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An Atraumatic Approach to Internal Sinus Lifting: The Motorized Expansion Drill Technique

Michael Sonick, DMD; Rui Ma, DMD; and Debby Hwang, DMD

Implant placement in the posterior maxilla is often complicated by both the presence of relatively low-density, atrophic bone and sinus pneumatization, conditions that can thwart fixture support. For the past 40 years, surgeons have proposed various methods to elevate the Schneiderian membrane to gain vertical height for dental implant placement, expand the osseous ridge bucco-lingually, and condense marrow spaces to improve primary stability.[1] In 1994, Summers described an internal sinus elevation technique using tapered osteotomes with increasing diameters that simultaneously augmented the vertical dimension of bone coronal to the maxillary sinus border, widened the lateral ridge, and increased the density of bone surrounding the implant.[2] While effective, the traditional Summers procedure involves compound percussion with a surgical mallet, which may be jarring to the patient-though not necessarily painful-and may also displace otoliths, inducing benign paroxysmal positional vertigo (BPPV).[3] Although the incidence of BPPV post-Summers technique is relatively low (<3%) and the condition self-resolves in about a month without specific treatment, hammering into the jaw tends to foster an unpleasant patient experience.[4,5]

The replacement of mallet-propelled, cylindrical osteotomes by motorized, screw-type drills to circumvent patient discomfort has been reported, mostly for buccolingual widening of resorbed ridges and concurrent densification of the surrounding osseous structure.[6-8] In this protocol, after the initial preparation with a pilot drill, the clinician uses threaded, smooth-surfaced, blunt-ended expansion burs with increasingly wide diameters at a machine torque of 15 Ncm (and a speed less than or equal to 75 rpm) to sequentially enlarge the osteotomy. This allows for better positional control and significantly less surgical trauma compared to conventional osteotome-based practices.[6-8] If resistance to motorized drilling occurs, then the dentist can unlatch the motor handpiece, seat a wrench adapter onto the submerged bur, and lightly hand-torque the drill.

Both Cosci et al and Kitamura documented the adoption of sequential motor-powered drilling with rounded "lifting" burs for infracture and preliminary vertical elevation of the maxillary sinus; however, they still used a manual instrument to introduce bone graft material into the osteotomy site.[9-11] Lee et al suggested the direct employment of proprietary expansion burs (BTI Biotechnology Institute, bti-biotechnologyinstitute.com) to pack bone upward during a crestal sinus lift but did not provide specific details regarding that particular scenario.[6]

The case series presented here describes an effective, clinician- and patient-friendly procedure for internal maxillary sinus elevation, ridge development, and implant placement using motorized bone expanders almost exclusively. The treatment process, including patient selection, necessary equipment and biologic materials, and surgical protocol, is conveyed in a step-by-step manner. The promising results gleaned from this pilot analysis encourage further investigation into and practice of this technique.

Method and Materials

Thirty-four private-practice patients were included in the study according to the following inclusion criteria: (1) American Society of Anesthesiologists physical status classification I or II; (2) no known medical contraindications for dental surgeries under local anesthetics and/or oral sedation, including no contraindications for sinus augmentation; (3) single maxillary posterior tooth prosthesis per dental implant placed; (4) partial edentulism in the posterior maxilla with at least 3 mm residual vertical bone height but less than 10 mm bone height; and (5) nonsmoking status.

In all cases, OSSEOTITE® Tapered Certain® (Zimmer Biomet, zimmerbiometdental.com) implants were used. The dimensions of the implants used in this study are listed in Table 1. (Table 1, Case Series Data, may be viewed online at compendiumlive.com/go/cced1920.) A total of 37 implants were placed with a motorized drilling technique with BTI expander burs (Figure 1). The dimensions of the burs were as follows: #1 = 1.4 mm apex, 2 mm body; #2 = 1.6 mm apex, 2.6 mm body; #3 = 2.1 mm apex, 3.1 mm body; #4 = 2.8 mm apex, 3.8 mm body. The drill speed used was 75 rpm.

Figure 1

Clinical Parameters

All patients enrolled in the study received an explanation regarding the procedure and signed a surgical consent form. A preoperative cone-beam computed tomography (CBCT) scan was obtained for each patient to assess the thickness of the Schneiderian membrane, sinus pathology, sinus morphology, major blood vessel locations, bone density, and residual vertical bone height (RVBH) coronal to the sinus border. A periapical radiograph was taken immediately after implant surgery to measure post-graft bone height (PGBH).

Surgical Method

Two clinicians performed all surgical procedures. Pre-operative amoxicillin/clavulanate potassium 875/125 mg and ibuprofen 600 mg were given to each patient 1 hour before the procedure. Nitrous oxide inhalation and/or oral triazolam 0.25 mg (1 hour before the procedure) was administered as needed for sedation. Local anesthesia was obtained via infiltration on the buccal and palatal gingiva of the edentulous space with 2% lidocaine with 1:100,000 epinephrine. A palatally oriented crestal incision was made over the edentulous site to preserve keratinized mucosa, and full-thickness flaps were raised buccally and palatally to expose the ridge. The surgical flaps were secured to adjacent mucosa with 4-0 polyglactin 910 suture (Vicryl Rapide™, Ethicon, ethicon.com) to facilitate visualization.

