

Surgical procedures with minimally-invasive autologous bone block graft

Including a tomographic analysis after 48 months

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_Autologous bone blocks were combined with a synthetic tricalcium phosphate (TCP) bone graft substitute to reconstruct the alveolar ridge in the region of the maxillary left canine. On re-opening for implant placement, the majority of the bone graft substitute had been replaced by newly formed bone and the bone blocks, although still discernible from the surrounding hard tissue, had been integrated into the host bone. Four years after surgery, the site was evaluated using CBCT. The results demonstrated preservation of the height and volume of the grafted area.

_Introduction

Dental rehabilitation of partially or totally edentulous patients with oral implants has become a routine treatment modality in the last few decades and offers reliable long-term results.¹⁻⁴ However, unfavourable local conditions of the alveolar ridge due to atrophy, periodontal disease or trauma sequelae may provide insufficient bone volume or unfavourable vertical, horizontal, and sagittal intermaxillary relationships, which may render implant placement impossible or undesirable

Figs. 1 & 2_Initial clinical situation and CT view of the critical bone defect in the canine area.
Figs. 3 & 4_After opening the flap, the large resorption was verified.



Fig. 1



Fig. 2

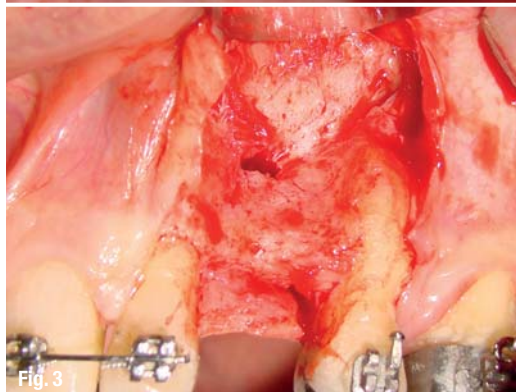


Fig. 3

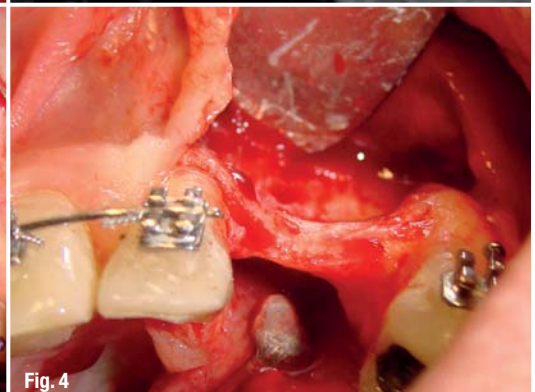


Fig. 4

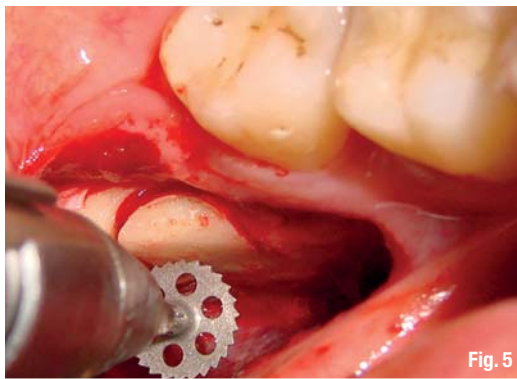


Fig. 5

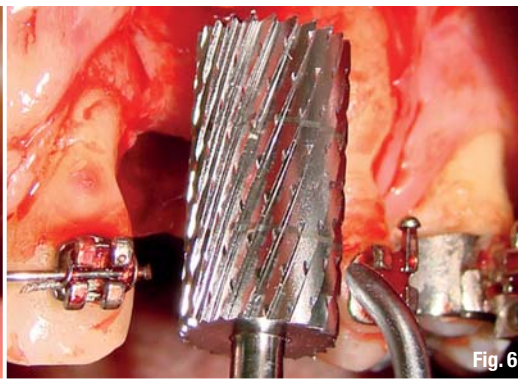


Fig. 6

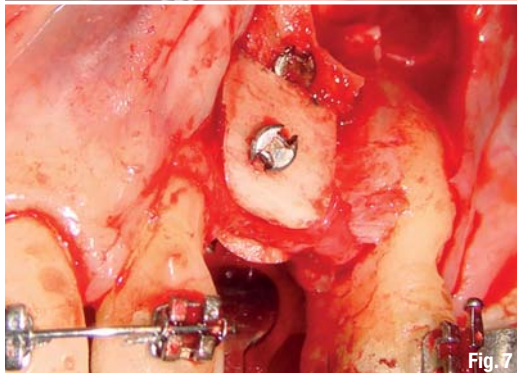


Fig. 7

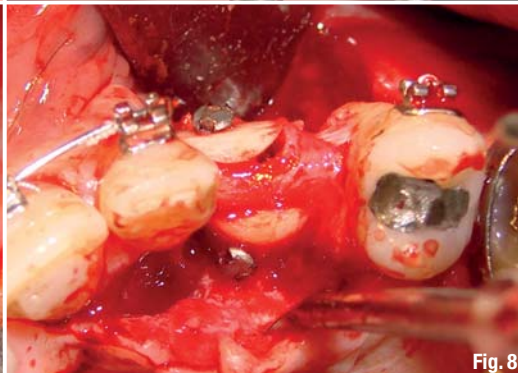


Fig. 8

Figs. 5 & 6_ Removal of the blocks using the Transfer-Control kit.

Figs. 7 & 8_ The blocks were positioned and fixed; two on the buccal side and one on the palatine side.

from a functional and aesthetic viewpoint. A reduced amount of bone in the surgical area, in terms of height and width, due to atrophy of the maxillae can determine the success of the implant.⁵ The atrophic maxillary ridges can be treated with bone grafts, followed by osseointegrated implants to obtain aesthetic and functional oral rehabilitation. In order to overcome this problem, various methods to augment the bone volume of deficient sites have been described: inlay or onlay bone grafts, guided bone regeneration, split ridge/ridge expansion techniques, and alveolar distraction osteogenesis are common methods to re-establish and correct intermaxillary relationships and produce adequate bone morphology and volume for implant placement.^{6,7} Autologous and non-autologous options are available for vertical and horizontal bone deficiencies, but autologous bone grafts have the advantage of providing osteogenic cells to the recipient site.