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Case Report

Immediate full-arch rehabilitation of atrophic maxilla using extra-long implants with bicortical anchorage in the canine pillars: a 16-month case report

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Rehabilitation of atrophic maxilla can be challenging, being used bone augmentation and modified implant designs. Despite many studies on more complex techniques, such as zygomatic implants. There are practically no case reports in literature using extra-long implants with bicortical anchorage in canine pillars for immediate rehabilitation in atrophic maxillae. This clinical report aims to describe a case in which extra-long implants were placed with bicortical anchorage in canine pillars region to allow full-arch immediate rehabilitation of an atrophic maxilla. A 60-year-old male patient, in good general health, was referred to a Dental College (Curitiba, Brazil) with complaints about his upper partial dentures. Patient´s rehabilitation was initiated with lower arch to achieve a full-mouth balanced occlusion. Platform-switched Morse taper connection implants were placed in regions #34, #36, #44, and #46 to support single and multi-unit fixed prostheses. For rehabilitation of maxillary arch, an all-on-four rehabilitation was planned. Guided surgery was performed to place four platform-switched Morse taper connection implants bicortically anchored in the canine pillar´s region, the two distal extra-long implants. Patient was followed for 16 months and presented good clinical and radiographic outcomes, including adequate peri-implant bone level maintenance and soft tissue health. No biological or mechanical complications were reported within this period. Therefore, use of extra-long implants bicortical anchored in canine pillars seems to be a suitable treatment option for rehabilitation of atrophic maxilla, enhancing possibility of obtaining sufficient primary stability, more even distribution of load on the remaining bone, possibility of immediate rehabilitation and maintaining peri-implant tissue health.

Keywords: Atrophic maxilla. Dental implant-abutment design. Mouth rehabilitation.

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Introduction

The rehabilitation of atrophic maxilla can be challenging, and different approaches have been discussed over the years[1-6], being divided into two modalities: bone augmentation and modified implant designs. The first one includes graft reconstruction, guided bone regeneration, and sinus floor elevation[7] and although these techniques are widely used, they tend to be more demanding regarding time and costs[8]. Therefore, implants with different designs and/or placed in tilted positions have been introduced to provide solutions for the reabsorbed maxilla, with less expensive and faster treatments, that also allow immediate loading[9].

Regarding implant length, short implants have been associated with higher failure rates[10] , due to reduced bone-to-implant contact, whereas longer implants lead to stress reduction on the implant and less strain on bone during immediate or delayed loading[2,11]. Biomechanical studies have shown that longer implants enhance primary anchorage and allow decreased cantilevers in the prosthesis, resulting in better load distribution[11].

While more complex techniques like zygomatic implants have been studied extensively, there are very few case reports in the literature about using extra-long implants with bicortical anchorage in the canine pillars for immediate rehabilitation in atrophic maxillae[11-13]. This clinical report aims to describe a case in which extra-long implants were placed with bicortical anchorage in the canine pillars region to allow full-arch immediate rehabilitation of an atrophic maxilla.

Case Description

This case report followed the CARE Guidelines[14].

Patient Information

A 60-year-old male patient, in good general health, was referred to a Dental College with complaints about the function and esthetics of his upper partial dentures, which had been in use for more than 10 years.

Clinical Findings

At the extraoral evaluation, it was observed loss of the vertical dimension of occlusion, deepened nasopalatine grooves, lack of lip support, and incisor exposure of only about 2mm (figure 1A-B). At intraoral evaluation, only teeth #17, #13 and #23 were still present in the upper arch, with visible caries. In the lower arch, there was the absence of teeth #36, #46, and #47, residual roots of #44 and #45, in addition to fracture of #34 and dental cervical erosion of #35 (figure 2A). The severity of the maxillary atrophy was class B[6] .

Diagnostic Assessment

Panoramic radiography and clinical evaluation were obtained for final diagnosis and treatment planning, in which periapical lesions of #44, #45, #13, #23, and

#17 were observed (figure 2B). Based on the findings of the imaging and clinical examinations, a treatment plan was proposed to rehabilitate function and esthetics, described in Table 1.