The initial osteotomy site was marked with a 1/4 round carbide bur using a high-speed handpiece. The implant osteotomy was then prepared with a starter drill, followed by a 2 mm pilot drill at 1200 rpm with irrigation to a depth approximately 2 mm inferior to the sinus floor. The #1 expander drill was used without water at a drilling speed of 75 rpm to 1 mm coronal to the sinus floor. Figure 2 through Figure 4 illustrate this portion of the procedure. The preparation of the osteotomy site was then continued with the #2 expander drill at a drilling speed of 75 rpm without water to reach just short of the sinus floor (Figure 5). The position of the drill was verified with a periapical radiograph (Figure 6).

At this point, the sinus floor integrity was uncompromised. The osteotomy was enlarged with the #3 expander drill and then with the #4 expander drill (both at 75 rpm without irrigation) to the inferior border of the maxillary sinus (as illustrated in Figure 7). Once the apical position of the expander drill was confirmed radiographically to be at the sinus border, the #4 expander was advanced at 75 rpm without irrigation to fracture and lift the alveolar border by approximately 1 mm. Extreme care was taken at this step to avoid perforation of the Schneiderian membrane (as illustrated in Figure 8). A Valsalva maneuver and direct visualization was used to examine the integrity of the sinus membrane. A periapical radiograph was taken to confirm the elevation of the sinus floor (Figure 9).

Upon completion of the initial sinus lift, either solvent-dehydrated cancellous bone allograft (Puros®, 250 µm to 1000 µm, Zimmer Biomet) or anorganic bovine bone xenograft (Bio-Oss®, Geistlich Biomaterials, dental.geistlich-na.com), depending on the clinician's preference, was used to raise the sinus floor further. These graft materials are commonly utilized for internal sinus elevation.[12,13] The chosen bone graft material was placed into the osteotomy and advanced with the #4 expander drill at 75 rpm to a position slightly coronal to the sinus border (as illustrated in Figure 10). The expander drills were used to pack the osteotomy site and lift the sinus membrane to the final length of the implant (Figure 11 and Figure 12). This step was repeated until a total of 0.5 cc of bone graft was placed and confined under the Schneiderian membrane as per radiographic verification (Figure 13). Drilling was performed without irrigation and at a speed of no greater than 75 rpm.

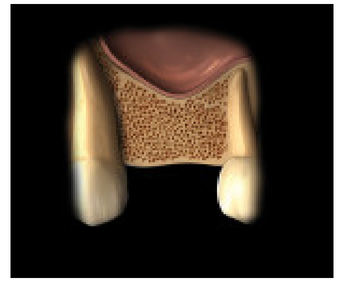
Figure 2

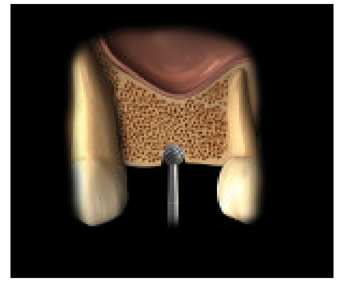
Figure 3

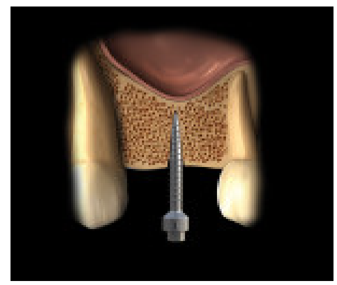
Figure 4


Figure 5


Figure 6

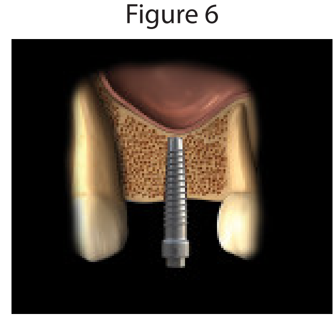
Figure 7

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The implant was inserted into the undersized osteotomy at a starting torque of 50 rpm via the motorized handpiece. The implant served as the final vertical and horizontal expander of the ridge (Figure 14). In all cases, the minimal implant length used was 10 mm. All implants had a final torque value of more than 90 Ncm as measured by a manual torque wrench.

The flap was repositioned, and primary closure was obtained with a 4-0 polyglactin 910 interrupted suture (Vicryl Rapide). The final periapical radiograph confirmed that the implant and bone graft material were restricted below the sinus membrane (Figure 14). Patients were placed on amoxicillin/clavulanate potassium 875/125 mg, twice a day for 1 week, and ibuprofen 600 mg as needed. Suture removal and postoperative evaluation were performed after 14 days. Healing time for the implants was 3 months. Prosthetic rehabilitation was started 3 weeks after implant exposure (Figure 15 and Figure 16).

