Personalized Rehabilitation of Atrophic Customized Subperiosteal Implants

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Abstract: Severe maxillary atrophy and edentulism can pose a range of challenges in implant planning and oral rehabilitation. Modern dentistry has allowed for a review of the concepts and surgical protocols of subperiosteal implants, presenting them as a solution for the rehabilitation of atrophic maxillary and mandibular bone deficiencies. This study aims to address a series of 3 patients with severe maxillary atrophy, as evidenced by presurgical and postsurgical radiographic images, as well as computer-assisted planning and analysis of patient anatomy for rehabilitation with custom sintered subperiosteal implants. Promising results these clinical cases, highlighting the precise technique, biocompatibility, and durability of these materials. The absence of postoperative complications was evident, with high success rates in procedures and patient reports. Importantly, periodic follow-up is needed to assess the longevity and effectiveness of the technique used.

Key Words: Dental implants, maxilla, oral rehabilitation, 3-dimensional printing

Severe maxillary atrophy and edentulism can pose a range of challenges in implant planning and oral rehabilitation. Excessive maxillary bone loss, poor bone quality, and pneumatization of the maxillary sinus are unfavorable conditions that result in relative contraindications for treatment with conventional dental implants.[1,2] Under these conditions, patients require sufficient bone quantity—height and width—and density for the insertion of endosseous implants.[3] Treatment with conventional implants can become an obstacle in correcting functional and esthetic issues, as well as improving the quality of life for patients with significant maxillary bone resorption.[4] To address these clinical conditions that limit traditional rehabilitation, a variety of treatment strategies are commonly used to allow for the rehabilitation of the maxilla, including preprosthetic surgical techniques using bone grafts for alveolar process reconstruction.[1,5] Other available protocols include guided bone regeneration with resorbable or nonresorbable membranes, osteogenic distraction, and maxillary sinus floor elevation. These bone surgical procedures use different materials, such as autogenous bone from intraoral/extraoral sites and homologous, heterologous, or synthetic bone grafts, all aimed at reconstructing maxillary bone volume. However, these surgical procedures are complex and have a high rate of complications, including unpredictable success rates, associated morbidity, long treatment times, and high costs.[3,4,6]

The number of partially or completely edentulous individuals is growing due to increased life expectancy, and consequently, the growing application of dental implants to restore function in these patients has fueled research on biomaterials and techniques for rehabilitation.[4] Providing an improvement in quality of life includes meticulous dental planning, considering that most elderly patients do not have sufficient bone quantity and are susceptible to a reduction in metabolic rate and regenerative capacity.[7] The advent of endosseous implants, which achieve osseointegration with a high degree of predictability, may be unfeasible at sites with insufficient bone quantity because of excessive resorption, trauma, or neoplasia.[6,8] Subperiosteal implants, which do not rely on the thickness of the maxillary bone, present an alternative to endosseous devices and have increasingly improved with new concepts and the implementation of fully digital workflows.[4]

Given the above, modern dentistry has allowed for a review of the concepts and surgical protocols of subperiosteal implants, constituting a solution for the rehabilitation of atrophic maxillary and mandibular bone deficiencies.[3,5,6] On the basis of a computerized analysis of the patient's anatomy, a structure made of biocompatible, stable, and inert titanium is designed and manufactured, allowing for more precise rehabilitation through 3-dimensional printing and a reduction in operation time.[9,10] This study aims to address 3 clinical cases of patients with severe maxillary atrophy, as evidenced by presurgical and postsurgical radiographic images, as well as computerized planning and analysis of the patient's anatomy for rehabilitation with custom subperiosteal implants.

CASE SERIES

This is a consecutive retrospective case series, following the recommendations of the Consensus Preferred Reporting Of CasE Series (PROCESS).[11]

CASE 1

Patient NSDO, a 68-year-old female, presented to the dental office expressing a need for the evaluation of the viability of rehabilitating the upper arch with dental implants. The patient reported using a removable partial denture for more than 20 years and complained of dissatisfaction with its use and difficulty chewing. An intraoral examination was performed, revealing edentulous regions in the upper jaw and extensive caries and infiltrations in the remaining restorations. A panoramic radiograph and cone beam computed tomography (CBCT) were requested as complementary exams, which, in addition to considerable alterations in the remaining teeth (extensive caries, tooth and restoration fracture, endodontic treatment), revealed pneumatization of the left maxillary sinus and insufficient bone quantity and quality for conventional surgical techniques for implant rehabilitation.

