Maxillary Sinus Elevation Using the Bone Ring Technique with Immediate Implantation: A Case Report

Compared to other areas of the oral cavity, an edentulous posterior maxilla poses a unique challenge for implant placement. The most important aspect to consider is the maxillary sinus. This paper describes a case in which the bone ring technique was used to raise the floor of the maxillary sinus, followed by immediate implantation. A 37-year-old woman presented with a ridge defect in the left maxilla and the absence of teeth 26 and 27 (FDI tooth-numbering system) on the same side. The treatment plan involved the extraction of tooth 25, periodontal regeneration on the distal face of tooth 24, and concomitant raising of the maxillary sinus (using the bone ring technique) with simultaneous implantation. The bone ring technique promotes bone augmentation, raises the maxillary sinus, and reduces the surgical time, surgical costs, and length of the rehabilitation period. In the case presented herein, bone tissue stability around the implants, ridge maintenance, and gingival margin stability were found at the 1-year follow-up after rehabilitation.


Adequate bone quality and quantity are essential to implant therapy. An edentulous posterior maxilla poses unique challenges compared to other regions of the oral cavity. The most important factor to consider in such cases is the presence of the maxillary sinus, which is a pyramid-shaped sinus reinforced by vertical septa, creating intrasinus cavities.1 The size of the maxillary sinus varies from individual to individual, with a mean width of 35 mm at the base and a mean height of 25 mm in adults.2 The sinus membrane lines the sinus and is attached to the underlying bone.3

Regions with tooth loss exhibit bone resorption, with different degrees of severity, that often impedes the direct placement of implants. Thus, surgical planning may involve bone reconstruction to reestablish sufficient bone thickness to receive the implants.1

Besides insufficient bone quality and quantity, a deficient alveolar ridge and sinus pneumatization are frequent findings after tooth loss in the posterior maxillary region. Different approaches have been developed to overcome these problems, such as bone augmentation to raise the maxillary sinus floor.4

Maxillary sinus elevation was first described by Boyne and James in 1980,5 and several successful techniques have since been reported.
for raising the maxillary sinus floor, including ridge and transalveolar approaches. The ridge approach involves the osteotomy technique introduced by Summers in 1994. These methods are performed with two main procedures for raising the sinus floor to enable implant placement: a two-stage technique using a lateral window approach followed by implantation and another technique using either a lateral approach or going through the bone ridge.

Knowledge of the maxillary sinus anatomy assists in adequate preoperative treatment planning and avoiding complications that may arise during the sinus elevation procedure. The most common intraoperative complication is sinus membrane perforation, as reported in 61 out of a total of 397 operations in one study. This complication occurs with greater frequency in residual alveolar bone with a low height. However, there is no statistically significant correlation between membrane perforation and the implant success rate.

The morphology of the remaining bone after extraction is another vital clinical aspect to consider in implant cases. Extractions can result in significant horizontal and vertical bone loss, requiring bone augmentation. Bone grafts are used for the three-dimensional reconstruction of alveolar bone. Autogenous bone grafts in the form of a corticomedullary block were originally proposed for lateral and vertical augmentation of bone deficiencies and are considered the material of choice for most vertical bone loss cases.

However, it is possible to improve results by using a bone graft with a predictable esthetic outcome. For example, the surgeon may increase the remaining bone structure and place the implant in a single session using the bone block transplant procedure first developed by Frieberg in 1995 and perfected by others. With this technique, autologous donor bone is obtained in the shape of a ring for the three-dimensional ridge reconstruction and augmentation in a combined procedure involving simultaneous implant placement. Bone grafts removed from the mentum in block form can be used for predictable bone augmentation of up to 6 mm in the horizontal and vertical dimensions. The bone ring thickness is very important; it cannot be too thin (due to the risk of fracture) or too thick (which would cause problems in shaping the ring). For stabilization and synthesis, a horizontal mattress suture without tension is used in the receptor area, along with simple sutures for complete flap coaptation and clot stabilization. These are important steps to minimize the risk of dehiscence and to enable graft incorporation and complete osseointegration of the implant within a period of 8 months.

This paper describes a case in which the bone ring technique was used to raise the floor of the maxillary sinus followed by immediate implantation.

Clinical Case

A 37-year-old woman presented with a ridge defect in the left maxilla and the absence of teeth 26 and 27 (FDI tooth-numbering system) on the same side (Fig 1a). The clinical and radiographic evaluations revealed a periodontal defect in the distal region of tooth 25 (Fig 1b) with a poor tooth position and subgingival caries (Fig 2), which rendered the maintenance of the tooth unviable. The treatment plan involved the extraction of tooth 25, periodontal regeneration on the distal face of tooth 24, and concomitant maxillary sinus elevation using the bone ring technique with simultaneous implantation, all during the same surgical session.

