
Osteotome Single-Stage Dental Implant Placement With and Without Sinus Elevation: A Clinical Report

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Forty-three sites in 16 patients were selected for placement of implants using osteotomes in a single-stage surgical technique. Most sites were treated to enhance bone quality. Sixteen sites in the posterior maxilla had sinus elevation performed in conjunction with implant placement. No soft tissue coverage of the implant cover screw was attempted in either the sinus-elevated or the nonelevated sites. Sinus elevation was significant relative to baseline (mean gain 3.25 mm, $P < .01$). The implant survival rate was 95.3%.

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Anatomic limitations in the maxilla provide challenges that may affect successful osseointegration and the fabrication of a functional and esthetic implant-supported prosthesis. Sites must have adequate bone volume and quality to allow precise implant placement and stabilization. An assessment of implant surgical success must include suitability for the intended restoration. Bone volume must be available in the position needed to facilitate the optimal implant position. Bone density should assist in the alignment and maintenance of the implant in proper position to meet the prosthetic goal.

Numerous surgical approaches in dealing with inadequate dental implant site bone volume have been reported. Nevins and Mellonig¹ studied the use of membranes and decalcified freeze-dried bone to augment localized ridge areas prior to implant placement. Shanaman,² in his retrospective study of 237 sites, reported on the quick resorption of demineralized freeze-dried bone allografts and the collapse of

nonreinforced membranes. Fugazzotto³ presented 3 case reports using simultaneous dental implant placement and sinus augmentation in 2-stage surgical systems. Jensen and Greer⁴ reported on a 2 1/2-year study of 15 patients and 74 implants in which simultaneous sinus augmentation and dental implant placement with a Gore-Tex membrane were performed as a 2-stage surgical procedure.

Duncan and Westwood⁵ reported using ridge widening in the placement of dental implants. Buser and Dula⁶ investigated the use of fixation screws and autogenous graft and membrane to augment a large bony defect site. Becker et al⁷ used resorbable pins and pillars and expanded polytetrafluoroethylene membrane to enlarge a ridge area for future implant placement. Simion et al⁸ were able to achieve 3 to 4 mm of vertical ridge augmentation using titanium-reinforced membranes.

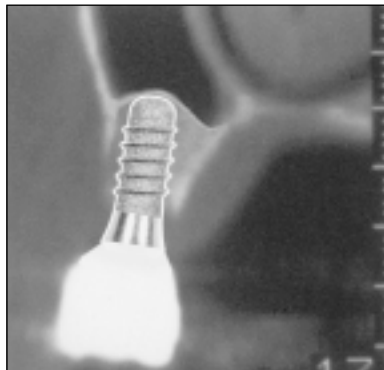
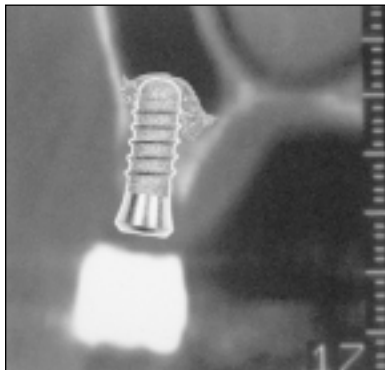
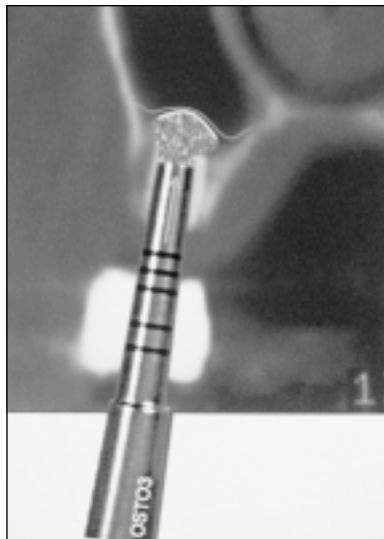
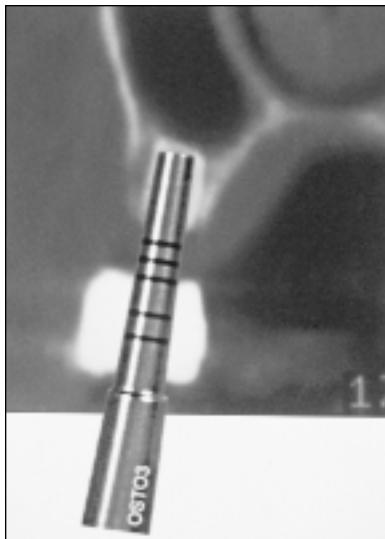
In a series of articles, Summers⁹⁻¹² reported on the use of round osteotomes to expand areas in the maxilla both horizontally and vertically that were not amenable to conventional preparation using drills of increasing diameter. The design of these instruments served to laterally compress the bone to increase the trabecular density adjacent to the site (Fig 1).

