotomies were carried out under abundant irrigation to harvest the bone tissue. After bone harvesting, autogenous bone blocks were used in the augmentation procedures.

To evaluate hard tissue deposition at the donor site, CBCT was carried out using a tomographic guide containing 0.5-mm steel balls, at three different time-points. The use of a tomographic guide enabled the standardization of the region evaluated in all tomography scans. CBCT was performed before the harvesting procedure (T1) and at 14 days (T2) and 6 months (T3) after bone augmentation. CBCT images were obtained with Galileos (Sirona, Bensheim, Germany) using the following specifications: 15 × 15 cm^3 FOV (field of view), 42 mAs, high contrast, 85 kV, slice thickness of 0.3 mm, image intensifier-based CT detector 12-bit grayscale (4096 shades). The total scanning time was 14 s. The technique was carried out in a standardized mode, with the patient's head positioned so that the occlusal plane was parallel to the ground and the midsagittal plane was perpendicular to the ground; the cephalostat settings were always constant.

Tomographic images were imported into the software InVivoDental 5.1.6 (Anatomage, San Jose, CA, USA). Measurements were obtained in two dimensions (2D; area in mm^2) and in three dimensions (3D; volume in mm^3) and compared in order to evaluate the hard tissue deposition at the donor site, as illustrated in Figs. 1 and 2, respectively. The region of interest (donor site) was selected based on the position of steel spheres placed in the tomographic guide. The spheres were then located on the CTs, and the region of interest was selected with the aid of tools from the specialized software, such as alignment, cutting, and millimetre grid.

The inferences of bone density were obtained by measuring the grayscale on tomographic images of the donor site at the different time-points (T1, T2, and T3) using Galaxis 1.7 software (Sirona, Bensheim, Germany). The area of interest was standardized based on the position of the steel balls, and the grayscale measurements were obtained using the tool 'view grey value' (ROI 3 mm) on axial slices.

All measurements were obtained at the different time-points (T1, T2, and T3) by a single calibrated examiner. The examiner (GFD) had been calibrated by an experienced radiologist (FNGKF). After 14 days, five CT were reanalyzed and the data were compared with previous measurements. Intra-examiner reproducibility was evaluated using the paired *t*-test (95% confidence interval) and no significant differences were found between measurements.

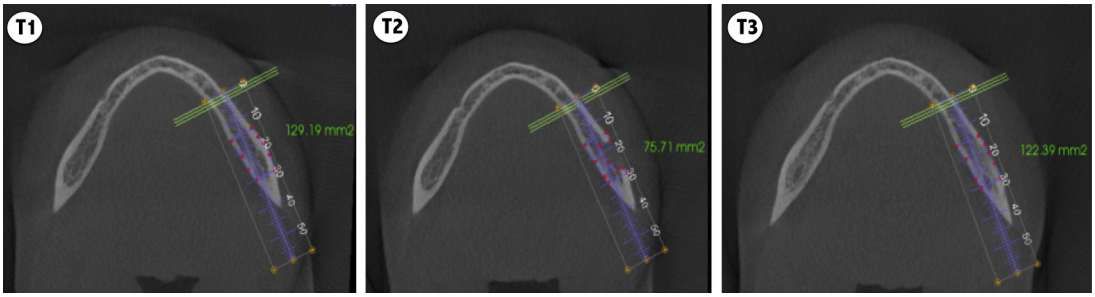

Fig. 1. Area measurements for the donor sites. Observed area measurements at different time-points: before harvesting (T1) and at 14 days (T2) and 6 months (T3) after harvesting from the mandibular ramus.