Oral rehabilitation through the application of a xenogenous bone graft prior to placement of a dental implant: a case report with 9 years of follow-up

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Background: Implantology has been restoring dentition for decades with a quality never seen before. Currently, one of the largest challenges in oral rehabilitation using dental implants is bone reconstruction after tooth extraction. Bone reconstruction can be difficult because of residual bone defects caused by endodontic lesions, root fractures, periodontal involvement, or even the surgical stage. These factors can cause a reduction in the height and width of the alveolar bone, which leads to a lack of sufficient residual bone that can be used for implant placement. Lack of this residual bone can therefore impact upon locking, primary stability, and bone preservation. Guided bone regeneration is a highly useful technique for repairing critical defects. However, it is not a simple technique. It has a straightforward concept and technique, but its execution must be performed with great accuracy to ensure a satisfactory result. Successful cases using this precise technique provide valuable tips for performing guided bone regeneration in an outpatient setting, and with the addition of exams such as the histopathological examination of the bone involved, it is possible to confirm the health and further preservation of this regeneration.

Case Description: This case report aims to discuss the parameters related to guided bone regeneration. It presents an alternative approach and illustrates the main features of a successful clinical case where a lyophilized bovine bone graft was used together with a bovine cortical membrane, in a 23-year-old female patient who presented a post-extraction bone defect characterized as a four-walled defect in the upper left canine region. Bringing as a differential some histological sections confirming the stage of maturation and health of the repaired bone tissue.

Conclusions: The case presented excellent results and had clinical imaging follow-up 9 years after the intervention. As observed in the histopathological examination, the bone quality, together with the vascularization of the regenerated tissue, were indicative of a good adhesion of the grafted material to the bone defect, which allowed excellent conditions for its maintenance. Demonstrating the longevity and effectiveness of the technique when properly indicated.

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Introduction

One of the great challenges in oral rehabilitation with dental implants is performing a bone reconstruction after tooth extraction because of the resulting bone defects from the extraction (1,2). Following tooth extraction, reduction in the height and width of the alveolar walls and the lack of residual bone available in which to place the implant influence the length, width, and primary stability of the implant (3). Successful treatment often involves osseointegration and long-term placement of a prosthetic implant to ensure stability and positive aesthetic and functional results, and to facilitate proper hygiene (4).

For the reconstruction of the three-dimensional volume of bone tissue in a critical defect, bone grafts and membranes are often used, which is called guided bone regeneration (5). Even though this technique is already well established in existing literature, there are still some doubts about the type of bone that can be used as a substitute, the osteopromotive membrane that should be used, and the time required before graft reopening (6).

After the bone regeneration period, when the bone aggregates the graft implanted and fixed in the region of the bone defect, the expected result is a cellularized bone, interspersed with inorganic material that will serve as a framework for all these cells and blood vessels (2,3). And later, it will provide conditions for osseointegration during rehabilitation. However, in the middle of this journey, many problems can arise, such as infections, recurrent trauma, rejection by the body and many others (4). The histopathological examination of the specimen collected at the time of milling, or at a time prior to the installation of implants, can portray exactly what this bone microarchitecture is going through at that given moment, a differential that can even define success or failure rates (5,6).

Therefore, this article aims to discuss the parameters related to guided bone regeneration and relate them to a clinical case report that had nine years of clinical-imaging follow-ups. We present the following case in accordance with the CARE reporting checklist (available at https://fomm.amegroups.com/article/view/10.21037/fomm-21-46/rc) (7).

Case presentation

The patient was a 23-year-old female, who had a history of autogenous dental transplantation of the left upper canine (tooth 23) that did not erupt in adolescence. After approximately 10 years, she presented for dental care, in which she had tooth 23 clinically replaced (*Figure 1A,1B*). Previous endodontic treatment and an infection to the root apex and active root resorption were observed, which were indicative of needing tooth removal.