The purpose of this prospective study was to assess the success of osteotome-assisted surgery in single-stage surgical placement of dental implants in the maxilla with and without sinus elevation.

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Figs 1a to 1d Use of round osteotomes to expand areas in the maxilla.

Fig 1a Site development with osteotome below the sinus floor.

Fig 1b Up-fracture of the sinus floor with the autogenous graft in place.

Fig 1c Placement of the implant into the sinus-grafted site with no soft tissue coverage of the cover screw.

Fig 1d Osseointegration of the implant and maturation of the sinus graft.

Materials and Methods

Forty-three sites in 16 patients were selected for placement of implants using a single-stage surgical procedure.

Prior to dental implant placement, a computed tomography (CT) scan was performed. The majority of patients had radiopaque, tooth-form templates fabricated from ditrizoate sodium, USP radiopaque powder (Hypaque sodium, distributed by Nycomed, New York, NY), and clear orthodontic resin in a 50-50 mix by volume that allowed for visualization of the tooth anatomy on the CT scan. These templates allowed presurgical visualization of the optimal dental implant angle and bone volume in relationship to the proposed final restorative treatment. After a comprehensive consultation, informed consents were signed and the patients were scheduled for treatment.

Patients were selected for osteotome bone site preparation based on diagnostic data for sites to be

treated with maxillary dental implants of varying length. Consecutive patients meeting the selection criteria were included. The selection criteria were: (1) inadequate bone height in the posterior maxilla; (2) type III or IV bone; or (3) inadequate bone width in the anterior maxilla. All candidates were selected prior to the surgical appointment. Commercially pure titanium plasma-sprayed (CPTPS) dental implants (ITI, Institut Straumann AG, Waldenburg, Switzerland) were placed in sites in a single-stage procedure.

The patients were premedicated with a bolus dose of oral Valium (15 mg) 1 1/2 hours prior to surgery and a postoperative course of amoxicillin (500 mg, 4 times a day for 10 days) was used. Surgical procedures were performed under local anesthesia. Written and oral postsurgical instructions were provided. Nonsteroidal anti-inflammatory agents were prescribed for postsurgical analgesia. A .12% chlorhexidine gluconate oral rinse (Peridex, Proctor & Gam-

ble, Cincinnati, OH) was prescribed for 60 seconds twice a day from day 2 for 2 weeks as a topical antiplaque agent. Follow-up visits before and after the restorative phases were completed.

Patient Selection. Consecutive maxillary implant recipient sites were selected in patients presenting to a private periodontal practice (OGK). The decision to use osteotomes was based on a review of the CT scan image of the implant sites. Those deemed to have poor bone quality or deficient bone volume were selected as previously described. Forty-three implants were placed in the maxilla, after using osteotomes to prepare the recipient site. Ten sites were prepared in the anterior maxilla, canine to canine; 33 implants were prepared in the posterior maxilla.

Surgical Sequence. Site preparation began using Summers #1 and #2 osteotomes (3i, Implant Innovations, Palm Beach Garden, FL). Some sites required minimal drilling with a 2-mm diameter twist drill. To provide for a more uniform, parallel-walled recipient site, an implant-site dilator 3.5 mm in diameter (Model #04-000-42, Ace Surgical Supply, Brockton, MA) was used. An autogenous graft from the tuberosity or maxillary edentulous ridge was placed into 16 sinus-elevated sites after using the Summers #1 and #2 osteotomes. Elevation of the maxillary sinus was achieved using a Summers #3 osteotome forcing graft ahead of its tip to achieve the sinus up-fracture. The amount of desired sinus augmentation ranged from 2 to 7 mm as measured on the CT scan (Fig 2). CPTPS implants were placed into the osteotomy sites prepared with the osteotomes (Fig 3). No attempt was made to submerge these implants under the flap, as implant placement was planned as a single-stage surgical procedure with simultaneous sinus augmentation. In some patients, manipulation of the gingival tissue was performed prior to starting the restorative phase to achieve an esthetic result (Figs 4 and 5).