Results

A total of 37 implants in 34 patients were placed (Table 1). (Please visit compendiumlive.com/go/cced1920 to view Table 1.) Of the 37 implants, 15 osteotome lifts were completed with anorganic bovine bone xenograft, and 22 osteotome lifts were completed with solvent-dehydrated cancellous bone allograft. The overall mean RVBH before surgery was 7.52 mm, and mean PGBH after surgery was 11.44 mm. The mean change in bone height was 3.92 mm. For the anorganic bovine bone xenograft group, the mean RVBH, mean PGBH, and mean change in bone height were 7.85 mm, 11.52 mm, and 3.67 mm, respectively. For the solvent-dehydrated cancellous bone allograft group, the mean RVBH, mean PGBH, and mean change in bone height were 7.30 mm, 11.39 mm, and 4.09 mm, respectively.

No sinus perforations were observed during the surgeries or the postoperative healing period. No significant postoperative complications, such as infections or vertigo, were detected or reported. Patients experienced minimal postoperative discomfort. No statistical analysis was performed for this case series.

Discussion

The surgical technique described in this case series utilizes motorized expander burs in a highly controlled, serial fashion to spread the ridge buccolingually; compact the bone comprising the walls of the osteotomy, potentially enhancing primary stability; infracture and push apically the maxillary sinus border; and insert bone graft under the sinus membrane. The #2, #3, and #4 expanders have rounded tips that, when used under the low rotational speeds recommended, render major sinus perforation unlikely. Notably, substituting slow, motor-powered drilling for hand malleting avoids potential vertigo, neck hyperextension, and disquieting noise/motions. According to a recent systematic review, patients prefer the kind of rotary instrumentation employed in this case series over the conventional manual alternative (mallet).[14]

The results of this study showed that this technique increased the residual vertical bone height by an average of 3.92 mm, with a maximum height increase of 7 mm. There was no significant clinical difference observed in terms of vertical bone height gain between the allograft and xenograft groups in the short term. As with any surgical therapy, case selection is critical. For ideal outcomes, eligible patients should be relatively healthy nonsmokers with a minimum of 7 mm residual vertical bone height apical to the sinus border. At least 2 mm of buccal and 2 mm of palatal bone beyond the anticipated implant diameter is preferred to maintain esthetic and mechanical stability. If plate fracture, such as a

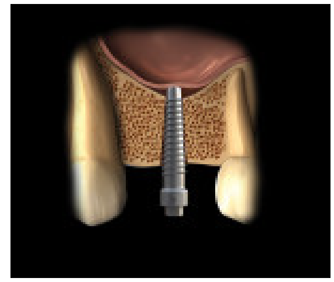

Figure 8

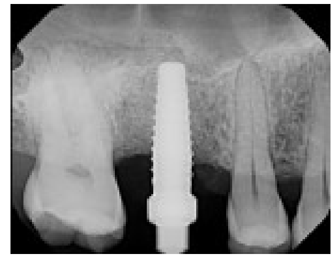

Figure 9

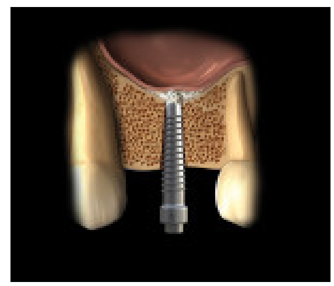

Figure 10

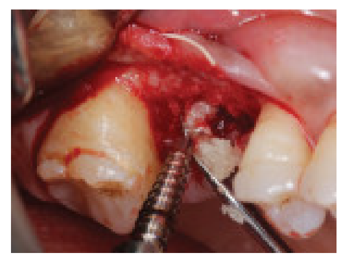

Figure 11

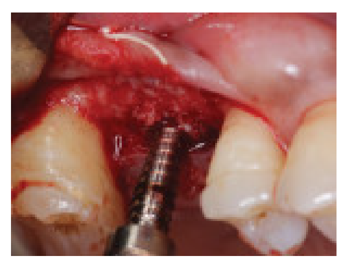

Figure 12

Figure 13

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greenstick-type break, or minor dehiscence/fenestration occurs within the envelope of bone, simultaneous guided bone regeneration must be performed.

Figure 14

Figure 15

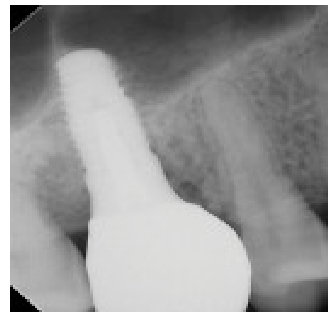

Figure 16

Conclusion

Although the follow-up time in this study is too short to draw any conclusions about long-term implant success, the motorized expansion drill technique does appear to be a relatively atraumatic, structured, and reliable approach to enhance posterior maxillary bone in three aspects (height, buccolingual dimension, density) for implant placement. Long-term follow-up data post-restoration and -function is needed to determine the stability of the bone graft materials and implants.

Disclosure

The authors had no disclosures to report.

About the Authors

Michael K. Sonick, DMD
Private Practice, Fairfield, Connecticut

Rui Ma, DMD
Private Practice, Fairfield, Connecticut

Debby Hwang, DMD
Private Practice, Ann Arbor, Michigan

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