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ENRICO MARCHETTI[2], MICHELE ANTONIO LOPEZ[1], LUCA CONFALONE[1], STEFANO MUMMOLO[2], GIUSEPPE MARZO[2]

[1] Private practice in Rome, Italy
[2] Department of Health Sciences, University of L'Aquila, Italy

Maxillary sinus augmentation by crestal approach and ultrasound

ABSTRACT

Background One of the most frequent causes of failure during maxillary sinus floor augmentation is rupture of the Schneiderian membrane, the laceration of which affects its graft containment function. Ultrasound surgery came into widespread use with the aim of reducing the incidence of complications, due to its specific ability to cut hard tissues with extreme precision and less trauma, thus reducing the risk of lacerating the soft tissues.

Case series For this study an ultrasound technique for maxillary sinus augmentation surgery by crestal approach was proposed to 10 volunteer patients. The technique employs cylindrical diamond inserts mounted on ultrasonic instruments, which are able to cut the hard tissues, such as bone, without damaging the soft tissues, such as the Schneiderian membrane. The cortical bone of the maxillary sinus is reduced until the sinus is accessed and the Schneiderian membrane is lifted toward the inside of the cavity.

Discussion and conclusion The working times for cortical bone reduction are shorter and percussion trauma is avoided. Reduced trauma and low invasiveness allow us to propose this technique as a valid and practical alternative to those hitherto known and applied.

KEY WORDS Dental implant; Hydroxyapatite; Maxillary sinus; Ultrasound.

INTRODUCTION

The increasing demand for implant dentistry treatments goes hand in hand with the higher number of anatomical sites where the placement of fixtures is required. Since anatomical limitations reduce the possibility of performing standard treatment, oral surgeons need advanced surgical techniques that will enable them to solve more complex cases.

In the event of upper distal edentulism, severe bone resorption is often observed due to marked maxillary sinus pneumatization. This condition requires surgical maxillary sinus augmentation techniques that can convert part of the sinus cavity into bone suitable for implant dentistry procedures.

When massive filling of the sinus cavity is needed, the lateral approach for maxillary sinus augmentation (sinus floor elevation with grafting) is employed, making it possible to obtain an average height increase of 10 mm (1). In these circumstances, contemporary placement of the implants is not always feasible, unless there is adequate residual bone thickness that can assure good primary stability of the fixture.

A less invasive surgical technique is represented by the crestal approach proposed by Tatum as early as 1986 (2) and perfected over the years by many authors (3–10), but it permits only limited volume increments compared to the lateral approach technique. The predictability of the crestal approach, regardless of the technique employed and with concomitant placement of dental implants, is greater when the height of the residual ridge is at least 5–6 mm (3).

Over the years several sinus augmentation techniques have been proposed, most of which require the use of osteotomes. Percussion trauma and the lack of a direct view of the sinus membrane represent the main disadvantages of this approach. The aim of this paper is to describe a mini maxillary sinus augmentation technique that, combined with piezoelectric surgery, reduces surgical trauma and probably decreases the rate of surgical failures.

MATERIALS AND METHODS

Ten adult subjects in good health (4 males and 6 females) were enrolled in the study. All patients signed an informed consent to participate in the study, which was conducted in accordance with the 1975 Declaration of Helsinki, as revised in 2000. The mean age of the subjects at the time of surgery was 43 years (SD 8.99).

The exclusion criteria were:

- active infection of the site at the time of implant placement;
- systemic diseases;
- radiotherapy treatment of the craniofacial region in the previous 12 months;
- smoking > 10 cigarettes per day;
- bruxism.

The inclusion criteria were:

- need for tooth replacement in the upper premolar region;
- distance between the alveolar bone crest and the maxillary sinus floor between 4 and 6 mm (Fig. 1).

All surgeries were performed by the same experienced operator (ML) at a private practice in Rome, Italy.

Fig. 1 *Preoperative X-ray taken 6 weeks after dental extraction.*

Surgical procedure

For all cases the postextraction delayed-immediate protocol was applied, which calls for implant placement 6–8 weeks after dental extraction. Following infiltration anesthesia of the affected area with 4% articaine with 1:100:000 adrenaline (Citocartin, Molteni Dental, Milan, Italy), we performed a mucoperiosteal flap opening and site preparation by means of a calibrated helical drill (diameter 2.3 mm). The drill is used to approach the sinus cortical bone, halting about 1 mm from it, and allows the concomitant harvesting of a small amount of autologous bone, which is collected in the threads of the drill during perforation. Under sterile saline solution irrigation the cortical bone was abraded with the use of a cylindrical diamond rounded tip (diameter 1.2 mm) mounted on an ultrasonic instrument (CM1, Mectron, Carasco, Genoa, Italy) (Fig. 2).

