Case Report

ONE SHOT SINUS LIFT, IMPLANT INSERTION, AND ALVEOLAR GUIDED BONE REGENERATION: A CASE REPORT

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ABSTRACT

Rehabilitation of the edentulous maxilla in the molar region is a challenging problem. In several cases, there is a scarce quantity of residual sinus floor bone, and the alveolar ridge high is reduced, carrying an increased inter-arches distance. In these cases, applying a single maxillary sinus lift technique for implant insertion is inappropriate since it requires constructing high crowns for prosthetic rehabilitation. High crowns are inappropriate not only from an aesthetic point of view but also functionally uncorrected since they determine the wrong crown/ratio proportion. In these cases, a sinus lift, implant insertion, and alveolar-guided bone regeneration can be performed in one operation. Here a case report is described and literature reviewed.

KEYWORDS: *sinus, alveolus, ridge, bone, fixture*

INTRODUCTION

A maxillary sinus lift (1-14), also known as a sinus augmentation or sinus elevation, is a surgical procedure performed to increase the amount of bone in the posterior maxilla. This procedure is undertaken when there is insufficient bone height in the back of the upper jaw, often due to the natural expansion of the maxillary sinus. During a maxillary sinus lift, a dental surgeon accesses the sinus cavity through a later window in the upper jawbone and lifts the sinus membrane, creating a space between the sinus membrane and bone. This space is then filled with bone graft material, which can be obtained from the patient (autograft), a donor (allograft), or a synthetic source (alloplast). The bone graft serves as a scaffold for new bone formation, promoting the growth of additional bone inside the sinus. Dental implants can be inserted after a period of 6-8 months of bone healing (two-stage procedure) or in the same operation of sinus lift (one-stage procedure). Maxillary sinus lifts are crucial for individuals who require dental implants in the upper jaw but lack sufficient bone volume. This procedure has become a routine and successful method for addressing bone deficiencies in the posterior maxilla, enabling more patients to benefit from dental implant-supported restorations.

Guided Bone Regeneration (GBR) is a dental surgical technique designed to enhance the growth of new bone in areas where bone loss has occurred, typically in preparation for dental implant placement or other restorative procedures (15-20). The goal of GBR is to create a stable environment that encourages the natural regeneration of bone tissue. During a GBR procedure, a barrier membrane is placed over the deficient bone area to protect it from soft tissue invasion and to create a secluded space for bone regeneration. This membrane acts as a barrier, preventing the infiltration of non-bone-forming tissues and allowing bone cells to populate and regenerate in the protected space. The barrier membrane may be made of biocompatible materials such as resorbable or non-resorbable membranes, and it serves as a scaffold for bone growth. Additionally, bone graft materials, often sourced from the patient (autograft), a donor (allograft), or synthetically

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produced (alloplast), may be placed beneath the membrane to provide additional support and stimulate the formation of new bone. Over time, the body's natural healing processes integrate the bone graft material and promote the development of new bone, effectively restoring lost bone volume. GBR is commonly employed in cases where there is insufficient bone for successful dental implant placement or where bone loss has occurred due to periodontal disease, trauma, or other factors.

The success of GBR depends on factors such as the patient's overall health, the quality of the bone graft material, and the proper placement of the barrier membrane. This technique has proven effective and reliable in implant dentistry, restoring adequate bone structure and facilitating the long-term success of dental implants and other restorative procedures.

In several cases, there is a scarce quantity of residual sinus floor bone, and the alveolar ridge high is reduced, carrying an increased inter-arches distance. In these cases, applying a single maxillary sinus lift technique for implant insertion is inappropriate since it requires the construction of high crowns for prosthetic rehabilitation. High crowns are inappropriate not only from an aesthetic point of view but also functionally uncorrected since they determine the wrong crown/ratio proportion. In these cases, a sinus lift, implant insertion, and alveolar-guided bone regeneration can be performed in one operation.

