Preliminary Results of a Minimally Invasive Microsurgical Approach to Sinus Floor Elevation and Bone Reconstruction Using a Palatal Septum Window

Jose A. Moreno Rodríguez, DDS, MSc1
Miguel Pecci-Lloret, PhD2
Eduardo Ortiz Ruiz, MD3
Antonio J. Ortiz Ruiz, DDS, MSc, PhD2

The aim of this case report was to present the preliminary results of a novel microsurgical approach to sinus floor elevation and bone augmentation. This technique was used to treat four patients in whom an implant could not be placed in the maxillary first molar position because of insufficient bone height. The maxillary first molar was extracted, and a sinus access window was created in the palatal area of the bony interradicular septum. The sinus membrane with the palatal septum fragment was elevated, and the sinus space between and above the roots was filled with xenograft. Alveolar preservation was done with xenograft and a nonresorbable membrane. Bone augmentation was evaluated 6 months after preservation by computed tomography and histology; clinical, radiologic, and histologic bone reconstruction were seen, allowing placement of implants. The novel approach utilized in this study demonstrated positive preliminary results in bone reconstruction with reduced morbidity. Int J Periodontics Restorative Dent 2021;41:e255–e263. doi: 10.11607/prd.4810

Sinus floor pneumatization may be present in the interradicular space.1,2 Studies suggest the extent of maxillary posterior molar roots inside the sinus can range from 12% to 28%,3 or from 30% to 36%,4,5 and is potentially related to ethnicity. Different arrangements of the maxillary molar roots, a thin cortical sinus floor enveloping the inner aspect of the roots, and insufficient bone height indicate that implant placement to replace the lost function is not possible without bone reconstruction.

Various surgical approaches have been proposed for bone augmentation in the posterior maxilla. When the floor of the maxillary sinus is close to the alveolar ridge and the available bone height is minimal (<5 mm), lateral sinus floor elevation is the recommended procedure.6 This involves exposing the lateral bony wall of the sinus by raising a very wide flap with frequent deep releasing incisions. Once the flap is raised, an access window is created, and the sinus membrane raised to a wide extent, well above the alveolar process, to access the area for reconstruction and expose the nearby bony walls, resulting in extensive invasion of the maxillary sinus.7,8 The result is bone reconstruction above the alveolar process and beyond the exact area where the implants will be placed, which may lead to

1Private Practice, Murcia, Spain.
2Department of Stomatology, Faculty of Medicine, University of Murcia, Murcia, Spain.
3Pathology Department, Virgen de la Arrixaca Hospital, Murcia, Spain.

Correspondence to: Dr Jose A. Moreno Rodriguez, C/Ctra de Granada no. 46, Caravaca de la Cruz, 30400, Murcia, Spain. Email: joseantonio171087@gmail.com

Submitted January 9, 2020; accepted February 28, 2020.
©2021 by Quintessence Publishing Co Inc.
acute inflammation and immediate postoperative pain.

This study aimed to introduce a novel minimally invasive approach to sinus floor elevation and bone augmentation, using a palatal septum window after the extraction of an impossible-to-preserve maxillary molar in cases with minimal bone height and maxillary sinus pneumatization.

Materials and Methods

Patients

A preliminary study was conducted using a palatal septum window. The inclusion criteria were as follows: (1) low plaque level (full mouth plaque score < 20%); (2) no acute disease related to the molar to be extracted; (3) no sinus pathology prior to intervention; (4) no disease or systemic conditions that contraindicate intervention; (5) maxillary first molar that could not be preserved and with an interradicular bone remnant height < 5 mm; and (6) invagination of the sinus cavity in the interradicular area.

Treatment options were discussed with patients, explaining the procedure to be carried out and obtaining informed consent prior to intervention. All clinical procedures were performed according to the Declaration of Helsinki and Good Clinical Practice Guidelines, as revised in 2013. The study protocol was approved by the Research Ethics Committee of the University of Murcia, Spain (protocol no. 233/2019).

Surgical Procedure

All interventions were performed by the same surgeon (J.A.M.R.) and under magnification (×6). The surgical area was anesthetized with articaine/epinephrine (1:100,000; Ultracain, Normon Laboratories). The surgical technique is shown in the schematic illustrations (Fig 1) and clinical views (Fig 2).

The maxillary molar was extracted after interradicular sectioning to avoid damage to the bony walls of the alveolus and intra-alveolar septum. Granulation tissue was curedt if present.

