Atraumatic Ridge Expansion and Implant Site Preparation With Motorized Bone Expanders

Ernesto A. Lee, DMD, DrCirDent*

The osteotome technique has been utilized for many years as a viable approach to expand atrophic ridges. Despite its effectiveness, the mechanical impact from the surgical mallet is not well tolerated by patients. Additionally, reports in the literature describe postoperative complications that include concussions and benign paroxysmal vertigo. These conditions can be alarming for the patient and clinician, as their effects may persist for several weeks. A new technique for atraumatic ridge expansion has been developed that introduces the surgical use of motor-driven instruments at low speeds.

Learning Objectives:
This article discusses the use of motorized bone expanders as a safe alternative to the osteotome technique. Upon reading this article, the reader should:
• Understand the role of limitations and risks associated with utilizing osteotomes.
• Become familiar with the advantages offered by motorized bone expanders, including increased control, reduced trauma, and greater precision.

Key Words: ridge expansion, bone expanders, osteotome, implant

*Private practice, Bryn Mawr, PA.
Ernesto A. Lee, DMD, DrCirDent, 976 Railroad Avenue, Suite 200, Bryn Mawr, PA 19010
Tel: 610-525-1200 • E-mail: ealeedmd@msn.com
Ever since their introduction in 1977, osteotomes have been utilized in a variety of techniques designed to elevate the floor of the maxillary sinus using a crestal approach. Summers subsequently adapted the use of osteotomes for the preparation of implant sites in the maxilla as an alternative to traditional drilling procedures. Techniques for expanding the atrophic edentulous ridge and treating the maxillary sinus prior to endosseous implant placement were also developed. These procedures have been subsequently modified by other clinicians. As a result, the osteotome technique has become widely utilized in situations requiring ridge expansion or less invasive sinus grafting alternatives than the lateral window approach or Caldwell-Luc technique.

Limitations and Complications
While effective in the anterior maxilla, the osteotome technique exhibits limitations when utilized in posterior areas. The instruments frequently encroach upon the facial soft tissues when treating second premolar or molar sites. Although osteotomes with angled offsets have been designed to circumvent this limitation, they are not as effective in transmitting compressive or expansion forces.

By nature, the osteotome technique is a traumatic procedure. The instruments are advanced with the impact of a surgical mallet, which compacts and expands the bone in the process of preparing osteotomy sites that will allow implant placement. Treatment of mandibular sites is often limited due to the increased density and reduced plasticity exhibited by the bone. Additionally, since the osteotome is inserted by hammering, the explosive nature of the percussive force that is delivered instantaneously provides limited control over the expansion process, which often leads to unintentional displacement or fracture of the labial plate of bone.

Many patients do not tolerate the osteotome technique well, frequently complaining about the impact from the surgical mallet. In addition, several reports have documented the development of a variety of complications (eg, labyrinthine concussion, benign paroxysmal positional vertigo) that result from the percussive trauma. Preparation of implant sites with osteotomes and a mallet transmits forces capable of detaching heavy inorganic particles from the otoconial layer of the utricular macula. The surgical positioning of the patient, with the head in hyperextension, favors the displacement of these particles into the posterior semicircular canal. Once the patient resumes a seated position, the particles deposit themselves on the ampullar crest, triggering an anomalous stimulus that results in vertigo. Symptoms include...
dizziness, nausea, and vomiting; in more serious cases, the patient’s gait could be imbalanced and the eyes may show nystagmus (ie, constant involuntary cyclical movement of the eyeball in any direction). The condition is considered self-limiting, usually with a duration of several days, but may last several weeks. If symptoms persist, treatment may include physical therapy, medication, chemical ablation, and surgery. Middle-aged and elderly patients exhibit increased susceptibility, particularly those with degenerative cervical spine disease that exhibit cervical proprioceptive dysfunction. 10,12

Atraumatic Implant Site Preparation

A technique has been developed that allows the atraumatic preparation of implant sites by eliminating the use of a surgical mallet. 13 This procedure is based on the use of a proprietary ridge expansion system that includes a bur kit and instruments known as motor-driven bone expanders (ie, BTI, Blue Bell, PA). The expanders are introduced into the bone with motor-driven rotation rather than hammer taps, which decreases surgical trauma while providing superior control over the expansion site. The thread pattern has been designed to compact bone laterally as the instrument advances into the osseous crest. This system allows expansion and preparation of implant sites in Type II and III bone, as well as compaction of Type IV bone.