CASE REPORT

A 61-year-old female patient presented requesting implant-prosthetic rehabilitation of the maxilla. The patient presented a severe bone atrophy in the maxilla. In agreement with the patient, it was decided to replace upper removable prostheses with implant-prosthetic rehabilitation. The patient underwent an orthopantomography and cone-beam computed tomography scan (Fig. 1, 2).

Fig. 1. *Pre-operative orthopantomography.*

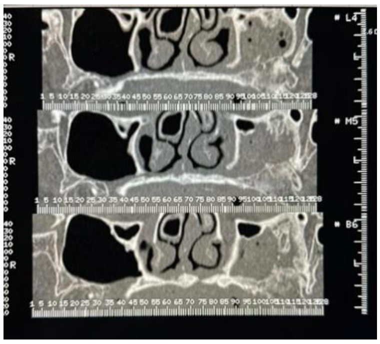

Fig. 2. *Pre-operative cone-beam computed tomography scan.*

The left maxillary sinus appeared opaque. Before surgery, the patient was informed about the operative risk and complications, and written consent was obtained from the patient for publication of this case report and accompanying images. After local anesthesia with articaine, the vestibular and palatine mucosa was incised and detached until the maxilla was completely skeletonized (Fig. 3).

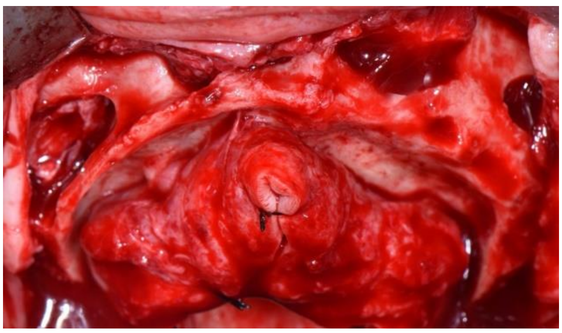

Fig. 3. *Vestibular and palatine mucosa was incised and detached until the maxilla was skeletonized entirely.*

A bilateral maxillary sinus lift was performed, and six implants were placed in the maxillary residual bone. Guided bone regeneration was performed with the placement of heterologous bone (Geistlich Bio-Oss® Thiene VI, Italy) and reinforced membranes (Geistlich Bio-Gide®, Thiene VI, Italy) fixed to the maxilla with mini-screws (Fig. 4). Three implants were inserted into the palate to stabilize the denture while waiting for bone regeneration and implant osteointegration (Fig. 5). Finally, the mucosa was sutured and a control orthopantomography was performed. The 3 implants emerge from the palatine mucosa (Fig. 6, 7).

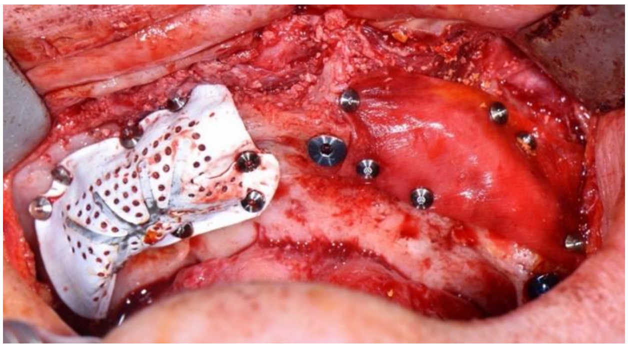

Fig. 4. *A reinforced membrane is visible on the right maxilla, while a resorbable membrane is on the left side. They cover bone grafts and are stabilized with pins.*

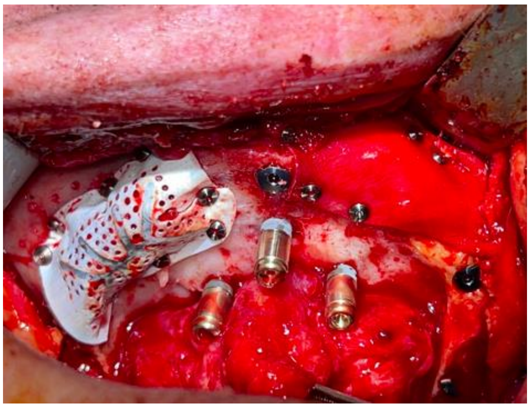

Fig. 5. *Three implants were inserted into the palate to stabilize the removable denture while waiting for bone regeneration and implant osteointegration.*

