sinus elevation

The use of minimally invasive antral membrane balloon elevation (MIAMBE) to treat the posterior maxilla: A clinical presentation

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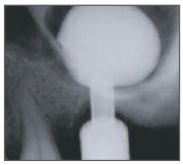

Sinus-floor elevation has become a predictable and effective technique for increasing the vertical dimension of atrophic posterior maxillary alveolar bone. However, this approach is time-consuming, costly, can have negative sequelae for patients, and poses the risk of a number of complications. A simple and less invasive version of the osteotome sinus-floor elevation technique has been developed. This procedure is described here, and its application is illustrated with a case presentation.

Key Words: sinus elevation, atrophic posterior maxilla, site preparation, grafting

Introduction

A number of anatomic factors complicate the placement of dental implants in the posterior maxilla. Post-extraction resorption patterns, use of a removable prosthesis, physical trauma, periodontal disease, and/or pneumatization of the maxillary sinus can all significantly decrease the height and width of the residual alveolar ridge.[1] Moreover, bone quality in this region tends to be the least dense in the oral cavity;[2] typically Type III and IV.

To increase the likelihood of long-term survival of dental implants placed into atrophic posterior maxillae, the use of shorter[3] and wider[4] implants has been recommended. An alternative approach has been to augment deficient ridges.[5] But problems with graft-material resorption have been reported,[6] and even when such grafting succeeds, the resultant reduction of the posterior interocclusal space may make prosthetic restoration difficult.[7]

Augmentation of the sinus floor has thus emerged as another alternative for increasing subantral bone height. First described by Tatum,[8] subantral augmentation has since evolved. In the modified Caldwell-Luc approach, a hinged window in the lateral wall of the maxilla is created, then gently pressed inward and upward into the sinus cavity, lifting the Schneiderian membrane and creating a new sinus floor. Bone-graft material is then introduced into the void between the elevated tissues and the original sinus floor. Implants may be placed simultaneously or after a healing period. Results from this approach have been so favorable that a 1996 consensus conference organized by the Academy of Osseointegration declared that sinus grafting

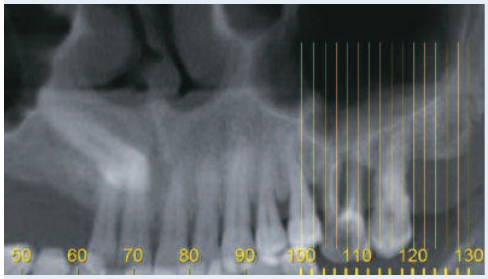

Fig. 1
A CT scan revealed that the subantral bone height was 2mm and the width was 10mm.

Fig. 2
Six weeks after extraction of the left maxillary molars, epithelialization of the sites was evident.

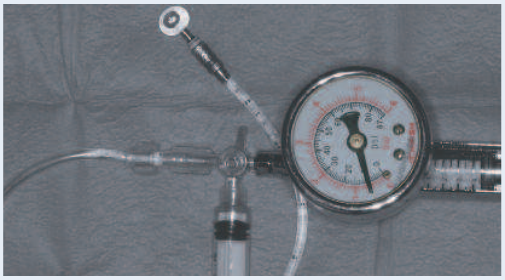

Fig. 3
A barometric pump was attached presurgically to the balloon-harboring device.

should be considered a predictable and effective therapeutic modality.[9] A systematic review by Wallace and Froum in 2003 found that implant survival in sinuses grafted with the lateral window technique averaged 91.8% (range: 61.7-100%).[10]

On the other hand, potential complications include tearing of the membrane, bleeding, infection, and sinus obstruction.[11] The technique requires considerable surgical skill and time, is costly, and commonly causes patient edema and discomfort.

A less invasive alternative was introduced by Summers[12] in 1994. Known as the osteotome or bone-added osteotome sinus-floor elevation (BAOSFE) technique, this approach uses a number of tapered osteotomes to push bone apically beneath the tented membrane while enlarging and deepening the osteotomies. However, it has been shown to yield an average bone height of only 3 ± 0.8 mm.[13] Membrane perforation and tears are also complications,[14] although expert technique and dedicated instrumentation can minimize that risk.[15]

To enable minimally invasive augmentation of more severely atrophic posterior maxillary sites, a modification of the BAOSFE technique was introduced in 2006.[16] The minimally invasive antral membrane balloon elevation (MIAMBE) procedure uses a dedicated balloon and other instrumentation to elevate the membrane through a 3mm to 3.5mm diameter osteotomy. The procedure can be learned quickly, typically can be executed in less than an hour, and may reduce the complications, discomfort, disfigurement, and disability associated with the lateral side window augmentation approach.