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This case report was guided by the ethical principles and guidelines established by the educational institution University of São Paulo where the patient undergoing any treatment and intervention authorized the execution of procedures and analysis regulated by the guidelines of the federal council of Brazilian dentistry. The images and exams were disseminated for only scientific and academic purposes without the identification of the patient. Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

The extraction of the tooth in question was performed in 2011, at the clinic of Faculty of dentistry of Bauru (USP) under local anesthesia. After extraction, the socket had horizontal bone loss, with vestibular and apical wall fenestration, which was categorized as a four-wall defect (*Figure 1C*). In the same surgical procedure, reconstruction was performed with demineralized lyophilized bovine bone (Bio-Oss® Large, Geistlich Pharma AG, Suíça), covered with a bovine cortical membrane (Gen-derm®, Baumer, Mogi das Cruzes, São Paulo, Brasil), and primary tissue closure (*Figure 1D*). Eight months after the extraction and grafting, the bone underwent helical milling, with a 2 mm trephine, the bone tissue was biopsied in the apical direction during a histological evaluation (*Figure 1E*) and the implant was inserted with an external hexagon platform (3.75 mm × 13 mm) (Neodent®, Straumman, Curitiba, Paraná, Brasil). Eight months after the implant was installed, the reopening was performed with a subepithelial connective tissue

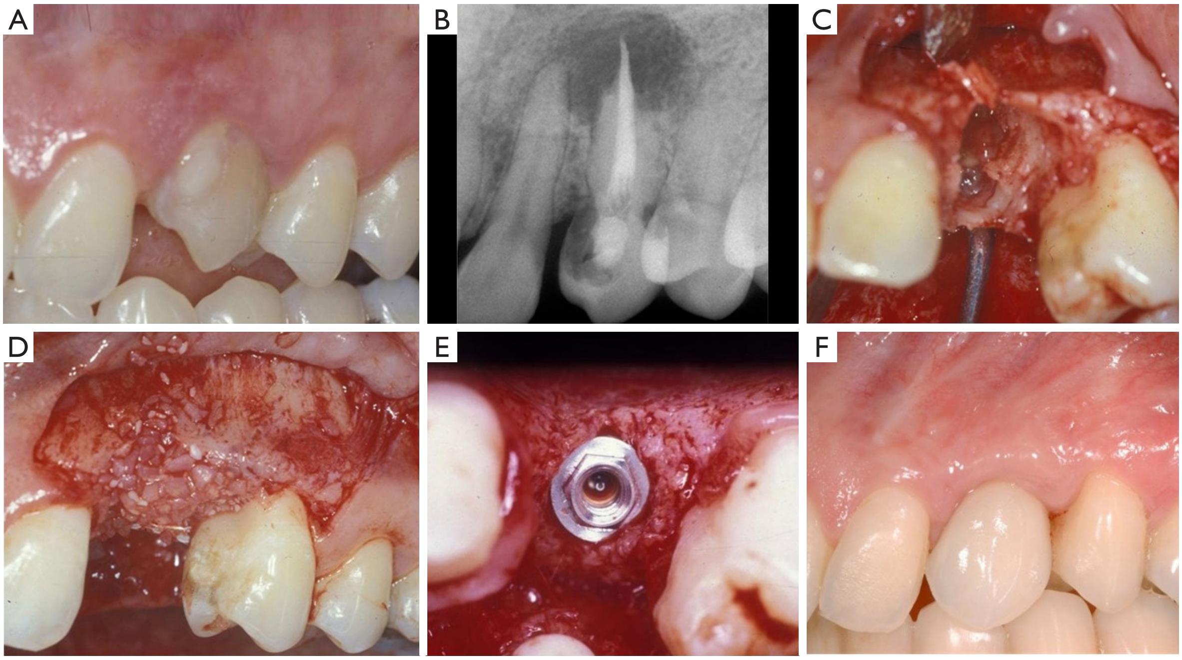

Figure 1 Early and perioperative surgical aspects of the canine and premolar region. (A) Initial clinical image; (B) initial radiography; (C) bone defect after extraction; (D) reconstruction with demineralized lyophilized bovine bone and bovine cortical membrane; (E) installation of the implant (3.75 mm × 13 mm—Neodent®); (F) final prosthetic rehabilitation.

graft and immediate provisional confection. Prosthetic rehabilitation was performed (*Figure 1F*).

