Sinus Augmentation for Single-Tooth Replacement in the Posterior Maxilla: A 3-Year Follow-up Clinical Report

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A technique for single-tooth sinus lift and simultaneous implant placement in the posterior maxilla is presented. Ten hydroxyapatite-coated cylindric implants, 13 to 15 mm in length, were placed together with a composite bone graft of demineralized freeze-dried bone allograft and autogenous bone in 10 adults. Surgical technique and anatomic considerations are discussed. Follow-up of 3 years showed successful function and no cervical bone loss in all patients.
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Key words: root-form implants, single tooth, sinus augmentation

Placement of endosseous implants in the posterior atrophic maxilla is often restricted because of a lack of supporting alveolar bone. To overcome this anatomic limitation, sinus lifting has become a common surgical procedure in oral implant treatment.[1–5] Since the initial application of sinus lift augmentation and implant placement in the mid-1970s, many articles have been published describing predictable techniques with reliable long-term results.[2,6–13] These procedures have been used for multiple implant restorations. Single-tooth implant–supported restorations are an acceptable restorative option.[14–17] In situations where insufficient alveolar bone remains for a single maxillary implant, the sinus lift procedure can be used.

The purpose of this article is to present a surgical technique and discuss its related anatomic problems and a 3-year follow-up of 10 clinical cases.

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Materials and Methods

Patient Selection. The study group consisted of 10 healthy patients (7 females and 3 males between 25 and 50 years of age; mean age 35) treated for missing single premolar or molar teeth in the posterior maxilla. Patients were selected consecutively based on the following criteria: the remaining dentitions were intact, with healthy periodontium; teeth adjacent to the edentulous areas were intact or treated with minimal class 1 or 2 amalgam restorations (Fig 1); edentulous spaces were minor (among the 10 patients, 6 first molars and 4 second premolars were missing); and a minimal crestal bone height of 5 mm between the sinus floor and the alveolar ridge was required. The specific residual bone height and implant site for each patient are shown in Table 1. Long cone periapical radiographs, orthopantomograms, and computed tomography (CT) scans were obtained for all patients (Fig 2).

Grafts. All patients received an autogenous composite bone graft consisting of a combination of 50% autograft harvested from the maxillary tuberosity area and 50% demineralized freeze dried cortical bone powder (DFDB, 250 to 500 μm particle size, Pacific Coast Tissue Bank, Los Angeles, CA).

Implant Type. Cylindric hydroxyapatite- (HA) coated dental implants (Sulzer Calcitek, Carlsbad,

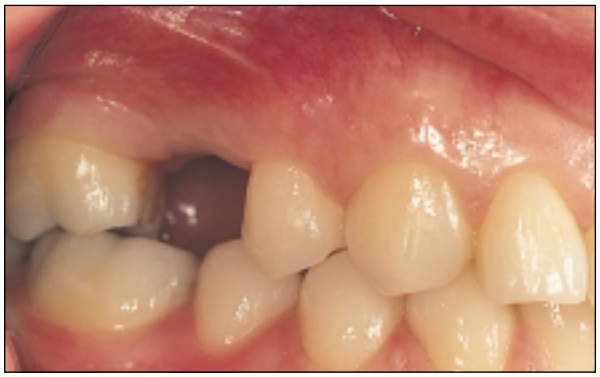

Fig 1 Buccal view of missing maxillary second premolar with adjacent intact maxillary first premolar and molar.

Table 1 Sinus Lift Implant Site Location and Residual Crestal Bone Height

Patient	Implant site	Crestal bone height (mm)*
1	Right second premolar	5
2	Right first molar	6
3	Left second premolar	5
4	Right first molar	5
5	Left first molar	5
6	Right second premolar	6
7	Left first molar	5
8	Left second premolar	5
9	Right first molar	7
10	Left first molar	5

*Mean bone height was 5.4 mm.

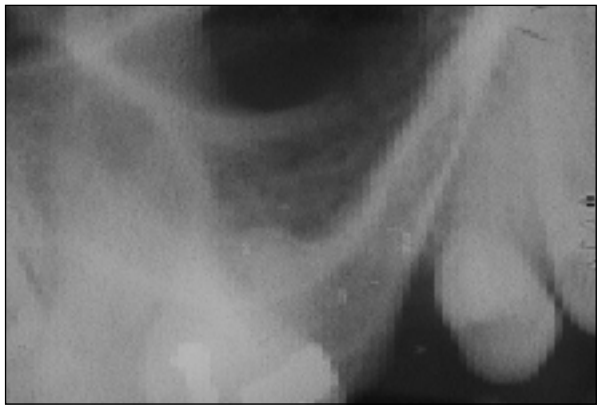

Fig 2a Periapical radiograph showing insufficient alveolar bone for a single-tooth implant in area of the second premolar.