^{8,9} When a limited amount of bone is needed, local grafts harvested from the mandibular symphysis or ramus have been used extensively.¹⁰⁻¹³ However, when less traumatic surgeries are possible, combination with biomaterials is a good choice. A large variety of biomaterials are available in the market, such as calcium phosphates. Materials such as TCP are osteoconductive because osteoblasts adhere to them and deposit bony tissue on their surface. The biomaterial forms a scaffold for closing the bony defect.¹⁴ Calcium phosphates have a high affinity for proteins (such as bone morphogenetic proteins).¹⁵ The pores of these bioceramics have a filter effect and accumulate the growth factors from the surrounding body fluid inside the micropores.¹⁶ Osteoclasts resorb bone or other resorbable calcium phosphate materials by releasing

acids to dissolve the mineral portion. This action forms resorption lacunae¹⁷ by dissolving the inorganic calcium phosphate components of the vital bone or graft. Materials degrade owing to their physical characteristics or mechanical forces, or they can be dissolved hydrolytically by fluids in the body milieu.¹⁸ Bone substitute materials are intended to be implanted during a surgical procedure and over time become a part of vital bone. Hydroxyapatite materials made of bovine bone, processed or partially synthetic, are not ideal bone grafting materials because they are non-resorbable.¹⁹ Moreover, the risk of disease transmission cannot be totally excluded. This case report aims to demonstrate the viability of the combination of autologous bone blocks and calcium phosphate granules for grafts in the restoration of a critically atrophied maxilla, reducing the amount of bone to be removed from the donor site. A control CBCT scan four years after the graft is shown in order to evaluate the long-term performance of this graft.

_Case report

A 52-year-old male patient presented with a missing upper left canine at the dental clinic of the Bioface Institute (Santa Maria, Brazil). According to the patient's report, several unsuccessful orthodontic traction attempts were made to provoke eruption of the impacted tooth. Then, surgery was performed to remove the canine; during the procedure, a large quantity of bone tissue had to be removed, leaving the area with quite a large defect, as shown in Figs. 1 and 2. Based on these preoperative examinations, severe resorption in this

Figs. 9 & 10_The Calc-i-oss™ particles were placed to fill the spaces between the blocks.

Figs. 11, 12 & 13_Images of implant placement after 6 months. There was adequate neoformation in the areas where the Calc-i-oss™ (arrows) was inserted.

