LATERAL BONE CONDENSING AND EXPANSION FOR PLACEMENT OF ENDOSSEOUS DENTAL IMPLANTS: A NEW TECHNIQUE

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KEY WORDS

Endosseous implants
Bone resorption
Bone condensing
Bone expansion

Placement of endosseous dental implants can be a problem due to bone resorption if the patient has been missing teeth for a considerable period of time. In the literature, bone-grafting techniques have shown variable results. Additionally, bone grafting requires a longer treatment time and a need for a second surgery, and it adds significant cost to the treatment. These factors often discourage patients from having dental-implant treatment. Another technique for placement of dental implants in narrow bone ridges is repositioning and remodeling of alveolar bone by condensing and expansion with the help of bone osteotomes. This article presents 2 cases, 1 in the maxilla and 1 in the mandible, for placement of endosseous dental implants with the use of a new bone-expansion osteotome kit that utilizes a screw-type configuration for bone condensing and expansion.

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INTRODUCTION

Endosseous dental implants are now considered to be the treatment of choice for replacement of all forms of tooth loss, as long as no surgical or systemic conditions restrict their placement.[1–5] However, successful dental implant placement requires sufficient bone to be available in 3 dimensions. Knife-edge residual alveolar bone ridges or nonspace-maintaining defects of the alveolar bone limit or complicate the successful placement of dental implants. If a tooth or teeth have been missing for a considerable period of time, or if there has been traumatic loss of tooth and bone, placement of endosseous dental implants may prove challenging and often requires elaborate bone-grafting procedures. Unfortunately, bone-grafting techniques require a longer treatment time, a need for a second surgical appointment, and an additional surgical site if autogenous bone is used. This may add significant cost and complexity to the treatment. Additionally, despite major advancements in the last 10 years and availability of several bone-grafting materials, bone-grafting techniques have shown varying results in the literature.[6–10]

Another technique to place dental implants in the maxilla when Type III or Type IV bone is encountered is with the use of osteotomes.[11–13] Summers introduced this technique whereby vertical and lateral expansion could be achieved in the maxilla with the use of sinus-elevation osteotomes of increasing diameters.[11–13] The osteotome sinus-floor elevation (OSFE) was proposed for implant sites with at least 5 mm to 6 mm of bone between the alveolar crest and the maxillary sinus floor and mainly in soft or poor quality, as is often encountered in the posterior maxilla. For this purpose, a set of osteotomes (Summers' Osteotome Kit, Implant Innovations, Inc, West Palm Beach, Fla) with increasing diameters was used to prepare the implant site up to 1 mm to 2 mm within the sinus floor.

Two main types of osteotomes are currently available. The original "Summers' osteotomes," with a cup-shaped tip (Summers' Osteotome Kit, Implant Innovations), and the cone-tipped osteotomes are also available from several manufacturers such osteotomes by Steri-Oss Corporation (Yorba Linda, Calif). Additionally, angulated/bin-angled osteotomes are also available from several manufacturers such as Salvin Dental Specialties Inc (Charlotte, NC). All of these osteotomes are based on a "palm-held" design that can be problematic to use in the posterior maxilla due to limited mouth opening. Additionally, considerable care needs to be taken in their use due to the possibility of uncertain amount and direction of force being exerted toward the apex.

A new type of lateral bone expansion with burs is available (Meisinger, Jacksonville, Fla). It utilizes a "screw-type" configuration of expansion and condensing burs and threadformers in increasing diameters for lateral bone expansion and condensing for placement of an endosseous dental implant. The aim of these burs is to widen, rather than increase the depth of, the osteotomy. The screw shape of the 2 expansion burs and 6 fingers of ratchet-tightened threadformers allows for gradual horizontal expansion. Initially, the threadformers are tightened with finger pressure. Then, a disengaging ratchet that allows only half of a turn at a time is used by the surgeon who has to remove it from the holder and reengage it by repositioning. Unlike conventional dental-implant ratchets that can be reversed, this ratchet needs to be disengaged after each half turn from the holder and repositioned back to allow further rotation and tightening. This allows a slow and gradual expansion of the bone, as recommended by the manufacturer. The authors prefer to wait approximately 20 seconds to 30 seconds after each half turn. In our experience this gives sufficient time, especially if considerable resistance is felt while turning. Often, when considerable resistance is noted, the clinician may need to reverse a few threads and then retighten. This article describes this interesting technique in 2 case reports that present the use of this lateral bone expander in both the maxilla and the mandible.