Fig. 2 *Ultrasonic insert in action at the bone site.*

The ultrasonic tips, which vibrate at frequencies of 24,000 to 29,000 Hz, abrade and cut hard tissues such as bone without damaging the soft tissues such as the Schneiderian membrane (11, 12). The cortical bone of the maxillary sinus was reduced to create a trap door, which allowed access to the sinus and lifting of the Schneiderian membrane inside the sinus cavity (Fig. 3).

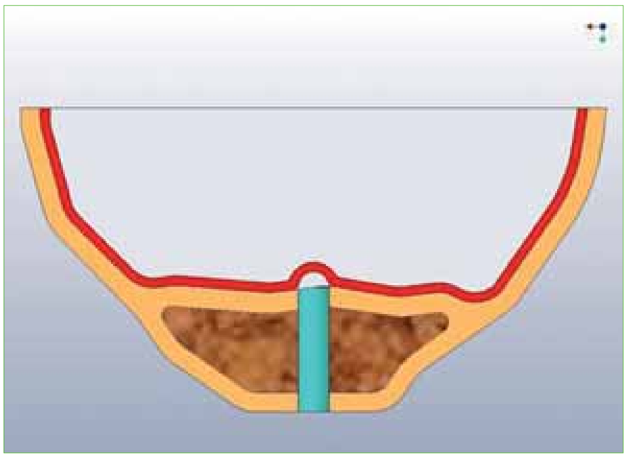

Fig. 3 *Diagram representing the localized lifting of the sinus membrane.*

The sinus membrane was then carefully lifted with a round-head instrument in order to avoid lacerations, and an equine collagen sponge was placed in the socket (Antema, Molteni Dental, Milan, Italy) to provide additional protection for the sinus membrane during placement of the grafting mixture (Fig. 4–5).

The grafting material to be inserted in the maxillary sinus, composed of autologous bone and

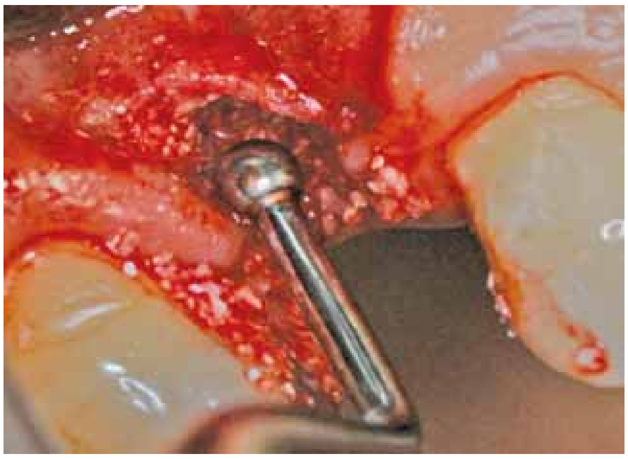

Fig. 4 *Smooth tip instrument used for membrane lifting.*

Fig. 5 *Placement of a collagen sponge to protect the maxillary sinus floor.*

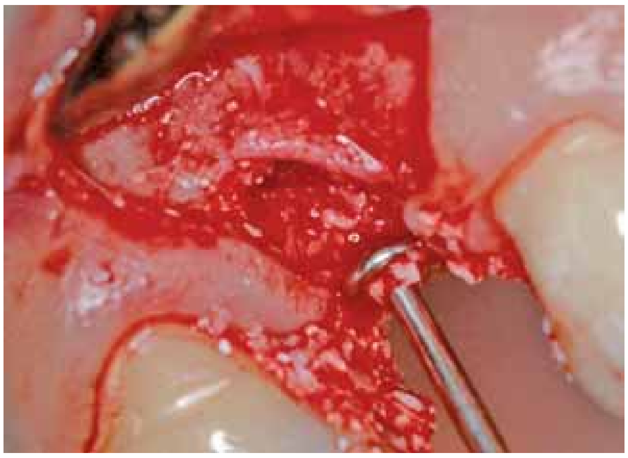

Fig. 6 *Placement and compaction of the grafting material.*

Fig. 7 *Check-up X-ray at 4 months.*

Fig. 8 *Check-up X-ray taken after 12 months, showing the remarkable integration of the graft.*

hydroxyapatite (Apagen 400Â, Stomygen, Rome, Italy) mixed with sterile saline solution (Fig. 6) was prepared in a titanium dappen dish. After the grafting material was placed with a special inserter, a self-tapping conical implant (F2 EVO, FMD, Rome, Italy) was placed, allowing the simultaneous horizontal expansion of the crest and greater primary stability, thus reducing the risk of possible dislocation of the implant within the sinus. The convexity of the apical third of the fixture reduces the risk of injury to the maxillary sinus during implant placement.
Transmucosal healing occurred and the implants were loaded 4 months after placement. Radiographs were performed with the parallel technique, using a long cone and a customized Rinn holder, before and after implant placement, and after 1, 4 and 12 months.