The hematologic and biochemical examinations revealed normal findings, indicating that the patient was in adequate health to undergo surgery. The mentum was selected as the donor region for bone ring collection, to be used as grafts for bone augmentation and maxillary sinus elevation. In the preoperative period, the patient was medicated with midazolam (15 mg, single dose), fexofenadine (60 mg, single dose), and amoxicillin (500 mg every 8 hours, initiated 24 hours before surgery and maintained for 7 days). Intraoral antisepsis was achieved by the patient rinsing her mouth with 0.12% chlorhexidine for 1 minute prior to surgery. Local anesthesia was performed with an injection of 4% articaine with epinephrine (1:100,000) in the donor area, and infraorbital and superior posterior

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alveolar block was used for the receptor area.

Surgery was initiated with a supracrestal incision in the receptor area to enable the creation of a pedunculated flap and bilateral vertical relaxing incisions, involving the papillae of the adjacent teeth to enable complete flap displacement. This incision technique is specific to this approach, as it enables coronal flap movement in such a way as to keep the teeth adjacent to the defect uncovered at the time of wound closure. It is of the utmost importance for the flap to have complete passivity in its coronal movement, which is achieved by superficial incisions under the flap to release the muscle insertions and, consequently, the tension at the time of suturing, thereby minimizing the risk of postoperative dehiscence.

Tooth 25 was extracted (Figs 3a and 3b). Once the defect was exposed, the appropriate trephine was selected to rectify the defect. The trephine used for bone ring collection from the donor region is one size larger than that used to rectify the defect in the receptor site, enabling the perfect fit of the ring to the rectified defect and achieving both greater stability and greater blood supply between the medullary faces of the underlying bone. The rectification of the defect is performed by taking into consideration the best threedimensional implant positions in accordance with previous prosthetic planning.

Lateral access to the maxillary sinus was then performed (Fig 3c), during which the membrane was perforated (Fig 3d). The rupture was sutured (Fig 3e) with resorbable Vicryl 6.0 thread (Ethicon, Johnson & Johnson). This was later sealed (after implant and bone ring placement) by placing a collagen

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**Fig 1**  
(a) A 37-year-old patient presented with edentulous areas corresponding to teeth 26 and 27 (FDI tooth-numbering system). Tooth 25 showed severe gingival recession.  
(b) A tomosgram showed sinus pneumatization and loss of horizontal bone volume in the area corresponding to teeth 26 and 27. The measurements in red correspond to the soft tissue thickness of the analyzed region.

**Fig 2**  
Clinical view of the subgingival caries on tooth 25 and the clinical attachment loss, impeding tooth preservation in the rehabilitation plan.
membrane (13 × 25 mm; Bio-Gide, Geistlich) and a fibrin membrane over the area.

In this same surgical stage, the selected donation area (in the chin) was anesthetized, and two bone rings were collected from the mentum (Fig 3f). Once the trephine was selected for the receptor site rectification, the blocks in the donor site were marked only to the cortical level with a no. 6 trephine (one size larger than the trephine selected for the receptor site). It is important to stress that the collection area should respect a space of 3 mm apical to the root apices and 3 mm coronal to the base of the mandible. In this first marking, the ring diameter was established, and the center of the ring was used for the boring sequence. The perforations in the ring were compatible with the implant to be placed at the receptor site (3.3 × 12 mm; BLT, Straumann). It is important for the entire boring sequence to be performed with a thread-inducing burr.

Once the boring was completed, the trephine was pressed down within the anatomic limits determined on the tomogram. A specific instrument was then used to gain access to the surgical alveolus of the ring for the apical release of the medullary bone. The cleavage and release of the ring was achieved with small, leveraging movements.

Fig 3 (a) The attachment loss of tooth 24 was measured, with the complete gingival flap folded after extraction of tooth 25, confirming a viable periodontal pocket for regeneration. (b) Buccal view of the alveolus after extraction of tooth 25 and the attachment loss at tooth 24. (c) Clinical view of the intact sinus membrane and remaining bone. (d) The sinus membrane was perforated during surgery, then (e) sutured with a resorbable thread to anchor it to the bone lateral to the surgical access. (f) Details of bone ring removal from the donor area of the chin.
The graft was stabilized by the implant itself (Fig 4a). In the donor area, collagen sponges (Hemosp, Maquira) were placed in the orifices created by the trephine, and the incision was sutured with dense polytetrafluoroethylene (PTFE) 3.0 thread (Cytoplast, Osteogenics Bio-medical).

