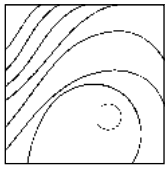
Use of Piezosurgery During Maxillary Sinus Elevation: Clinical Results of 40 Consecutive Cases



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The aim of this study was to evaluate the performance of piezoelectric devices during sinus elevation to determine the percentage of sinus membrane perforation and the time required to perform the antrostomy and elevation of the membrane. A total of 35 patients and 40 grafted sinuses were included. The parameters recorded were bony window length and height, bone thickness, osteotomy area, operative time, and number of perforations. Seven (17.5%) membrane perforations were observed, which were repaired with resorbable membranes. The mean length, height, and thickness of the osteotomy were 13.8 ± 2.9 mm, 6.9 ± 1.4 mm, and 1.4 ± 0.4 mm, respectively. The mean osteotomy area was 96.8 ± 32.2 mm², and the mean operative time was 10.3 ± 2.1 minutes. This study demonstrated that a piezoelectric device could be an attractive alternative for successful sinus augmentation. (Int J Periodontics Restorative Dent 2012;32:e182–e188.)

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Maxillary sinus elevation, first used by Boyne and James[1] in 1980, has become a predictable surgical procedure to achieve an effective and sustainable vertical augmentation of the severely atrophic posterior maxilla using a multitude of grafting materials.[2,3] The sinus elevation procedure is usually performed with different forms of rotary surgical instrumentation, such as an air-driven or electric handpiece with diamond or carbide burs.[4] During sinus elevation, the most frequent intraoperative complication, occurring in 7% to 35% of procedures,[5] is the accidental perforation of the sinus membrane either with burs during the osteotomy or with manual elevators during separation of the membrane.[6] A review of the literature showed that the perforation rate in lateral window sinus elevation surgery ranged from 14% to 56%.[7]

Preservation of the sinus membrane is essential for a successful sinus grafting procedure.[8] In particular, its integrity is crucial to stabilize grafting materials during the healing period and to allow revascularization, which in turn will lead

to the maturation and mineralization of the bone tissue.[9] Perforation occurs most frequently during the rotary osteotomy stage when using a round diamond handpiece.[10] Piezoelectric techniques were developed in response to the need for greater precision and safety in bone surgery than was available with other manual and motorized instruments.[6] A histologic study showed that Piezosurgery provides more favorable osseous repair and remodeling than carbide or diamond burs when surgical osteotomy and osteoplasty procedures are performed.[11] The piezoelectric bony osteotomy through the mineralized tissue occurs without damaging the membrane and allows easy separation.[6] At present, the use of piezoelectric instruments for sinus elevation seem to have several advantages: reduction of the membrane perforation rate, intraoperative bleeding, and surgical trauma and improved intraoperative visibility.[4]

Vercellotti et al[9] found no membrane perforations in 95% of 21 osteotomies performed in 15 patients using a piezoelectric device. In a recent clinical study of 26 maxillary sinus elevations, 4 perforations were observed, representing 15.3% of procedures.[12] Moreover, this alternative approach reduces not only the complications of the surgical technique but also the operating time and therefore the morbidity of the patient.[9] However, the time factor seems to depend on the bone structure and thickness, and the duration of the osteotomy procedure can be increased by up to fivefold when compared with conventional osteotomy devices.[13]

The aim of this clinical series was to evaluate the performance of a piezoelectric device during maxillary sinus floor elevation to determine the percentage of sinus membrane perforations and the time required to perform the antrostomy and elevation of the membrane.

Method and materials

Thirty-five consecutive patients (17 women, 18 men) with a mean age of 53.6 years (range, 42 to 67 years) were selected at the Department of Oral Science of "Sapienza" University, Rome, Italy, between June 2005 and January 2007. A total of 40 sinus elevation procedures (5 bilateral, 30 unilateral) were performed by means of a Piezosurgery device.

All patients were systemically healthy and completely edentulous in the posterior maxilla with a residual bone crest of approximately 4 mm.[9] Maxillary bone atrophy was scored (Class V) on the basis of the Cawood and Howell classification[14] and assessed by either preoperative orthopantomography (OPT) or computed tomography (CT).