MATERIALS AND METHODS

The materials used in this case report consist of the Meisinger Split Control Bone Expansion Kit (Meisinger USA, LLC, Jacksonville, Fla), as described next.

The Meisinger Split Control Bone Expansion Kit and technique

The Meisinger Split Control Bone Expansion Kit (Figure 1A and the Table) consists of 2 pilot burs (with diameters of 1.0 mm and 1.8 mm), a disk used for crestal-bone splitting, 2 expansion burs that allow condensing of the bone, and 6 threadformer burs. Except for the diamond disc, all burs and threadformers are available in a length of 15 mm. The deployment of a series of nonablative threadformers with increasing diameters leads to bone spreading and condensation (order of diameter and codification of the instruments must be respected). With the help of the carrier, the nonablative threadformers may be carefully screwed into the osteotomy site so as to spread the cortical bone and condense the cancellous bone (Figure 1B). The precondensed implant cavity increases the primary stability irrespective of the subsequent implant brand to be used. The properties of the Split Control system (Meisinger) allows for substance-saving densification of cancellous bone of sufficient horizontal dimension. This prepares the implant cavity for subsequent implant insertion. The contents of this kit are as follows:

- Incisal bur: The incisal bur is a trispade design (1.8 mm in diameter) mainly used to mark the osteotomy site. If used to the full desired depth, it will lead to an osteotomy measuring 15 mm in length.
- Diamond disc: This is a 0.080-inch-thick, extrafine diamond disc used to create a cortical osteotomy as shown in Case 2. The radius of the disc is 4.0 mm, but it is mainly used for about 2 mm to penetrate the

FIGURE 1. (A) The Meisinger Split Control Lateral Bone Expansion Kit. (B) Threadformer used for lateral bone expansion. (C) The 6 threadformers from left to right (2.7 mm–4.0 mm in diameter).

cortical plate and develop the crestal split.

- Two pilot burs: With diameters of 1.0 mm and 1.8 mm, these burs are used to reach the desired depth of the osteotomy according to the length of the implant to be used.
- Two expansion burs: With diameters of 2.3 mm and 3.0 mm, these burs are used for condensing the bone to the desired osteotomy. These are not meant for cutting; rather, they are used for condensing the bone.
- Six threadformers: In maximum diameters of 2.7 mm, 2.9 mm, 3.1 mm, 3.3 mm, 3.5 mm, and 4.0 mm at 15-mm depth (Figure 1A and 1C), these threadformers are conical in shape so that the diameter increases as maximum depth is reached. When using implants shorter than 15 mm in length, the clinician will need to measure the required depth. For example, if using a 10-mm-length implant, the clinician will need to stop the threadformers 4 threads short. This will provide an osteotomy depth of 10 mm. The width of the burs at 10- and 15-mm length is given in the Table.
- Two threadformer carriers: The short carriers are for posterior regions and the long ones are for the anterior regions.
- One driver or ratchet for the carrier: Unlike ratchets used for implant placement that click on a reverse turn, the ratchet used for driving the threadformers requires being lifted off the carrier after every half turn. This is a precautionary measure built into the system because it allows time for the bone to expand after each turn, thus ensuring a gradual spreading and expansion. The authors prefer to wait 10