Atrophic ridges frequently exhibit significant amounts of Type I bone. In addition to being difficult to manipulate, this bone also tends to guide the expansion toward the path of least resistance. With the traditional technique, the osteotome would be forced in a labial direction after encountering the denser Type I bone. 14

This situation would frequently result in expansion of the atrophic ridge purely at the expense of the labial plate, leading to an unusable site, inadequate primary stability, or to an implant placed in an excessively labial position. The motor-driven bone-expander system includes surgical burs that allow drilling into the cortical bone to improve control of the expansion so that the implant may ultimately be placed in an appropriately centered position within the expanded crest. Expansion may be initiated at a more palatal position, and then mechanically oriented in a labial direction by applying pressure on the bone expander as it rotates while advancing into the atrophic ridge.

Since they are operated with an electric handpiece, the expanders can be utilized in the anterior as well as posterior regions without impingement of the facial tissues or the positional limitations imposed by traditional...
osteotomes. Furthermore, the rotational control of the expansion permits treatment of the mandibular atrophic ridge. The system can be utilized by itself or with osteotomes and surgical drills to assist in the placement of a variety of implant designs. In the authors’ experience, this technique offers enhanced control of the application, timing, and direction of the expansion forces.

Clinical Technique
Site preparation begins with the use of the initial bur at a speed of 700 rpm to 800 rpm with irrigation, according to the manufacturer’s instructions (Figure 1). This bur will remain in place without vibration or “walking” movements, even when utilized on inclined surfaces or uneven residual ridges. The initial bur is used to a depth of 8 mm to 10 mm, creating an osteotomy of 1.5 mm in diameter. The specific drill and bone-expander sequence followed will vary according to the width of the atrophic ridge, the expansion characteristics of the site, and the desired diameter of the implant (Figures 2 and 3). Provided that the residual ridge is sufficiently wide, the 1.8-mm and 1.8-mm/2.5-mm burs may be subsequently utilized at 50 rpm without irrigation, followed by the #3 expander and, when indicated, the #4 expander (Figures 4 through 8). The bone expanders are driven by an electric handpiece used at speeds of 1.5 rpm to 30 rpm. The torque settings on the surgical motor should remain between 15 Ncm and 20 Ncm to prevent damage to the handpiece. Once sufficient resistance is encountered, expansion should then continue with a manual ratchet wrench. The instruments may be inserted in intervals, pausing to allow time for the bone to expand.

Since the bone expanders have a tapered design, it is important that the clinician possess a clear understanding of the dimensions involved in order to avoid excessive expansion that may compromise implant placement. The maximum diameter for each instrument is reached at the 15-mm-length marking. Clinical judgment must, therefore, be exercised to determine the degree to which the bone expander should be inserted in order to accommodate the length, diameter, and design of the implant selected.

Generally speaking, it is safer to keep the diameter of the expanded site less than the diameter of the implant. Final expansion of the site, however, will depend on the type of implant selected. Implants with a tapered,
self-tapping design may be placed into a more under-sized osteotomy; the only prerequisite is that the site should be prepared to an adequate width to accommodate the implant apex. Conversely, implants with a limited self-tapping ability should be placed into an osteotomy that closely approximates the dimensions of the fixture selected. This situation may require preparation with the corresponding final drill, following the utilization of bone expanders.

Clinical Applications
The authors’ clinical experience suggests that the motor-driven bone expanders may provide increased control over the expansion site, therefore allowing treatment of more severely atrophic ridges than previously possible with traditional osteotomes. Additionally, once the plastic capacity of the bone has been exceeded, this technique allows a gradual and controlled fracture of the buccal plate that may be deliberately induced to meet the expansion requirements. The displacement of the fractured segments may be closely monitored and, as long as adequate implant stability is achieved, the fracture site may be grafted and implant placement may be accomplished with a single-stage approach (Figures 9 through 13). Compared to the smooth-sided osteotomes, the threaded design of the motor-driven bone expanders prepares taps in the osteotomy site that facilitate the subsequent insertion of a threaded implant, and promote initial stability as well.