Osteoplasty of the intra-alveolar septum was performed, if necessary, to improve visibility and manipulation. A microwindow was prepared on the palatal wall of the intra-alveolar...
septum to give access to the maxillary sinus, covering at least two coronal thirds of the palatal wall of the septum without damaging the most coronal edge or fornix of the septum.

The membrane was raised together with the bone fragment, when it could be preserved, so that the palatal septum slid over the sinus aspect of the buccal septum.

The sinus membrane was elevated above the root processes through the access window, creating the space required for bone reconstruction.
The space created below the membrane (interradicular space, slightly above the root processes) was filled with a bone xenograft (Bio-Oss, Geistlich). Subsequently, a periapical radiograph was taken to control the size of the filled area in the sinus aspect (showing a typical half-moon image).

To perform alveolar preservation, all alveolar margins were detached and bone xenograft (Bio-Oss) was placed, filling the alveolus; this was covered with non-resorbable polytetrafluoroethylene non–titanium-reinforced membrane (Cytoplast TXT-200, Osteogenics Biomedical).9,10 The membrane was adapted under the margins of the tissue surrounding the socket and was sutured using internal mattress sutures in the buccal and palatal aspects. The buccal and palatal edges of the soft tissue surrounding the alveolus were cross-sutured to compress the area. Sutures were removed at 7 days, and the membrane was removed at 3 to 4 weeks without the need for anesthesia.

The implant was placed 6 months after the first surgery. Prior to completion of the implant bed, a biopsy sample was taken using a trephine bur with a 3.5-mm internal diameter (Figs 2 and 4a). The biopsy bed was made in the center of, and perpendicular to, the crest, and always contained the area where the interradicular septum and the area generated was initially located, both above and below the fornix of the interradicular septum.

### Postoperative Care

Postoperative pain and inflammation were controlled using self-administered ibuprofen (600 mg). The total dose was recorded. Amoxicillin (500 mg) was administered three times a day for 1 week (amoxicillin, Normon Laboratories). Patients were instructed not to blow their nose, exhale strongly, or use nasal decongestants for at least 5 days; to rinse with chlorhexidine 0.2% three times a day for 4 weeks; and not to use electric toothbrushes in the operative area. Control visits were made at 1, 2, 3, and 4 weeks and 3 and 6 months. At routine appointments, the area was irrigated with chlorhexidine 0.2%.

### Parameters Recorded

The following radiologic parameters were measured by computed tomography (CT), taking the highest value as the reference: (1) crest width, measured in a buccopalatal direction in the mesiodistal middle third of the crest and perpendicularly to the buccal aspect of the crest (measured prior to and 6 months after surgery); (2) interradicular bone height, measured at the most coronal point of the interradicular bone peak (presurgical); (3) postsurgical bone height at 6 months, measured in an area centered occlusally on the crest, from the occlusal cortical end to the apical end of the bone filling, perpendicular to the crest; and (4) thickness of the cortical end of the palatal septum in the middle third (measured presurgically) (Fig 3). All radiologic evaluations were made by the same researcher (M.P.L.L.).

### Histologic Study

Bone tissue biopsy samples were fixed in 10% buffered formalin for 5 days, dehydrated in ascending grades of alcohol, and embedded in a photocuring one-component methacrylate-based resin (Technovit 7200 VLC, Heraeus Kulzer). Three sections, cut parallel to the long axis of the cylindrical core, were obtained from each specimen. The sections were ground and polished with Exakt cutting and grinding equipment (Exakt Apparatebau) to a final thickness of 40 to 50 μm. Samples were stained with hematoxylin and eosin, and areas of interest were observed on a Leica DMRB optical microscope with Leica DC500 digital camera (Leica Microsystems) to evaluate new bone formation at ×4, ×10, ×20, and ×40 magnifications. All histologic evaluations were performed by the same researcher (E.O.R.).

### Results

Four healthy patients (three women, one man; one smoker and three nonsmokers) with ages ranging from 21 to 40 years were consecutively treated.

