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Technical Note

Additively manufactured custom-made subperiosteal implant rehabilitation for severely atrophic maxillary molar area: A technical note

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ABSTRACT

Implant-prosthetic rehabilitations of severely atrophic posterior maxillary sectors currently is challenging, often requiring multiple surgeries and long rehabilitation times. Recently, graftless techniques (e.g. zygomatic, pterygoid and nasal implants) have gained popularity as they offer a reduction in rehabilitation time, aligning more closely with patient preferences but may not be feasible for sectorial rehabilitations. Subperiosteal implants, suggested for full-arch rehabilitations of atrophic maxilla, haven't been explored for sectorial rehabilitations. In this report we present the case of a patient with maxillary molar edentulism, rehabilitated with a subperiosteal implant.

1. Introduction

Implant-prosthetic rehabilitations of severely atrophic posterior maxillary sectors currently is challenging, often requiring multiple surgeries and long rehabilitation times [1]. The rehabilitation of Cawood & Howell class V and VI atrophy of the posterior maxillary sectors generally requires a two stages approach with a first surgical time consisting in lateral approach sinus lift and a second surgery, 4–6 months after the first, for the implant placement. This significantly lengthens the rehabilitation times, making these approach often difficult for the patient to accept. Recently, graftless techniques (e.g. zygomatic, pterygoid and nasal implants) have gained popularity as they offer a reduction in rehabilitation time, aligning more closely with patient preferences but may not be feasible for sectorial rehabilitations. The implant emergence for pterygoid and zygomatic implants is indeed constrained by the morphology of the upper jaw and it becomes impossible to have closely spaced emergences if the rehabilitation is limited to just two adjacent dental elements in the posterior maxillary sectors.

Subperiosteal implants represent a technique first proposed in the late 1940s for the rehabilitation of patients with maxillary and mandibular atrophy. This first generation of implants, however, was burdened with a high rate of failure primarily due to an imprecise fit on the bone, a design that did not adequately consider the distribution of masticatory forces on the implant, and the lack of a rigid fixation that would provide primary stability to the implant. In 2017, Mommaerts [2] presented a modification of the capitalizing on the strides made in CAD/CAM and laser sintering technologies to fabricate custom-designed implants. These implants are designed for solid anchorage to the maxillary pillars, effectively overcoming the conventional challenges faced in this type of dental restoration.

This second generation of subperiosteal implants [2-5], suggested for full-arch rehabilitations of atrophic maxilla, haven't been explored for sectorial rehabilitations [6]. In this report we present the case of a patient with maxillary molar edentulism, rehabilitated with a subperiosteal implant.

2. Case report

A 54-year-old woman was referred to our Department for implant-prosthetic rehabilitation of the right upper molar region [Fig. 1]. CT scans revealed Class V atrophy, for which a maxillary sinus

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Fig. 1. Preoperative intraoral view showing upper right molar area edentulism. Published with the patient's consent.

lift with delayed implant placement was proposed. The patient declined the procedure due to the lengthy rehabilitation time. Given the location and extent rehabilitation, the use of zygomatic or pterygoid implants was not possible. Therefore, a one-stage rehabilitation with a custom-made subperiosteal implant was proposed. The implant fabrication followed procedures previously described [7,8]. the implant design, including the length and orientation of the abutments, was based on the superimposition of CT images with dental arch scans and diagnostic wax-up using dedicated software (GS Software, B&B Dental, San Pietro in Casale, Italy) [Fig. 2]. The implant (B&B Dental) was designed to achieve primary stability through rigid fixation on the maxillary buttresses, based on load distribution studies conducted on full-arch rehabilitations [9,10] and laser milled in grade V titanium.

The surgery [Video 1] was performed under local anesthesia, blocking the infraorbital nerve, zygomatic nerves, and then intraorally the vestibular fornix and palatal mucosa. The surgical access extended from the lateral incisor to the tuber maxillae with a crestal incision in the edentulous region and an intrasulcular incision in the toothed area. The crestal incision was made 2–3 mm palatally to provide better coverage of keratinized gingiva on the buccal aspect of the abutments. A full-thickness flap was raised to expose the alveolar crest, where the abutment housings were prepared using a surgical guide. Great care was taken to preserve the integrity of the Schneiderian membrane at the bottom of the housings. The flap was elevated further to visualize the nasomaxillary pillar, the infraorbital nerve, and the zygomatic buttress. For better exposure of the latter, the most anterior insertions of the masseter muscle can be sectioned.