Furthermore, the dental professional’s enhanced ability to manipulate and expand the alveolar walls and interradicular crests may result in an increased number of sites that may be amenable to immediate posterior extraction implant placement and avoid the need for multiple-stage procedures. Sinus floor elevation may also be performed with these motor-driven bone expanders by utilizing a crestal approach to access the maxillary sinus and elevate the Schneiderian membrane (Figures 14 through 17). Due to their dimensions and blunt apical design, the #3 and #4 expanders are better suited for this purpose. Additionally, these instruments may subsequently be used to pack the grafting material. Although the narrower bone expanders may be utilized to penetrate the sinus floor, caution must be taken because of the increased risk of perforating the Schneiderian membrane.
Conclusion

The utilization of motor-driven bone expanders serves as an innovative technique that offers an atraumatic alternative to the traditional use of osteotomes. Motor-driven bone expanders may be utilized to treat maxillary and mandibular atrophic ridges, crestal sinus floor elevations, and post-extraction immediate implant sites. These instruments provide increased control of the bone expansion, which facilitates implant-site preparation while allowing universal introral use. Previously complex sites may now be treated with a one-stage approach provided that adequate implant stability is achieved. The motor-driven bone expanders enhance a clinician’s ability to manipulate implant sites in Types II, III, and IV bone while avoiding the potential complications caused by the percussive trauma generated with the osteotome technique.

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References


Figure 15. With the use of motor-driven bone expanders, the implant site was developed by expanding the interradicular bone into the adjacent sockets.

Figure 16. Adequate expansion allowed immediate placement of a 5-mm-diameter, wide-platform implant with no exposed threads and excellent primary stability.

Figure 17. The maxillary sinus floor was atraumatically elevated utilizing the blunt apex of the bone expanders through a crestal approach. Final implant length was 11.5 mm.
1. How is the implant receptor site developed in the traditional osteotome technique?
   a. With manual pressure and careful monitoring of the expansion site.
   b. Using the impact of a surgical mallet to advance the osteotome into the bone.
   c. Measuring the torque applied to the atrophic ridge with digital sensors.
   d. None of the above.

2. Which of the following is a documented complication resulting from the use of osteotomes?
   a. Benign paroxysmal positional vertigo.
   b. Lack of primary stability following implant placement.
   c. Increased prevalence of bone necrosis in the expansion site.
   d. Abscess formation.

3. Compared to the motor-driven bone expanders, what limits treatment of atrophic ridges with the osteotome technique?
   a. Inadequate control of the expansion process.
   b. Compromised healing ability of the expanded site.
   c. Implants placed with insufficient countersink.
   d. None of the above.

4. The motor-driven bone expander technique includes the use of which of the following?
   a. A high-speed handpiece with fiberoptic illumination.
   b. Specially adapted torque controllers.
   c. An electric handpiece to operate specifically designed rotary instruments.
   d. A reciprocating, latch-type contrangle.

5. Compared to osteotomes, motor-driven bone expanders can be more universally applied for which of the following reasons?
   a. They may be oriented at off-axis angles relative to the handpiece.
   b. Osteotomes are difficult to utilize in second premolar and molar sites.
   c. Angulation may be compensated during implant placement.
   d. Motor-driven bone expanders are available with different angled offsets.

6. Symptoms of labyrinthine concussion or benign paroxysmal positional vertigo include(s) which of the following?
   a. Dizziness and lack of equilibrium.
   b. Nausea and vomiting.
   c. Nystagmus.
   d. All of the above.

7. Which of the following statements is true regarding the use of motor-driven bone expanders to treat the atrophic ridge?
   a. It is atraumatic because it eliminates the use of percussive trauma.
   b. It requires modification of the flap design and suturing technique.
   c. It may enhance the plasticity of the bone if properly utilized.
   d. It is incompatible with certain implant designs.

8. How do motor-driven bone expanders allow increased bone manipulation?
   a. Through biologically driven instrument design.
   b. Through enhanced control of the application, timing, and direction of the expansion forces.
   c. Through reverse hydraulic surgical principles.
   d. Through a piezoelectric effect caused from the metal alloy.

9. Which of the following best applies to the motor-driven bone expander technique?
   a. It should be used in conjunction with implants with a stepped design.
   b. It should be used in conjunction with threaded root-form implants exclusively.
   c. It should be used in conjunction with pressfit, cylinder-type implants.
   d. It is adaptable for use with most root-form implants.

10. How may sinus lifts be performed with motor-driven bone expanders?
    a. Utilizing a lateral window approach or the Caldwell-Luc technique.
    b. Using only the blunt-tipped #3 and #4 expanders to avoid perforating the sinus membrane.
    c. In combination with the use of allograft blocks.
    d. All of the above.