Posterior Maxillary Sandwich Osteotomy Combined with Sinus Grafting with Bone Morphogenetic Protein-2 for Alveolar Reconstruction for Dental Implants: Report of Four Cases

Ole T. Jensen, DDS, MS1/Jared Cottam, DDS, MD2

Four patients underwent posterior sandwich osteotomy combined with sinus floor grafting using bone morphogenetic protein-2 and other grafting materials. The patients were treated over a period of 4 years. Two to four implants were placed in each site subsequently. Of the 12 implants placed, none failed. Alveolar crest bone levels appeared to be stable over time, with an average vertical gain of about 5 mm. Overall vertical gain, including the sinus graft, exceeded 13 mm in all patients. The procedure appears to hold promise for combined vertical alveolar defects and prominent pneumatization of the posterior maxilla. INT J ORAL MAXILLOFAC IMPLANTS 2013;28:e415–e423. doi: 10.11607/jomi.te21

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Maxillary posterior reconstruction with dental implants in the presence of vertical osseous deficiency is usually accomplished via sinus bone grafting.1–6 When the alveolus is relatively atrophic, vertical augmentation grafting can be done simultaneously with sinus grafting,7–9 but vertical onlay grafting can be complicated by graft exposure, infection, or late-term resorption.10–12 The use of the sandwich osteotomy with interpositional bone graft has minimized these types of complications and has provided a relatively stable alveolar crest.10–15 The sandwich bone graft has been documented in the anterior maxilla,15–17 but not in the posterior maxilla, where access is more difficult and sinus prominence provides an added degree of difficulty. Reported here is a transsinus segmental osteotomy used to elevate (toward the crest) the residual alveolus to level the alveolar plane.18 The osteotomy procedure is done through a lateral approach following sinus membrane elevation via Caldwell-Luc access.19,20 The procedure restores the vertical alveolar dimension at the same time sinus grafting is done. The technique has the advantage of creating a stable crestal morphology with increased alveolar and sinus floor bone mass to support an implant restoration with favorable crown-to-implant ratios.16,21,22 Also reported here is the treatment of four patients with marked alveolar atrophy in the presence of a relatively low sinus floor via alveolar repositioning combined with sinus floor grafting.

TECHNIQUE

The technique of posterior maxillary segmental sandwich osteotomy is generally indicated when the anterior teeth are sound and there is sufficient intraoral opening to perform the operation in the face of alveolar height insufficiency and a prominent sinus cavity (Fig 1a). Following local and intravenous anesthesia, a vestibular incision is made and reflected superiorly (minimally inferiorly) to expose the lateral wall of the maxilla adjacent to the maxillary sinus. A lateral approach...
(Caldwell-Luc access) is done by elevating the sinus membrane to provide space for grafting (Fig 1b). A horizontal osteotomy is then created anterior and posterior to the sinus access osteotomy; anteriorly, this tapers to the alveolar crest just behind the most posterior tooth, and in the posterior it reaches to just in front of the pterygomaxillary suture (Fig 1c). This buccal cut is then connected transsinus with a similar palatal bone cut using a piezosurgical device or a curved sagittal saw (Figs 1d and 1e). An osteotome is needed to free the segment so it can be downfractured 5 mm or more. Once the segment has been...
The segment is grafted in this position, with the segment often in palatal version (arrow).

Interpositional bone graft material (BMP-2/ACS) fills not only the osteotomy site but the floor of the sinus. The procedure is essentially an inferior expansion of the sinus cavity.

Implants are placed after consolidation is complete, usually about 6 months later.

The implant platforms are located at an improved alveolar plane.

The final alveolar form and crown-to-implant ratio should be improved from the preoperative situation.

The definitive dental restoration should be more hygienic and self-cleansing with the alveolar vertical dimension restored.

Moved down to the appropriate alveolar level, it is fixed with a bone plate (Fig 1f). Once fixed, the bone plate can be used to compensate for the palatal pull of the palatal mucosa: the plate can be twisted with a wire twister to torque/force the segment laterally (Fig 1g).

If the segment is still too far to the palatal, this must be addressed at a later time. Once the segment is stabilized, bone morphogenetic protein-2 in an absorbable collagen sponge carrier (BMP-2/ACS) and 20% allograft is placed into the sinus floor and the interpositional graft zone (Fig 1h). The wound is then closed in two layers with resorbable sutures.