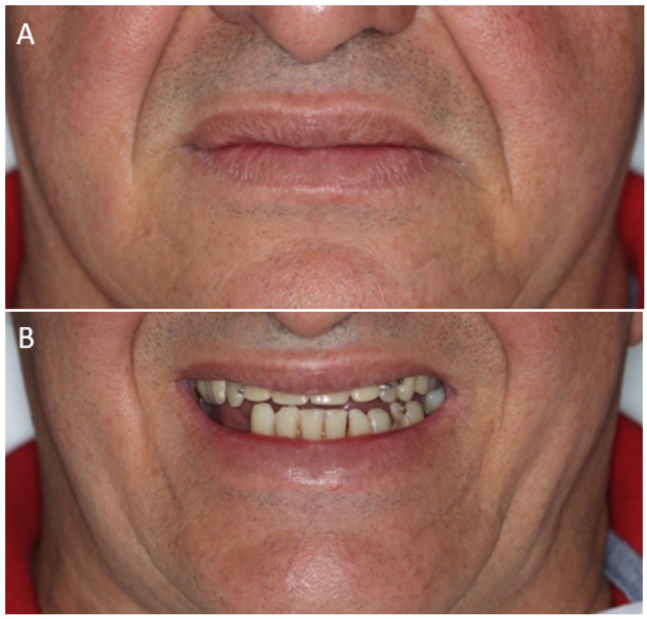

Figure 1. Extraoral frontal view of patient´s initial aspect.

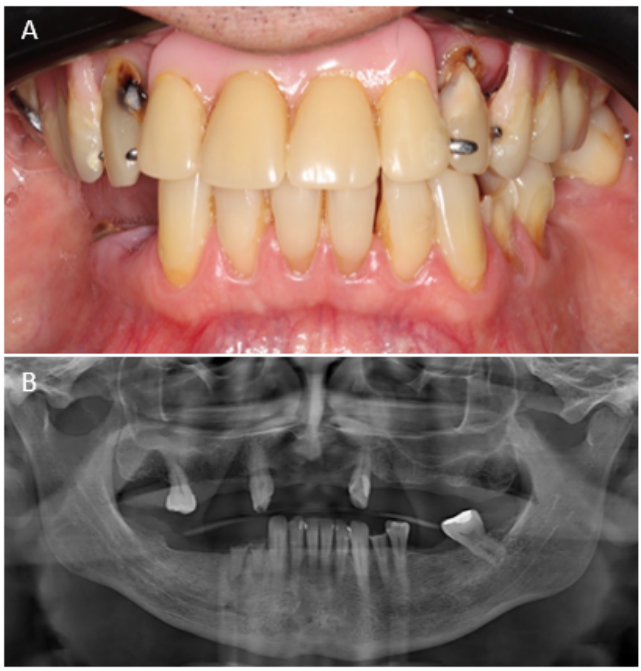

Figure 2. Intraoral frontal view with patient´s upper partial dentures (A). Initial panoramic radiography showing the absence of several teeth in both arches (B).

Table 1. Treatment planning for maxillary and mandibular arches.

Maxillary arch	• Reverse planning with wax casting and teeth try-in for tomographic guide confection; • Scanning of the maxillary arch for surgical guide confection, supported by the remaining teeth (#17, #13, and #23); • Extraction of teeth #17, #13 and #23. • Full-arch prosthesis supported by four implants, being the two distal extra-long platform-switched Morse taper connection implants bicortically anchored in the canine pillar´s region.
Mandibular arch	• Extraction of tooth #34 and residual roots of #44 and #45. • Platform-switched Morse taper connection implants placement in regions #34, #36, #44 and#46; • Single-unit implant-supported prostheses in #34 and #36; • Multi-unit fixed prosthesis supported by implants #44 and #46; • Restoration of erosive lesion of #35 with composite resin.

Therapeutic Intervention and Follow-up and Outcomes

It was decided to initiate the patient´s rehabilitation with the lower arch since balanced occlusion is required to obtain a good prognosis in full-arch immediate loading. Thus, Infiltrative terminal anesthesia was performed and tooth #34 and well as residual roots of #44 and #45 were extracted followed by immediate placement of platform-switched Morse taper connection implants (GM Helix implant, Neodent, Curitiba, Brazil), in regions #34 (3.5x11.5mm) and #44 (4.3x11.5mm), in addition to regions #36 (3.75x10mm), and #46 (4.3x8mm). The final torque was 50 N.cm for all implants. Then, 0.8-mm GM Mini Conical Abutments (Neodent) were selected for implants #44 and #46 (figure 3A), while implant #34 received a Cover Screw (figure 3B) and #36 a 4.5x2.5mm GM Healing Abutment (Neodent) (figure 3C).

