The edentulous posterior maxilla generally provides insufficient bone height because of atrophy of the alveolar ridge and pneumatization of the maxillary sinus. Maxillary sinus augmentation is performed to attain sufficient bone height for placement of dental implants in the posterior maxilla. It has been shown to be a predictable and effective treatment modality to overcome the problem of the pneumatized sinus.1–3

Sinus augmentation is considered an invasive procedure, and morbidity and complications may be encountered.4,5 Perforation of the maxillary sinus membrane is the most common surgical complication.4–6 Membrane perforation occurs in 10% to 44% of sinus floor elevation procedures when conventional rotary instruments are used.4–10 Although the results are controversial, studies have also shown that membrane perforations are associated with postoperative complications.5–9

Surgical instrumentation, as well as the limitations of anatomical structures, can influence the probability of membrane perforation. Studies demonstrate that the use of a piezoelectric round insert makes it possible to osteotomize the bony window without injury to the sinus membrane.11–15 This device operates at a modulated ultrasonic frequency, producing microvibrations, and is designed to work in hard tissues without damaging the adjacent soft tissues.11–18 Thus, it can create a precise and tactile-controlled osteotomy. Piezoelectric round inserts have been used to make the bony window for maxillary sinus floor augmentation. However, there are currently very few data from clinical studies examining the characteristics of sinus

Comparison of Two Piezoelectric Cutting Inserts for Lateral Bony Window Osteotomy: A Retrospective Study of 127 Consecutive Sites

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Purpose: The aim of the present retrospective clinical study was to compare the efficacy of two piezoelectric cutting inserts for the incidence, size, and types of sinus membrane perforations, and to evaluate their various advantages for lateral window osteotomy. Materials and Methods: The study consisted of 127 maxillary sinus augmentation procedures performed at two centers. A bony window was made on the lateral wall of the maxillary sinus with either the piezoelectric saw or the round diamond insert and repositioned over the bone graft as a homologous bony barrier. The rate of membrane perforation during sinus augmentation between the two groups was compared and analyzed statistically by the chi-square test and the two-sample t-test. Results: Seven perforations were seen in the 127 maxillary sinus procedures in this study (5.51%). Six perforations in 84 cases (7.14%) occurred with the piezoelectric saw and one perforation in 43 sites (2.32%) occurred while using the round insert. No statistically significant difference was found between the rates of membrane perforation between the two inserts. Conclusion: The lateral bony window was created effectively with either of the two kinds of piezoelectric inserts. The membrane perforation rate was not significantly affected by the type of piezoelectric insert. The piezoelectric saw insert was more advantageous than the round diamond due to its greater precision and easier repositioning of the lateral bony window as a barrier. INT J ORAL MAXILLOFAC IMPLANTS 2010;25:571–576

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membrane perforation caused by different kinds of piezoelectric inserts.

Hence, the purpose of the present retrospective clinical study was to evaluate the efficacy of two piezoelectric inserts—a saw and a round diamond—for their incidence, size, and types of sinus membrane perforations, and evaluate their advantages for maxillary sinus augmentation.

### MATERIAL AND METHODS

#### Patient Selection

The present study included 117 patients treated with 10 bilateral sinus augmentations and 117 unilateral sinus augmentations between 2004 and 2008; 67 were men and 50 were women, and they ranged in age from 28 to 76 years (mean age, 49.60 years; Table 1). They presented with partially or completely edentulous atrophic maxillae with pneumatised sinuses, which were consecutively treated with sinus floor elevation via the lateral window approach. Treatment was performed at two centers: the Department of Oral and Maxillofacial Surgery, Catholic University Hospital of Daegu, contributed 111 sinus augmentations in 101 patients, and a private practitioner contributed 16 sinus augmentations in 16 patients. Surgeons involved in the present study had training and experience with the maxillary sinus augmentation technique using a piezoelectric device and had about 10 years experience in implant dentistry. In accordance with the protocol followed at the Department of Oral and Maxillofacial Surgery, Catholic University Hospital, all surgeons precisely adhered to common standards for surgical procedures. Preoperative examinations with panoramic views and computed tomographic scans were performed. The piezoelectric round insert was used to prepare the bony window in 43 sites, and the piezoelectric saw was used in 84 sites.

The present study examined the following parameters: (1) the number of sinus membrane perforations, (2) the types of sinus membrane perforations, and (3) the size of the sinus membrane perforations. Patients who had already received sinus augmentations that had failed, and patients who exhibited pathologic findings or had a history of maxillary sinus diseases or operations were excluded from the study.