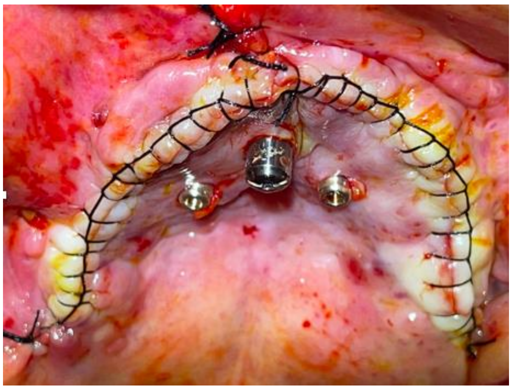

Fig. 6. *Mucosa is sutured, and 3 implants emerge from the palatal mucosa.*

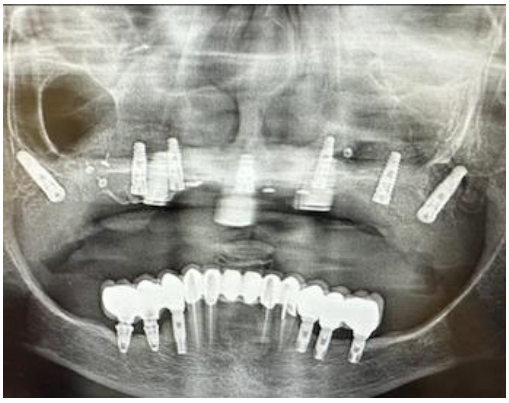

Fig. 7. *A control orthopantomography showing the inserted implants and pins stabilizing membranes.*

Six months after surgery, the maxillary mucosa was again incised and dissected to remove the 3 temporary fixtures inserted in the palate, uncover submerged implants and place the healing screws (Fig. 8-10). In the following month, the mucosa appeared completely healed, and the implants could be loaded for prosthetic implant rehabilitation (Fig. 11-14). Follow-up at 2 years showed successful implant placement. (Fig. 15).

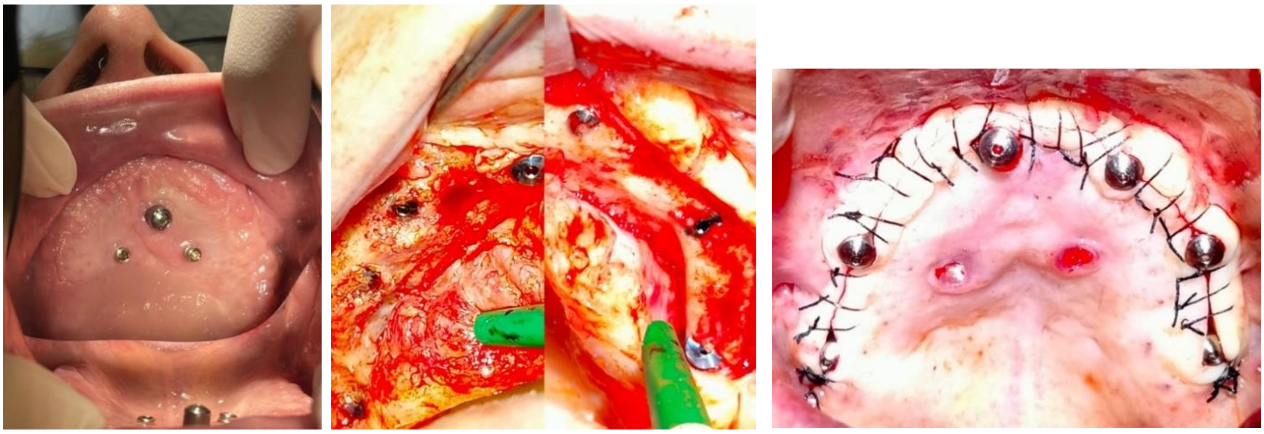

Fig. 8-10. *Six months after surgery, the maxillary mucosa was again incised and dissected to uncover the implants and place the healing screws.*

