Mini-Lateral Windows for Minimally Invasive Maxillary Sinus Augmentation: Case Series of a New Technique

Leon Pariente, DDS,* Karim Dada, DDS,* and Marwan Daas, DDS, MS, PhD†

The sinus augmentation procedure using the lateral window technique is a well-documented method for increasing bone volume in the posterior atrophic maxilla.1–4 The goal of this procedure was to provide adequate bone volume for implant placement.

The success of a sinus augmentation procedure can be measured by the survival rate of implants placed in that bone under functional load and by the quantity and quality of vital bone formed in the pneumatized sinus after graft maturation.4

Implant survival rates in grafted sinuses have been reported to be influenced by the bone graft material, the presence or absence of a membrane over the window, and the implant surface characteristics. The implant placement timing (simultaneous vs delayed) and the residual crestal bone height are parameters that have also been examined.1,2,4 Evidence-based literature reviews reported an average implant survival rate of 91.8% with a range of 61.7% to 100% for the lateral window sinus augmentation.1,2 Simultaneous and delayed implant placement showed similar survival rates of 92.17% and 92.93%, respectively. In the same study,

Objectives: The purpose of this article was to introduce a new technique for minimally invasive lateral window sinus augmentation, developed to maximize the amount of residual lateral wall after the procedure.

Materials and Methods: Fourteen consecutive patients requiring maxillary sinus augmentation by a lateral approach and delayed implant placement were treated using standardized mini-lateral windows. Before the procedure, the remaining height of alveolar bone was determined; 6 months after the procedure, the augmented height and augmented width were measured. The extent of the antrostomy was calculated using a gauge and compared with a conventional window size.

Results: A total of 15 maxillary sinus augmentation procedures were performed in 14 patients using this technique. Every patient received the planned implant treatment 6 months after the sinus augmentation procedure. The average residual bone height was 2.1 ± 1.1 mm, the average augmented height was 13.4 ± 3.4 mm, and the average augmented width was 19.0 ± 5.5 mm. The average total area of the antrostomy was calculated to be 59.2 ± 12.8 mm².

Conclusions: The results of this case series study suggest that this technique allows for the achievement of a similar result as with conventional size windows, but with a significantly smaller total window area.

Key Words: lateral window dimension, membrane elevation, second window

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used. The literature shows a wide range of results using different grafting materials. Use of barrier membranes has been shown to increase vital bone formation. Tarnow et al20 performed 12 bilateral sinus grafts and reported 11.9% vital bone for the side without the membrane and 25.5% for the side with the membrane. Avera reported similar clinical and histological results using an absorbable membrane made of polyactic acid compared with a nonabsorbable membrane of expanded polytetrafluoroethylene in lateral wall sinus augmentation procedures.13

Wallace et al7 reported that time of healing was a positive factor in the amount of vital bone formation. In that study, the xenograft material was completely resorbed and replaced with vital bone during 12 to 20 months healing period. Valentini confirmed that anorganic bovine bone allograft (ABBA) has good osteoconductive properties. Six months after sinus augmentation with ABBA, 57 implants were placed into the augmented sinuses. New bone formation was confirmed and calculated in biopsies of 3 patients, which showed an average of 21.08% new bone after 6 months and 27.55% after 12 months. Average residual ABBA was reported as 39.17% after 6 months and 27.01% after 12 months. After a mean loading period of 4.0 ± 0.5 years, 56 implants remained in place.9 However, other histologic studies reported different results for time of xenograft resorption.6,10,11,13–21

Recently, a new factor has been introduced by Avila-Ortiz et al22: the dimension of the lateral window. They were the first to report a negative correlation between the average window dimension and the percentage of vital bone with a high statistical significance when grafting with an allograft.22 They also observed a positive correlation between the size of the window and the percentage of remaining particles of allograft after 6 months of healing. Although allograft particles were solely used in this study, these results suggest that the preparation of large lateral windows for maxillary sinus augmentation negatively influences the rate of vital bone formation. The technique to create the lateral window and access to the Schneiderian membrane seems to be a crucial factor.

After Tatum,23 Boyne and James24 introduced the lateral window for sinus augmentation procedure, in which various instruments have been used for the creation of the lateral window and the elevation of the Schneiderian membrane. The window was originally prepared with the use of the slow-speed surgical handpiece.23,24 Later, other clinicians began to use the high-speed handpiece for the window preparation. Although these techniques were acceptable, they were not without risks. The intraoperative complications of membrane perforation and bleeding were addressed by a new technique, designed to minimize the complications of sinus augmentation surgery. The Piezo-electric surgery concept (Piezosurgery) was introduced by Vercellotti25 as a method to decrease the incidence of perforation of the Schneiderian membrane, which had been one of the most common complications of the lateral window sinus augmentation procedure.26 A perceived disadvantage of the use of Piezosurgery is the additional time that may be necessary for the preparation of the window in the lateral wall.