TABLE
Component of the expansion kit

Component	Catalog No.	Length	Maximum Diameter at Collar	Diameter at 10-mm Depth	Purpose
Incisal bur	186RF	15 mm	1.8 mm	1.8 mm	To mark the osteotomy site
Diamond disc	943DC	N/A*	N/A	N/A	To help decorticate the crest of the alveolar ridge
Pilot drill (1)	A1001	15 mm	1.0 mm	1.0 mm	First of 2 burs used to reach desired osteotomy depth
Pilot drill (2)	D1001	15 mm	1.8 mm	1.0 mm	Second of 2 burs used to widen the desired osteotomy
Expansion bur (1)	A1003	15 mm	2.3 mm	1.5 mm	First condensing and lateral bone-expansion bur
Expansion bur (2)	D1003	15 mm	3.0 mm	2.5 mm	Second condensing and lateral bone-expansion bur
Threadformer bur (1)	A1005	15 mm	2.7 mm	2.2 mm	Condensing and lateral bone expansion using carrier or ratchet
Threadformer bur (2)	B1005	15 mm	2.9 mm	2.4 mm	Condensing and lateral bone expansion using carrier or ratchet
Threadformer bur (3)	C1005	15 mm	3.1 mm	2.6 mm	Condensing and lateral bone expansion using carrier or ratchet
Threadformer bur (4)	D1005	15 mm	3.3 mm	2.8 mm	Condensing and lateral bone expansion using carrier or ratchet
Threadformer bur (5)	E1005	15 mm	3.5 mm	3.0 mm	Condensing and lateral bone expansion using carrier or ratchet
Threadformer bur (6)	F1005	15 mm	4.0 mm	3.6 mm	Condensing and lateral bone expansion using carrier or ratchet

*N/A indicates not available.

seconds to 20 seconds between each half turn.

Case 1

Patient S.W., a 45-year-old female, presented for replacement of a missing maxillary right lateral incisor. The tooth had been extracted 3 years ago, and the patient was currently wearing an acrylic resin removable partial denture. The patient desired an implant-supported restoration, but wanted to avoid any bone-grafting procedure. Clinical exam (Figure 2A) revealed significant buccal concavity that would challenge an esthetic outcome due to buccal bone loss. It was decided to place a 10-mm length, 3.7-mm diameter Tapered Screw Vent implant by Zimmer Dental (previously Centerpulse, Carlsbad, Calif) with a rough, acid-etched surface using the Meisinger split-control spreading and condensing technique.

Preoperative antibiotics were prescribed to the patient prior to surgery. At the time of surgery, the patient was prepared in a sterile environment. A full-thickness mucoperiosteal flap was raised. This revealed further bone concavity on the buccal aspect. The osteotomy was started by using the pilot burs in 1.0-m diameter followed by the 1.8-mm diameter bur. This was followed by condensing of the bone using the 2.3-mm diameter condensing bur. Because the bone quality was subjectively judged to be Type III bone, it was decided to skip the 3.0-mm-diameter condensing bur and progress to the threadformers. Further osteotomy widening was started by the use of the thinnest threadformer (2.7-mm diameter) initially fitted to the threadformer carrier by hand and then by using the disengaging ratchet (Figure 2B). Extreme care was taken to proceed as slowly as possible. After each half turn, a 20- to 30-second waiting time was used before turning the ratchet another half turn. This is important because at each half turn, as the threadformer sinks further, the bone needs time to accommodate to the expansion. It should be stressed that rapid expansion would obviously result in fracture of the buccal bone plate and should be avoided. After each of the expansion burs had reached a depth of 10 mm (this was measured as when 4 threads were left exposed from the top), it was

