Ridge Expansion and Immediate Placement With Piezosurgery and Screw Expanders in Atrophic Maxillary Sites: Two Case Reports

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Endosseous dental implants may require bone augmentation before implant placement. Herein is described an approach to edentulous ridge expansion with the use of piezosurgery and immediate placement of implants. This may allow for a shortened treatment time and the elimination of donor-site morbidity. Two cases are reported. This technique uses a piezoelectric device to cut the crestal and proximal facial cortices. Space is then created with motorized osteotomes to widen the split ridge. This technique allows for expansion of narrow, anatomically limiting, atrophic ridges, creating space for immediate implant placement. The facial and lingual cortices provide support with vital osteocytes for osteogenesis. The 2 patients presented had adequate bone height for implant placement but narrow edentulous ridges. In patient 1 at site #11, the ridge crest was 3.12 mm thick and was expanded to accept a 4.3 mm × 13 mm implant. The resulting ridge width was 8.88 mm, which was verified using cone beam computerized tomography (CBCT). In patient 2 at site #8 and site #9, the narrow ridge was expanded using the same technique to accept 2 adjacent 3.5 mm × 14 mm implants. The implants were restored to a functional and esthetic outcome.

Key Words: dental implant, immediate implant placement, immediate placement, minimally invasive, piezosurgery, split-crest, ultrasonic bone surgery

INTRODUCTION

For dental implant treatment to be successful, an adequate amount of bone and soft tissue must be present. Several methods have been used over the years to achieve these results. When the alveolar ridge is not optimal in width, some authors have advocated the use of onlay block or particulate grafts. The challenge of many of these techniques is that they require secondary surgical sites with increased morbidity and discomfort so that in many cases patient sedation is necessary. All of these factors combine to increase the time and cost of treatment delivery. Edentulous ridges can be cut and expanded to widen a narrow ridge to accept a standard-sized implant. Osseous ridge expansion with a piezoelectric-driven saw and subsequent expansion of the bone cut with motor-driven expansion screws can create space for immediate implant placement.

Piezoelectric bone surgery was introduced to the dental profession to perform precise, minimally traumatic bone surgery. Traditional approaches to treating narrow alveolar ridges require careful effort and care. Earlier techniques for ridge expansion were performed with chisels, air-driven rotary handpieces, or oscillating saws. Ridge expansion can be difficult when the cortex is dense, as in the mandible. Rotating and oscillating instruments are effective but may damage nerves and arteries. Piezoelectric saws will not significantly damage these structures.

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Ultrasonically driven saws have the ability to cut hard tissues but preserve gingiva, blood vessels, nerves, and sinus membranes from injury. Piezosurgery is suitable for edentulous ridge expansion, bone block section, sinus elevation, nerve laterализation, resective bone surgery, and bone biopsy. The purpose of this article is to demonstrate that piezoelectric surgery and motor-driven screws for edentulous ridge expansion and immediate implant placement may be effective and minimally invasive.

**CASE 1**

A 48-year-old nonsmoking woman presented in general good health and with no contraindications for dental treatment. She had been missing the maxillary left cuspid tooth (#11) for 15 years. A clinical and radiographic evaluation was completed, treatment options were reviewed, a treatment plan was accepted, and informed consent was obtained. A ridge expansion and immediate implant placement were planned with subsequent crown restoration. Bone height was 17.09 mm and bone width 3.12 mm, as measured on cone beam computerized tomography (CBCT) (Figure 1).

The patient was prescribed a chlorhexidine gluconate 0.12% oral rinse (Peridex, 3M ESPE Dental Products, St Paul, Minn) and cephalixin 500 mg tablets instituted 2 days before the procedure. The patient was administered 1.8 mL infiltrated local anesthesia articaine (Septocaine 4% with epinephrine 1:100 000, Septodont, Inc, New Castle, Del) and, later, during the procedure, 1.8 mL 4% prilocaine (Citanest Forte, Dentsply, York, Pa). At this time, 800 mg ibuprofen was administered orally. A partial thickness flap was raised with a #15 scalpel, and the piezosurgery unit (Ace Surgical, Brockton, Mass) was used to cut the osseous crest. The bone cut was expanded with screw-type expanders (Meisinger, Centennial, Colo) (Figure 2). Sequential drilling for the osteotomy at the deep portions of the bone cut