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This article is exempt from ethical approval, as it was conducted within our private practice. The study was conducted in accordance with Good Clinical Practice guidelines and the principles of the Declaration of Helsinki. The authors certify that they obtained the appropriate informed consent forms from the patients.
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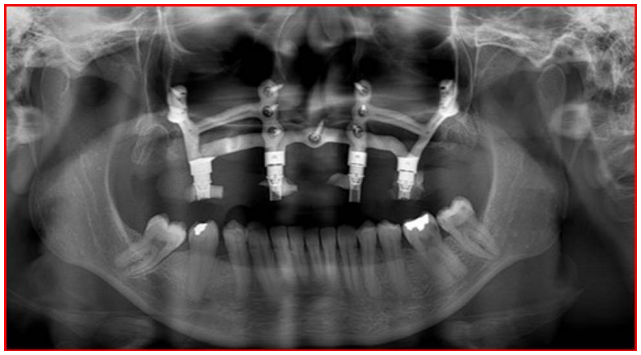

FIGURE 1. Patient 1: final panoramic X-ray with periosteal implant installed.

Owing to the unfavorable prognosis of the remaining teeth, the treatment plan included extraction of the upper teeth and oral rehabilitation through customized implants.

In a single surgical session, extraction of the remaining teeth, osteotomy, and installation of the titanium mesh with a provisional prosthesis were performed (Fig. 1). The definitive prosthesis was made 3 months after the surgical procedure.

CASE 2

Patient LML, a 50-year-old male, arrived at the dental office for an evaluation of the possibility of oral rehabilitation with dental implants. He reported using removable partial dentures for both the upper and lower jaws but complained of discomfort due to fracture and poor adaptation.

Intraoral assessment revealed edentulous areas in both the upper and lower jaws, with extrusion of the upper molars and residual roots. Panoramic radiography and cone beam computed tomography were requested, revealing pneumatization of the left maxillary sinus, considerable bone loss, and insufficient quality for conventional treatment.

The treatment plan consisted of extraction of the upper and lower teeth with customized digital planning by the same company, as well as rehabilitation of the lower arch with a protocol-type prosthesis (Fig. 2). The panoramic radiograph revealed stability. The patient-reported improved quality of life and adaptability following the procedure.

CASE 3

Patient MPG, a 49-year-old female, presented to the dental office with esthetic and functional dissatisfaction. During anamnesis, the patient reported having undergone orthognathic surgery more than 22 years prior. The patient used an upper removable partial denture but complained of difficulty using it and poor adaptation.

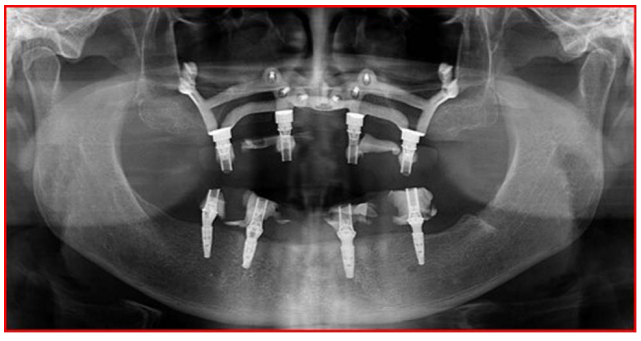

FIGURE 2. Patient 2: final panoramic X-ray with periosteal implant installed.

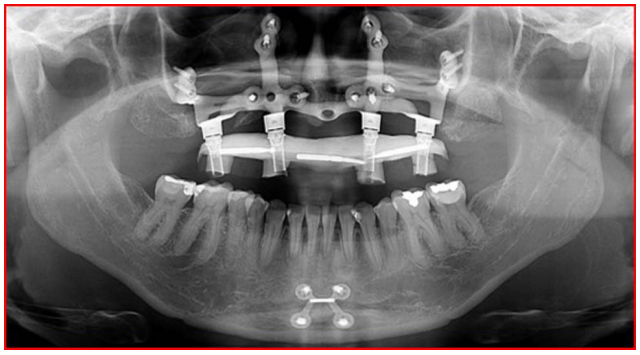

FIGURE 3. Patient 3: final panoramic X-ray with a periosteal implant installed.