The following exclusion criteria were used to select the patient population: history of systemic disorders that would contraindicate surgical treatment; history of maxillary sinus, nose, or throat pathologies; and smoking more than 10 cigarettes per day. With respect to tobacco use, 28 patients were nonsmokers and 7 smoked 1 to 10 cigarettes per day. Patients completed a presurgical questionnaire aimed at screening their medical, dental, and habitual histories and underwent blood tests. Before treatment, radiographic examinations, such as OPT and CT scans, were used to assess the anatomical conditions, position, and dimension of the bony window (Fig 1). In addition, the CT examination determined the mean thickness of the sinus lateral wall, and it was ascertained that there was no sinus pathology.

All patients were informed of the therapeutic alternatives to sinus elevation and of the possible complications of such an intervention. Informed written consent was obtained from the patients, and approval of the surgical procedure was granted by the Ethics Committee of the "Sapienza" University of Rome.

Either autologous bone or a mixture of 50% autologous bone and 50% deantigenated collagenated bone substitute of porcine origin (OsteoBiol, Gen-Os) was used as a filling material. The autologous bone was collected from the retromolar trigone.

Surgical procedure

Antibiotic therapy (1 g of amoxicillin) was prescribed 1 hour before intervention and twice a day for 5 days. Patients were asked to rinse with a 0.2% chlorhexidine digluconate solution for 2 minutes before surgery, and postoperative medication included analgesics and 0.12% chlorhexidine digluconate

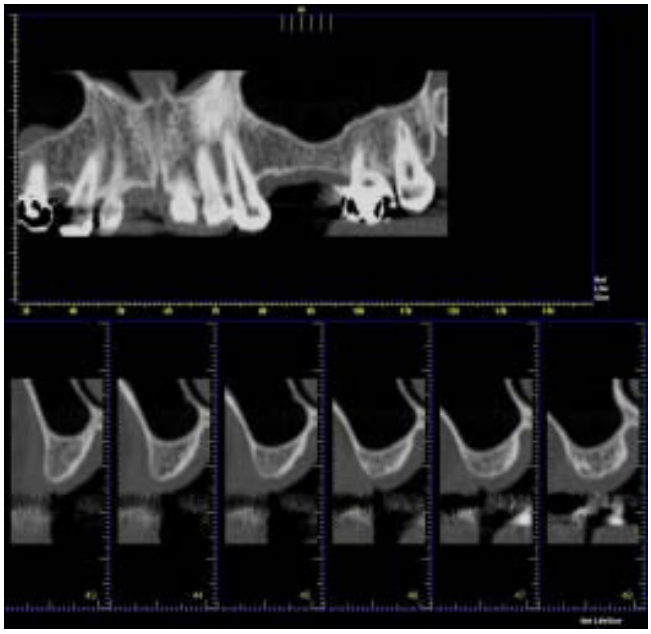


Fig 1 *Presurgical CT scan used to determine the correct position of the bony window and to measure the thickness of the lateral sinus walls. The bone height was 4 mm. No sinus pathology was present.*

mouthrinse for 10 days. All procedures were completed by the same surgeon. Patients were treated with a local anesthetic by infiltration with Articaine (Ubistesin 4%, ESPE Dental) associated with epinephrine 1:100,000.

A horizontal crestal incision was made with two additional vertical releasing incisions, and a full-thickness mucoperiosteal flap was lifted to expose the complete lateral wall of the maxilla. The osteotomy for sinus access was performed using a Piezosurgery device (Easy Surgery, BioSAFIN), and the following surgical procedure was carried out. A window osteotomy was performed on the lateral wall of the maxillary sinus using a BioS 520 ES diamond insert to draw an outline. The posterior margin of the osteotomy was placed 3 to 4 mm above the sinus (Fig 2a). The osteotomy was completed by rounding the angles of the bony window. Separation of the sinus membrane was performed using a BioS 540 ES surgery tip, which was inserted up to 2 mm into the edge of the exposed sinus membrane (Fig 2b). Membrane elevation was completed using manual sinus elevators or a BioS 532 ES surgery tip as with manual procedures, and the sinus mucosa was carefully dissected.

The space obtained with the sinus elevation was filled with graft material (autologous bone or a mixture of 50% autologous bone and 50% deantigenated collagenated bone substitute of porcine origin) (Fig 2c). The total amount of graft material at each site varied according to the extent of maxillary bone resorption and the sinus anatomy.

During the sinus elevation procedure, seven perforations occurred, and in those cases, the bony sinus windows were covered with a resorbable membrane (OsteoBiol) (Fig 2d).

Periosteal horizontal incisions were made to extend the flap as far coronally as needed over the bony window, and the mucoperiosteal flaps were sutured using tension-free single sutures (GORE-TEX, W.L. Gore), which were removed 10 days after surgery. Patients were restricted to a soft diet for 4 weeks, and oral hygiene instructions were provided. During the postoperative healing period, the occurrence of clinical complications such as acute or chronic sinus infection or bleeding was recorded.