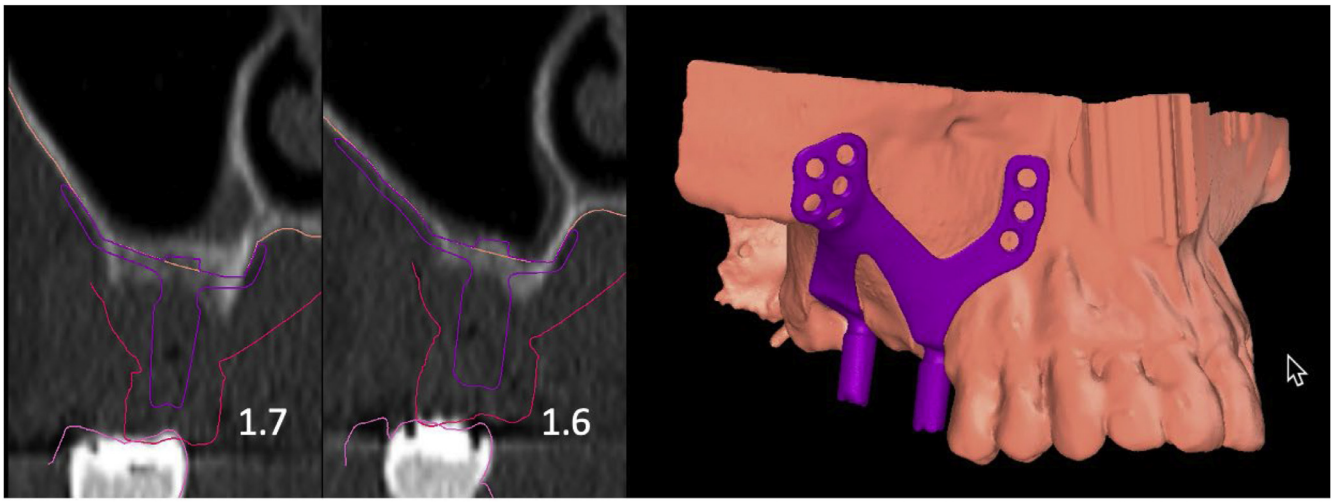

Fig. 2. Digital planning showing the abutment position and the implant design.