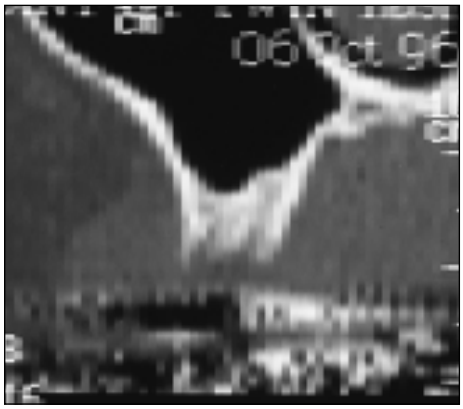

Fig 2b CT scan showing lack of necessary alveolar bone height for implant placement.

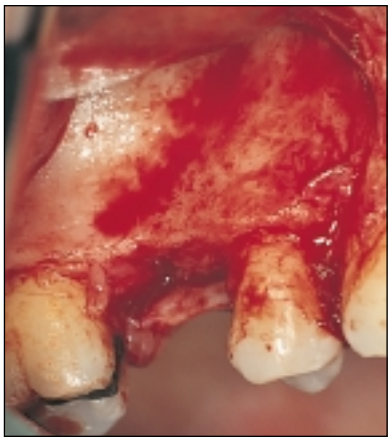

Fig 3 Lateral aspect of buccal bone after flap elevation.

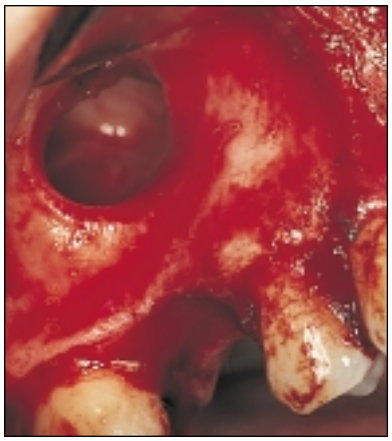

Fig 4 Buccal access window after dissection and elevation of the sinus membrane.

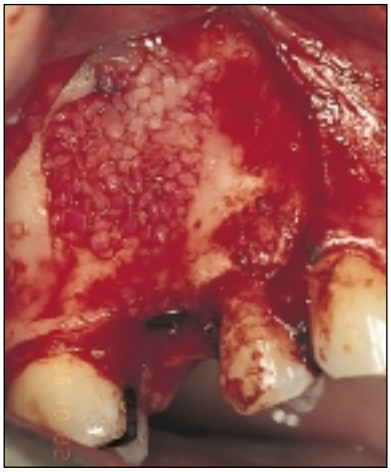

Fig 5a Composite bone graft is condensed around the implant body, filling the buccal window.

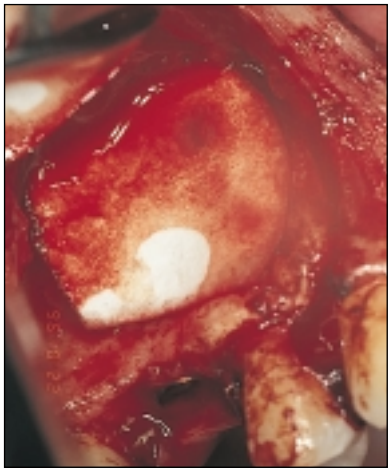

Fig 5b Resorbable collagen membrane, covering the buccal window.

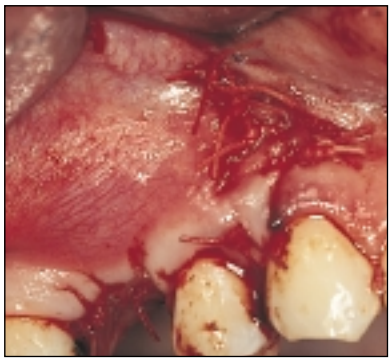

Fig 5c Full thickness mucoperiosteal flap sutured with interrupted vertical mattress suture.

CA), with lengths ranging from 13 mm to 15 mm and a diameter of 3.25 or 4.0 mm, were used throughout the study.

Surgical Technique. The sinus floor augmentation was performed using a modified Caldwell Luc procedure described by Kent and Block.[10] Midcrestal incisions were made in the edentulous ridges. In a typical patient situation (Fig 3), a vertical incision was made into the buccal vestibule to facilitate the elevation of a full-thickness mucoperiosteal flap and to expose the lateral wall of the maxilla. A large, round surgical bur was used in a straight handpiece at 2,000 RPM with copious irrigation to create a window in the lateral wall of the maxillary sinus. Bone was removed until the sinus membrane was exposed, creating an access window between and above the adjacent root apices.

