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Maxilla reconstruction with autogenous bone block grafts: computed tomography evaluation and implant survival in a 5-year retrospective study

J. L. Gulinelli[1], R. A. Dutra[1], H. F. Marão[2], S. F. P. Simeão[1], G. B. Groli Klein[1], P. L. Santos[1]
[1]Universidade Sagrado Coração – USC, Bauru, São Paulo, Brazil; [2]Oral and Maxillofacial Surgery, Universidade Estadual Paulista – UNESP, Araçatuba, São Paulo, Brazil

J. L. Gulinelli, R. A. Dutra, H. F. Marão, S. F. P. Simeão, G. B. Groli Klein, P. L. Santos: Maxilla reconstruction with autogenous bone block grafts: computed tomography evaluation and implant survival in a 5-year retrospective study. Int. J. Oral Maxillofac. Surg. 2017; 46: 1045–1051.

Abstract. This retrospective study was performed to evaluate the bone thickness of the anterior maxillary region after reconstruction with autogenous bone blocks at 6 months and 5 years after surgery using computed tomography (CT) and to determine the implant survival rate. Eleven patients with a horizontal bone deficiency were treated with reconstructive procedures and implant placement. CT measurements were obtained before surgery (T0) and at 6 months (T1) and 5 years (T2) after surgery. The values were analysed statistically (analysis of variance and Tukey's test; $P < 0.05$). Implant survival was evaluated at follow-up. The mean width of the lower region of the ridge (± standard deviation, in millimetres) was 3.8 ± 1.6 at T0, 7.0 ± 1.6 at T1, and 6.5 ± 1.0 at T2; the mean width of the upper region of the ridge was 5.7 ± 2.3 at T0, 8.3 ± 2.2 at T1, and 7.3 ± 1.6 at T2. The mean total thickness of the ridge was 4.7 mm at T0, 7.6 mm at T1, and 6.9 mm at T2; the average increase in horizontal thickness was 2.9 mm at T1 and 2.2 mm at T2. A statistically significant difference was observed in the mean width of the lower portion at T1 and T2 compared to the width at T0. The implant survival rate was 94.1%. This technique demonstrated high predictability for implant survival, with a reduction in the graft bone during the follow-up period.

Key words: bone graft; dental implant; maxilla; tomography.

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Introduction

Several reconstructive procedures for the maxilla have been proposed with the aim of increasing alveolar bone dimensions in both the vertical and horizontal directions. These include guided bone regeneration, bone block grafting, distraction osteogenesis, alveolar ridge expansion, and alveolar or maxillary osteotomy, as well

as different combinations of these techniques. In some cases, bone augmentation procedures are performed simultaneously with implant placement; however, in certain situations, the implant can only be placed after the bone graft has healed[1,2].

When the bone volume is insufficient for adequate implant placement (a minimum of 1 mm more than the selected diameter of the implant is required in all directions), bone reconstruction is necessary[1–10].

Autogenous bone is considered the gold standard among the different biomaterials for use in the restoration of bone thickness, as it is the only material to present osteoconductive, osteoinductive, and osteogenic properties[11]. It also presents immunogenic compatibility, has great vascularization potential, will not result in disease transmission, and has a physical and chemical structure identical to that of the host site. However, the use of autogenous bone is associated with some disadvantages, such as increased surgical morbidity, increased operative and treatment times, the potential risk of neurovascular injury, and a decrease in the volume of the graft[12–17].

The mandibular retromolar region is the best option for bone block harvesting, due to the volume of bone tissue, easy removal of the block, and lower morbidity in the postoperative period when compared to other intraoral areas, such as the chin[18]. The approximate bone volume is 4 ml and this bone is cortical with trabecular bone[19].

One of the disadvantages of a horizontal increase using an autogenous bone block graft is significant bone graft resorption[20]. Few studies have reported the increase in maxillary bone thickness after reconstruction surgery using autogenous bone blocks harvested from the retromolar region[10,16,20–22]. In addition, studies evaluating changes in bone block graft measurements using computed tomography (CT) after 5 years of follow-up and the association with implant survival are lacking in the literature. Therefore, the purpose of this study was to use CT to evaluate the bone thickness of the anterior maxillary region after reconstruction with autogenous bone block grafts harvested from the retromolar region after 6 months of healing and 5 years of follow-up and to determine implant survival.

Materials and methods

This retrospective study received ethical approval from the Research Ethics Committee of the University of the Sacred Heart (USC) in Bauru, São Paulo, Brazil. Eleven patients were recruited and their records analysed. These patients had undergone autogenous bone graft surgery for an atrophic maxilla (retromolar donor area) at the IMPPAR Dentistry Clinic in Paraná, Brazil. The surgeries and data collection were performed between 2008 and 2014. The following inclusion criteria were applied: (1) the patient presented a single missing tooth or partially edentulous space in the anterior maxilla with a residual average bone thickness of <5 mm as measured using CT; (2) the patient agreed to participate and provided a signed informed consent agreement. The following patients were excluded: (1) smokers; (2) patients with systemic diseases and patients taking drugs that could interfere with bone metabolism; (3) patients who did not complete prosthetic rehabilitation.