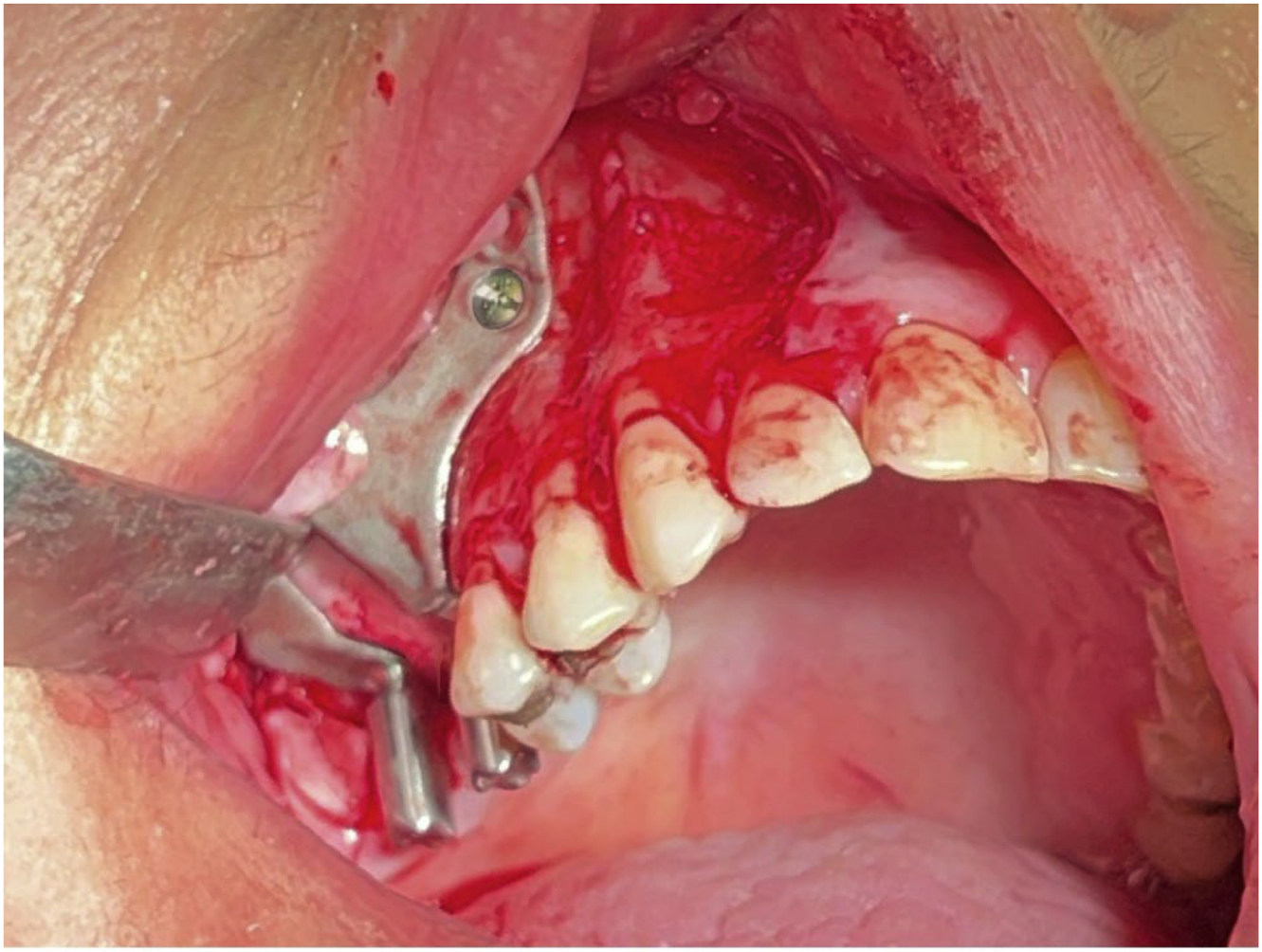

Fig. 3. Implant fixed in site. Published with the patient's consent.

The subperiosteal implant was then inserted into position and, after checking the fit, fixed with 2.0 mm titanium screws (B&B Dental, San Pietro in Casale, Italy), the length of which was determined based on the underlying bone thickness established during planning [Fig. 3]. Bichat's fat pad flap was transposed to cover the implant, thickening the soft tissues to prevent implant exposure and the surgical wound was sutured. The implant was loaded with a 3D-printed resin temporary prosthesis 10 days post-surgery based on a precision silicone impression of the abutments. After conditioning the soft tissues, the definitive prosthesis, in CAD/CAM milled monolithic zirconia, was delivered 6 months after surgery. At 38 months of follow-up both the implant and the prosthesis show no clinical or radiological complications [Fig. 4].