The bone ring was anchored with implants (3.3 × 12 mm, BLT) in the region of tooth 25 for alveolar reconstruction and with implants (3.3 × 10 mm, BLT) in the region of tooth 26 for the maxillary sinus elevation (Fig 4a). A fibrin membrane was placed over a collagen membrane (Bio-Gide) on top of the sinus membrane to cover the perforation (Fig 4b). The spaces were filled in with autogenous bone particles and bovine hydroxyapatite (Bio-Oss small, Geistlich; Fig 4c). A collagen membrane (13 × 25 mm, Bio-Gide) was placed over the lateral access and attached with pins (Fig 4d). The access was closed with flap repositioning. The tensionless flap was sutured with dense PTFE 3.0 thread (Cytoplast) using horizontal mattress sutures and simple sutures (Fig 4e). The donor area was sutured with simple sutures using the same PTFE thread.

The patient was given instructions regarding the need for rest and dietary control (pasty foods and liquids) for 72 hours, ice pack therapy for the first 6 hours, and bacterial control and hygiene maintenance with 0.12% chlorhexidine beginning 48 hours after the procedure. An analgesic (500 mg metamizole every 6 hours for 48 hours) and an antibiotic (500 mg amoxicillin every 8 hours for 7 days) were prescribed. The stitches were removed 10 days postsurgery, and a clinical evaluation was performed at 30 days. Clinical (Figs 5a and 5b), panoramic radiographic, and tomographic (Fig 5c) follow-ups were performed after 7 months. At this follow-up time, the site was reopened for placement of the prosthetic abutments and a temporary partial denture (Fig 6). The suture was removed after 10 days (Fig 7a), and a periapical radiograph was taken (Fig 7b).

The temporary partial denture was used for 30 days to establish the proper peri-implant emergence profile (Fig 7c). The transference molds were then performed using a material compatible with the placed abutments. Once the models were obtained, the ceramic crowns were made in lithium disilicate (Fig 8a). With the conclusion of rehabilitation, a radiographic follow-up was performed after 12 months (Fig 8b).
Fig 5 (a) Lateral and (b) occlusal views of the surgical site 7 months postoperatively. (c) A tomogram was taken at 7 months postoperative.

Fig 6 (a) The site was reopened at 7 months, and the implant lids could be seen. (b) After the temporary prosthetic crowns were placed, the flap was sutured.
One difficulty encountered in the rehabilitation of critical defects is the fact that three-dimensional bone loss can result in repeated surgical interventions until a sufficient quantity of bone is achieved for implant placement. The maxillary region is particularly challenging in terms of achieving an excellent esthetic outcome. Therefore, knowledge of block bone reconstruction techniques that enable three-dimensional gains enables a better surgical outcome.

When the maxillary gingival architecture is compromised due to insufficient bone quality and quantity, a deficient alveolar ridge, and sinus pneumatization (which are common findings following tooth loss in the maxillary region), reconstruction techniques are used for bone augmentation and elevating the maxillary sinus floor. These techniques involve filling the region with autogenous, xenogeneic, allogeneic, or alloplastic bone particles or a bone block.

The two-stage surgical intervention method is generally employed in cases of three-dimensional defects using autologous bone blocks. To avoid the loss of bone volume during the healing phase of the transplants, it is imperative for the bone block to be rigidly fixed at the receptor site for adequate graft incorporation. Any remaining space should be filled with autogenous bone particles (obtained from the donor site) combined with a slow-resorption biomaterial, such as a deproteinized inorganic bovine matrix, as used in the present case. Moreover, a natural collagen membrane of swine origin (Bio-Gide) was used to cover the entire augmented area.

Bone reconstruction with an autogenous graft (bone block) enables this three-dimensional gain, but the conventional technique requires two surgeries: graft placement and implant placement. The bone ring method was conceived to enable both graft and implant placement.
placement in a single surgery.25,29,36 Although there is a related morbidity, the surgical time is considerably reduced with the bone ring technique, which is a positive aspect in these borderline cases: The implant can be inserted at the same time as bone graft placement, and the treatment time is shortened by at least 6 to 8 months, which is the great distinction of this technique.

Conclusions

As demonstrated in the present case report, the bone ring technique promotes bone augmentation, elevates the maxillary sinus floor, and reduces the surgical time, thus reducing the costs related to additional surgeries and enabling rehabilitation in a shorter period of time.

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