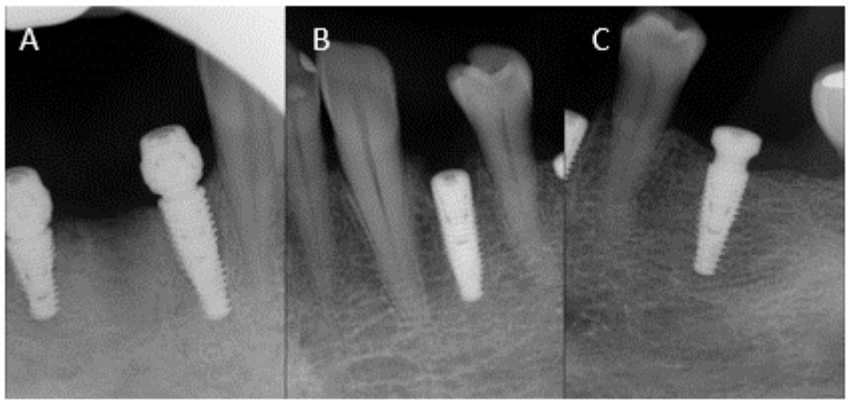

Figure 3. Post-surgical periapical x-rays of implants #44 and #46 with GM Mini Conical Abutments (Neodent) (A), implant #34 with cover screw (B), and #36 with healing abutment (C).

The occlusal vertical dimension and centric relation were determined the following day, with upper cast bases for teeth selection and try-in. Then, it was decided to duplicate it in transparent acrylic resin to be used as a tomographic guide. Four perforations were made in the guide with an nº8 spherical handpiece drill in the buccal ridges of regions #15, between central incisors and #23 and #26, which were filled with white gutta-percha. An interocclusal registration made with condensation silicone material (Optosil, Heraeus Kulzer GmbH & Co., Wehrheim, Germany) was positioned to avoid any movements during the CT scan.

Later, digital impressions of the maxillary arch were obtained using a TRIOS scanner (3Shape, Copenhagen, Denmark), and the STL files, together with the DICOM files of a full-mouth CBCT, were uploaded on diagnostic software (Chemnitz, Germany) for Guided Implant Surgery planning with bicortical anchorage (figure 4). The surgical guide was then fabricated with a 3D printer (Rapid Shape GmbH, Heimsheim, Germany).

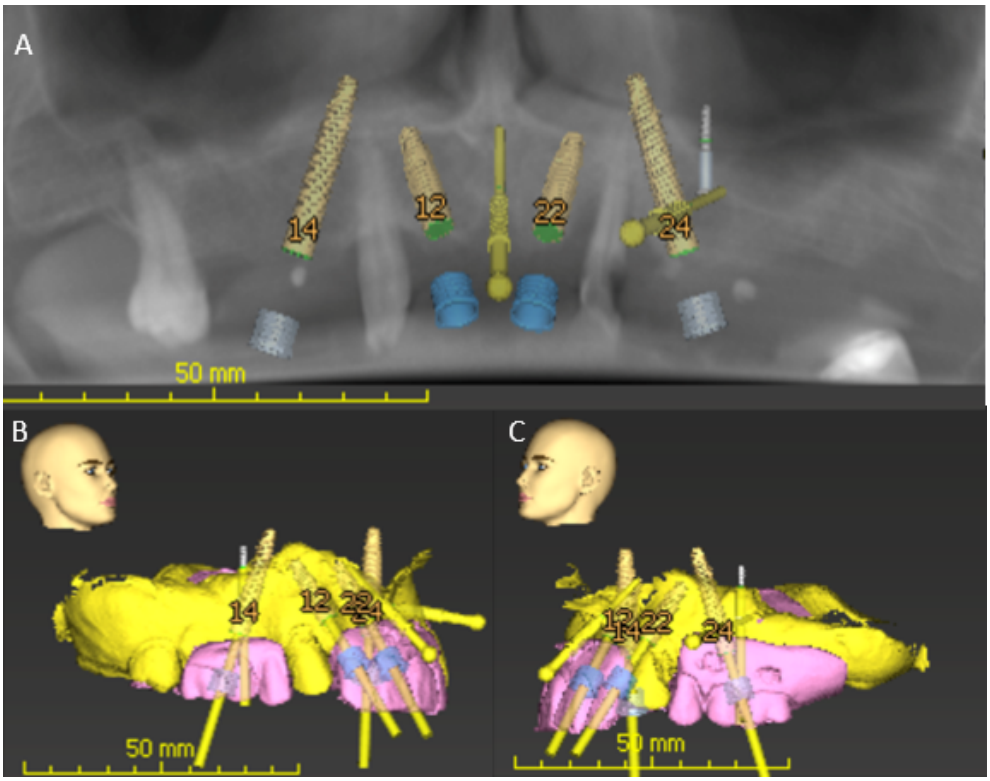

Figure 4. Frontal (A) and lateral (B-C) views of Guided surgery planning of maxillary implants on coDiagnostix software (Chemnitz, Germany).