**Figures 1–5.** **Figure 1.** Preoperative cone beam computerized tomography (CBCT) sagittal image of the edentulous #11 in patient 1, demonstrating a 17.09 mm height and 3.12 mm width. **Figure 2.** Intraoperative radiographic image of the expansion screw. **Figure 3.** Radiographic image of the #11 implant in place. **Figure 4.** CBCT image of site #8, demonstrating a ridge height of 18.97 mm and width of 4.56 mm. **Figure 5.** Clinical outcome of the #11 implant.
was performed. A 4.3 × 13 mm Camlog implant (Camlog, Henry Schein, Carlsbad, Calif) was placed (Figure 3). The facial cortex was approximately 1.5 mm, so a 6 × 7 × 8 mm bovine-collagen sponge was soaked with the patient’s blood and manipulated into place (NuOs Dental Implant System, Ace Surgical). The xenograft was stable and immobile, so screws were not needed. A cover screw was placed on the implant with triple antibiotic ointment (Neosporin, Pfizer, New York, NY), taking care not to express this onto the tissue. Then 3-0 chromic gut suture (Ace Surgical) was placed. The final width of ridge expansion was 8.90 mm, so a net gain of 5.75 mm was attained (Figure 4). The patient was given verbal and written postoperative instructions. At 1 week the sutures were removed, and healing was noted as uneventful.

The patient presented 3 months later for restoration of the #11 implant. A tissue punch was used to expose the cover screw, and this was removed. A closed tray type analog impression was taken, and a porcelain fused to metal crown was ordered. A tissue healing cap was placed. Three weeks later, the abutment was placed and torqued, and, after the patient’s approval, the crown was cemented with resin cement (Premier Implant Cement, Premier USA, Plymouth Meeting, Pa) (Figure 5). The patient has had successful function for 3 years.

**Case 2**

A 37-year-old nonsmoking healthy woman presented with no contraindications to implant treatment and requested replacement of missing teeth #8 and #9 (Figure 6). She had been wearing an acrylic, tissue-supported removable partial denture for 3 years after traumatic loss of these teeth. A clinical and radiographic evaluation was completed, treatment options were reviewed, and informed consent was obtained. The site was determined to be atrophic. The bone height of both sites averaged 18.9 mm, and the width was 4.5 mm, as measured on CBCT. Ridge expansion and the immediate

**Figures 6–10.** Figure 6. Postoperative cone beam computerized tomography (CBCT) of site #8, demonstrating the facially displaced coronal bone. Note the thinner apical facial bone. A ridge width of 8.19 mm has been attained. Figure 7. Postoperative CBCT of site #9, demonstrating the thickened coronal ridge. A ridge width of 8.20 mm was attained. Figure 8. Postoperative CBCT of site #11, demonstrating the thickened coronal ridge. A ridge width of 8.90 mm was attained. Figure 9. Radiographic image of restored implants. Figure 10. Clinical appearance of implant-supported crowns.
placement of 2 implant-supported crowns was the treatment decided upon.

The patient was prescribed cephalexin 500 mg starting 2 days before the procedure. The patient presented for the procedure and was orally administered 800 mg ibuprofen and prepared in the usual fashion for implant surgery. After infiltration of 2.8 mL articaine (Septocaine), administered over the course of the procedure, a fully thick crestal and an apically directed split thickness flap was elevated with a #15 scalpel to preserve the periosteum. The atrophic ridge was then expanded using piezosurgery (Ace Surgical). The edentulous ridge was cut at the crest using a piezosurgery blade to separate the facial and palatal cortical plates. The cut bone was then expanded with expansion screws (BioLock, BioHorizons, Birmingham, Ala). Apical drilling was done to accept two 3.5 mm × 13 mm (Ankylos, Tulsa, Okla) implants at 35 Ncm placement torque. The interproximal gaps were filled with demineralized freeze-dried bone graft mixed with beta tricalcium phosphate (Ceresorb, Research Triangle Park, NC). The flap was coronally advanced to cover the expanded alveolar crest and primarily closed with 3-0 chromic gut suture (Ace Surgical). A CBCT scan was taken to confirm dental implant placement. An acrylic temporary removable partial denture was soft lined, relieved, and delivered. The patient was prescribed hydrocodone as needed for pain. After the ridge expansion and placement of the implants, the resulting ridge width averaged 8.2 mm, as measured on the CBCT, giving a net width gain of 3.7 mm (Figures 7 and 8). The patient returned for follow-up appointments.

After 3 months of healing, the patient returned for restorations. She was administered 3.0 mL articaine (Septocaine), and the implants were uncovered with tissue punches. An analog impression (Genie, Sultan, Hackensack, NJ), centric record, and shade were taken and the healing abutments placed. One month later, the healing abutments were removed, the prepped abutments were placed, and the crowns were placed with provisional cement (Durelon and petroleum jelly, 3M-ESPE, St Paul, Minn) for the patient’s approval and functional assessment. The patient approved the esthetic and functional outcome and presented 1 month later for definitive cementation with resin cement (Premier Implant Cement, Premier USA) (Figures 9 and 10).

**DISCUSSION**

In these patients piezosurgery was used to minimize surgical trauma, preserve the cortices for support, and serve as a source of osteocytes for appropriate osseointegration of the implants.