Nine months was deemed the minimum time interval after surgical placement before abutment connection. In some patients, longer intervals were used because of scheduling difficulties.

Results

Forty-three CPTPS dental implants were placed into individual sites prepared using osteotomes. Forty-one were successful in integration intervals ranging from 9 months to nearly 4 years.

One implant failed and was replaced at the same site. The failed first implant had been placed into an immediate extraction site with an enucleated cyst approximately 14 mm in diameter. The bony cavern was the sequelum of a failed apicoectomy. The first implant failed to integrate, and its subsequent

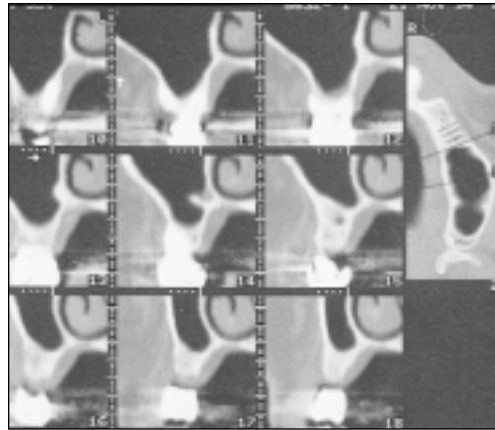


Fig 2 Cross-sectional reformatted CT image #17. The image of the tooth-form template allows orientation of available bone to the desired implant location. Note more bone height (8 mm) is available on the buccal aspect than on the palatal aspect (6 mm).

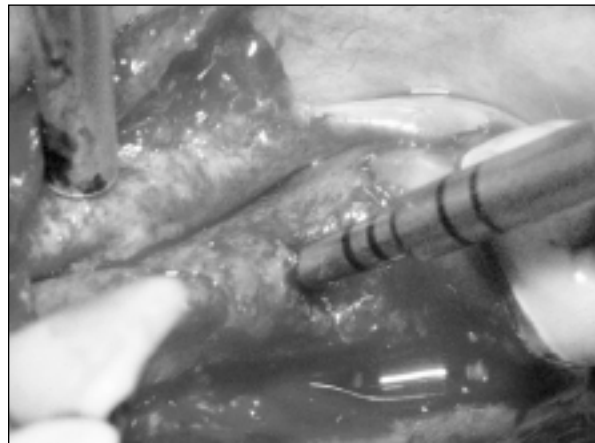


Fig 3 A Summers #3 osteotome is used to up-fracture the floor of the sinus. An autogenous bone graft was harvested from the edentulous maxillary first premolar area and packed into the implant site (not shown here).

replacement was placed 6 months after removal of the first implant. Successful integration of the second dental implant was achieved. The other failure occurred in a sinus augmentation site and is described later.

Sinus Elevation. Sixteen of the dental implant sites required vertical elevation of the sinus to allow placement of the implant apex above the presurgical height of the maxillary sinus. This need was determined presurgically via CT scan analysis. The presurgical bone height had a buccal range of 3 to 8 mm and a palatal range of 3 to 9 mm. The presurgical means were 5.31 and 5.50 mm respectively (Table 1).

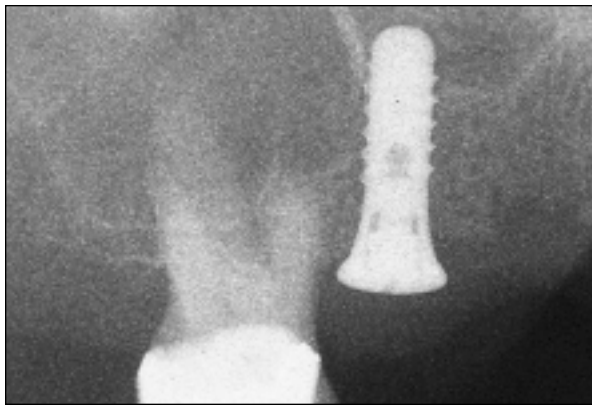


Fig 4 Periapical radiograph taken immediately after implant placement. Note the 4.1 × 10 mm implant appears to be perforating the sinus floor. As per ITI protocol, no soft tissue coverage of the healing cap was attempted.