#### Surgical Procedure

Prophylactic oral antibiotics (Cefditoren pivoxil, Meiact Boryung Pharm, 300 mg three times daily) were used routinely, beginning 1 day prior to the procedure and continuing for 7 days. Surgery was performed under local anesthesia through maxillary block anesthesia by using 2% lidocaine that included 1:100,000 ephedrine. Flomoxef sodium (Flumarin Ildong Pharmaceutical, 500 mg intravenous) was administered 1 hour before surgery. The basic surgical procedure in all patients consisted of maxillary sinus floor elevation via a lateral approach. The lateral wall of the maxillary sinus was exposed after the elevation of a mucopeurosteal flap, according to surgical needs. Either a piezoelectric round insert (Surgynbone, Silfradent; or Piezosurgery, Mectron) or a saw insert with a thin blade (S-Saw, Bukboo Dental), connected to piezoelectric devices (Surgynbone, Silfradent; or Piezosurgery, Mectron), was used with copious saline irrigation to create the lateral window of the maxillary sinus (Fig 1).
The anterior vertical osteotomy was made 2 mm distal to the anterior vertical wall of the maxillary sinus, and the distal osteotomy was made approximately 20 mm away from the anterior vertical osteotomy. The height of the vertical osteotomy was approximately 10 mm. The bony window was detached carefully to expose the sinus membrane after completion of the osteotomy in the lateral wall of the maxillary sinus. After elevation of the sinus membrane superiorly and placement of the graft material, the bony window was repositioned over the graft material as a barrier. When the piezoelectric saw was used to make the bony window in the lateral wall of the sinus, the anterior and inferior osteotomy lines were created perpendicular to the inside of the maxillary sinus lateral wall, and then superior and posterior osteotomies perpendicular to the sinus wall were made. This osteotomy design facilitated the precise repositioning of the bony window as a barrier over the bone graft in the maxillary sinus.

The sinus membrane perforations were classified according to Fugazzotto and Vlassis.19 This simplified classification (classes I to III) is based on both position and extent. Class I and Class II perforations are easily repaired, whereas a Class III perforation is relatively rare.

### Statistical Analysis

For the descriptive analysis of baseline characteristics (demographic and clinical characteristics; Table 1), means with standard deviations for continuous data and frequencies with percentages for discrete data were recorded. The saw and the round insert groups were compared statistically using the chi-square test and the two-sample t test (Table 2). All statistical analysis was performed using SPSS/PC+ (version 14.0, SPSS), and a P value of .05 was adopted for all statistical analyses.

### RESULTS

Among the 127 sites, seven sinus membrane perforations were detected after completion of the osteotomy in the lateral wall of the maxillary sinus. Six perforations occurred in the 84 sites in which the piezoelectric saw insert was used during sinus grafting (7.14% perforation rate; Table 2). There was one membrane perforation in the 43 sites operated with the piezoelectric round diamond insert for window osteotomy (2.32% perforation rate; Table 2). No statistically significant difference in the perforation rate was found between the two inserts. Regardless of the kind of insert, all perforations were classified as Class II, and all the perforations were smaller than 3 mm (Table 3). All intraosseous arteries were well preserved at the time of lateral window creation by both types of piezoelectric inserts (Fig 2).

The osteotomy line, with minimal bone loss, created by the piezoelectric saw was more precise than the line created using the piezoelectric round diamond inserts, which exhibited as much bone loss along the osteotomy line as that made by a conventional cutting bur (Fig 3). It was possible to reposition the bony window immediately as a barrier after the sinus floor augmentation in 110 patients. Variable resorbable or nonresorbable barrier membranes were used in the other patients. The bony windows created with the piezoelectric saw were repositioned more precisely over the bone graft (as a barrier) than those made with the round diamond inserts (Fig 4). Even in sites that did not use any other bone graft in the maxillary sinus after elevation of the sinus membrane, the bony windows created by the piezoelectric saw were repositioned passively and precisely as barriers.

At the time of stage-two surgery, 6 months postoperatively, favorable bone formation from the bony surface at the previously operated site was apparent in both groups (Fig 5).
**Fig 2** Intraoral view of the exposed sinus membrane and intraosseous artery after the prepared lateral bony window was separated using the piezoelectric saw. Note the preservation of the discernible intraosseous artery.

**Fig 3** Comparison of the appearance of the lateral bony windows created by (left) the round diamond bur and (right) the piezoelectric saw. Note the minimal bone loss and precise osteotomy lines created with the piezoelectric saw.

**Fig 4** Comparison of the appearance after repositioning the lateral bony window as a barrier immediately after bone grafting. (Left) Site prepared with the round diamond insert; (right) site prepared with the piezoelectric saw. The bony window created by the piezoelectric saw was repositioned more precisely than that created by the round diamond inserts.