Radiographic examinations (OPT and CT scan) were performed after

Fig 2a (left) *Osteotomy to access the maxillary sinus was performed using a BioS 520 ES diamond insert.*

Fig 2b (right) *Sinus membrane elevation and separation was performed using a BioS 540 surgery tip.*

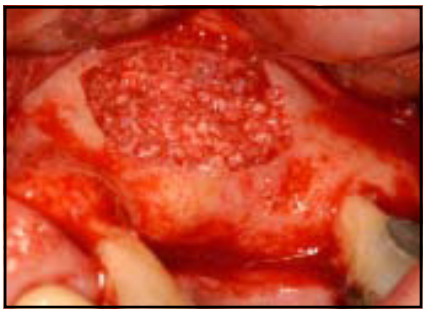


Fig 2c (left) *Sinus filled with graft material.*

Fig 2d (right) *Bony sinus window covered with a resorbable membrane.*

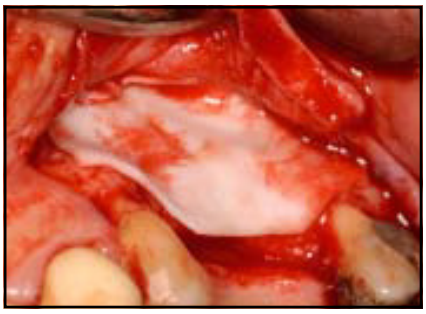
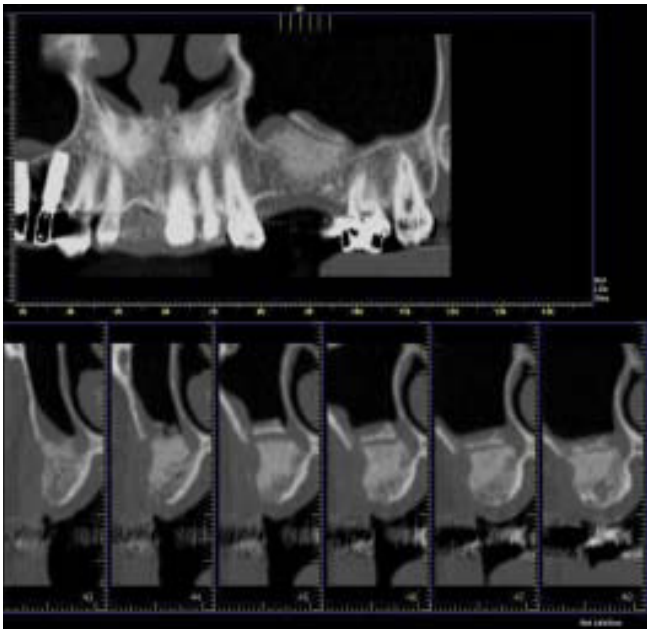


Fig 3 *After 2 months, an adequate amount of radiopaque material was present, and no signs of maxillary sinus infection could be observed.*



a period of 2 months to evaluate the outcome of the surgical procedure (Fig 3). The parameters recorded were bony window length and height, bone thickness, and osteotomy area—the latter calculated by multiplying bony window length by height.[13]

Moreover, the time necessary for the osteotomy and sinus elevation as well as the number of surgical complications were calculated.

The mean values and standard deviations were determined for each parameter in all cases.

Results

A total of 40 consecutive sinus elevation procedures (30 unilateral, 5 bilateral) were performed with a Piezosurgery system in 35 patients who required sinus floor elevation for implant-prosthetic rehabilitation.

Postoperative healing was uneventful and free of complications in all patients, except for inflammation and swelling of the surgical site. Only one patient showed dehiscence of the covering soft tissues, but no clinical inflammatory signs or infections were observed. This patient was instructed to apply a 1% chlorhexidine gel twice a day. After 2 months, at radiographic analysis, an adequate amount of radiopaque material with greater density than the bone was present, and no signs of maxillary sinus infection were observed (Fig 3).

Seven perforations of the sinus membrane (17.5%) were observed, all of which were less than 3 mm. Six perforations occurred during the antrostomy, and one perforation during initial membrane elevation was related to the presence of a septum and an extremely thin membrane. The perforations were repaired using a collagen membrane in direct contact with the sinus membrane.