All autogenous bone grafts were performed by the same surgeon through the removal of the bone block from the retromolar region and fixation with titanium screws. All of the procedures were performed under local anaesthesia with infiltration of articaine hydrochloride 4% with epinephrine 1:200,000 (Nova DFL, Rio de Janeiro, Brazil). Access to the maxillary bone bed was gained through a mucoperiosteal incision in the crest and an oblique incision distal to the defective bone with preservation of the papilla. This was followed by elevation of the flap and decortication with a number 701 drill bit mounted in a straight line, with an approximate speed of 1200 rpm, under copious irrigation with 0.9% saline.

The incision for access to the mandible followed the direction of the oblique line and was made in the posterior–anterior direction, always supported on the bone tissue. The osteotomies were performed with a number 701 drill bit mounted in a straight line. The anteroposterior extent of the block corresponded to the size of the edentulous space in the maxilla to be treated, with the addition of a margin of 2 mm or 3 mm for safety. The depth of the cuts encompassed the cortical bone. After the osteotomies, the blocks were cleaved and removed with the help of straight chisels. Closure was performed with 5–0 nylon sutures (Johnson & Johnson, São José dos Campos, Brazil).

During the second surgical stage, 6 months after the grafting procedure, a mucoperiosteal flap was raised, the screw used to fix the bone graft was removed, and the implants were placed in accordance with the manufacturer's instructions. Titamax implants (Lot 800037070; Neodent, Curitiba, Brazil) with a Poros surface treatment (abrasive blasting followed by acid etching) and external hexagon connections were used. The implants were uncovered after 3 months, and a dental restoration crown with an adequate emergence profile was fabricated and placed to guide and shape the peri-implant tissue. The final impression of the implant was made approximately 3 months after placement of the provisional crown. Subsequently, an all-ceramic crown was fabricated on a customized titanium abutment (Neodent, Curitiba, Brazil) (Fig. 1).

Clinical and surgical data were evaluated and data sheets were prepared based on the patients' records. The following data were collected: sex, age, missing teeth, length and diameter of the implant, initial stability of the connection, number of implants, condition of the peri-implant tissue, implant loss, bone graft technique used, and prosthetic rehabilitation delivered.

The patients were assessed immediately after implant placement and at 6 months (A1), 1 year (A2), 2 years (A3), 3 years (A4), 4 years (A5), and 5 years (A6) thereafter (Fig. 2). The clinical condition of the prosthesis was evaluated during these examinations. Complications related to the prosthetic restoration were recorded, including prosthesis fracture (bar, acrylic, porcelain), prosthesis mobility (implant loss or abutment screw loosening), peri-implantitis, pain, and temporomandibular joint symptoms. For the analysis of implant survival, implants that were still present and were free of biological and/or technical complications were considered to have survived[23]. The implants were assessed after the clinical condition of the prosthesis had been evaluated.

CT scans were obtained before the reconstruction surgery (T0) and at 6 months (T1) and 5 years (T2) after the surgery. All CT images were obtained using a cone beam scanner (i-Cat; KaVo Dental, Joinville, Santa Catarina, Brazil) at the IMPPAR Dentistry Clinic; the scans were acquired in 0.2-mm thick sections with a 1-mm gap at settings of 120 kVp and 100 mA.

Intra-examiner error was evaluated prior to the start of this study in a separate retrospective study of five postoperative images of bone block grafts from random cases. The same radiologist repeated the measurements in all of the images three times in the pilot project. The graft measurements were obtained from the CT DICOM data using Somaris Sienet Magic View software (Siemens AG Medical Solutions, Erlangen, Bavaria, Germany), with a selection tool to identify the region of interest. The measurements were made by a single experienced radiologist.