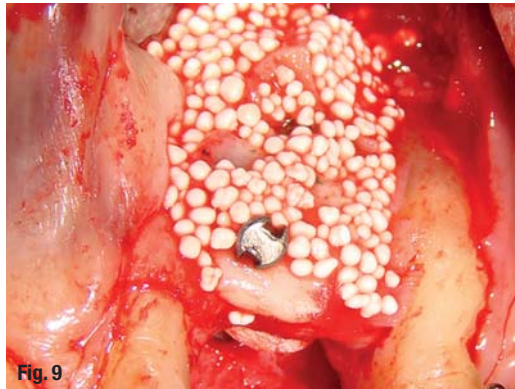


Fig. 9

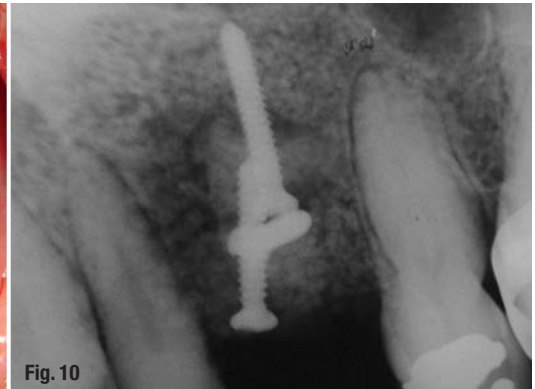


Fig. 10

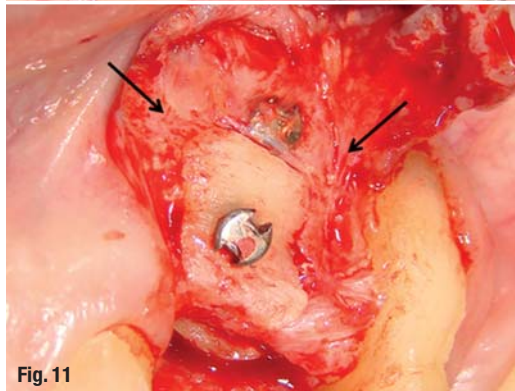


Fig. 11

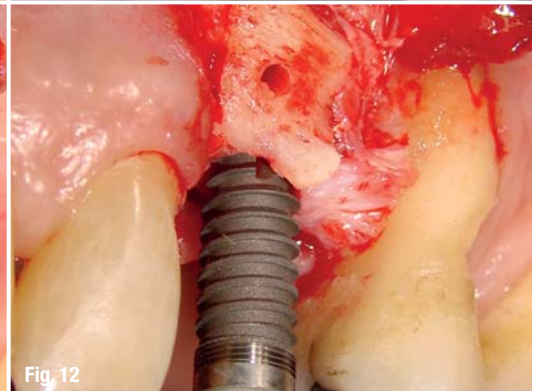


Fig. 12

area was diagnosed, which prevented the placement of a dental implant. The patient was advised to undergo a bone grafting procedure using autologous bone harvested from the mandibular ramus in conjunction with a synthetic biomaterial. Subsequently, implant placement and prosthesis were planned. In the first step, the maxillary area was surgically prepared. Figs. 3 and 4 show the massive bone loss in this area. Once the donor site was exposed (ramus mandibular), osteotomy was performed using a trephine and a saw of the Transfer-Control kit (Hager & Mesinger GmbH, Neuss, Germany) under abundant irrigation with sterile saline solution (Figs. 5 and 6); 3 bone blocks were removed from the mandibular ramus, and these blocks were then placed in the recipient site and held in place with screws (Figs. 7 and 8). The spaces between the blocks were filled with synthetic calcium phosphate bone granules (Calc-i-oss™, Degradable Solutions AG, Switzerland) with particle sizes averaging at 500 - 1000 µm (Fig. 9). The granules provide resorption protection and produce a smooth outline. The mucosa was sutured with 5-0 nylon. Sutures were removed on the 10th postoperative day, and a control radiograph was performed (Fig. 10). Clinically, there was a normal inflammatory reaction after surgery in this area. Six months after augmentation of the alveolar ridge, a conical implant (4.0 mm x 13 mm) with an internal hexagon was placed (Implacil De Bortoli Ltda, São Paulo, Brazil) (Figs. 11, 12 and 13). Three months after implant placement, the site was reopened and an immediate temporary crown was installed to conform the mucosa. After tissue healing, the permanent crown was placed. The patient was educated

and motivated, and thorough oral hygiene instructions were provided. Four years after the installation of the prosthesis, a control tomography to evaluate the behavior of the grafted bone tissue was performed; this allowed the maintenance of bone in the vestibular portion of the implant to be evaluated (Figs. 14 and 15).