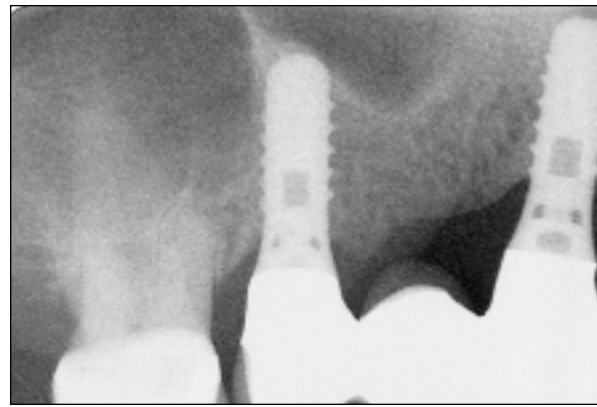


Fig 5 Periapical radiograph taken 3 years postsurgery and 2 years postseating of the implant-supported, screw-retained, fixed partial denture. Note the increase in radiopacity at the apical extent of the implant.

Table 1 Bone Height Before and After Sinus Elevation in 16 Implant Sites

	Presurgical bone height (mm)	Postsurgical bone height (mm)	Bone height gain (mm)	Paired <i>t</i> test
Mean buccal	5.31	8.69	3.38	<i>P</i> < .01
Mean palatal	5.50	8.63	3.13	<i>P</i> < .01

The range of sinus elevation was from 2 to 7 mm with a mean of 3.38 mm on the buccal and 3.13 mm on the palatal (from CT measurement to length of implant in bone). The comparisons of bone height pre and post surgery were statistically significant (*P* < .01, paired Student's *t* test). The overall average gain was 3.25 mm. Postoperative periapical radiographs initially showed no radiopacity in the elevated sites. Radiopacity that was interpreted as bone fill was noted in all patients 8 months postimplant placement. In most patients, the radiopacity extended to the tip of the implant but not beyond. Implants ranging from 8 mm to 10 mm in length were placed in the sinus-elevated sites.

Sinus Complications. One patient was taking aspirin as an anticoagulant (which was not reported) and suffered postsurgical hemorrhaging. This was controlled by discontinuing aspirin therapy for 5 days, prescribing over-the-counter decongestants, and instructing the patient not to blow her nose. No other complications were recorded. All patients were comfortable and reported no unusual symptoms. One of the 16 sinus augmentation implants became mobile at the abutment connection appointment when a 35 Ncm force was applied to seat the abutment in the implant. This failed implant was successfully replaced and the new implant is also included herein.

Implant Success. The 41 osseointegrated implants represent a survival rate of 95.3% using the criteria of Albrektsson et al.¹³ Follow-up intervals ranged from 9 to 47 months postimplant placement. All implants were restored and in full function with intervals ranging from 3 to 38 months. No implant has failed after final restoration. Follow-up radiographs show bone maturation with increased radiodensity and trabecular definition (Figs 6 to 9).

Discussion

The use of osteotomes to enhance dental implant site development is a highly predictable procedure. This noninvasive technique can enhance effective bone quality of a site for primary stabilization from type IV or III to type II in the maxilla. Site development includes the lateral condensation of bone to increase density and improve primary stability. In some situations, bone compression at the apical portion of the implant site may require drilling with a 2-mm twist drill to create an implant site of the desired length. Lateral augmentation of a medially or distally located sinus can be achieved by strategic placement of a graft and lateral sinus elevation. Vertical augmentation and localized sinus elevation with minimal surgical trauma are consistently possible with the use of

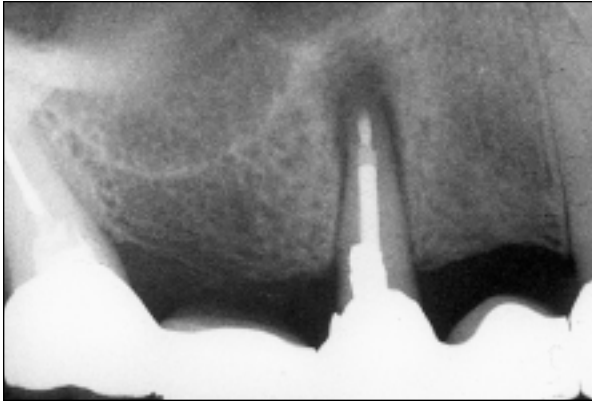


Fig 6 Periapical radiograph of the suppurating maxillary premolar. Note the dipping of the maxillary sinus floor mesial to the maxillary second molar.