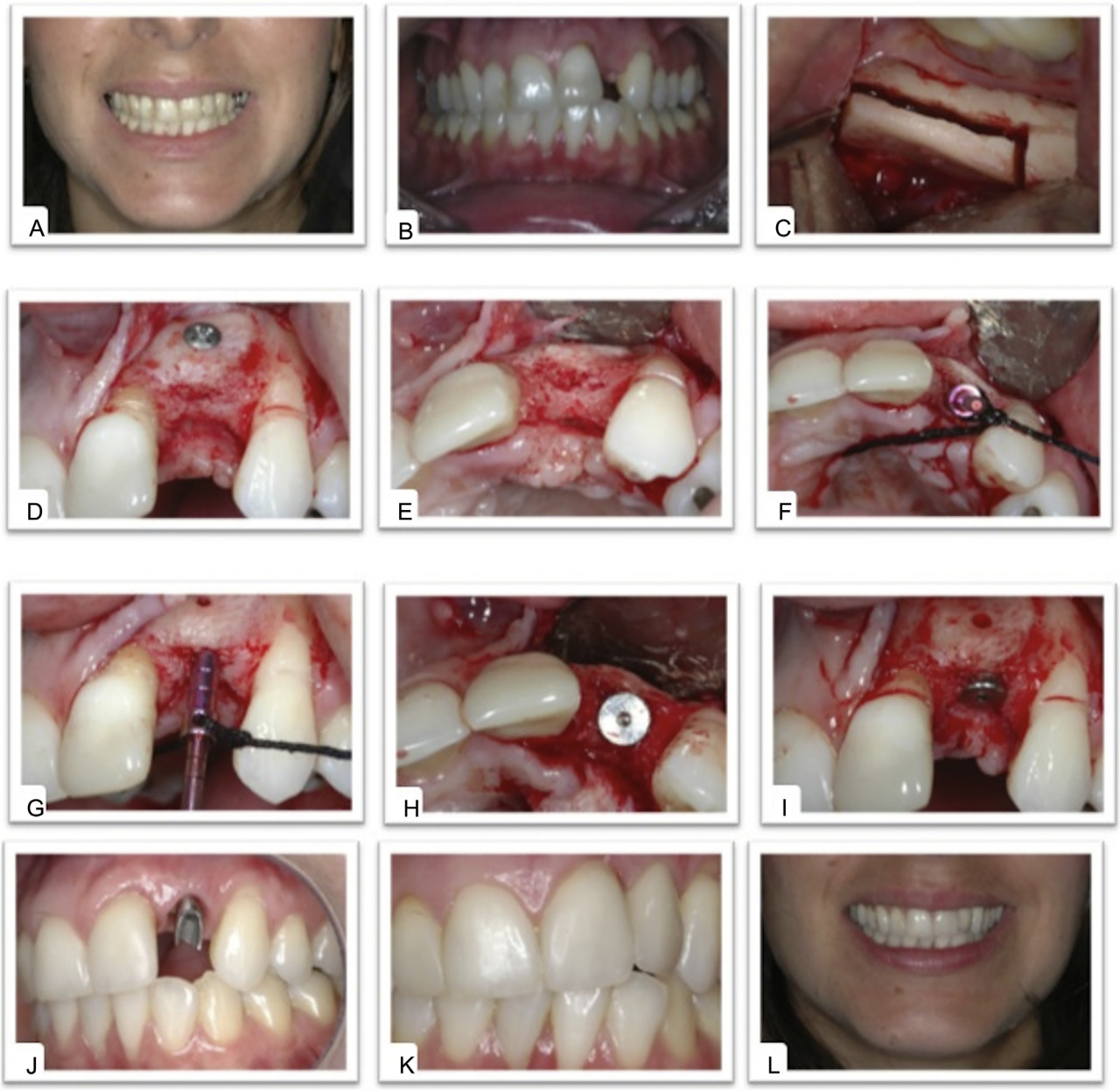

Fig. 1. Clinical procedure: (A) and (B) clinical aspects of the initial case; (C) bone block harvested from the mandibular ramus; (D) and (E) images obtained at 6 months after maxillary ridge augmentation with a block; (F) implant placement at 6 months in the second stage surgery; (G), (H), and (I) placement of the dental implant with connection of the external hexagon; (J), (K), and (L) final clinical aspects of the case after installation of the definitive implant-supported prosthesis.

A single point where the implant was to be placed was used to determine the bone block graft thickness at time points T0, T1, and T2. The alveolar ridge crest was identified in a sagittal section (distance from the lowest point of the alveolar ridge (A) to the upper point of the nasal cavity (B) in Fig. 3). Next, the region was divided into three equal parts by drawing straight lines parallel to an imaginary line in the nasal cavity (fixed point). The line closest to the nasal cavity in the direction of the palatal vestibule marked the 'upper' region, and the furthest line marked the 'lower' region (Fig. 3).

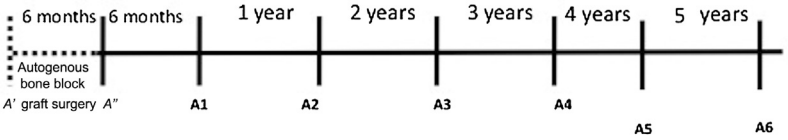

Fig. 2. Timeline of treatment: A′ is the time at autogenous bone block graft surgery in the atrophic anterior maxilla region; A″ is the time at implant placement, 6 months after bone reconstruction with the autogenous bone block graft; A1 to A6 represent the follow-up visits after implant placement.