Discussion

The utilisation of dental implants sometimes requires an increase in the amount of bone in the implant site. The technique to be used when reconstructing a bone defect is largely at the surgeon's discretion; however, certain situations demand particular techniques. Furthermore, the selection of a minimally invasive technique must always be considered. Autologous bone has been considered the gold standard biomaterial for bone grafts because its characteristics are similar to the lost bone and it is the only biomaterial with osteogenic, osteoinductive and osteoconductive properties.²⁰ However, it requires two surgeries, one for harvesting of the bone and one for grafting, increasing the trauma and sometimes the cost of treatment. Although excellent clinical and histological outcomes have been demonstrated with the use of bone substitute materials as synthetic scaffolds,^{21, 22} some types of bone defects cannot be repaired with these materials because of local mechanical instability and defect size. Therefore, in cases in which large amounts of bone are required, autologous bone is considered the first choice and can be harvested from sites such as the iliac crest, tibia, skull or mandible.²³⁻²⁶ In cases in which the required increase in

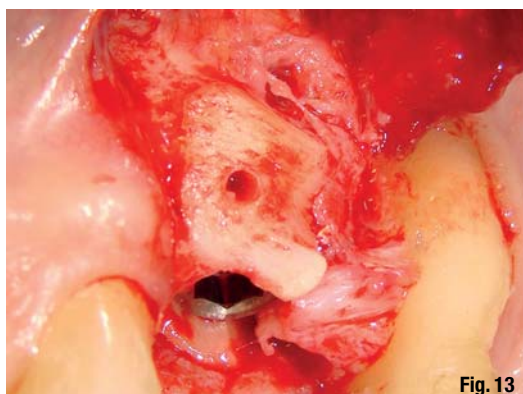


Fig. 13



Fig. 14



Fig. 15

Figs. 14 & 15 _Photograph and tomography image after 4 years; maintenance of bone in the palatine and vestibular portions of the implant is illustrated (yellow arrow).

volume is very high and critical because of very severe bone loss, especially sites in which most of the new bone tissue will receive and support the implant load, autologous bone blocks stabilised by screws are the more suitable and predictable material for the graft. Mandibular bone with its predominantly cortical micro-architecture exhibits a small volume loss and achieves good integration after a short healing period.²⁷⁻²⁹ In comparison with cortical bone grafts, autologous cancellous bone grafts have been thought to be more osteogenic because spaces within their structure allow the diffusion of nutrients and thereby limited revascularisation by micro-anastomosis of the blood vessels.³⁰⁻³² A cancellous graft is a good space filler, but it does not supply substantial structural support. Because only the endosteal and osteoblasts cells on the grafts' surface survive the transplant, a cancellous graft basically behaves as an osteoconductive substrate.³³ This effectively supports the ingrowth of new blood vessels and the infiltration of new osteoblasts and osteoblast precursors.³³ Cancellous grafts do not provide direct structural support, but they quickly integrate. Within six to twelve months, they finally reach a structural strength that is equivalent to that of cortical grafts.³⁴ Several authors have observed that cortical bone grafts will maintain their volume better than cancellous bone grafts will.^{35, 36} Cancellous bone grafts revascularise much more quickly than cortical bone grafts do; however, cortical bone is much stronger.³⁷ The combination of cortical and cancellous bone in grafts promotes early vascularisation and maximum graft maintenance.³⁸ Thus, beta-TCP (β -TCP) was used in this case because it

promotes resorption similar to cancellous bone and cortical bone was harvested from the mandibular ramus. Structurally, porous β -TCP has a compressive strength and tensile strength similar to cancellous bone.³⁹ Studies have suggested that the morbidity when harvesting bone from the mandibular symphysis is higher than when harvesting from the retromolar region,^{29, 40-43} and very few complications with intra-oral bone harvesting occur at the lateral ramus/corpus of the mandible. The lack of adaptation of bone blocks in the recipient site or the presence of gaps can cause the interposition of fibrous tissue.⁴⁴ Therefore, filling these spaces is necessary and autologous bone scrapings,⁴⁵ platelet-rich plasma⁴⁶ or biomaterials can be used for this purpose.⁴⁷ Furthermore, bone graft substitutes are used to prevent resorption and to produce a smooth outline. The use of bone graft substitutes reduces the amount of bone to be harvested from the donor site and thereby improves post-operative recovery. In the case presented, which was followed for four years, it was observed that the material (calc-i-oss) was replaced by new bone formed through the integration of the autologous blocks, facilitating better adaptation in this area.

Conclusion

The principal problems regarding the use of autologous bone for regeneration are limited availability and donor site morbidity; therefore, there is a need for bone graft substitutes. The combination of small autologous blocks with β -TCP offers a good alternative for reconstruction in critical areas and reduces post-operative complications. In the case presented, excellent bone volume was observed after four years.

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