The following clinical presentation illustrates the use of the MIAMBE technique.

Clinical Case Presentation

The patient was a 47-year-old female who presented complaining of mobility of her left maxillary molars. Advanced periodontal disease was diagnosed, and a CT scan and panoramic radiographs were taken to ascertain the maxillary bone dimensions, mucosal thickness, sinus anatomy, and location of the major blood vessels. The CT scan (Fig. 1) revealed the alveolar bone directly below the sinus to be approximately 10mm wide but only 2mm high.

A treatment plan was developed, calling for extraction of the maxillary left first and second molars. After healing of the extraction sites, the MIAMBE technique would be used to augment the ridge, followed by simultaneous placement of two dental implants.

The teeth were extracted, and after six weeks, the patient returned for the sinus-elevation procedure and implant placement (Fig. 2). Approximately 40ml of the patient's blood was drawn by venous puncture and processed to obtain platelet-rich fibrin (PRF). The dedicated barometric pump was connected to the balloon-harboring device (MIAMBE, Netanya, Israel). This is a stainless steel tube that connects on its proximal end to the dedicated inflation syringe and on its distal end has a screw-in mechanism that secures the device into the osteotomy site (Fig. 3). Immediately pre-operatively, the balloon was inflated extraorally and inspected to confirm its integrity.

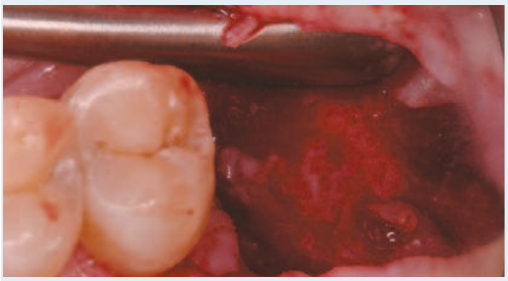

Fig. 4
A full-thickness mucoperiosteal flap was raised, revealing the alveolar crest.

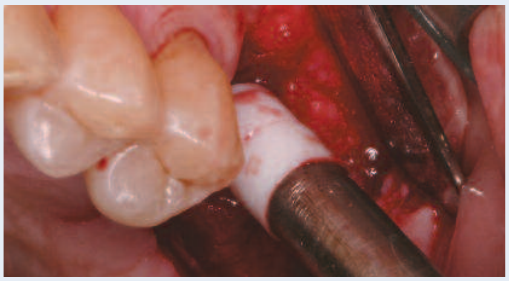

Fig. 5
The Teflon stopper prevented the Schneiderian membrane from being torn, as the floor of the maxillary sinus was in-fractured.

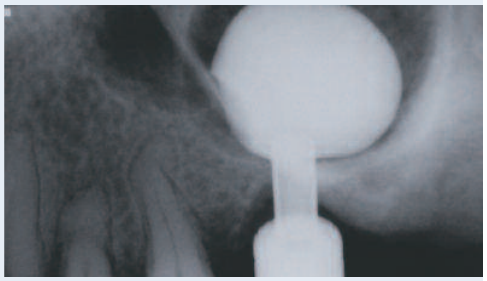

Fig. 6
Periapical radiograph of balloon-harboring device after being filled with the contrast material.

Local anesthesia was administered to the patient, and a full-thickness mucoperiosteal flap was raised to expose the alveolar crest (Fig. 4). In the first molar position, a 1mm-deep osteotomy was created using a piezosurgical diamond tip. A dedicated osteotome connected to a Teflon stopper was then inserted into the osteotomy and gently tapped with a hammer, infracturing the sinus floor (Fig. 5). The purpose of the stopper is to limit the extent of the osteotome's penetration into the sinus, with the aim of ensuring the integrity of the Schneiderian membrane. After the integrity of the sinus membrane was confirmed by Valsalva maneuver and direct visualization, the metal sleeve of the balloon-harboring device was inserted into the osteotomy to a point 1mm beyond the sinus floor.

A coronary angioplasty inflation syringe (Merit Medical, Galway, Ireland) filled with diluted contrast material was screwed into the balloon-harboring device. The syringe was then slowly depressed, inflating the balloon to two standard atmospheres. Typically, the pressure drops to 0.5 atmospheres once the balloon emerges from the metal sleeve. Inflation of the balloon with approximately 1cc of contrast fluid then continued. A periapical radiograph was taken to verify the balloon's positioning. Fig. 6 demonstrates how well the filled balloon conforms to the contours of the sinus cavity along the septum.

Once the desired elevation was obtained, the balloon was left inflated for five minutes to reduce the membrane's elasticity. The balloon was then deflated by retracting the fluid back into the syringe, and the balloon-harboring device was removed from the osteotomy.