The lower and upper region width values at the three time points (T0, T1, and T2) were analysed statistically using the software program PAST for Windows (Øyvind Hammer, Natural History Muse-

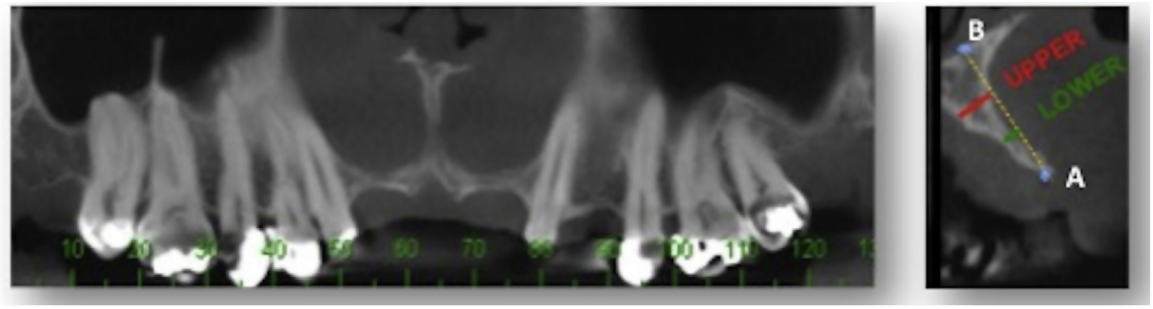

Fig. 3. Measurement of the increase in thickness of the bone from a CT scan.

um, University of Oslo, Oslo, Norway). Analysis of variance (ANOVA) and Tukey's test were applied, and the significance level was set at $P < 0.05$.

Results

Of the 11 patients treated, four (36.4%) were female and seven (63.6%) were male. The most commonly represented age range in the patient population was 40–49 years (36.4%), followed by 50–59 years (27.3%). The average age of the patients in this study was 45.9 years (Table 1).

Clinical analysis

Among the edentulous regions treated ($n = 17$), 11 were on the right side (64.7%) and six were on the left (35.3%). The central incisors were the most commonly affected teeth on both sides. A total of 17 regions were reconstructed with autogenous bone blocks and 17 implants were placed; 14 of these implants (82.3%) were in the region covering teeth 11 to 21 (Tables 2 and 3).

The 17 bone block grafts were maintained and one of the 17 implants was lost. Paresthesia occurred in the donor area in one patient and a coronoid process fracture was observed in another patient (Table 4). The patient with paresthesia was treated with vitamin B complex and corticosteroids. The paresthesia had resolved after 2 years. The patient with the coronoid fracture underwent conservative treatment with a soft diet for 3 months. Bone healing was observed on CT after 7 months of follow-up. The implant success rate was 100% after 2 years and 94.1% after 5 years.

Table 1. Distribution of patients by age and sex (mean age 45.9 years).

Age, years	Male	Female	Total
30–39	2	0	2
40–49	3	1	4
50–59	2	1	3
60–69	0	2	2
Total	7 (63.6%)	4 (36.4%)	11 (100%)

Table 2. Distribution of dental implants installed in the grafted areas.

Region	Number of implants
13	1
12	1
11	9
21	5
22	1
Total	17

CT analysis

A total of 33 CT scans from the 11 patients were evaluated. The mean width of the lower region of the ridge (± standard deviation) was 3.8 ± 1.6 mm at T0, 7.0 ± 1.6 mm at T1, and 6.5 ± 1.0 mm at T2, with a mean horizontal gain in thickness of 3.2 mm at 6 months and of 2.7 mm at 5 years. The mean width of the upper region of the ridge (± standard deviation) was 5.7 ± 2.3 mm at T0, 8.3 ± 2.2 mm at T1, and 7.3 ± 1.6 mm at T2, with a mean horizontal gain in thickness of 2.6 mm at 6 months and of 1.6 mm at 5 years. The mean total thickness of the ridge was 4.7 mm at T0, 7.6 mm at T1, and 6.9 mm at T2, with a mean increase in the average horizontal thickness of 2.9 mm at 6 months and of 2.2 mm at 5 years.

The Kolmogorov–Smirnov test was applied to assess the normality of the data. Tukey's test was used for non-paired multiple comparisons at a significance level of 5%. A statistically significant difference was observed in the mean width of the lower region at 6 months (T1) and at 5 years (T2) when these values were compared to those obtained at T0. A statistically significant difference was found in the mean width of the upper region at 6 months after reconstruction (T2) compared to T0 (Fig. 4).