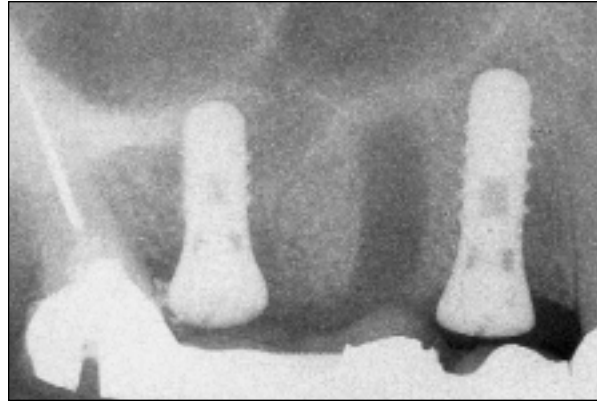


Fig 7 Periapical film of 2 implants placed for use as abutments for a fixed partial denture (same patient as shown in Fig 6). Note that the maxillary first molar implant appears to be perforating the maxillary sinus.

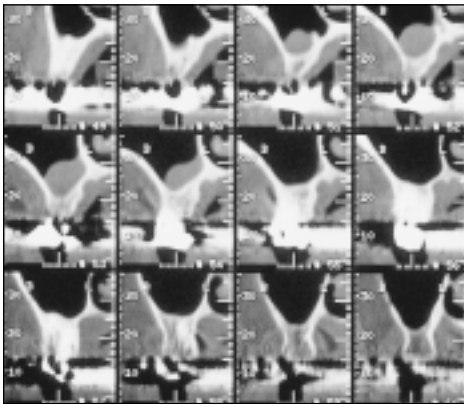


Fig 8 Reformatted cross-section CT images of the posterior maxilla. Image #52 shows only 4 mm of bone height available both buccally and palatally. A 4.1 × 9 mm solid-screw implant was placed in this area.

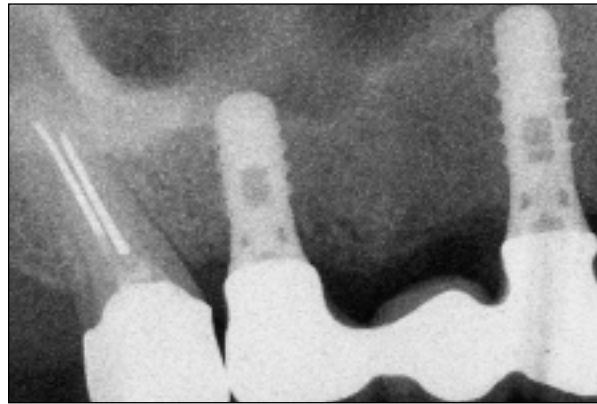


Fig 9 Periapical radiograph taken 10 months after implant placement and 6 weeks postinsertion of the fixed partial denture. Note the changes in the radiopacity of the radiograph at the apical extent of the implant, which is interpreted as bone fill and osseointegration.

autogenous bone harvested at the time of surgery. Postoperative complications in these patients were comparable to those in patients who received conventional drilling procedures. The implants used in the posterior maxilla were 4.1 mm in diameter and 8 to 10 mm long. Because of the high survival rate of implants placed using this procedure, longer implants may not be needed if good stability is obtained.

Conclusion

While limited to the maxilla, single-stage surgical placement of dental implants using osteotomes, with or without sinus lift, is a highly predictable surgical procedure for the placement of dental implants. The procedure generally does not require extended surgi-

cal time. Healing intervals of 9 months, representing an increase of 3 months over the typical healing period, were used before abutments were connected in this study. As seen here, the osteotome technique, even for sinus augmentation, does not appear to compromise implant stability. Stability was adequate even when implants were left exposed during single-stage initial healing.

Use of more invasive procedures, such as block grafts, Caldwell-Luc procedures, and guided bone regeneration may not be needed as often. Only when there is inadequate bone for initial implant stabilization are these other procedures mandatory. The ease and predictability makes osteotome procedures the preferred technique in many situations, including single-stage applications.

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