During the histological evaluation, the piece of bone was decalcified in ethylenediaminetetraacetic acid (EDTA) and cut in five-micrometer slices that were mounted on histological slides and stained in hematoxylin and eosin (HE). Optical microscopy showed the permanence of biomaterial particles in the new bone formation between the particles and also showed small areas of medullary tissue with blood vessels (*Figure 2A,2B*).

Clinical-imaging follow-up was performed at six, seven, and nine years of rehabilitation (*Figure 2C,2D*). In these follow-up appointments, clinical observation showed that gingival tissues surrounding the implant had been maintained, and radiographical observation showed that the peri-implant bone tissue had been maintained (*Figure 3*). The patient reports pleasant esthetics, reestablished masticatory function and ease of cleaning.

Discussion

After tooth removal, the remodeling of the alveolar bone is a challenge for further rehabilitation planning (3,4,8). During the first six months post-extraction, bone resorption is accentuated, but, after this period, bone remodeling becomes slow and gradual (5,9). By understanding the modification process of the dental alveolus and its height and width over a long-term period, we can use implantology to maintain the alveolar tissue that enables rehabilitation. In particular, implants can be used to maintain alveoli that present bone fenestrations or defects in vertical and horizontal directions immediately after extraction (4). Our case report demonstrates that grafting with biomaterials to immediately maintain the area after extraction is a valid strategy that has a well-documented history of success in existing literature (10).

An essential factor during three-dimensional reconstruction of a large post-extraction site, such as this case, is the biological characteristics of the biomaterial. For bone preservation, the use of osteoconductive biomaterials that allow bone neoformation and, at the same time, biodegrade slowly is essential for success. In the context of this case, demineralized bovine bone had both characteristics and had decades of excellent clinical results for this purpose (5).

The time needed after alveolar reconstructions under the load of the implant is another factor widely discussed in existing literature, different times for bone maturation in different types of biomaterials are described in the literature