Discussion

The objective of this study was to evaluate the gain in and maintenance of bone volume with the use of bone block grafts harvested from the mandibular retromolar region fixed in the host bone site prior to implant placement. From an aesthetic point of view, the anterior region of the

Table 3. Patient data and measurements of the ridge width (millimetres) at T0 (before surgery), T1 (6 months after surgery), and T2 (5 years after surgery).

Patient	Sex	Age, years	Region	T0 upper	T0 lower	T1 upper	T1 lower	T2 upper	T2 lower
1	Male	43	11	3.0	3.2	3.2	6.5	4.6	7.0
2	Male	52	11	3.3	2.4	8.9	8.0	4.7	7.6
			21	6.0	2.9	6.4	4.9	6.8	5.2
3	Female	63	11	7.0	3.3	9.6	7.0	10.2	7.6
			21	5.0	3.2	7.2	5.2	7.8	7.1
4	Female	43	11	2.7	1.5	6.1	3.8	7.3	4.8
			21	2.8	1.6	7.3	5.3	5.2	6.2
5	Male	47	11	6.6	5.6	11.0	9.4	4.7	4.1
			21	7.9	6.5	11.2	8.1	8.1	6.2
6	Male	47	11	6.0	5.9	8.9	9.1	7.3	6.3
			21	8.1	3.6	10.3	7.4	7.8	6.3
7	Male	50	13	10.2	5.7	9.5	7.2	7.0	6.5
8	Female	59	11	3.3	2.1	6.9	6.8	8.0	5.2
9	Female	62	11	6.0	3.9	6.3	7.2	6.5	5.2
10	Male	38	11	8.8	5.4	10	7.0	10.8	9.6
11	Male	35	12	5.9	4.3	6.9	6.1	6.1	6.2
			22	4.6	3.2	11.6	10.2	11.1	9.7

Table 4. Main complications observed in the study.

Complication	Partial rehabilitation	Single rehabilitation	Total
Paresthesia	1	–	1
Coronoid fracture	1	–	1
Infection	–	–	–
Wound dehiscence	–	–	–
Implant loss[a]	1	–	1
Total	3	0	3

[a] The implant survival rate was 94.1%.

oral cavity is the most challenging, and in many cases the horizontal bone volume needs to be increased due to partial or complete bone loss[24].

Bone grafts harvested from an intraoral site provide better results when compared to grafts harvested from the calvaria or iliac crest[25]. However, there is no consensus regarding the absorption of different types of graft. Thus, the best time for implant placement and prosthesis installation needs to be established for the different bone grafts. In this study, implants were placed 6 months (T1) after the onlay bone grafting procedure, as recommended in the literature, which reports an average resorption of approximately 1.2 mm and greater incorporation of the graft in the host site when implants are placed at this time point, thus ensuring the stability of the reconstruction[26].

Von Arx and Buser have claimed that the main criterion for selecting the best time for implant placement (simultaneous with the graft or after bone block healing) is the volume of the bone at the host site[27]. It is possible to place the implant at the same time as the bone graft if the remaining bone allows for the correct positioning of the implant and primary stability. However, Clementini et al. found that when implants are placed later, the result is a revascularized bone graft, which can lead to better bone–implant contact and secondary stability[1]. Cara-Fuentes et al. conducted a study on implants placed in a grafted area with a follow-up period of 70 months and found a survival rate of 93%[28]. These findings are in agreement with the high implant survival rate observed in the present study (94.1%).

Nkenke et al. did not observe any complications during or after bone block graft harvesting from the retromolar region[12]. Nevertheless, there is a risk of damage to the inferior alveolar nerve during bone cutting and at the time of bone block removal. A safety margin of 2 mm above the inferior alveolar nerve should be allowed, and extensive bleeding after removal of the bone graft should be avoided. From a surgical point of view, the authors recommend protecting the nerve and lingual artery during the incision and bone osteotomy. The bone block graft should be removed carefully, especially in cases where the mandible is thin, because bone cutting in the retromolar area can lead to mandible fracture. Two complications were identified in the present study: paresthesia and coronoid fracture.

Von Arx and Buser proposed the use of inorganic bovine bone to cover the bone block graft, along with a collagen membrane to promote guided bone regeneration[27]. In their study, resorption of 7.5 mm and a total gain of 4.6 mm in the graft width were observed after 6 months. This technique was not performed in the present study and less than half the gain in bone width (2.9 mm) was obtained. The lack of predictability must be considered when a procedure is performed without associated osteoconductive bone substitutes, due to the extensive bone resorption that occurs during bone healing[29]. Approximately 30% of the thickness is resorbed in the first 6 months, and this resorption can reach more than 50% of the block thickness[17].

De Stavola and Tunkel used inorganic bovine bone with a collagen membrane at the time of implant placement in alveolar ridges previously grafted with autogenous bone blocks harvested from the retromolar region[20]. They stated that the trauma of the implant placement may have been responsible for the bone resorption observed in the graft. The authors reported an increase in bone thickness of 7.6 ± 0.8 mm. This value is higher than the value observed in the present study.