Two months after mandibular implant placement, a multi-unit provisional acrylic prosthesis was inserted on implants #44 and #46, and maxillary guided surgery was performed. A tooth-supported surgical guide was placed, and an adequate fitting

was verified through the inspection windows. Infiltrative terminal anesthesia was performed. Self-drilling graft screws (Neodent) were used to stabilize the surgical guide and each implant bed was prepared following the drills sequence recommended by the manufacturer through the corresponding drill guide and sleeve (GM Neodent Guided Surgery system).

The surgical technique used for the atrophic maxilla was the V-4 implant placement[5]. Two 3.75x13mm platform-switched Morse taper connection implants (GM Helix implant, Neodent) were inserted on regions #12 and #22, with connection for torque wrench H9 followed by H11 in order to avoid positioning errors. Then, two 3.75x20mm platform-switched Morse taper connection extra-long implants (Helix GM Long implant, Neodent) were placed on the posterior regions #14 and #24, being distally tilted and anchored in the canine pillar´s region (figure 5). The insertion torque for these implants was at least greater than 50 Ncm each. Thereafter, the guide was removed and the remaining teeth #17, #13 e #23 were extracted.

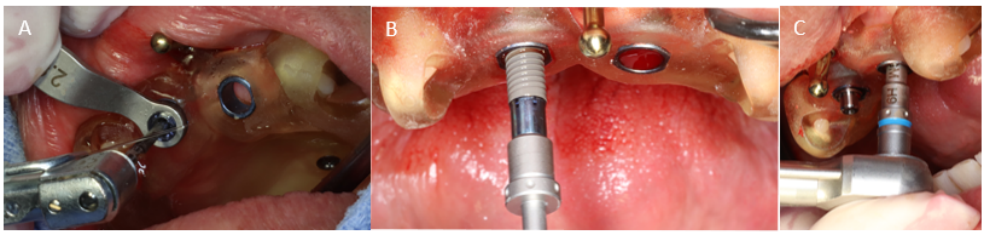

Figure 5. Drilling with abundant irrigation (A), Implant connection with stop that indicates when the implant reaches the planned position (B) and final placement with connection for torque wrench (C).

In order to provide sufficient prosthetic space, alveolar bone height needed to be removed and regularized in the anterior maxillary region. After that, prosthetic abutments were selected, and the implants #14, #22 and #24 received 17° Mini Conical Abutments with 1.5 mm of gingival height whereas implant #12 received a 30° Mini Conical Abutment (Neodent).

Impressions were then carried out, with a multifunctional guide. For that, titanium abutment impression copings (Neodent) were inserted, cut at the height of occlusion line, and fixed with acrylic resin (Pattern Bright, Kota Imp., São Paulo, Brazil), then bite registrations were taken, so casts could be mounted on semi-adjustable articulator.

On the following day, the prosthetic bar and the wax-mounted teeth were tried-in and sent to the laboratory for minor adjustments and subsequent resin curing. The full-arch implant-supported hybrid prosthesis1 was then inserted, as well as the mandibular provisional acrylic prosthesis of #34 and #36 (figure 6), which was important to obtain healthy biomechanics for the immediate loading. The cantilever length observed in the maxillary arch after rehabilitation was 10mm.