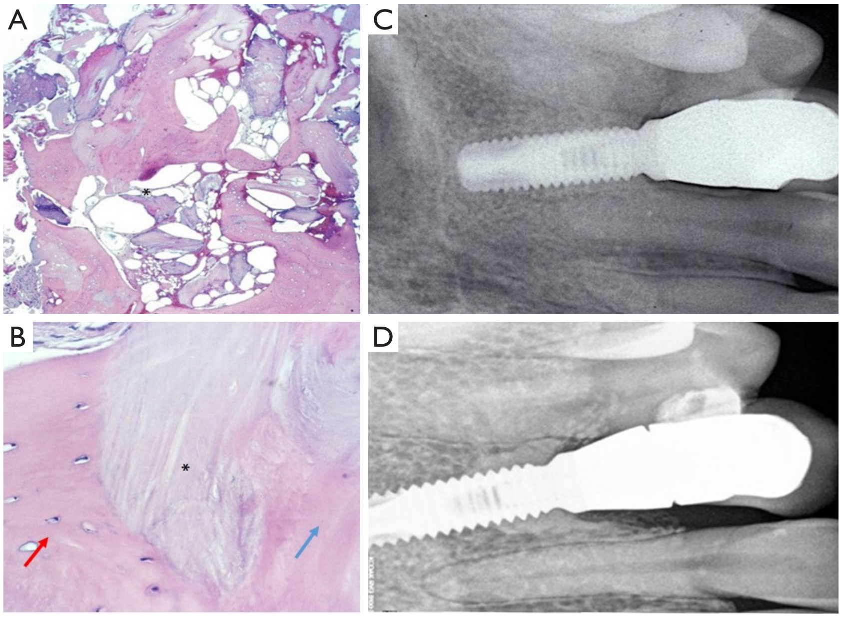

Figure 2 Radiographic and histological aspects of the intervention. (A,B) Histological slices (HE) showing the bone formation and the presence of biomaterial (*). Note the newly formed bone arround particulate biomaterial in a region without any cells (blue arrow), showing immature bone tissue, and another region with mature bone tissue, full of osteocytes (red arrow). (C) Radiography during follow-up 7 years after them intervention; (D) X-ray during follow-up 9 years after the intervention. Magnification: A, ×100; B, ×40.

Figure 3 Clinical image during follow-up 9 years after the intervention, showing healthy supporting soft tissue in the peri-implant region and excellent smile harmony due to rehabilitation.

and cited by commercial companies, especially given the enormous availability of osteoconductive biomaterials with different structural characteristics, such as pore size, degradation time, and potential for new bone formation (10). Due to the chronology of bone repair, after 6 months, the bone tissue remodeling process becomes slower and more gradual. Additionally, in the secondary bones that are reconstructed by the graft, immediate loading will not be applied to the implants. Therefore, even if, after 6 months, the osteoconductive biomaterial is not capable of osteoconduction to obtain a bone of structural quality, 6 months is enough time for the installation of the implants.

Evolution of the processes of surface texturing in the macro geometry and connection systems of the implants provides substantial improvement in osteointegration, maintenance of peri-implant bone, stability and aesthetics after the prosthetic has been installed (11), what has greatly contributed to the reduction in the waiting time for implant installation and its maintenance. These factors support our previous assertion about the expected time for implants installation after bone reconstruction.

Implants mostly had a hexagonal external connection at the time of their installation in the case in this report. Existing research shows that the force stresses are concentrated in the first threads (upper turns) of the implant that was used in this case and the interface of the prosthetic component (11,12). This is in contrast to ConeMorse connections, which show a higher concentration of stress adjacent to the long axis of the implant and a better adaptation of the abutment with the internal surface of the implant, which reduces micro movement and marginal bone loss (12,13). Marginal bone loss can compromise aesthetics over the years, which is a factor to be considered prior to rehabilitation. However, in the reported case, even though this factor could be unfavorable, the aesthetic and functional success does not depend only on the characteristics of the implant connection (13). Other characteristics that impact on success are the patient's collaboration regarding hygiene, maintenance of periodontal health through long-term follow-up appointments, and the installation of a prosthesis that allows hygiene and adaptation in the gingiva.

Still, concerning bone reconstruction, the use of bovine cortical membranes is quite interesting in defects four to five since the resorption process of these membranes is slow, and the proximal and palatal walls remain to sustain the biomaterial used in the reconstruction (9). This is because, in reconstructions with loss of more bone walls, the use of collagen membranes or non-resorbable membranes is necessary for the maintenance of a three-dimensional bone (4). Depending on the magnitude of bone atrophy, reconstruction using autogenous block grafts is often required (4).

As for the availability of complementary exams, it is known that it is not always feasible to perform them in all guided tissue regeneration procedures. As in the case of histopathological examinations (8,9). In addition to being expensive, they are often not easily accessible to the population. However, they are a useful tool for these cases (9). Within the limitations of the study, we know that a well-executed technique still lacks excellent patient care, since several factors related to post-operative care and food consumed can directly influence the final result (3,6).

Conclusions

The use of osteoconductive biomaterials in bone reconstruction of sites following a tooth extraction is a viable method, as seen in the results obtained in this report and supported by existing literature. Some factors are essential for success, such as maintaining the soft tissues in a healthy condition, making a prosthesis with an adequate emergency profile, and patient collaboration.

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Footnote

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