Lekholm et al. reported the survival rate of implants placed in bone grafts and

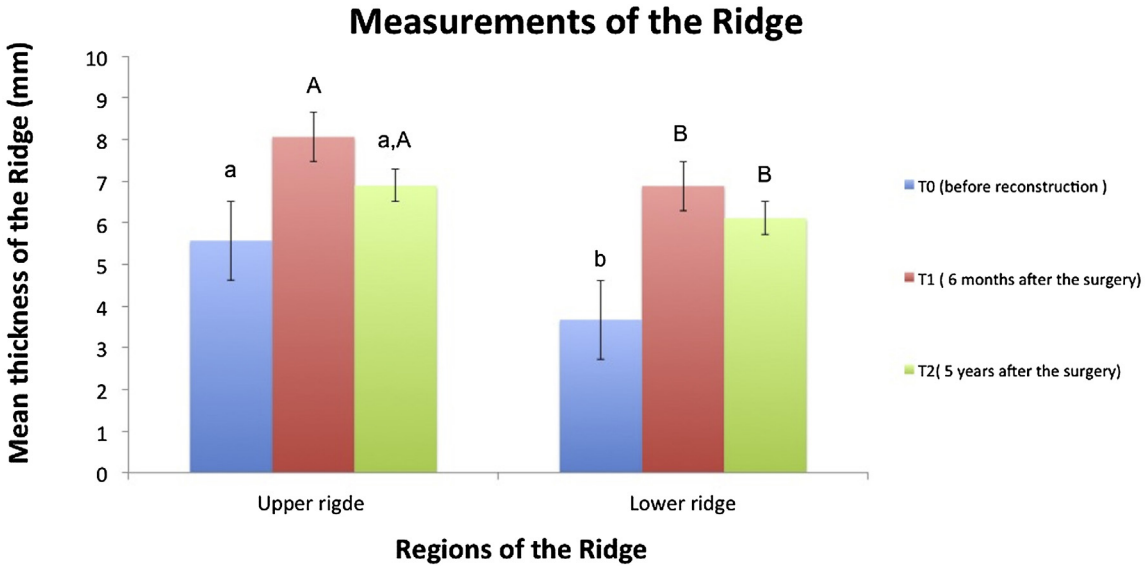

Fig. 4. Graphic representation of the dimensions of the upper and lower regions of the ridge (mean and standard deviation values) before grafting (T0), at 6 months after surgery (T1), and at 5 years after surgery (T2). There were significant differences between the measurements at T0 and the measurements at T1 and T2: a $\neq$ A and b $\neq$ B; analysis of variance (ANOVA) and Tukey's test ($P < 0.05$).

Table 5. Changes in autogenous bone graft volume reported in the literature.

Authors	Donor site	Evaluation period	Method of analysis	Result (bone loss)
Von Arx and Buser 2006[27]	Symphysis and ramus Bovine bone mineral	5.8 months	Caliper	0.4 mm
Verdugo et al. 2009[10]	Ramus and symphysis	42 months	Caliper	2%
Acocella et al. 2010[16]	Ramus	3–9 months	Caliper	13%
Verdugo et al. 2011[22]	Ramus and symphysis	40 months	CT	0.2 mm
Dasmah et al. 2012[32]	Iliac crest	2 years	CT	22%
Sbordone et al. 2012[33]	Iliac crest	6 years	CT	13%
De Stavola and Tunkel 2013[20]	Ramus Bovine bone mineral	8 months	Caliper, CT	1 mm
Pieri et al. 2013[34]	Ramus and symphysis	5 years	CT	0.6 mm
Present study	Ramus	5 years	CT	0.7 mm

CT, computed tomography.

observed a loss of 10% of the implants after 3 years[30]. In their study, the bone blocks were harvested from the chin and iliac crest and the implants had no surface treatment. Furthermore, the surgeries were performed by a large number of surgeons. It is probable that the high number of variables contributed to the rate of implant failure, which was almost twice that observed in the present study. This indicates the importance of performing the proper surgical technique, as well as using implant systems with a surface treatment.

With the advancements made in biomaterials and surgical techniques for guided tissue regeneration, new possibilities have been proposed for increasing the bone volume for subsequent dental implant placement. These procedures are less aggressive for the patient and in most cases result in a more comfortable postoperative period[31]. However, intraoral autogenous bone block grafts remain the gold standard for bone reconstruction, with predictable results over 5 years of follow-up, as observed in the present study. It is important to conduct long-term clinical evaluations of the different bone graft techniques and materials in order to observe the bone healing patterns both clinically and biologically and thus offer safe options to the patient. According to the results of the present study, bone block grafts harvested from the retromolar region are effective in the atrophic maxilla, since the thickness was maintained and the implant survival rate at 5 years of follow-up was high. Changes in the autogenous bone graft volume reported in the literature are shown in Table 5[10,16,20,22,27,32–34].