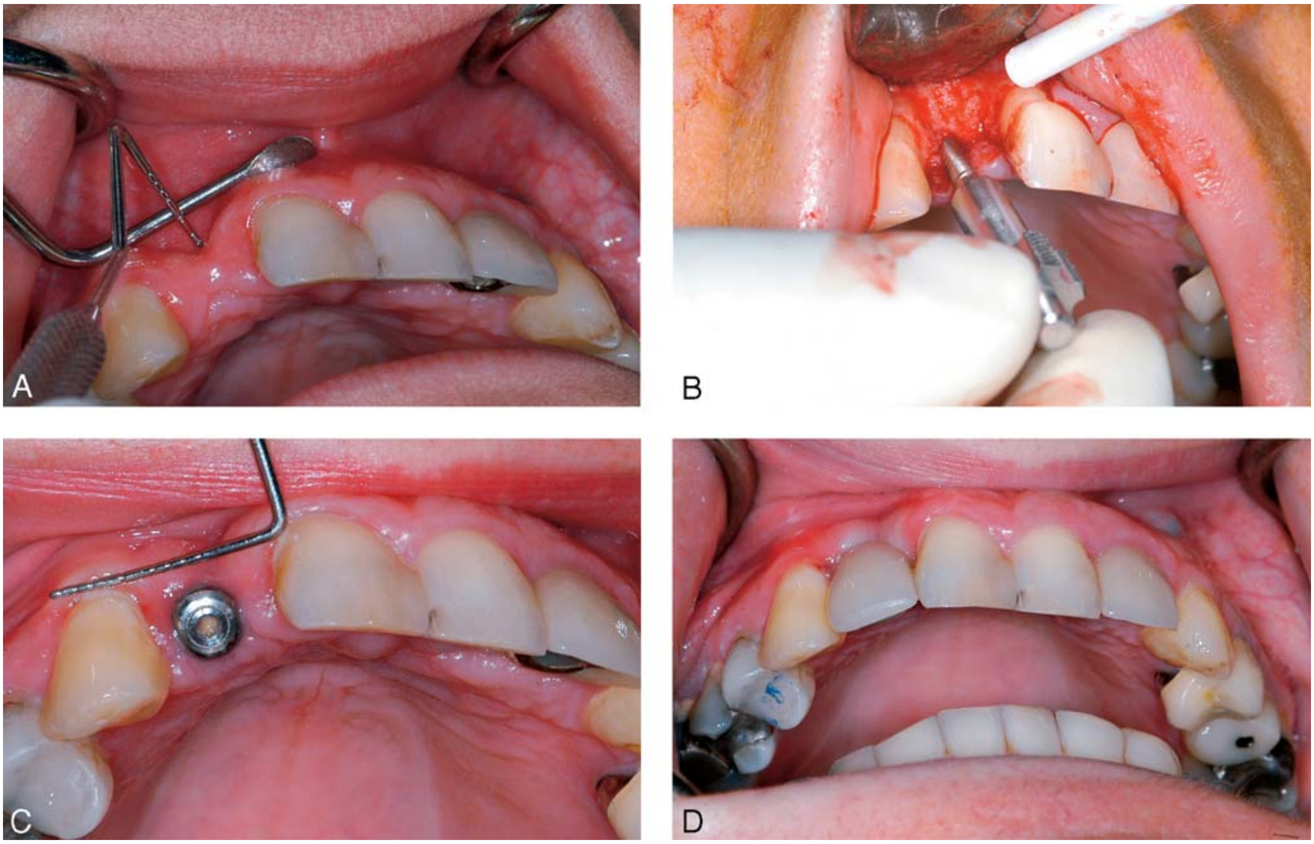

FIGURE 2. (A) Buccal bone loss secondary to tooth loss several years ago. (B) Threadformer being used in the pilot hole for lateral bone expansion. (C) A healing cap in place secondary to uncovery (6 weeks after implant surgery). (D) Final implant-supported crown in place. Significant buccal bone remodeling is evident.