The sinus membrane was dissected and elevated from the sinus floor to permit placement of a 15-mm implant (Fig 4). Tearing of the subjacent sinus membrane may occur because of the irregular nature of the overlying bone located between the root apices and the small dimension of the access cavity. Repair of the torn membrane is complicated because of minimum access and restricted working space. In this study, membrane tearing was observed in 4 patients. This was repaired using resorbable membrane (Biomend Sulzer Calcitek, Lambone, Pacific Coast Tissue Bank, Los Angeles, CA) to separate the graft material from the sinus.

An osteotomy of the implant site was prepared according to conventional surgical protocol. Composite bone graft material was placed against the medial aspect of the cavity below the elevated membrane. The implant body was placed and further graft material was condensed around it to cover the exposed implant body (Fig 5a). A resorbable collagen membrane (Biomend Sulzer Calcitek, Carlsbad, CA) was placed to cover the buccal window (Fig 5b) and the flap was sutured using 3/0 Vicryl interrupted vertical mattress sutures (Ethicon, Edinburgh, United Kingdom) (Fig 5c). For all patients, antibiotics (1.5 g amoxicillin per day) were prescribed for 10 days following surgery.

Results

Ten HA-coated dental implants were placed in 10 grafted sites. No postoperative complications in the sinuses were observed. Implants were uncovered at 9 months. Radiographic evaluation, including CT scans, orthopantomographs, and periapical radiographs, taken at the time of exposure showed well-consolidated bone grafts around the implants (Fig 6). Clinically, all implants were successfully integrated according to the criteria of Albrektsson et al[18] and Cox and Zarb.[19] In all patients, bone partially covered the implant cover screws. Implants were restored with cement-retained porcelain-fused-to-metal crowns (Figs 7a to 7c). Temporary restorations were placed in all patients 2 to 3 weeks after uncovering and were replaced 4 to 5 weeks later with definitive restorations. This was carried out to ensure that intercuspal occlusal contact occurred simultaneously with the adjacent teeth and to avoid the introduction of eccentric occlusal interferences.

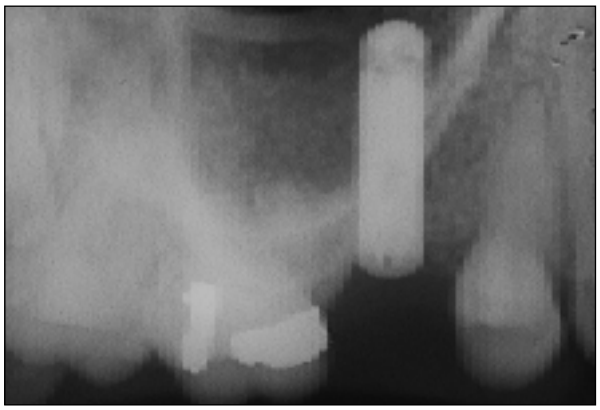

Fig 6a Postoperative radiograph showing cylindric HA-coated implant in the augmented sinus.

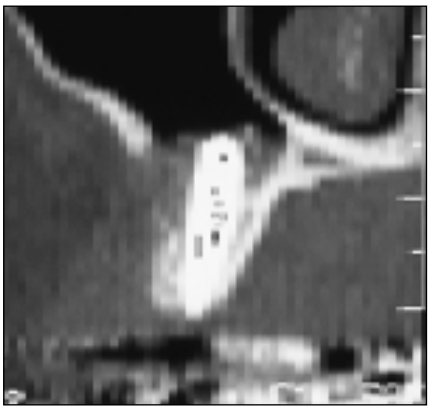

Fig 6b CT scan showing supporting bone around the implant in the augmented sinus.

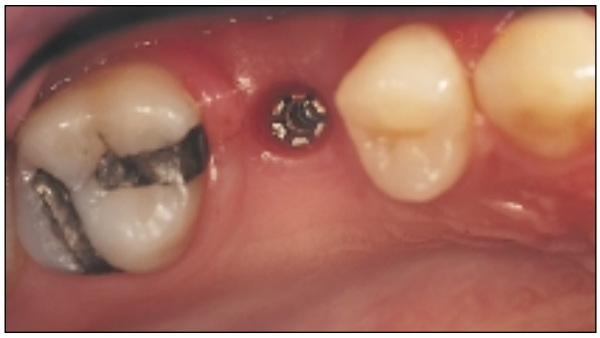

Fig 7a Occlusal view of implant and healthy surrounding tissue 3 weeks after exposure.