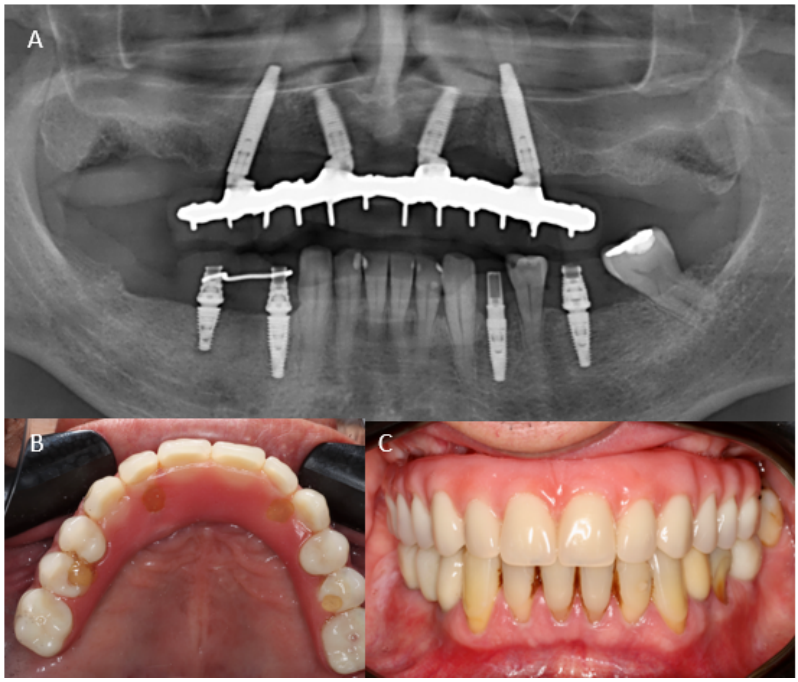

Figure 6. Radiographic(A) and clinical aspects (B-C) after maxillary full-arch immediate rehabilitation and mandibular provisional prostheses

CT Scan was obtained evidencing the bicortical anchorage of extra-long implants on the canine pillars (figure 7). Moreover, at 16-month post-surgery, excellent clinical and radiographic outcomes were observed, with favorable aesthetics and soft tissue health (figure 8) clinical aspects of the patient 6 days after implant placement (A) and 16-month follow-up (figure 9), as well as adequate peri-implant bone level maintenance whole rehabilitation, therefore, this case achieved implant success based on the criteria proposed by Buser et al.[15-16] with the absence of persistent subjective complaints, absence of recurrent suppurative peri-implant infection, absence of implant mobility on manual palpation, and absence of continuous circular radiolucency around the implant.

The patient reported expressed satisfaction with the functional and aesthetic aspects of the rehabilitation.

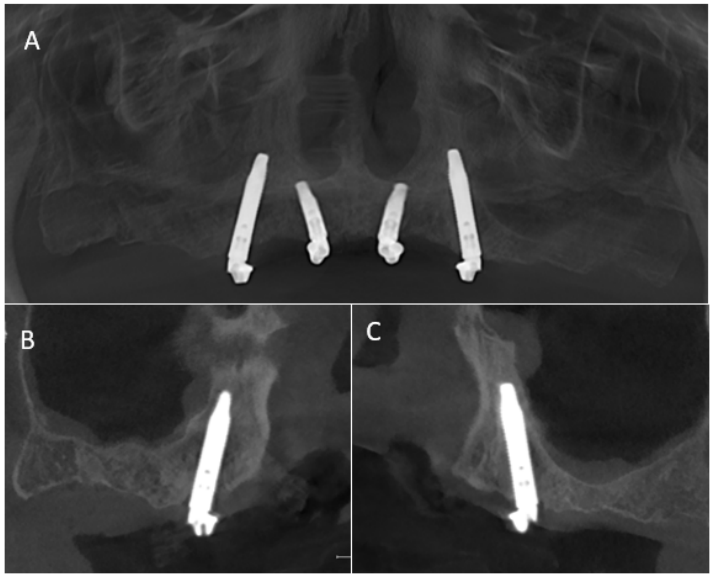

Figure 7. Post-surgical CBCT aspect of maxillary full-arch rehabilitation(A). Bicortical anchorage in the canine pillars of implants inserted in regions 14 (B) and 24 (C).

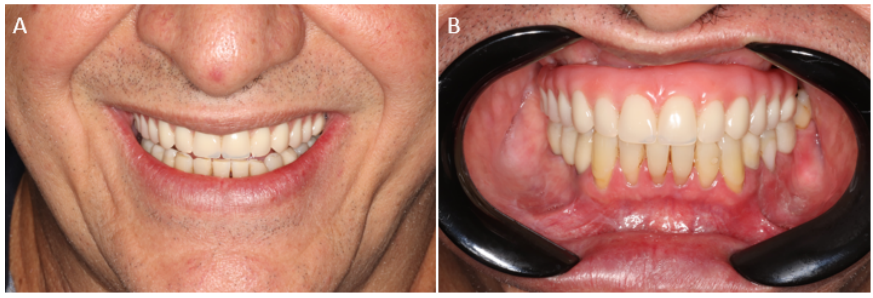

Figure 8. Patient´s clinical aspects at 16-month follow-up. Extraoral (A), and intraoral frontal view (B) photos.