allowed to ''sit'' in place for 30 seconds to 60 seconds. Once placed to the full depth of 10 mm, a periapical radiograph was taken to check for angulation. The final expansion bur prepared the site for approximately 3.5 mm to receive a 3.7-mm diameter Tapered Screw Vent implant (Zimmer Dental) with an acid-etched surface. Leaving the osteotomy slightly narrower than the diameter of the implant allowed the implant to be self-tapped and achieve good primary stability. It is worth mentioning that the tapered shape of the Tapered Screw Vent implant itself works as the final ''osteotome,'' assuring good primary stability. Primary stability was tested by torquing the implant to 30 NCm. The soft tissue flap was approximated, and primary closure was achieved. The patient was provided with home-care instructions and discharged. Six weeks postsurgery showed good soft-tissue healing. Three months postimplant placement, the implant was uncovered using a tissue punch and a healing abutment was placed (Figure 2C). The final implant-supported crown was inserted 2 weeks later (Figure 2D). Figure 2D shows the amount of bone expansion achieved and good esthetic results obtained without the use of any bone-grafting material.

Case 2

This case presents the expansion of bone in the posterior mandible. Due to the presence of hard cortical bone, the expansion technique for the placement of dental implants is considerably different. Figure 3A shows a partially edentulous patient missing the mandibular left molars and first premolar and both mandibular premolars on the right. Note the extremely thin mandible in the region of the right mandibular premolars. Figure 3B shows a sectioned preoperative cast exactly 7 mm from the distal surface of mandibular right canine. The patient was offered the option of block-graft augmentation by taking bone either from the chin or the mandibular ramus, then waiting approximately 6 months to 8 months, followed by implant placement. Then, the patient