Patients had a maxillary first molar that had undergone root canal treatment with sufficient destruction of the tooth crown that made restoration impossible. One case had an apical granuloma associated with the apices of the vestibular roots.
In all cases, the sinus cavity extended between the molar roots, leaving a mean interradicular bone height of 2.4 ± 0.58 mm (range: 1.8 to 3 mm). At baseline, the crest width was 12.4 ± 1.1 mm (range: 12 to 13.5 mm) and the cortical thickness of the palatal septum was 1.77 ± 0.95 mm (range: 0.5 to 2.8 mm). At 6 months, the postsurgical bone height was 10.27 ± 1.8 mm (range: 8.9 to 12.8 mm), and the crestal width was 11.2 ± 1.15 mm (range: 10 to 12.4 mm). The mean gain in bone height was 7.87 ± 1.3 mm, while there was a reduction in the crestal width of 1.35 ± 0.23 mm. In all cases, implant surgery was performed without the need for additional bone reconstruction (Table 1).

There were no biologic complications, marked inflammation, or bruising in the immediate postoperative period. The mean consumption of ibuprofen was 4,950 mg during the postoperative period.

**Histologic Assessment.**

The histologic evaluation (Fig 4) showed native bone with the bone marrow component, newly formed bone, and residual graft material. Residual particles of material graft were surrounded by osteoid islets.
Newly formed trabecular bone was seen, containing blood vessels and osteocytes among the residual particulates of graft material. The new mineralized bone was completely integrated and almost indistinguishable from the mature cortical bone typical of the preexisting maxilla, with a fine linear delimitation between the two structures. No inflammatory cells were observed in the newly formed tissue around the residual graft material.

Table 1 Radiologic Measurements Before Surgery and 6 Months Postsurgery

<table>
<thead>
<tr>
<th>Case</th>
<th>Crest width, mm</th>
<th>Bone height, mm</th>
<th>Mean palatal cortical thickness, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presurgical</td>
<td>6 mo postsurgery</td>
<td>Change</td>
</tr>
<tr>
<td>Case 1</td>
<td>13.5</td>
<td>12</td>
<td>−1.5</td>
</tr>
<tr>
<td>Case 2</td>
<td>13</td>
<td>12.4</td>
<td>−1.4</td>
</tr>
<tr>
<td>Case 3</td>
<td>11</td>
<td>10</td>
<td>−1</td>
</tr>
<tr>
<td>Case 4</td>
<td>12</td>
<td>10.5</td>
<td>−1.5</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>12.4 ± 1.1</td>
<td>11.2 ± 1.15</td>
<td>−1.35 ± 0.23</td>
</tr>
</tbody>
</table>

Fig 4 Histologic images of a biopsy sample taken at 6 months. The new bone forms trabeculae between the residual graft particulates. Osteocytes and the bone marrow component of the native bone and osteoid-type material are identified, with osteocytes in the newly formed bone. (a) The bone cylinder biopsy sample. Metallic residue was observed from the extraction of the trephine biopsy sample. There were three defined areas, from left to right (apical to coronal): sinus area (green line), septum area (yellow line), and marginal alveolar area (red line). The sample was stained with hematoxylin and eosin, then viewed at (b) ×4, (c) ×10, (d) ×20, and (e) ×40 magnifications. The asterisk indicates a blood vessel, and the triangle indicates osteocytes. MNB = mineralized new bone; RG = residual graft; BM = bone marrow.
Discussion

The potential of maxillary sinus membrane elevation for the generation of new bone has been widely reported due to the osteogenic potential of the bone cavity formed below the sinus membrane.\(^6\)

Evidence indicates that, when the remaining bone height is < 5 mm in the posterior maxilla, bone reconstruction using the lateral access to the maxillary sinus is indicated,\(^6\) although it has a high morbidity rate.\(^12,13\) The procedure usually achieves a bone increase well above the alveolar process, which leads to a decrease in sinus volume much larger than necessary for implant placement; this can cause short-, medium-, and long-term problems, such as obstruction of the ostium secondary to inflammation, blocking of the air flow, reduced activity of the mucus of the maxillary sinus, rhinosinusitis, and changes in resonance sounds.\(^14–18\)

Fugazzotto\(^19\) proposed sinus floor elevation at the time of maxillary molar extraction. Using a trephine bur and with the aid of osteotomes, the interradicular bone was condense and elevated, permitting the bone to be used for bone reconstruction. The technique required a minimum bone thickness of > 3 mm in the residual interradicular alveolar septum. In cases where bone availability was reduced, this technique was only partially successful, and bone reconstruction had to be delayed or an additional transcrestal intervention was necessary at the time of implant placement.