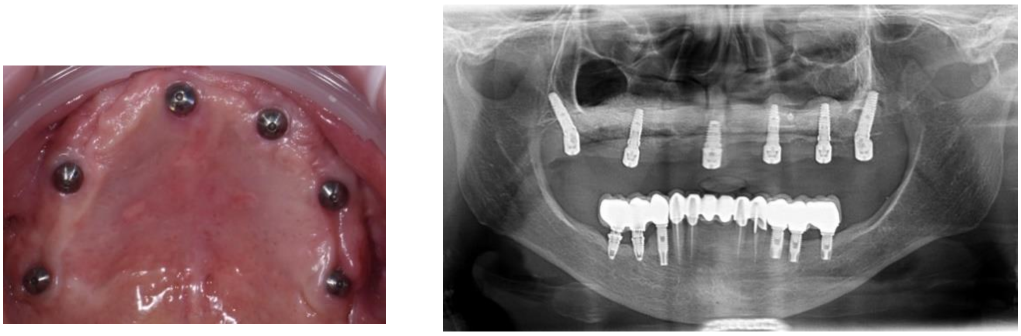

Fig. 11, 12. *One month later, the mucosa appeared completely healed, and the implants were loaded for prosthetic implant rehabilitation.*


Fig. 13, 14. *Final prosthesis.*

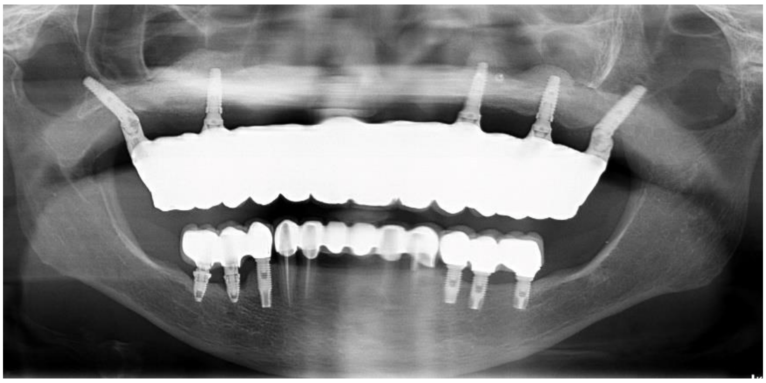

Fig. 15. *X-ray at 2-year follow-up.*

DISCUSSION

For the last twenty years, sinus lift and GBR has been applied to rehabilitate the posterior upper jaw. Several systematic reviews focus on the indication, contraindication, and outcome of these surgical techniques (1-20).

In 2010, Esposito et al. (1-3) investigated whether and when augmentation of the maxillary sinus is necessary and which are the most effective augmentation techniques for rehabilitating patients with implant-supported prostheses. The authors concluded that 5 mm short implants can be successfully loaded in maxillary bone with a residual height of 4 to 6 mm, but their long-term prognosis is unknown. Elevating the sinus lining with 1 to 5 mm of residual bone height without adding a bone graft may be sufficient to regenerate new bone and allow rehabilitation with implant-supported prostheses. Bone substitutes might be successfully used as replacements for autogenous bone. If the residual alveolar bone height is 3 to 6 mm, a crestal approach to lifting the sinus lining to place 8 mm implants may lead to fewer complications than a lateral window approach to place implants at least 10 mm long.