**Fig 5** Clinical views 6 months after sinus augmentation using (left) the round diamond insert and (right) the piezoelectric saw. A well-healed lateral window was observed at both sites of the repositioned lateral bony window.
DISCUSSION

Maxillary sinus membrane perforation is the most common complication of sinus augmentation\(^5\) and has been shown to cause postoperative complications and endanger the survival of endosseous implants.\(^9,20\) Very careful management when creating bony windows and dissecting sinus membranes from the floor of the maxillary sinus is required to reduce the incidence of membrane perforation. Although one study reported no statistically significant difference in the rate of sinus membrane perforation between groups operated with piezosurgery and conventional diamond burs for bony window creation,\(^21\) other studies have reported a lower rate of membrane perforation with piezoelectric round inserts during sinus augmentation.\(^11–14\)

In the present study, the effects of two piezoelectric inserts in the creation of lateral windows, in terms of perforation rates of the maxillary sinus membrane and characteristics of the osteotomy, were evaluated. The present study observed a total rate of membrane perforation using both kinds of piezoelectric insert at 5.51%. The rate of perforation created by the piezoelectric saw (7.14%) was relatively higher than that created by the round diamond insert (2.32%) in this study. However, with a \(P\) value of .05 indicating significance, statistical analysis showed no significant difference between the rates for membrane perforation for the two types of piezoelectric inserts \((P = .260)\). This finding suggests that the rate of perforation of the sinus membrane does not vary according to the characteristics of the inserts used. Round piezoelectric inserts are effective in creating bony windows in sites with thin lateral walls of the maxillary sinus, but the procedure is time-consuming in thick lateral windows because of the low cutting efficacy compared to that of the sharp cutting edge of the piezoelectric saw.\(^18\)

According to this study, the piezoelectric saw insert has some advantages over the round inserts, such as precision, minimal bone loss, and facilitation of precise replacement of the bony window. Furthermore, all perforations, which were smaller than 3 mm, were classified as Class II according to the simplified Fugazotto and Vlassis criteria.\(^19\) Class II perforations occur along the lateral or crestal aspects of the prepared sinus window and are further subdivided according to their position. The perforated sites were favorable for repair because of their small sizes (3 mm or less) and their crestal location, which allowed better access.

In the present study, the lateral bony window was repositioned after bone grafting in a total of 110 sites. The barrier membrane between graft materials and the overlying soft tissue is necessary to prevent growth of fibrous connective tissue in the augmented space.\(^22\) The repositioned bony window acts as a homologous barrier over the bone graft. As a barrier, the homologous bony window is free from viral cross-contamination of animal or human origin, and precise adaptation of the lateral bony window completely prevents soft tissue ingrowth. The lateral bony window made by the piezoelectric saw insert was repositioned precisely, whether or not bone grafts were used in the sinus for sinus augmentation, because of the tilted osteotomy into the sinus and minimal bone loss during osteotomy. The bony window also acts as an osteoinductive/osteconductive substrate in the maxillary sinus in the grafted/nongrafted sinus.\(^23\) The replaceable bony window could be made by a microreciprocal saw,\(^24\) but this device is irritating to the patients because of the loud noise during surgery. In addition, access to the oral cavity may be limited. However, the piezoelectric device, with its pen grip, can fit easily into the deep oral cavity.

The blood supply to the lateral wall of the maxillary sinus derives from the branches of the maxillary artery. The branches anastomose, forming an extraosseous loop near the periosteum and an intraosseous loop near the lateral wall of the sinus.\(^25\) A previous study reported that the intraosseous artery has the potential to cause bleeding complications in approximately 20% of normally positioned lateral window osteotomies.\(^26\) In general, if a large intraosseous artery is observed in a preoperative computed tomogram, a modified surgical design, such as an elevated osteotomy or crestal approach, is needed. However, a small artery in the sinus wall cannot be detected by a preoperative computed tomogram. The use of the piezoelectric device makes it possible to create a lateral bony window without injury to the intraosseous artery because of its microvibrations and selective cutting, according to the results of the present study.

CONCLUSION

Based on the present retrospective clinical study, there was no significant difference in the rate of sinus membrane perforation between the piezoelectric round insert and the saw insert when creating an osteotomy for sinus augmentation. This study suggests that the piezoelectric saw insert is more effective than that of the round insert in creating window osteotomy, regardless of the thickness of the maxillary sinus wall. It also allows for the precise repositioning of bony windows as homologous bony barriers.
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