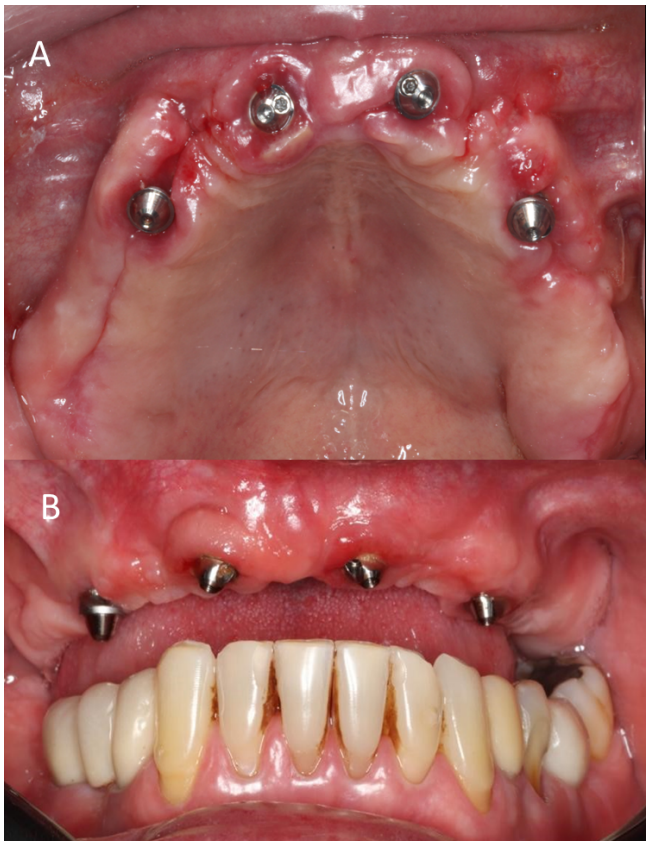

Figure 9. Clinical aspects of the patient 6 days after implant placement (A) and 16-month follow-up (B).

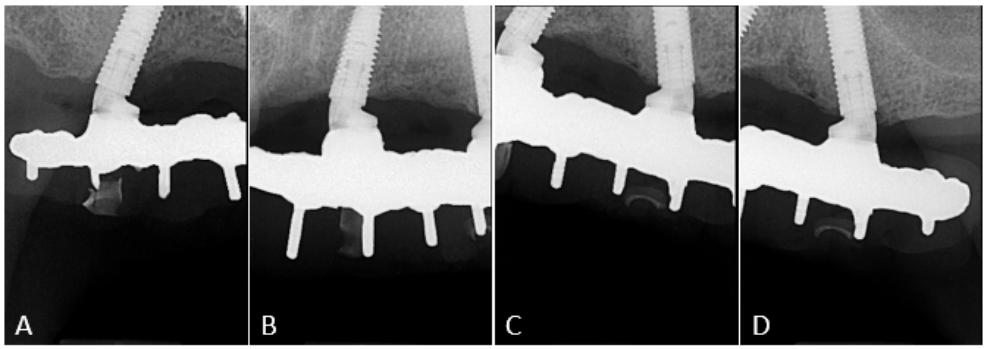

Figure 10. Periapical x-rays of maxillary implants at 16-month follow-up.

Discussion

Long and extra-long implants allow the rehabilitation of atrophic maxillae without requiring prior bone augmentation procedures. These procedures have significant drawbacks, including increased treatment time, higher costs, greater risk of postoperative complications, and reduced patient satisfaction[9,17-18].

In addition to long implants, short implants are also considered for maxillary rehabilitation in cases with moderate vertical deficiencies[2]. However, a recent case report demonstrated that extra-long implants can be successfully installed in atrophic maxillae. These implants are placed at a tilted angle, providing greater contact with the bone surface than short implants. This results in improved primary stability and more predictable outcomes[10-11]. Furthermore, longer implants effectively distribute mastication stress on supporting implants, whether loaded immediately or with a delay[19] .