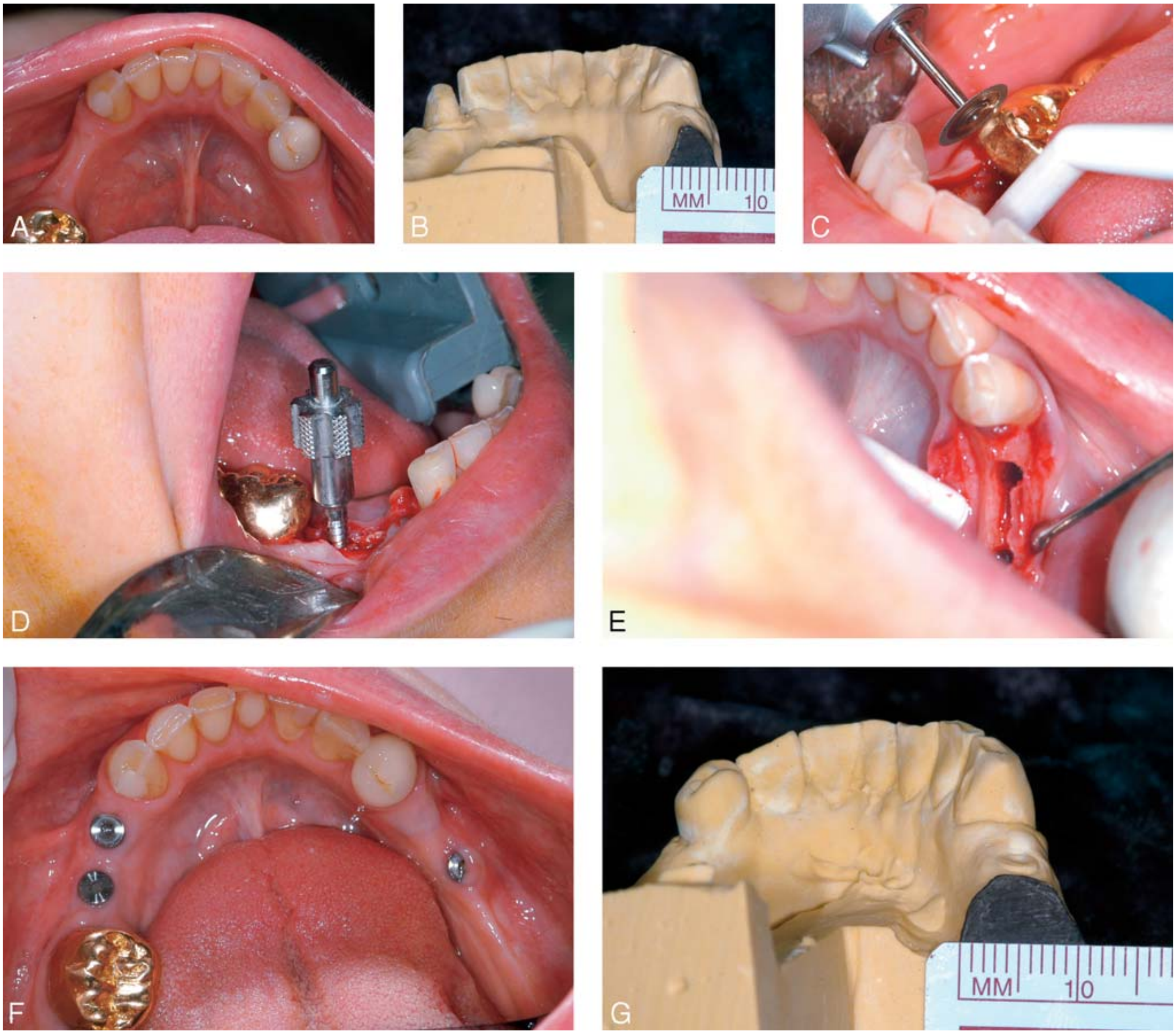

FIGURE 3. (A) Preoperative photograph showing thin bone in the area missing mandibular right premolars. (B) A sectioned preoperative mandibular cast in the area of the missing teeth. (C) A separating disc being used to decorticate the crest of the ridge. (D) The threadformers used in the pilot holes to split the bone and to widen the osteotomy. (E) The completed osteotomy site with minimal reflection of the flap. (F) Six-week postimplant healing. The exposed cover screws do not pose a determent to healing. (G) A sectioned postimplantation cast showing significant bone expansion. Compare with Figure 3B.

would possibly have to wait for another 6 months prior to final uncovery and prosthetic restoration. This was unacceptable to the patient. The second option was to try placement of dental implants by expanding the bone using the Meisinger bone-expansion system. The patient chose the latter due to reduce timed and cost, as well as not desiring an additional surgery to harvest the graft.

The site was anesthetized using ocal anesthetic in the immediate buccal and lingual vestibule. A crestal incision was used, but only minimal tissue reflection was done in order to preserve the periosteum attachment surrounding the buccal and lingual bone. This was done as it was feared that the buccal bone plate may crack. Keeping the periosteum intact would facilitate repositioning of the fragments and achieve good healing. Using a thin separating disk (Figure 3C) and then a 1.0-mm-diameter pilot drill, a thin trench was created 5.0 mm distal from the mandibular right canine extending to 5.0 mm from the mesial of the mandibular right first molar. The depth of the trench was maintained at 10 mm vertically, using the 1.0-mm pilot drill, which was the select length of the implants to be used. At each terminal end of this trench, the bur was pushed slightly toward the buccal wall to create a "weak" point for the buccal wall. This was done due to the hard cortical bone and to allow the entire buccal wall to expand. If a crack would appear, it would still be held in place by the intact periosteum.

The Meisinger expansion burs were then used in the 2 select sites where the implants were to be placed (Figure 3D). Care was taken to go only half way in diameter in the first site, and then start in the second site. This gradual alternating of the mesial and distal sites allowed equal expansion of the bone on both sites, along with uniform expansion (Figure 3E). Once expanded to the desired diameter, 2 Screw Vent Implants (Zimmer Dental) in 3.3-mm diameter and 10.0-mm length were used in the regions of the right mandibular first and second premolars. InterGro DBM (Interpore Cross International, Irvine, Calif) bone-graft material was used to fill the trench between the implants. Soft tissue was approximated, and primary closure was achieved.