The dimensions of the lateral window are commonly determined by the amount of augmentation required, which is directly related to the number of missing posterior teeth that need to be replaced. Whereas antrostomy size of 20 mm mesiodistally and 15 mm apico-coronally (surface area of 300 mm²) are sufficient to guarantee easy surgical access. For experienced operators, smaller windows are described in the literature; 14 mm height and 6 mm width (surface area of 84 mm²) seems to be an admitted average size for conventional windows.25 Despite being one of the key points of the procedure, there is a lack of literature on the surface area of the window. Avila-Ortiz et al22 reported an average window surface area of 69.71 mm², and Barone et al28 described window surface area of 137 mm².

The purpose of this article was to introduce a new technique for minimally invasive lateral window sinus augmentation and to report 15 cases of sinus augmentation made using this technique preliminary to a prospective clinical study.

MATERIALS AND METHODS

This case series consisted of 15 consecutive maxillary sinus augmentations using the lateral window approach and delayed implant placement. All patients received maxillary sinus augmentation surgery to allow the placement of endosseous implants between September 2012 and March 2013 at 62LTM private practice (Paris, France).

Preoperative intraoral examination was performed along with cone beam computed tomography (CBCT) in each case. Patients were provided with treatment plans, including all relevant options. Written consents for the procedures were obtained. Computed topographies were performed 6 months after the sinus elevation to plan for implant placement.

Surgical Procedure

Preoperative Medications. Antibiotic treatment (Amoxicillin 500 mg, 4 per day for 7 days) was started 24 hours before the surgery. Patients allergic to Penicillins were requested to take Clindamycin 300 mg per day for 7 days. On the day of surgery, the patients received a dose of Attarax (1 mg/kg) 1 hour before the surgery as sedative premedication.

Surgery. Local anesthesia was performed with local infiltration and greater palatine nerve block anesthesia using 2% of lidocaine with 1/100,000 epinephrine (3M ESPE).

A midcrest incision was made, and the distal limit for this incision was established 5 mm distally to the position of the planned most distal implant. The incision was extended mesially intrasulcularly to the first bicuspid when it was present. Two vertical incisions were prepared from the mesial and distal end of the horizontal incision, extending up to 5 mm apically beyond the mucogingival junction. A full-thickness flap was then elevated allowing a complete vision of the lateral wall of the sinus (Fig. 1). A sinus kit with microsurgical instruments, the EBI Sinus Kit (EBI North America, New York, New York) was used to design and perform the lateral window sinus augmentation.

The Schneiderian membrane seems to be a crucial factor.

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York, NY, USA) was used to determine the size of the windows and proceed through the membrane elevation. The SCC4 instrument, which presents a probe type side and an ovate shape side, was used on its probe type side to locate the most apical portion of the window corresponding to the apical part of the implant planned in the most mesial position. The ovate shape of the SCC4 instrument was used to draw the windows in the lateral wall of the sinus. It has an elliptic shape of 5 mm height (a) and 8 mm length (b): its total area was calculated to be 31.4 mm². Because it appeared that drawing the window with the gauge did not prevent from clinical variation after the window was completed, the maximal height (a) and maximal width (b) of the ellipsoidal window were measured during the surgery using a periodontal probe on the mesial window (mesial Window Clinical Dimensions) and on the distal

Fig. 1. Buccal view of the lateral wall of the maxillary sinus after flap elevation.

Fig. 2. Buccal view of the beginning of the elevation of the Schneiderian membrane. The instrument used is a flat-ended noncutting tip (SL3; Satelec) on the piezotome.

Fig. 3. The Schneiderian membrane is elevated anteriorly using the SCC1 instrument (EBI) through the first window.

Fig. 4. The Schneiderian membrane is elevated posteriorly using the SCC2 instrument (EBI) through the first window.

Fig. 5. The medial wall of the sinus is reached using the SCC3 instrument (EBI).