In 1993, Maló introduced the concept of using tilted implants in the 'all-on-four' technique. In this clinical case, two vertical implants were placed in the anterior region, while two posterior implants were angled at 35 to 40 degrees[20-21]. Tilted implants offer advantages: they avoid compromising critical anatomical structures[22], reduce cantilever length, and enhance prosthetic support[23]. Moreover, titled extra-long implants can benefit patients with systemic conditions that often contraindicate grafting procedures[24].

Furthermore, this study observed that all tilted implants survived after 16 months. Similarly, a systematic review found no significant difference in survival rates when comparing axial and tilted implants[25].

This technique has been successfully applied in patients with partially or completely edentulous maxillae. The success rates are comparable to those observed for straight implants, even when immediate loading is used[26]. Short-term and long-term prognosis are favorable, with cumulative survival rates ranging from 96.7% to 99.3% for implants and up to 100% for prostheses[27]. Notably, peri-implant bone loss around tilted implants is similar to those around axial implants[28].

An additional advantage of employing extra-long implants is their capacity to achieve robust bicortical anchorage. In the maxilla, this can be achieved by placing the implant apex in various locations: the nasal cavity floor, maxillary sinus cortical, canine pillars, or pterygoid plates A finite element analysis found that bicortical anchored long implants exhibit improved initial stability in the apical portion[10]. Other studies have also reported higher primary stability for bicortical implants, regardless of implant length[27].

Moreover, an in vivo study with rabbits, in which mono and bicortical anchored implants were evaluated, showed significantly higher bone-to-implant contact as well as higher removal torque for bicortical implants after 6 to 12 weeks[27]. Therefore, the more cortical bone is engaged in implant placement, the more favorable it seems, especially in the treatment of dental arches with low-density bone, leading to higher success rates when compared to non-bicortical anchored implants[27-31].

Immediate full-arch prostheses supported by just four bicortical implants have shown highly predictable results. In a follow-up of up to 2 years, 212 bicortical implants placed in the maxilla and mandible to support 53 all-on-four full-arch prostheses achieved a remarkable 100% survival rate for both implants and prostheses[32].

Rehabilitating atrophic maxillae with extra-long implants and bicortical anchorage offers a key advantage: it significantly enhances primary stability. This, in turn, improves the likelihood of providing patients with immediate rehabilitation[11,33].

For the technique described in this study, achieving primary stability in at least 2 implants is essential for enabling immediate function, preferably in the anterior implants. From a biomechanical perspective, achieving immediate function requires an anteroposterior spread of 12 to 15 mm. In definitive prostheses supported by a bar, cantilevers can extend up to approximately 10mm[5,34].

The primary limitation of this technique is that not all patients are suitable candidates, particularly those with atrophic maxillae due to bone limitations. Additionally, operational technical challenges exist, necessitating specialized instruments[35].

In a recent clinical case, the all-on-four concept was applied, and extra-long tilted implants were strategically inserted to achieve bicortical anchorage in the canine pillars. As a result, high primary stability was achieved for all implants, even those placed in the atrophic maxillary posterior region. The 16-month outcomes suggest that this technique is a safe and reliable option, delivering excellent esthetic results and maintaining peri-implant bone and soft tissue health.

Using extra-long implants anchored in the canine pillars appears to be a viable treatment for rehabilitating reabsorbed maxillae. It improves the chances of achieving strong initial stability for immediate loading. Notably, no mechanical or biological complications were observed, and medium-term immediate rehabilitation was successful. However, more extensive studies are needed to assess long-term outcomes.

Data availability

All data that support this case report is present within the manuscript.

Conflict of interest

The authors Farid J. S. Arruda, Andrew S. Melenikiotis, and Paola A. Rebelatto have no conflicts of interest. The author Geninho Thomé is the Scientific President of Neodent, whose implants were used in this case report. The authors Ivete A. M. Sartori and Luis E. M. Padovan work as consultants for the same company.

Author Contributions

Farid Jamil Silva de Arruda: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Supervision; Validation; Visualization; Roles/Writing - original draft; Writing - review and editing. **Andrew Sotirios Melenikiotis**: Conceptualization; Formal analysis; Methodology; Project administration; Supervision; Visualization; Writing - review and editing. **Paola Rebelatto Alcântara**, **Geninho Thomé**, **Ivete Aparecida de Mattias Sartori** and **Luis Eduardo Marques Padovan**: Data curation; Formal analysis; Methodology; Roles/Writing - original draft; Writing - review and editing. All authors actively revised and approved the final version of the manuscript.

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