The main objective of bone augmentation is to achieve bone reconstruction in the least invasive way and with the least morbidity in order to predictably place implants to replace lost function. The palatal septum window technique described herein achieved sufficient bone height for implant placement with minimal side effects. In the present study, at 6 months postoperative, there was a mean bone height of 10.27 ± 1.8 mm (range: 8.9 to 12.8 mm) with a gain of 7.87 ± 1.3 mm, while a height of 8 to 10 mm is sufficient to place an implant with a modern surface.\(^6\) Furthermore, the histologic evaluation showed the formation of new trabecular bone, with blood vessels and osteocytes between residual particulates of graft material, integrated with the mature cortical bone of the maxilla.

This new technique is indicated when the maxillary sinus presents an invagination of the interradicular space of the existing molar, and therefore it is also indicated when a cortical bone separates the palatal root of the maxillary sinus. The greater the height and the lesser the width of the cortical bone, the easier it is to access. In addition, radicular divergence is an important factor to be considered, as the technical difficulty increases when there is less divergence, due to limitations in access and reduced visibility. However, less radicular divergence increases the osteogenic potential due to the greater proximity between the bone walls.

An advantage of the new technique is the reduction in morbidity compared to sinus elevation with lateral access. In fact, patients only needed low doses of ibuprofen for short periods of time to control pain and inflammation. Access to the sinus through the alveolus after tooth extraction significantly reduced surgical trauma to hard and soft tissues, as the osteotomy is limited and a wide flap with vertical and internal releasing incisions is avoided.

The main limitations of the technique are reduced buccal opening for the patient and an unfavorable anatomy (very convergent and deep roots or a palatal septum with a limited extension), which reduce access and visibility. Sinus membrane perforation may be the greatest complication in these cases, and bone augmentation may need to be postponed to favor the maxillary sinus, using a conventional technique, after healing of the alveolar bone.

The osteotomy is performed in the palatal septum wall for the following reasons: (1) this wall allows the widest access from the alveolus to the maxillary sinus; (2) the palatal root of the first molar is one of the most frequent root tips extending above/inside the maxillary sinus floor (with frequencies from 24% to 26%\(^4,20,21\); (3) the distance from the molar roots to the maxillary sinus floor is about 1 mm\(^20\); (4) 50% of the palatal roots are closer to the sinus than to the palate; and (5) there is apical communication with the sinus in 20% of cases, and in 40%, the distance is only 0.5 mm.\(^22\)

Bone reconstruction through the palatal septum window provides several technical advantages. The sinus area to be reconstructed is contained by various bony walls that are close to each other (external and internal bony walls of the intra-
alveolar septum, in addition to the bony walls of the alveolus perimeter), increasing the regenerative potential. Transseptal communication open to the sinus amplifies the alveolus within the sinus space, extending the high osteogenic potential of the alveolus to the sinus space to regenerate, where the regenerative potential may be reduced or slowed. The maintenance of much of the septum, together with the fornix, favors the stability of the xenograft together with the clot in the interradicular sinus space. In addition, the intra-alveolar septum, as well as the bone fragment of the palatal septum displaced as a roof in the sinus area to be regenerated, can act as a center of bone formation in the most cranial part of the area to be reconstructed.

The alveolar preservation that occurs after sinus regeneration compensates for the collapse of soft tissue and supports bone formation. The use of exposed, nonresorbable membranes avoids flap-raising, periosteal incisions, and the release of flat muscle to obtain primary closure. In addition, keratinized tissue was preserved or even increased, as the mucogingival line was not displaced.

After removing the membrane, a soft tissue that was covering and protecting the filling material inside the alveolus was observed; although the membrane presented bacterial plaque on the outer surface, no bacterial contamination of the underlying tissue was observed. This finding was also seen by Laurito et al.

Conclusions

The present study reports a new transalveolar sinus floor elevation technique at the time of maxillary molar extraction using a palatal septum window. This technique is indicated in cases with reduced crestal height, where the floor of the maxillary sinus is invaginated between the roots of the molars, leaving the palatal root in close contact with the sinus cavity. A divergent arrangement of the roots would facilitate the surgical technique. The limitations of the technique are the difficult accessibility, the limited visibility, and the need to use magnification and microsurgical instruments. Further studies are required to corroborate the preliminary results presented herein.

Acknowledgments

The authors report no conflicts of interest or external funding.

References