The maxillary sinuses showed a mean bone thickness at the window of 1.4 ± 0.4 mm. The mean length of the osteotomy was 13.8 ± 2.9 mm, and its height was 6.9 ± 1.4 mm. The mean osteotomy area was 96.8 ± 32.2 mm^2. The mean time necessary for the osteotomy procedures and sinus membrane elevation with the piezoelectric device was 10.3 ± 2.1 minutes. The values for operating time were compared with the osteotomy area, and it was determined that the larger the bony window area, the greater the time required to perform the augmentation procedures.

Discussion

The Piezosurgery system uses ultrasonic vibration to work only on mineralized hard tissue, not on soft tissue, and therefore does not cause any nerve damage. During osteotomy in sinus bone grafting, the use of ultrasonic techniques has advantages over other conventional instruments, including a highly precise cut geometry without the need for excessive force and efficient bone ablation, minimizing the risk of accidental damage to the sinus membrane.[11,15]

In this study, sinus membrane perforation occurred in 7 of 40 cases, representing 17.5% of procedures. These results are similar to those reported by several authors[4,9,12,16] who also found very low perforation percentages using piezoelectric devices. Vercellotti et al[9] noted perforation in only 5% of 21 maxillary sinus elevations. Moreover, a few studies[4,13] analyzed the membrane perforation rate by comparing piezoelectric devices and conventional instruments. In a series of 100 consecutive cases, Wallace et al[4] found that the membrane perforation rate had been reduced from the mean reported rate of 30% with rotary instrumentation to 7% using the piezoelectric technique. Additionally, all perforations with the piezoelectric technique occurred during the hand instrumentation phase. These results were not in agreement with the data reported in a recent comparative study by Barone et al[13] in which membrane perforation occurred in 30% of sites in the test group (piezoelectric device) and 23% of sites in the control group (conventional instruments), with no statistically significant differences between the two groups.

Despite the ability of the piezoelectric technique to selectively cut the different tissues, the sinus membrane may be perforated or injured by excessive mechanical force from the instrument tip.[16] In this study, six perforations occurred during osteotomy using a BioS 520 ES diamond insert and one perforation occurred during initial membrane elevation, but the latter was associated with the presence of a septum and an extremely thin membrane. The initial release of the membrane from the bony window is the most difficult part of sinus elevation surgery.[9] In this study, only one perforation occurred at this moment. This is probably a result of the use of a noncutting BioS 540 ES surgery tip. Such an insert was specifically designed to safely work on the in-

ternal part of the sinus bone wall and to easily achieve a small internal elevation through piezoelectric cavitation.

The dimensions of the sinus membrane perforations in this study were less than 3 mm; therefore, perforations were patched with a resorbable membrane in direct contact with the sinus membrane. In most instances, the repair of this perforation is necessary to contain particulate grafting material and to finalize the procedure.[7] Several studies showed successful sealing of sinus membrane perforations using fibrin glue and resorbable collagen membrane.[17–19] However, the repair increased the cost of the procedure and the time necessary to complete the surgery; therefore, this resulted in a higher sinus graft infection rate and increased patient morbidity.[4]

The most clear disadvantage in clinical routine use of Piezosurgery is the longer time required for the osteotomy.[13,20] Barone et al[13] showed that the time necessary for the osteotomy and sinus membrane elevation with conventional instruments was 10.2 ± 2.4 minutes, while it was 11.5 ± 3.8 minutes with the piezoelectric device, with no statistically significant differences. These findings were in agreement with the data recorded in this study, where the mean operating time with the piezoelectric device was 10.3 ± 2.1 minutes. In this investigation, the time necessary for the osteotomy procedures and the sinus membrane elevation was also compared with the osteotomy area. It has been found that the larger the area of the bony window, the greater the time required for the augmentation procedure. According to other studies,[13,21] the bone structure and thickness affected the time required for surgery. Moreover, this study revealed that the location and size of the sinus septa encountered in sinus elevation procedures also increased the surgical period. Radiographic examinations (OPT and CT) are essential to predict sinus volume and degree of septation and to evaluate the thickness of the sinus lateral wall to avoid an increase in operative time. Interestingly, in all cases evaluated in this analysis, the presence of perforations lengthened the surgical time. Further clinical studies are needed to confirm these results and to better understand the relationship between the possible factors affecting operating time and the rate of complications.

Based on the results of this study, sinus augmentation can be successfully performed by means of a piezoelectric device, which was demonstrated to be an attractive alternative to simplify sinus elevation procedures and offer promising results in terms of complications such as sinus membrane perforations.

Acknowledgment

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