Using a bone syringe, Endobon® Xenograft Granules* (BIOMET ***3i***), mixed with the PRF prepared pre-surgically, were inserted into the newly created space beneath the membrane (Fig. 7). A radiograph taken at this point (Fig. 8) confirmed that the sinus floor had been elevated by approximately 11mm. Additional xenograft was added (Fig. 9), and when the elevated sinus was completely filled with the xenograft, a second osteotomy was created in the second molar site. Two 13mm length x 5/4mm diameter NanoTite™ Tapered PREVAIL® Implants (BIOMET ***3i***) were then inserted in the osteotomies (Fig. 10). The design of these implants incorporates platform switching to aid in crestal bone height preservation. Two EP® Healing Abutments were placed into the implants, and the soft-tissue flaps were secured with resorbable sutures. The tissues were approximated, and the patient was instructed to limit herself to a soft diet for 10 days.

After five months, excellent soft-tissue healing was noted around the healing abutments (Fig. 11). Radiographic examination also confirmed that the crestal bone height gained after the sinus elevation had been maintained around the platform-switched implants.

The EP Healing Abutments were removed, and the soft-tissue response around the implants was found to be excellent (Fig. 12). Certain® Implant Impression Copings were attached to the implants, and an impression was made. Corresponding Certain (4mm restorative seating surface) Laboratory Analogs were mated to the impression copings in the impression (Fig. 13), and a soft-tissue model was made prior to pouring of the impression in stone.

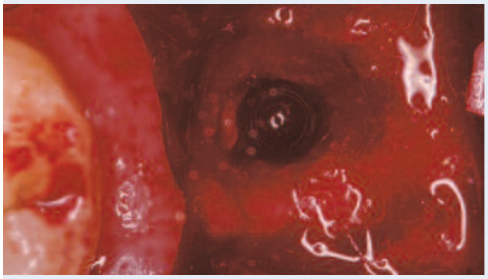

Fig. 7
Occlusal view of the osteotomy in the first molar site, showing Endobon® Xenograph Granules mixed with PRF inserted into the space created by the newly elevated sinus floor.

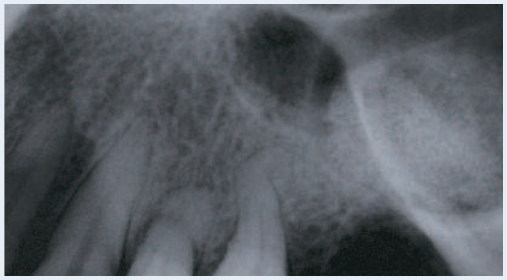

Fig. 8
Periapical radiograph taken immediately after filling the sinus with xenograft bone-replacement material.

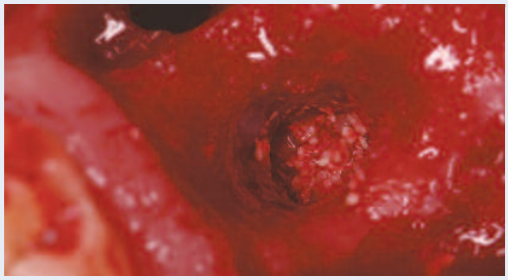

Fig. 9
After the first graft site was completely filled with the xenograft material, a second osteotomy was created in the second molar position.

Fig. 13
Photograph of the intaglio surface of the impression. The corresponding Certain® Laboratory Analogs have been mated to the impression copings in the impression.

Fig. 14
The prepared GingiHue® Posts were placed into the internal interfaces of the implants.

Fig. 15
The splinted metal copings were tried in over the abutments to confirm accuracy of fit and returned to the lab for porcelain application.

In the laboratory, two GingiHue Posts were placed onto the master cast and modified. Splinted metal copings were fabricated for the modified abutments, and these were sent to the dental office for try-in. The patient returned, and the prepared GingiHue Posts were placed into the internal interfaces of the implants (Fig. 14). The splinted metal copings were tried in over the abutments to confirm accuracy of fit (Fig. 15) and returned to the lab for porcelain application.

Figure 16 shows the porcelain-fused-to-metal restoration in place after occlusal equilibration. A panoramic radiograph and CT scan (Figs. 17 and 18) confirmed the success of the sinus graft and osseointegration of the implants achieved using the MIAMBE technique.

Discussion

Kfir et al in two separate studies[17,18] reported six-nine-month survival rates of 95% and 97% respectively for implants immediately placed in 145 patients who underwent the MIAMBE procedure. In both investigations, the procedure was completed in less than an hour, on average, and incremental bone height consistently exceeded 8-10mm. A 95.2% implant success rate was reported in a separate 2009 study[19] of 26 patients receiving the procedure who had antral septa of the maxillary sinus. This is considered a relative contraindication for the closed osteotome procedure.