There is no evidence that PRP treatment improves the clinical outcome of sinus lift procedures with autogenous bone or bone substitutes. In 2014, Pinchasov et al. (4) reviewed the scientific literature with respect to bone formation in the sinus after the membrane elevation procedure without using any bone substitutes. It shows that 100% of the reviewed articles presented increased bone formation and high implant survival rates resulting from the graft-free technique. In 2014, Ali et al. (5) found that a thorough knowledge of conventional augmentation procedures such as bone augmentation techniques, guided bone regeneration, alveolar distraction, maxillary sinus elevation techniques with or without grafting, and contemporary techniques of implant placement provide effective long-term solutions in the management of the atrophic maxilla. In 2015, Fugazzotto et al. (6) and Kao et al. (7) showed that maxillary sinus lift is a predictable procedure to provide adequate bone height for implant placement.

However, complications are encountered during or after the execution of the sinus lift procedure. In 2016, Kelly et al. (8) focused on the effectiveness of recombinant human bone morphogenetic protein-2 (rhBMP-2) as a viable alternative to bone graft substitute in localized alveolar ridge augmentation and maxillary sinus floor augmentation. They show that for localized alveolar ridge augmentation, rhBMP-2 substantially increases bone height. However, rhBMP-2 does not perform as well as the autograft or allograft in maxillary sinus floor augmentation. In 2019, Ragucci et al. (9) reported that membrane perforations represent the most common complication. Consequently, their review aimed to elucidate the relevance of this phenomenon on implant survival and complications. The authors found that the overall survival rate of the implants into the sinus cavity was 95.6%, without statistical differences according to the penetration level. The clinical and radiological complications were 3.4% and 14.8%, respectively. The most frequent clinical complication was epistaxis, and the radiological complication was the thickening of the Schneiderian membrane without reaching a statistically significant difference according to the level of implant penetration inside the sinus.

In 2020, Iwanaga et al. (10) review the reported anatomy and variations of the maxillary sinus septa, greater palatine artery/nerve, and posterior superior alveolar artery and discuss what has to be assessed preoperatively to avoid iatrogenic injury. They stated that to determine the risk of injury of surgically significant anatomical structures in the maxillary sinus and hard palate, the operator should have preoperative three-dimensional images in their mind based on anatomical knowledge and palpation. The same year, Bernardi et al. (11) examined the properties of the platelet concentrates harvested bone and dentin-derived materials, reporting favorable results.

In 2021, Bhalla et al. (12) reviewed the traditional lateral sinus lift maxillary approach to achieve vertical augmentation and the trans-crestal osteotome intraoral approach. The same year, Díaz-Olivares et al. (13) proposed a treatment protocol for repairing intraoperative perforation of the Schneiderian membrane during maxillary sinus floor augmentation procedures with a lateral window technique. After that, the authors assessed subsequent implant survival rates placed below repaired membranes compared with intact membranes, determining whether membrane perforation constitutes a risk factor for implant survival. They concluded that Schneiderian membrane perforation during maxillary sinus floor augmentation procedures with a lateral approach is not a risk factor for dental implant survival. The knowledge of the exact size of the membrane perforation is essential for deciding on the right treatment plan.

Regarding alveolar ridge augmentation, Cordaro et al. (15) evaluated a surgical approach for 3D reconstruction of the posterior maxilla with autogenous mandibular bone in 16 patients. Bone blocks were harvested from the mandible and used as lateral or vertical block grafts (onlay); they were also partially milled and used for sinus elevation (inlay). In 4 cases, an organic bovine bone was added at the periphery of the blocks. Four months after grafting, implants were placed in a second operation and loaded after 12 weeks. Lateral and vertical augmentations were measured immediately after grafting and re-entry for implant placement. The mean lateral augmentation performed was 5.5mm, reduced to 4.3mm ($p<0.01$) after 4 months' healing. Mean vertical augmentation was 3.2mm, reduced to 2.1mm ($p<0.01$) after healing. The amounts of lateral and vertical graft resorption were similar (1.2mm vs. 1.1mm) but were different when compared with the original graft (22% vs. 34%). Forty-nine implants were placed 4 months after grafting. Implant parameters were evaluated after 32-48 months of follow-up and demonstrated 100% survival rates. The authors concluded that the use of mandibular bone grafts for 3D augmentation of the posterior maxilla has shown promising results and minor complications.