Piezosurgery devices (Ace Surgical) consist of a titanium alloy tipped saw that oscillates with a vibration frequency in the 23–29 kHz range with a maximum 90 W power. Vibrational amplitude is 50 μm. Sterile water or saline irrigation is necessary to prevent thermally induced tissue necrosis. Generally, to make a bone flap, a full thickness exposure of the osseous crest may be done for access but a partial or split thickness is then performed to expose the ridge while preserving the blood supply imparted by the periosteum. The bone flap is created by crestal, vertical mesial, and distal cuts. The vertical mesial and distal incisions are prepared 1 mm from natural teeth and 7–11 mm deep, as needed to release the facial cortical flap, mobilizing it but keeping it attached at the osseo-mucoperiosteal base.

Motorized screw osteotomes of incrementally larger diameters from 1–4 mm (BioLock, BioHorizons) are used on an electric drive motor (W & H International, A-DEC Inc, Newberg, Ore) at 25 rpm. This mobilized and gradually expanded the bony flap, allowing access to the deep bone for osteotomy drilling. The ridge split procedure, in combination with immediate implant placement, has been previously reported by Scipioni and colleagues\(^9\) and Blus and colleagues.\(^{10}\) Additional case reports and studies have reported survival rates in the 97%–100% range.\(^{11–13}\) This procedure removes the need for onlay grafts taken from various sources (eg, ilium, maxillary tuberosity, symphysis of the mandible, and external oblique ridge). Thus, a second surgical site is avoided, thereby reducing morbidity.

Traditional ridge-split procedures involve chisels and rotating or oscillating saws or burrs. Bone chisels and osteotomes can be cut into bone by the impact of a surgical mallet, but the minor head trauma may induce a labyrinthine concussion and vertigo.\(^{14}\) However, with rotating saws or burrs the procedure is relatively atraumatic. With piezosur-
gery, the splitting procedure is less technique sensitive, and the risk of soft tissue injury is minimized. The bone incision in the horizontal and vertical directions can be easily performed without danger of damaging adjacent anatomical structures. In addition, the cavitation effect of the vibrating blade cleans the working area and maximizes visibility.

After ridge expansion, a gap can occur between the separated cortices, and a 2-mm gap may need to be filled with a graft material to enhance osteogenesis.\textsuperscript{10} The bone fill provides a scaffold for osteoconduction for the vital bone cells in the cortical plates. Osseous resorption of the crestal bone around implants may occur, but to minimize the clinical effects of this loss, the implants may be placed 1–2 mm below the bone rim.

The net ridge width gains in both patients described here were slightly more than the actual width of the implants placed. This is probably due to a lack of close intimate bone contact with the implants and the bending of the cortex to the facial.

When the ridge is split and expanded generally only the coronal portion is affected. The apical aspect is not displaced facially. As a result the apical encasing bone is not as thick facially as the coronal bone (Figures 5 and 6). Optimal marginal bone may be 1.8 mm at the facial coronal around an implant, but there is no known optimal bone thickness at the apical end.\textsuperscript{15} Because this aspect is not percutaneous and the bone is contiguous, there may not be adverse consequences for thin facial bone here. A facial osseous fenestration did not occur, but a fenestration may not be a clinical detriment. It may be that as long as encasing bone prevents a micromovement there will be no loss of bone, irrespective of the thickness. The supportive quality, related to the density and trabecular pattern, may be the important parameter for implant longevity.

A small amount of triple antibiotic ointment was placed on the cover screw during insertion to inhibit bacterial growth. It is important to remove all excess to prevent the petrolatum carrier from disturbing the healing process.\textsuperscript{16}

Bone expansion techniques for dental implants do have limitations related to the displacement of the facial cortex. When these procedures are performed flaplessly, there is an intact peristomeum that provides a blood supply and some physical support and containment of the displaced cortex. However, the limitations entail the cortical thickness available and the dimensional movement that may be required for the desired clinical result. No published work was found that describes the facial limitations of cortical luxation. Raising a full thickness surgical flap to perform a ridge expansion compromises the bone by removing the facial blood supply and the containment attributes of the periosteum and allows better visualization of the surgical site. A partial thickness flap preserves most of the advantages of the periosteum. Some atrophic sites may require more than 5 mm of facial augmentation for an appropriate esthetic and osseous supportive outcome. It is questionable if a ridge expansion can provide this extent of augmentation. These patients may be better treated with an extracortical block or particulate graft technique.

Piezosurgery may provide better healing but this has yet to be proven in human studies.\textsuperscript{8}

**CONCLUSION**

Edentulous ridge expansion with a piezosurgery device and motorized expansion screws for immediate implant placement may be a predictable surgical technique that is safe, less technique sensitive, and without significant risk of soft tissue injury. This technique may expand and create width for appropriate osseous support for implants with an acceptable esthetic outcome.

**ABBREVIATION**

CBCT: cone beam computerized tomography

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