Four to 6 months later, with a crestal incision located slightly to the palatal, the lateral maxilla is exposed and the bone plate is removed. Implants are placed according to a surgical guide, and contour grafting to shape the ridge is done with nonresorbing xenograft as needed (Figs 1i and 1j). When the ridge is too far to the lingual, an alveolar split osteotomy can be done to bring the buccal plate laterally, with implants placed in the split site at the same time if possible. The definitive restoration is placed 4 months later (Figs 1k and 1l).
Patient 1
A 51-year-old woman presented with missing first and second molars in the right maxilla (Fig 2a). Two sinus grafts had been attempted but had resorbed completely. In addition, the alveolar process had resorbed considerably, leaving an 8-mm vertical defect. A panoramic radiograph of the area (Fig 2b) displayed minimal alveolar bone, but there was no evidence of chronic sinus disease to indicate a possible cause for previous graft failure. A sandwich osteotomy procedure was decided upon as a way to increase bone mass and restore alveolar height.

The sandwich graft proceeded through a vestibular incision, which was minimally reflected toward the crest and stopped at the fixed gingival tissue. Next, a lateral Caldwell-Luc osteotomy approach was used for sinus membrane elevation, which was accomplished without membrane perforation. A lateral horizontal osteotomy was then extended from either side of the sinus opening, tapering toward the alveolar crest on both sides.
The palatal bone was then osteotomized transsinosus using an oscillating saw, and a curved osteotome was employed to complete the osteotomy. The palatal osteotomy line curved toward the alveolar crest in a “frown shape” when viewed from the sinus opening. This osteotomy did not extend high into the palatal vault but was only about 5 mm from the crest. Following completion of the osteotomy, the segment was mobilized about 6 mm toward the crest. The resulting palatal deflection, caused by the strong “pull” of the palatal mucosa, could not be completely corrected axially, so the segment was fixed with a bone plate laterally (Fig 2c). Sinus grafting was then done, as well as grafting in the sandwich osteotomy site interpositionally using particulated mandibular autograft (50%), xenograft (50%), and platelet-derived growth factor-bb (Fig 2d). The vestibular wound was closed primarily without tension. Four months later, two implants were placed into the fairly well-consolidated bone graft, and a soft tissue flap was mobilized from the palate to help correct the palatal deflection of the alveolar ridge. Four months later, the definitive crowns were placed, and no significant bone loss has been observed after 3 years in function (Figs 2e and 2f).

Patient 2

Posterior segmental interpositional grafting was done for a 67-year-old man who presented with loss of the maxillary posterior teeth that had resulted in about 5 mm of vertical alveolar deficiency (Figs 3a and 3b). The osteotomy was completed, fixed, and grafted with BMP-2/ACS only, without additional material. In this case, because the sinus floor was relatively high, there was still bone present below the sinus floor after the osteotomy cut, which was made with a curved saw and did not require a transsinosus approach to free the palatal cortex. After downfracture, the sinus floor was intruded with an osteotome through the osteotomy site to add vertical dimension for graft placement. The segment was fixed with about a 5-mm vertical increase in height (Fig 3c). The wound was closed in two layers. Implants were placed 4 months later and restored another 4 months after that (Fig 3d).
Patient 3
A 60-year-old woman presented with an 8-mm vertical alveolar defect, which started immediately behind the maxillary left first premolar, caused by the loss of molars from periodontal disease (Fig 4a). A sandwich osteotomy/sinus graft was done using BMP-2/ACS only through a vestibular incision (Fig 4b). By 4 months, the grafted area had consolidated, and three implants were placed. Xenograft was used to shape and contour the alveolar ridge (Figs 4c and 4d). A palatal roll flap was used to augment the attached connective tissue buccally. The 8-mm defect was corrected by about 6 mm, which left the site amenable to a more anatomical dental restoration (Fig 4e).

**Fig 4a** A 60-year-old woman presented with vertical bone loss in the posterior left maxilla.

**Fig 4b** Following osteotomy and healing of the BMP-2/ACS graft, the wound was exposed crestally and the bone plate was removed.