Macroscopic and microscopic evaluation of four methods of indirect sinus-floor elevation investigated *ex vivo* using 36

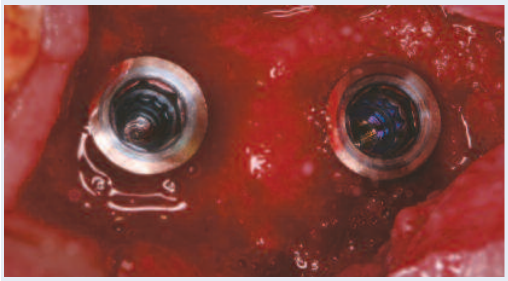

Fig. 10
Two NanoTite™ Tapered PREVAIL® Implants in place. Note that the occlusal surfaces of the implants are clearly visible at the time of implant placement.

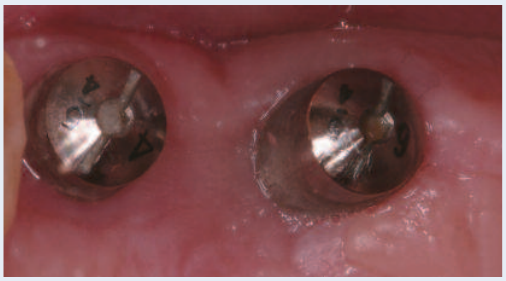

Fig. 11
Occlusal view of healthy soft-tissue healing surrounding two EP® Healing Abutments, which were placed at the time of implant placement.

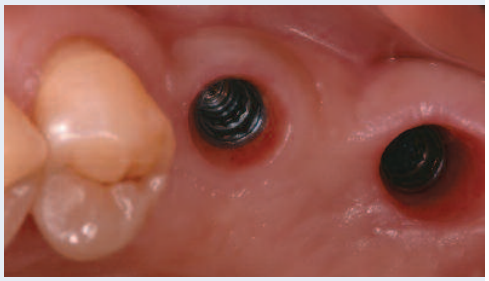

Fig. 12
Occlusal view taken five months after implant placement. Note the excellent soft tissue response around the platform-switched implants.

Fig. 16
The PFM restoration was seated, and occlusal equilibration was done.

Fig. 17
The 12-month post-restorative panoramic radiograph.

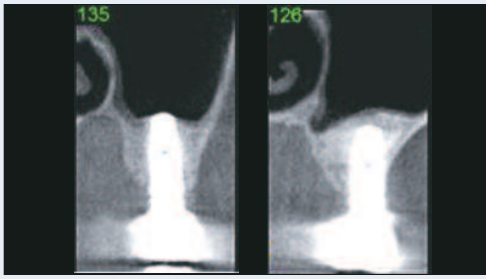

Fig. 18
CT axial slices of the two implants taken 12 months after definitive restoration.

bisected pigs' heads found that when elevation was conducted using an inflatable balloon, no perforation of the Schneiderian membrane occurred, in contrast with more traditional techniques.[20] If the membrane ruptures during the MIAMBE procedure, the procedure must be aborted.

It is important to note that although immediate implant placement was carried out in the case reported here, a minimum amount of residual subantral bone must be present to enable primary implant stabilization and subsequent osseointegration. In the experience of the author, a minimum ridge height of 2-3mm must be present. In the presence of even that minimal amount, the design of the PREVAIL® Tapered Implant enables adequate fixation of the implant neck in the bone.

Clinical Relevance

When atrophy of the subantral alveolar ridge complicates placement of dental implants, the minimally invasive antral membrane balloon elevation technique described in this report can enable substantial elevation of the sinus floor. If a minimum of 2-3mm of residual subantral bone height is present, it may be possible simultaneously to place and achieve primary stability of properly designed tapered implants. This technique is simpler and less expensive than more invasive techniques and may avoid the complications associated with lateral window-elevation techniques. The design of the PREVAIL Implant not only allows for high primary stability, it also allows this technique to be employed in minimal amounts of pre-existing bone under the sinus.

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*Sinus lift indication for Europe only.

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Dr. Ziv Mazor graduated from the periodontal department of Hadassah School for Dental Medicine in Jerusalem, Israel where he served as clinical instructor and lecturer for undergraduate and postgraduate dental students. He maintains a private practice limited to periodontal and implant dentistry in Raanana, Israel and is engaged in clinical research in the field of bone augmentation and sinus floor elevation. Dr. Mazor is a well-published author on these subjects and has lectured extensively both nationally and internationally. He is the past president of the Israeli Periodontal Society.