Intraoral evaluation revealed edentulous areas in the upper arch, with inadequate bone support in the anterior region, as well as grade I mobility in the molars. The panoramic radiograph revealed severe bone resorption in the upper anterior region, pneumatization of the maxillary sinus, and surgical artefacts due to a history of orthognathic surgery.

Owing to the extensive bone loss in the anterior region and the unfavorable prognosis of the remaining upper teeth, the treatment initially consisted of tooth extraction, maxillary sinus lift in the posterior region, and rehabilitation with customized implants (Fig. 3). Similar to the cases described earlier, individualized digital planning was conducted. For the surgical procedure, it was necessary to remove the old fixation plates from the orthognathic surgery.

DISCUSSION

Patient satisfaction rates and impacts on quality of life have been reported in studies[3,5] involving the rehabilitation of customized subperiosteal implants. Modern dentistry has improved with the effectiveness of 3-dimensional printing and the ability to conduct extensive studies on materials (eg, titanium) and to review concepts related to subperiosteal implants.[5] The authors examined the efficacy of different treatments on titanium surfaces and reported that titanium alloys used in the manufacture of subperiosteal dental implants do not produce cytotoxic or proinflammatory effects, allowing for better osseointegration and biocompatibility and more efficient healing.[4]

Both clinical cases addressed in this study used customized implants with high patient satisfaction rates, as well as a calm postoperative period. Importantly, extensive maxillary bone loss can result in poorly adapted prostheses, compromising esthetics and function.[5] Subperiosteal implants represent an alternative in cases of extensive bone resorption and are supported by manufacturing technologies assisted by computerized analysis.[4] The earliest subperiosteal implants presented greater complications because they were not rigidly fixed, which resulted in increased progressive bone loss.[3] The authors followed a sample of patients over a period of 6 months and observed a high implant survival rate and minimal postoperative complications.[3] Only one isolated case of implant exposure was observed, but it did not affect functionality.

Given the above, some authors assert that complications can include bacterial infections during the surgical procedure, material fracture due to fatigue, exposure or mobility of the implant, a lack of osseointegration, and issues with the length of the abutment pillars, which can predispose the implant and prosthesis to fractures.[3,6]

In the 3 clinical cases addressed in the study, no postoperative complications were observed; however, the need for periodic follow-up of implant longevity and procedure efficacy is important.

A similar case report[6] highlights several advantages of using subperiosteal implants over endosseous implants, such as[1] the possibility of a single-stage procedure with immediate loading,[2] a simpler and quicker technique,[3] a viable option for failed endosseous implants, and[4] an alternative to more invasive surgical techniques such as iliac crest bone grafts (which require an extraoral tissue/bone donor site or the use of any allografts).[6,10]

Computerized analyses involving software data and design are essential aspects for the fabrication of customized implants.[7] Advances in planning and manufacturing processes for direct production have eliminated restrictions on shape, size, internal structure, and mechanical properties, allowing the creation of implants that meet the physical and mechanical demands of the region.[9]

There is a significant need for more affordable and widely available software options for patient planning.[7] In support of this view, a developed study[10] confirmed that 3-dimensional printing technology allows for precise results, reduces work time, and eliminates the need for apparatus modification or adjustment during the surgical procedure, although it is still not accessible to all patients owing to high costs.

The planning and fabrication process met expectations regarding customization according to the patient's bone anatomy and the printing of the apparatuses, which undergo surface treatment processes, allowing for greater durability and biocompatibility.

CONCLUSION

Subperiosteal implants are a viable alternative when appropriately indicated for patients with atrophy and extensive bone loss in the maxillary region. They show promising results in the literature, which corroborate the respective clinical cases addressed in the study. The combination of computerized analysis and 3-dimensional printing results in greater precision, biocompatibility, and rigidity. The absence of postoperative complications was noted, as the clinical cases demonstrated a high success rate in the procedure and positive patient reports, with no postoperative complications. Importantly, periodic follow-up is needed to assess the longevity and effectiveness of the used technique.

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