RESULTS

The treated cases showed an average volume augmentation of 4.2 mm (SD 0.98), as assessed at the twelve-month X-ray check-up (Figs. 7–8).
The results are comparable to those obtained with augmentation procedures performed with conventional techniques. No implant was lost and there were no sign of inflammation of the soft tissues.
No post-surgical epistaxis and no positional vertigo were reported.

DISCUSSION AND CONCLUSION

This paper reports the surgical procedure of a transalveolar approach for sinus floor elevation using piezoelectric surgery without a mallet.
One of the most frequent causes of failure during maxillary sinus floor augmentation by crestal approach is rupture of the Schneiderian membrane.

Although the crestal approach is less invasive, the lack of a direct view of the membrane prevents an assessment of a possible perforation, with subsequent dispersion of the grafted material placed in the maxillary sinus and failure of the regenerative treatment. Another important disadvantage of the crestal approach techniques involves trauma due to the surgical mallet used to fracture the floor of the maxillary sinus, and the osteotome used to compact the grafting material.
One of the most widespread bone compaction techniques is that of Summers, which is mainly indicated for sites with low bone density (D3, D4). The technique requires the use of osteotomes of increasing diameter (3, 4). The chief benefit is compaction of the bone, which is usually less dense in the upper distal sectors, while the disadvantage is represented by the numerous traumatic percussions.
This technique was modified in 1999 by Fugazzotto, who introduced the use of core drills (7). Other authors have proposed additional crestal approach techniques for augmentation of the maxillary sinus floor (5, 6, 8–10), but the general trend is to use tools and techniques that can reduce trauma and the rate of complications. Piezoelectric surgery has become widespread due to the fact that it can cut hard tissues with enormous precision and less trauma, thus avoiding damage to the soft tissues. These features clearly meet the requirements for maxillary sinus surgery, where the least possible trauma is crucial. The use of ultrasound instruments seems to reduce the rate of rupture of the Schneiderian membrane during procedures of sinus floor elevation with grafting (12). However, considering the learning curve of the operator, the use of a substantially correct technique notably reduces the percentage of cases showing membrane perforation, which in literature is reported as 7% (13-15), but in the only one randomized controlled trial comparing piezosurgery with conventional instruments in maxillary sinus surgery no significant differences were observed between the two groups (16). This study has been conducted using the lateral access technique, while, to the best of our knowledge, there are no randomized studies on the use of piezosurgery in the crestal approach.
We thought of employing this technique also for maxillary sinus augmentations by crestal approach, in order to reduce the incidence of perforations of the sinus membrane and in particular to avoid trauma from osteotome malleting, which is a source of great discomfort for the patient.
Despite the limitations of this study due to the small number of cases and short follow-up, based on the results that have been obtained we can nevertheless suggest that the described technique represents a viable option in maxillary sinus augmentation procedures. Several clinicians have reported postoperative positional vertigo related to the use of osteotomes during sinus floor elevations; a trauma to the inner ear seems to be produced by the striking of the surgical mallet (17-20).
In this technique the piezoeletric device used ultrasonic vibrations to cut the hard tissue which allowed it to come in contact with the membrane without tearing it. The sinus membrane was carefully lifted with a round-head instrument in order to avoid lacerations and the grafting material was gently inserted in the maxillary sinus with a manual inserter. Because surgical osteotome and mallet were never used, this technique seemed to be free from trauma and postoperative vertigo.
Our data showed good results in sinus augmentation procedures, in a similar way of the trancrestal technique which used osteotomes and mallets. No complications like positional vertigo or epistaxis were reported, and no implant was lost.
Despite the limitations of this study due to the small number of cases and short follow-up, based on the results that have been obtained we can nevertheless suggest that the described technique represents a viable option in maxillary sinus augmentation by the crestal approach. In fact, due to the reduced trauma and to the fact that the technique is less invasive, we can propose it as a valid and practical alternative to those hitherto known and used.
Further studies will be needed to determine its greater or lesser effectiveness in relation to the success rate in statistically significant terms.

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