In 2016, Mestas et al. (16) systematically reviewed the survival rates of titanium dental implants placed using split crest procedures for alveolar ridge expansion. They found that using split crest techniques appears to provide predictable alveolar ridge augmentation and high survival rates in the short and long term for implants placed in the maxilla or mandible. The same year, Baj et al. (17) reviewed not only bone graft and guided bone regeneration for rehabilitation of alveolar ridge but also sinus floor elevation and bone osteogenesis distraction, a process of bone generation between two bone segments in response to tensile stress. In 2019, three studies were reported (18-20). Starch-Jensen et al. (18) tested the hypothesis of no difference in implant treatment outcome after maxillary alveolar ridge expansion with split-crest technique compared with lateral ridge augmentation with autogenous bone block graft. They found that the split-crest technique is helpful for horizontal augmentation of maxillary alveolar deficiencies with a high survival rate of prostheses and implants.

Khoury et al. (19) use a tunneling approach to evaluate the long-term outcome of the split bone block technique for vertical bone augmentation in the posterior maxilla in combination with sinus floor elevation. Patients were treated for extensive vertical and horizontal alveolar bone defects without simultaneous implant placement and followed up for at least 10 years postoperatively. Autogenous bone blocks were harvested from the mandibular retromolar area. The harvested bone blocks were split longitudinally. Implants were inserted and exposed after every 3 months, and prosthetic restoration was performed. They found that the combination of thin autogenous bone blocks and bone particles allows an acceleration of transplant revascularization and, thus, of graft regeneration, shortening the patient treatment time and long-term three-dimensional volumetric bone stability. Finally, Cha et al. (20) investigated whether or not alveolar ridge preservation reduces vertical changes in the posterior maxilla compared to spontaneous healing following tooth extraction.

For this research, forty subjects requiring extraction of maxillary posterior teeth with root apices protruding into the maxillary sinus floor were consecutively enrolled. Patients were randomly assigned to one of two surgical interventions: an alveolar ridge preservation procedure using collagenated bovine bone mineral and a resorbable collagen membrane (test) or no grafting (control). Cone-beam computed topographies were taken immediately and 6 months after surgery, before dental implant placement. The authors found that alveolar ridge preservation in the posterior maxilla maintained the vertical bone height more efficiently and resulted in less need for sinus augmentation procedures at 6 months compared to spontaneous healing.

Our case report demonstrated that performing a one-shot sinus lift, implant insertion, and alveolar-guided bone regeneration is possible in cases with a reduced quantity of residual sinus floor bone and increased inter-arches distance. Major attention should be paid to several complications associated with maxillary bone augmentation and implant dentistry. These complications can be broadly categorized into intraoperative, early postoperative, and late postoperative complications. Intraoperative complications include perforation of the sinus membrane, damage to neurovascular structures, and inadequate bone graft stability. Early postoperative complications encompass infection, hematoma formation, and graft failure. Late postoperative complications involve implant failure, peri-implantitis, and soft tissue complications.

Complications in maxillary bone augmentation and implant dentistry can arise due to various factors, including surgical technique, patient-related factors, and anatomical considerations. Preoperative evaluation, careful treatment planning, and meticulous surgical execution are crucial to minimize complications. Additionally, prompt recognition and appropriate management of complications are vital to achieve successful outcomes.

Maxillary bone augmentation and implant dentistry offer practical solutions for patients with missing teeth. However, it is important to be aware of the potential complications associated with these procedures. Understanding the etiology, prevention strategies, and management techniques of these complications is essential for dental professionals to provide optimal patient care. By staying updated with the latest research and advancements, clinicians can minimize complications and improve the long-term success rate of maxillary bone augmentation and implant dentistry.

CONCLUSIONS

Our case report demonstrated that in cases with a reduced quantity of residual sinus floor bone and increased inter-arches distance can be treated by performing a one-shot sinus lift, implant insertion, and alveolar-guided bone regeneration. However, different groups should report more studies to establish this procedure's indications and complications.

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