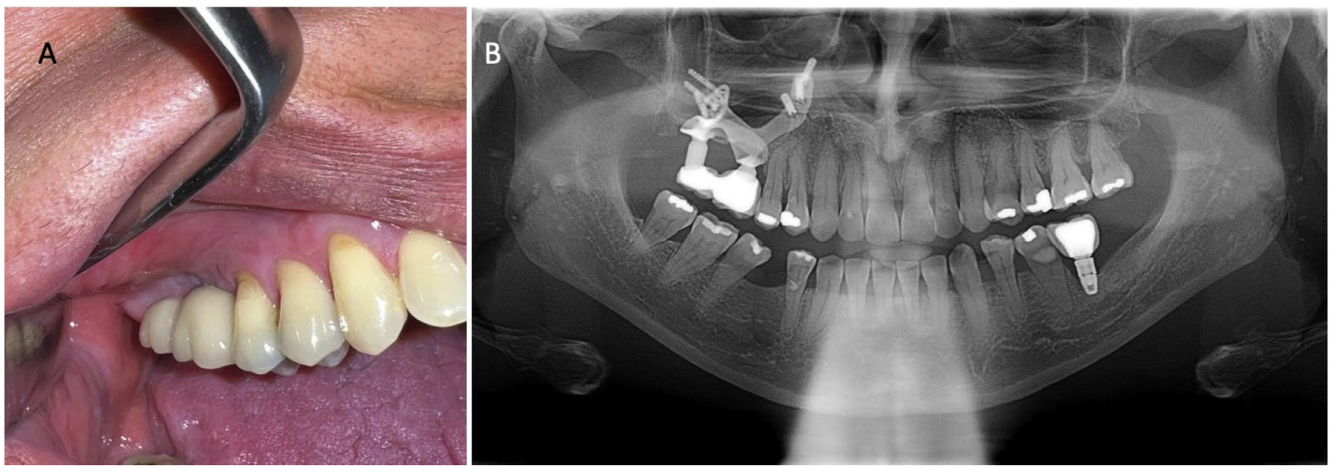

Fig. 4. A: Post-operative intraoral view 32 months after the surgery. B: Post-operative orthopantomography 32 months after the surgery. Published with the patient's consent.

3. Discussion

Graft-less implantology is becoming increasingly popular for full-arch rehabilitations of the atrophic upper jaw as it reduces the burden of surgery and rehabilitation times [1]. However, in the case of rehabilitation limited to a few dental elements it may be impossible to carry out this type of rehabilitation. In the case presented in this report, the close contiguity of the two dental elements to be restored did not make it possible to use a pterygoid and a zygomatic implant with such close emergences. Additively manufactured subperiosteal implants, proposed for full-arch rehabilitations of the maxilla, can also be useful in these cases as they have no limitations in planning the position of the abutments. However, the design of the subperiosteal implant followed that proposed for full-arch rehabilitations and based on finite element analysis and stress shielding studies [9,10]. The implant should therefore always include two arms that discharge the masticatory forces on the osteosynthesis screws positioned on the resistance buttresses of the maxilla [9,10]. One of the problems linked to first generation subperiosteal implants, which undermined their long-term results, was the resorption of the alveolar bone beneath the abutment which led to superficialization of the implant and consequent exposure. Thanks to digital planning it is possible to provide housings at the level of the alveolar crest which leads to the removal of any residual alveolar bone and to position the abutment on regular basal bone which is less subject to resorption over time. The rate of bone resorption beneath the abutments of the subperiosteal implants in full-arch rehabilitations has proven to be comparable to that around the endosseous implants [11].

During the preparation of the crestal housings, great attention must be paid to preserving the integrity of the Schneiderian membrane which must be isolated and delicately detached. In case of perforations, it is possible to isolate the implant by positioning a reabsorbable membrane under the abutment. One of the problems reported for subperiosteal implants is the exposure of the implant structure on the vestibular side [12]. It is therefore important to try to increase the amount of keratinized gingiva by making an incision a few millimeters on the palatal side so as to bring tissue to cover the abutments on the buccal side. The Bichat fat pad, harvested and transposed to cover the implant, is another useful technical refinement that can increase the amount of tissue on the vestibular side. In this case, no exposures of the implant structure were reported.

The use of subperiosteal implants in sectoral defects of the upper jaw has not yet been codified but this report demonstrates how, following the principles indicated for full-arch rehabilitations, it can have promising results. These cases, unlike total rehabilitations, could not be treated with any other graft-less technique. Future studies on large series will be necessary to effectively evaluate the safety and reliability of this technique for rehabilitating sectorial atrophies of the upper jaw.

Ethical approval

Not required. The patient's written consent for the publication of the images was acquired.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Luigi Angelo Vaira: Writing – original draft, Conceptualization. **Andrea Biglio:** Writing – review & editing. **Giovanni Salzano:** Writing – review & editing. **Jerome R. Lechien:** Writing – review & editing. **Giacomo De Riu:** Writing – review & editing, Supervision.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jormas.2024.101917.

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