**Fig 4c** Implants were then placed into the well-consolidated graft.

**Fig 4d** Nonresorbable graft material was used to shape the alveolus.

**Fig 4e** Radiographic appearance of implants on the day of surgery.
Patient 4

Failure of several implants in the posterior left maxilla in a 75-year-old woman had resulted in a large alveolar defect in the presence of a prominent sinus cavity (Fig 5a). With a vestibular incision with minimal crestal reflection, the sinus membrane was elevated through a lateral osteotomy. A horizontal osteotomy was extended anterior and posterior and then connected to a horizontal palatal osteotomy, which curved toward the crest both anterior and posterior. Following downfracture of the segment, there was a strong tendency for palatal deflection. The segment was fixed, and then the segment was forced laterally a few millimeters using a wire twister and the fixed plate. Graft material was placed beneath the sinus membrane, which had not been perforated by the surgical procedure. A large amount of BMP-2/ACS was required to fill the interpositional defect. Six months later, computed tomographic scans revealed excellent consolidation (Figs 5b to 5d), and the clinical appearance of the alveolar crest had improved dramatically, with more than 20 mm of bone height (Fig 5e). Four implants were placed (Fig 5f). A palatal roll was used to improve marginal gingival form and help compensate for palatal version of the alveolar crest. The dental restoration therefore featured an improved alveolar plane, equalized crown-to-implant ratios, and a more favorable gingival form.
DISCUSSION

Although it is technically difficult to perform, the posterior segmental osteotomy can be done to mobilize a resorbed alveolus toward the crest in conjunction with sinus floor grafting from a lateral approach. The osteotomy segment, usually two or three teeth in length, need not extend to the pterygomaxillary suture. In an outpatient setting, the elevated sinus membrane helps to control the bleeding from the palatal osteotomy site, making the procedure amenable to intravenous sedation management in an office setting. The greater palatine vasculature is not encountered as long as the palatal osteotomy is kept relatively shallow in the palatine vault.29 (The segment itself need be only 5 mm in vertical height.) Because of the pull of the palatal mucosa, a 5- or 6-mm vertical movement is usually all that can be obtained, unless the segment includes four or more teeth.

The use of a sandwich osteotomy graft provides a stable alveolar crest; however, this is often misplaced slightly to the palate, a problem that can usually be addressed after consolidation. When the segment is in good position, transgingival implant placement can be done.30 Movement of soft tissue buccally at the time of implant placement, usually in a one-stage approach, is highly favorable to establishing a more ideal gingival form.31

Although the presence of an ideal crown-to-implant ratio is no longer considered essential for biomechanical reasons,32 the need for long clinical crowns or a ridge-lapped restoration as a result of palatally placed implants makes the osteotomy approach attractive for hygienic reasons33 and not to improve biomechanics.32–34

The procedure is probably indicated for vertical alveolar defects of 5 mm or more to gain bone for osseointegration. In addition, the procedure is sometimes indicated for esthetic reasons for patients with broad smiles that extend to the first molar region. The greater alveolar crest; however, this is often misplaced slightly to the palate, a problem that can usually be addressed after consolidation. When the segment is in good position, transgingival implant placement can be done.30 Movement of soft tissue buccally at the time of implant placement, usually in a one-stage approach, is highly favorable to establishing a more ideal gingival form.31

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The procedure is probably indicated for vertical alveolar defects of 5 mm or more to gain bone for osseointegration. In addition, the procedure is sometimes indicated for esthetic reasons for patients with broad smiles that extend to the first molar region. The use of BMP-2 as a grafting material provides a valid, well-researched on-label use of the product in what is essentially an expansion of the sinus graft location by lowering the sinus floor.35 The technique should be restricted to maxillofacial surgeons who are familiar with segmental Le Fort I osteotomy surgery.25 and palatally will free the residual alveolus and allow vertical repositioning of the alveolar crest toward the alveolar plane. This technique has advantages over onlay grafting approaches, which may fail for various reasons, although it is technically difficult. Four case reports illustrate the technique that has been used for a number of years, most recently using bone morphogenetic protein-2 in an absorbable collagen sponge carrier as graft material.23

SUMMARY

A planned sandwich osteotomy bone graft in the posterior maxilla to level the alveolar plane usually conflicts with the location of the sinus cavity. When sinus membrane elevation is done through a lateral approach, an extension of the osteotomy anteriorly, posteriorly, and palatally will free the residual alveolus and allow vertical repositioning of the alveolar crest toward the alveolar plane. This technique has advantages over onlay grafting approaches, which may fail for various reasons, although it is technically difficult. Four case reports illustrate the technique that has been used for a number of years, most recently using bone morphogenetic protein-2 in an absorbable collagen sponge carrier as graft material.23

REFERENCES