The methodology used in the present study is unique in terms of the analysis of volumetric changes after bone reconstruction. Thus, due to the experimental design, it is difficult to compare the results with those of other studies reported in the literature. Although the results are encouraging, there is a need for further studies using this methodology and the same analysis periods immediately after bone reconstruction.

Funding

None.

Competing interests

None.

Ethical approval

Ethical approval was obtained from the Research Ethics Committee of the University of the Sacred Heart (USC), Bauru, São Paulo, Brazil (#227/2012).

Patient consent

Not required.

References

1. Clementini M, Morlupi C, Agrestini C, Barlattani A. Immediate versus delayed positioning of dental implants in guided bone regeneration or onlay graft regenerated areas: a systematic review. *Int J Oral Maxillofac Surg* 2013;**42**:643–50.
2. Milinkovic I, Cordaro L. Are there specific indications for the different alveolar bone augmentation procedures for implant placement? A systematic review. *Int J Oral Maxillofac Surg* 2014;**43**:606–25.
3. Mardas N, Chadha V, Donos N. Alveolar ridge preservation with guided bone regeneration and a synthetic bone substitute or a bovine-derived xenograft: a randomized, controlled clinical trial. *Clin Oral Implants Res* 2010;**21**:688–98.
4. Brkovic BM, Prasad HS, Rohrer MD, Konandreas G, Agrogiannis G, Antunovic D, Sándor GK. Beta-tricalcium phosphate/type I collagen cones with or without a barrier membrane in human extraction socket healing: clinical, histologic, histomorphometric, and immunohistochemical evaluation. *Clin Oral Investig* 2012;**16**:581–90.
5. Santos PL, Gulinelli JL, Telles Cda S, Betoni Júnior W, Okamoto R, Chiacchio Buchignani V, Queiroz TP. Bone substitutes for peri-implant defects of postextraction implants. *Int J Biomaterials* 2013;**2013**:307136.
6. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single tooth extraction: a clinical and radiographic 12-month prospective study. *Int J Periodontics Restorative Dent* 2003;**23**:313–23.
7. Chen ST, Wilson TG, Hammerle CH. Immediate or early placement of implants following tooth extraction: review of biologic basis, clinical procedures, and outcomes. *Int J Oral Maxillofac Implants* 2004;**19**:12–25.
8. Shi B, Zhou Y, Wang YN, Cheng XR. Alveolar ridge preservation prior to implant placement with surgical-grade calcium sulfate and platelet-rich plasma: a pilot study in a canine model. *Int J Oral Maxillofac Implants* 2007;**22**:656–65.
9. Farmer M, Darby I. Ridge dimensional changes following single-tooth extraction in the aesthetic zone. *Clin Oral Implants Res* 2014;**25**:272–7.
10. Verdugo F, Simoniam K, Nowzari H. Periodontal biotype influence on the volume maintenance of onlay grafts. *J Periodontol* 2009;**80**:816–23.
11. Marx RE. Bone and bone graft healing. *Oral Maxillofac Surg Clin North Am* 2007;**19**:455–66.
12. Nkenke E, Radespiel-Troger M, Wiltfang J, Schultze-Mosgau S, Winkler G, Neukam FW. Morbidity of harvesting of retromolar bone grafts: a prospective study. *Clin Oral Implants Res* 2002;**13**:514–21.
13. Kao ST, Scott DD. A review of bone substitutes. *Oral Maxillofac Surg Clin North Am* 2007;**19**:513–21.
14. Sbordone L, Toti P, Menchini-Fabris G, Sbordone C, Guidetti F. Implant survival in maxillary and mandibular osseous onlay grafts and native bone: a 3-year clinical and computerized tomographic follow-up. *Int J Oral Maxillofac Implants* 2009;**24**:695–703.
15. Urban IA, Lozada JL. A prospective study of implants placed in augmented sinuses with