Fig. 6. The second window, half the size of the first one is created distally to the first one with the round diamond coated sinus lift tip (SL2; Satelec).
window when present (distal Window Clinical Dimensions). In all cases, the size of the first window was made using this instrument as a gauge. The window was prepared using a round diamond coated sinus lift tip on the Piezotome (SL2; Satelec-Acteon, Bordeaux, France). The bone was delicately removed on the entire area of the planned window until the membrane was visible and could be elevated using a flat-ended noncutting tip on the Piezotome (SL3; Satelec) (Fig. 2), the SCC1 (Fig. 3) to reach the anterior limit, the SCC2 instruments (Fig. 4) to reach the posterior limit, and the SCC3 to reach the medial wall (Fig. 5). In cases where a single implant was planned, this was the only window to be prepared. In cases where multiple implants were planned, the second window was prepared the same way distally at the apical portion of the planned most distal implant (Fig. 6). The size of this window was first prepared half the size of the gauge and was extended to the full size of the gauge when necessary, that is, when a tear in the membrane was detected, to manage excessive bleeding, to help to elevate the Schneiderian membrane or allow better visibility or access.

In each case, even in the absence of visible membrane tear, a resorbable collagen membrane (Bio-Gide, Geistlich, Paris, France) was placed over the membrane before placing the bone graft into the sinus. All augmentations were accomplished with xenograft (Bio-Oss; Geistlich) (Figs. 7 and 8). All lateral windows were covered with a resorbable collagen membrane (Bio-Gide; Geistlich) (Fig. 9). The full-thickness flaps were repositioned and sutured into place with 5-0 Vicryl (Ethicon) horizontal mattress sutures and interrupted sutures. After each surgery, any membrane perforation or abnormal perioperative bleeding were reported in the patient’s chart.

Postoperative Care. All patients received amoxicillin 1 g 2 times per day for 7 days subsequent to the surgery. Ibuprofen 400 mg 4 times per day for 7 days was prescribed for pain management. Oral hygiene instructions were given along with prescription for chlorhexidine mouthwash twice daily for 2 weeks. Patients were seen for control visit 1, 2, 6, and 12 weeks after surgery. A cone beam CT scan was performed after 6 months of healing to plan for implant placement.

CBCT Analysis. The CBCT were collected, anonymized and reviewed by 2 calibrated blinded examiners, radiologists from the University of Paris V. They were asked to measure the remaining alveolar bone (RAB) height on the preoperative CBCT, the maximal augmented height (MAH), the maximal augmented width (MAW) on the 6 months postoperative CBCT. Maximal height and width were averaged and expressed as their mean value between the average of the 2 sets of measurements (Fig. 10).

RESULTS

Fourteen patients, 8 women and 6 men, with a mean age of 55.3 ± 10.8 years (range, 35–72 years) participated in the study. As part of the usual protocol in the office, after the CBCT analysis, 3 patients were referred for otolaryngology medical consultation because of maxillary sinus abnormalities (eg, thickening of the sinus membrane or mucous retention cysts). All were cleared to proceed with the surgical intervention. One patient underwent a bilateral maxillary sinus augmentation, a total of 15 sinus elevation procedures were therefore performed. In each procedure, the total volume of xenograft used ranged from 2 to 5 cm³. The clinical and radiographic measurements are reported in Table 1. The mean RAB height was 2.1 ± 1.1 mm. The MAH obtained was 13.4 ± 3.4 mm. The MAW (in mesiodistal direction) obtained was 19.0 ± 5.5 mm. The Clinical Window Area (CWA) was calculated using this formula: CWA = 1/4 × π × a × b. The mean value for CWA was 59.2 ± 12.8 mm². It can be compared with the Gauge Calculated Window Area, which would be the area obtained from a perfect drawing of the gauge on the lateral wall: 52.3 ± 11.4 mm².

The surgical parameters are reported in Table 2. The incidence of membrane perforation was 13.3%. In the 2 cases that perforations were visible, there were no larger than 3 mm (as measured with a periodontal probe) and were sealed intraoperatively.
using a resorbable collagen membrane (Bioguide; Geistlich). There was no report of preoperative or postoperative bleeding.

The patients were regularly followed for the 6-month healing period. No patient suffered from sinus infection or abnormal postoperative bleeding. In all cases, the bone augmentation achieved after sinus augmentation allowed implant placement as planned in the initial treatment plan. The duration of the surgery did not exceed 40 minutes in each case. This is in the same timeframe as with conventional windows in our daily practice.

**DISCUSSION**

The use of single or multiple mini-invasive lateral sinus windows has, to the best of our knowledge, never been discussed in the literature. However, in cases where septa are present, the use of multiple lateral windows has been described. The purpose of this case series was to evaluate the potential benefits and limitations of using these mini-invasive lateral sinus windows in delayed approach cases grafted with xenografts. Since in these situations where the residual alveolar bone height is limited, the quality of the future interface bone-implant relies mainly on the healing and maturation of the graft. It requires the use of the full potential of osteogenic capacity of the maxillary sinus walls.