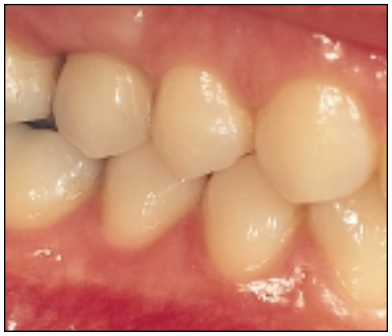

Fig 7b Buccal view of cement-retained restoration.

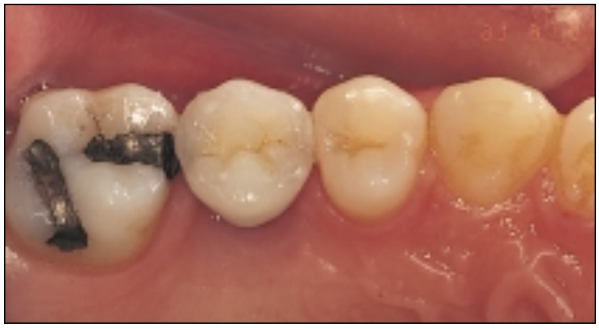

Fig 7c Occlusal view of restoration.

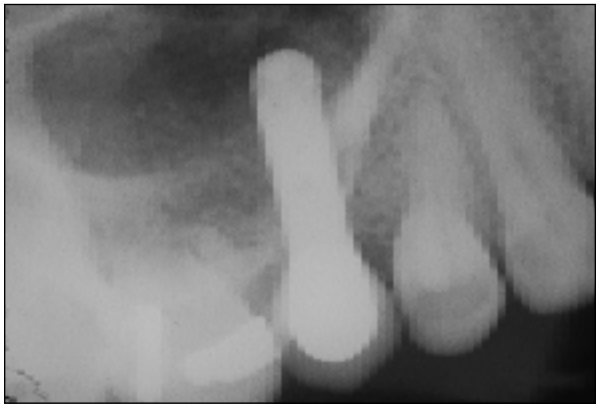

Fig 7d Periapical radiograph of the restored implant.

Patients were prospectively followed at 6-month intervals over 3 years. At the 3-year evaluation, there was no evidence of crestal bone loss, no soft tissue inflammation, and no screw loosening in any of the restored implants (Fig 7d).

Discussion

Based on sound physiologic principles and clinical experience, sinus augmentation has become a predictable and successful procedure for dental implant placement in the severely atrophic posterior maxilla.[2,9–13,20,21] To the best of our knowledge, the use of this technique for single-tooth replacement has not been reported. Loss of a single maxillary molar or premolar in adult patients because of caries, localized trauma, or congenital absence is not uncommon. The clinical decision to restore a missing posterior tooth with a single implant–supported restoration or a fixed partial denture poses a common clinical dilemma. Conventional prosthetic options include fixed partial dentures or fixed bonded restorations. These are prone to recurrent caries, periodontitis, and cementation loss.[22–24] When adjacent teeth are intact, the use of a single implant–supported restoration offers a viable option to circumvent the destruction of sound enamel and dentin.[15,16,25]

Single-tooth implants in the posterior maxilla can withstand posterior vertical and lateral occlusal forces.[26] Maximum implant length and the support of high-quality bone increase the ability to absorb these forces and enhance implant survival. To achieve maximum implant length and provide bone support, single-tooth sinus augmentation can be used to provide the necessary supporting bone volume.

The surgical technique is complicated by restricted access space and the overlying zygomatic buttress. The root of the zygomatic buttress is located above the alveolar bone in the maxillary first molar region. The bone in this region is particularly dense, precluding the use of a conventional folded sinus window and necessitating bulk bone removal over the sinus membrane. Bone is removed until the sinus membrane is exposed.

Because of the restricted surgical access site, bone morphology, and adjacent root apices, tearing of the subjacent sinus membrane may occur. Of the 10 patients, 4 showed evidence of membrane tears. Following the repair procedures, healing was uneventful. Sound bone was verified radiographically by periapical radiographs and CT scans.

Summary

1. A 3-year prospective study of 10 consecutive implant-supported, single-tooth restorations following sinus augmentation is reported.
2. Because of the limited surgical access membrane, tearing was observed in 4 of the 10 patients. Following repair with resorbable membranes, healing and bone support after 3 years of loading was the same for all patients.
3. There was no evidence of crestal bone loss, soft tissue complications, or screw loosening after 3 years.
4. Within the limitations of the small sample size and limited follow-up period, these results indicate that sinus augmentation for single tooth implant–supported restorations can be a viable treatment option.

Acknowledgments

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