minimal moderate residual crestal bone: results after 1 to 5 years. *J Oral Maxillofac Implants* 2010;**25**:1203–12.
16. Acocella A, Bertolai R, Colafranceschi M, Sacco R. Clinical, histological and histomorphometric evaluation of the healing of mandibular ramus bone block grafts for alveolar ridge augmentation before implant placement. *J Craniomaxillofac Surg* 2010;**38**:222–30.
17. Block MS, Ducote CW, Mercante DE. Horizontal augmentation of thin maxillary ridge with bovine particulate xenograft is stable during 500 days of follow-up: preliminary results of 12 consecutive patients. *J Oral Maxillofac Surg* 2012;**70**:1321–30.
18. Raghoebar GM, den Hartog L, Vissink A. Augmentation in proximity to the incisive foramen to allow placement of endosseous implants: a case series. *J Oral Maxillofac Surg* 2010;**68**:2267–71.
19. Hatano N, Shimizu Y, Ooya K. A clinical long-term radiographic evaluation of graft height changes after maxillary sinus floor augmentation with a 2:1 autogenous bone/xenograft mixture and simultaneous placement of dental implants. *Clin Oral Implants Res* 2004;**15**:339–45.
20. De Stavola L, Tunkel J. A new approach to maintenance of regenerated autogenous bone volume: delayed relining with xenograft and resorbable membrane. *Int J Oral Maxillofac Implants* 2013;**28**:1062–7.
21. Nystrom E, Nilson H, Gunne J, Lundgren S. A 9–14 year follow-up of onlay bone grafting in the atrophic maxilla. *Int J Oral Maxillofac Surg* 2009;**38**:111–6.
22. Verdugo F, Simonian K, Frydman A, D'Addona A, Pontón J. Long-term block graft stability in thin periodontal biotype patients: a clinical and tomographic study. *Int J Oral Maxillofac Implants* 2011;**26**:325–32.
23. Bruggenkate CM, Krekeler G. Symmetrical placement of implants in the edentulous mandible: a new technique. *J Oral Maxillofac Surg* 1990;**48**:1124–6.
24. Kuchler U, von Arx T. Horizontal ridge augmentation in conjunction with or prior to implant placement in the anterior maxilla: a systematic review. *Int J Oral Maxillofac Implants* 2014;**29**:14–24.
25. Fretwurst T, Nack C, Al-Ghrairi M, Raguse JD, Stricker A. Long-term retrospective evaluation of the peri-implant bone level in onlay grafted patients with iliac bone from the anterior superior iliac crest. *J Craniomaxillofac Surg* 2015;**43**:956–60.
26. Zakhary IE, El-Mekkawi HA, Elsalanty ME. Alveolar ridge augmentation for implant fixation: status review. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2012;**114**:179–89.
27. Von Arx T, Buser D. Horizontal ridge augmentation using autogenous block grafts and the guided bone regeneration technique with collagen membranes: a clinical study with 42 patients. *Clin Oral Implants Res* 2006;**17**:359–66.
28. Cara-Fuentes M, Machuca-Ariza J, Ruiz-Martos A, Ramos-Robies MC, Martinez-Iara I. Long-term outcome of dental implants after maxillary augmentation with and without bone grafting. *Med Oral Patol Oral Cir Bucal* 2016;**21**:229–35.
29. Jensen SS, Terheyden H. Bone augmentation procedures in localized defects in the alveolar ridge: clinical results with different bone grafts and bone-substitute materials. *Int J Oral Maxillofac Implants* 2009;**24**:218–36.
30. Lekholm U, Wannfors K, Isaksson S, Adielsson B. Oral implants in combination with bone grafts. A 3-year retrospective multicenter study using the Brånemark implant system. *Int J Oral Maxillofac Surg* 1999;**28**:181–7.
31. Margonar R, Queiroz TP, Saito CT, Luvizuto ER, Betoni-Júnior W, de Oliveira JC, Marcantonio É.. Prosthetic rehabilitation using short dental implants associated with homogenous bone graft. *J Craniofac Surg* 2010;**26**:946–50.
32. Dasmah A, Thor A, Ekestubbe A, Sennerby L, Rasmusson L. Particulate vs. block grafts: three-dimensional changes in graft volume after reconstruction of the atrophic maxilla, a 2 year radiographic follow-up. *J Craniomaxillofac Surg* 2012;**40**:654–9.
33. Sbordone C, Toti P, Guidetti F, Califano L, Santoro A, Sbordone L. Volume changes of iliac crest autogenous bone grafts after vertical and horizontal alveolar ridge augmentation of atrophic maxillas and mandibles: a 6-year computerized tomographic follow-up. *J Oral Maxillofac Surg* 2012;**70**:2559–65.
34. Pieri F, Aldini NN, Marchetti C, Corinaldesi G. Esthetic outcome and tissue stability of maxillary anterior single-tooth implants following reconstruction with mandibular block grafts: a 5-year prospective study. *Int J Oral Maxillofac Implants* 2013;**28**:270–80.

Address:
Pâmela Letícia dos Santos
Departamento Pró-Reitoria de Pesquisa e Pós-graduação
Universidade Sagrado Coração
Rua Irmã Arminda
10–50
17011-160 Bauru
SP
Brazil
Tel: +55 14 2107 7340
E-mails: pamelalsantos@hotmail.com, pamela.odonto@gmail.com