The first issue of this type of study was to standardize the size of the lateral windows for each case for proper evaluation. To attempt to solve this matter, the ovate side of the SCC4 instrument of the sinus kit (EBI) was used as a gauge. This instrument was chosen from among the other instruments of this mini-invasive sinus kit because each of the other instruments could be passed and used through a window of this size and shape. It appeared that the obtained windows were not the exact size of the gauge, and that there were small irregularities (≤1 mm) in height or length due to the free-hand surgical technique used. Therefore, measurement of the maximal height (a) and width (b) of the ellipsoidal shaped windows were made using a periodontal probe. The standardization of the windows was already described as an issue by Avila.8 The

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**Table 1. Cone Beam CT Measurement and Windows Area**

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<tr>
<th>Case No.</th>
<th>RAB (mm)</th>
<th>MAH (mm)</th>
<th>MAW (mm)</th>
<th>mWCD (a/b) (mm)</th>
<th>dWCD (a/b) (mm)</th>
<th>CWA (mm²)</th>
<th>GCWA (mm²)</th>
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**Table 2. Report of the Surgical Parameters**

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<th>Case No.</th>
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developments of bone reamers to create the lateral windows seem promising and should be evaluated as a mean of achieving perfect standardization in additional studies.

The clinical indication for sinus elevation varies from 1 to 4 implants. Those variations in indication have an influence on the procedure. The amount of bone augmentation is different, and the need for distal extension of the augmentation varies also significantly. As a result, it appeared that in cases where a single implant placement was planned only 1 window of the size of the gauge (31.4 mm²) was necessary. Attempts were made to achieve the procedure with only 1 half-size window. However, in the 2 cases reported in this case series study, it was rendered necessary to enlarge the windows to a full gauge size to achieve satisfactory results.

When multiple implants were planned, the second window was used. The size of the second window could be, first, limited to only half the size of the gauge. The second window could then be extended to a full-size window, to reach the limits of the needed augmentation, if there were any difficulties in the membrane elevation or in cases of surgical complications such as tear of the membrane or bleeding.

The amount of lateral bone that can be preserved compared with conventional size windows may be clinically relevant in some situations where high osteogenic capacities are necessary. The sinus augmentation relies on the same principles as other bone regeneration procedures: the osteogenic potential of the walls surrounding the graft is crucial. The immediate benefit of maintaining this band of bone intact is that it helps to contain the biomaterial. It has also been reported that the lateral wall of the sinus has a high osteogenic capacity. Preserving a large area of lateral bone could therefore enhance the healing in improving the consolidation and maturation of the graft as well as the vital bone formation. In cases of delayed implant placement protocol, the mechanical stability and the osseointegration of the implant rely solely on the properties of the regenerated tissue.

Preserving as much as possible the lateral wall of the sinus could have a positive influence in cases where there is lack of osteogenic potential: when using xenograft particles only for sinus grafting and when the residual alveolar bone height is limited.

In this case series study, the mean ratio between the total window length and the total augmented width was calculated to be 72.8 ± 13.1%. This ratio averages 100% in a conventional approach. The lower values were found in cases where the maximal augmented width were the highest, when the osteogenic potential of the lateral wall of the sinus is the most necessitated.

The incidence of membrane perforation using this technique was shown to be in the same range as the perforation rates of conventional techniques (13.3% vs 23%). All perforations occurred during membrane elevation. It was of prime importance to demonstrate that preparing the second window does not increase the perforation rate. Likewise, it was not observed that the second window, or smaller window, affect the preoperative or postoperative bleeding as well as the capacity to obtain the desired bone augmentation for proper implant placement. Under no circumstances in any of the cases, it was necessary to increase the size of the windows to a conventional window size. When a repair of the Schneiderian membrane was rendered necessary, a collagen membrane (Bio-Gide; Geistlich) could easily be folded and placed to patch up the Schneiderian membrane by using microsurgical forces through both windows access.

Furthermore, the small sizes of the windows and the flexibility in the planning of their positions allowed avoiding the maxillary artery when it was visible on the CBCT scan. It is important to note that this technique did not require additional time for the surgery as compared with the conventional technique and, therefore, can be used routinely in a daily practice.

**Conclusions**

The results of this case series suggest that this technique is predictable to achieve proper bone augmentation in maxillary sinus before implant placement. It allows the clinician to achieve a similar result with a window area that is smaller than conventional techniques. It would be of prime interest to investigate, in a prospective human study, the influence of this technique on maturation of the bone, on consolidation of the graft and on the vital bone formation after maxillary sinus augmentation.

**Disclosure**

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the article.

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