Figure 3F is 6-weeks postimplant placement, and the surgical site was healing normally. Although the cover screws were exposed, this is not considered to be detrimental to normal healing and osseointegration. An irreversible hydrocolloid impression was made, and the poured cast was sectioned 7 mm from the distal surface of the right mandibular canine to evaluate bone dimensions. Figure 3G shows the comparative bone width secondary to bone expansion. As can be seen, a significant increase was achieved in the bone dimension that enabled placement of an endosseous dental implant. The clinicians intend to allow for approximately 5 months' healing prior to loading and final restoration.

Discussion

Bone expansion and compaction for the placement of endosseous dental implants, with or without adjunct bone grafting, is not new. Vertical bone compaction and elevation as proposed by Summers for sinus floor elevation with the use of osteotomes of increasing diameters is well documented.[11–13] The OSFE was proposed for implant sites with at least 5 mm to 6 mm of bone between the alveolar crest and the maxillary sinus floor. For this purpose, a set of osteotomes (Summers' Osteotome Kit, Implant Innovations, Inc) with increasing diameters was used to prepare the implant site up to 1 mm to 2 mm within the sinus floor.

An animal histologic study compared the osteotome technique to conventional implant placement with burs in 52 New Zealand white rabbits using 104 implants placed in the distal femoral condyles.[14] The implants were studied after 2, 4, and 8 weeks of placement. The authors concluded that the osteotome technique increases new bone formation and leads to an enhanced osseointegration of dental implants in trabecular bone. In a multicenter study, this technique has shown success rates as high as 96%.[15] Another recent study evaluated sinus elevation along with the osteotome technique in a longitudinal radiographic study and concluded that the osteotome technique represents a substantially less-invasive alternative for predictable implant installation in maxilla. The authors used Bio-Oss (Geistlich Sons Ltd, Wolhusen, Switzerland) mixed with autogenous bone along with the Summers' osteotome. The authors found that the grafted area apical to the implant undergoes shrinkage and remodeling and reported that the sinus floor boundary is eventually consolidated and replaced by newly formed cortical plate.[16]

However, despite the benefits of the Summers' osteotome technique, there are limitations because it is mainly designed for the maxilla. Additionally the "palm-held" design requires considerable force to be used, which can be intimidating for most clinicians because there is the risk of too much force been applied with resultant fracture of the osteotomy site. The Meisinger split control lateral bone expansion kit, as the name suggests, is mainly aimed at lateral bone expansion and, as such, it is quite different from the Summers' osteotome both in configuration of design as well as the technique of use. In summary, the major benefits of this design follow:

- Is an alternative to block grafting in select cases to increase ridge width for implant placement
- Allows immediate placement of implants in narrow ridges at the time of expansion
- Can be used in both the maxilla and mandible with some technique modification
- Utilizes controlled and gradual force application
- Requires less time from first surgery to final restoration as compared to the use of block grafts
- Does not require grafting, in most cases

- Is minimally invasive
- Is cost effective
- Can be used with most commercially available implants

Using the same concept of bone compaction and expansion as in the Summers' osteotomes, the Meisinger Split Control Lateral Bone Expansion kit uses increasing diameters of bone-condensing burs and threadformers of gradually increasing diameters. The use of threadformers of increasing diameter with a disengaging ratchet allows controlled, gradual expansion. This technique offers a viable alternative to bone grafting in select cases for lateral bone expansion where teeth have been missing for a considerable time with resultant buccal bone concavity.

CONCLUSIONS

Endosseous-implant placement using a bone-condensing-and-expansion technique is not new, and several studies have shown excellent bone response as well as implant survival using osteotomes for placement of dental implants in the maxilla. The key to proper expansion is a slow, gradual technique with controlled force application that leads to gradual expansion and minimal site trauma. The Meisinger Split Control Bone Expansion kit appears to be a viable mode of bone expansion. Long-term data regarding the outcome and success rates would require randomized studies to evaluate the predictability of this technique.

DISCLOSURE

The authors have no financial interest in any of the companies or any of the products mentioned in this article.

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