A Novel Technique for Osteotome Internal Sinus Lifts With Simultaneous Placement of Tapered Implants to Improve Primary Stability

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INTRODUCTION

"Primary stability" is a term coined by Branemark to describe the prerequisite for achieving osseointegration.[1] It is the stability of an implant body that is achieved during implant installation. Primary stability is determined by the structural and functional connection between the surgically created bone bed (osteotomy) and the implant. This stability is contingent upon bone density, macroscopic implant design, and surgical technique. Primary stability can also serve as a predictor of future osseointegration.[2] It has been considered essential for the success of dental implants.[3,4] Because implant stability vitally depends on bone quality and quantity, the posterior maxilla, with its poor inherent bone quality (Type III or IV) and compromised quantity (pneumatization of maxillary sinuses, thin spiny ridges), has been the most challenging area in which to achieve primary stability.[5–7]

In 1994, Summers[8] described a classical surgical protocol for use in the posterior maxilla. Primary stability is improved because of the increased bone-to-implant contact observed during the osteotome technique.[9] Furthermore, osteotomes have been successfully used to (1) aid in sinus membrane elevation via the crestal approach, (2) expand narrow ridges, (3) aid in immediate implant placement, and (4) improve implant stability.[10–13]

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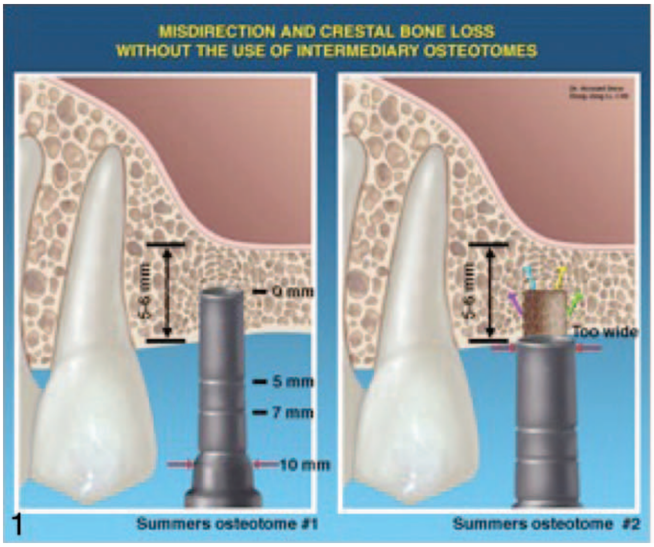
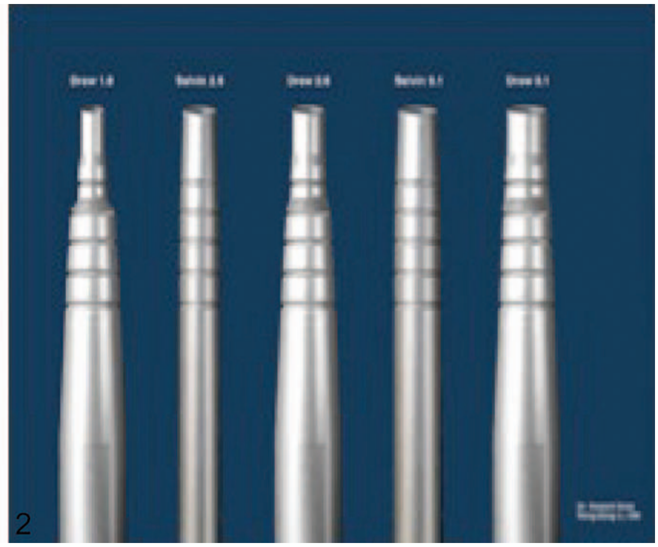
Another important parameter that can influence implant stability and that has been extensively investigated is implant geometry. Because of the minimal amount of cortical bone in the posterior maxilla (Type III or Type IV bone quality), the tapered implant design is preferred over a parallel design. A tapered implant can provide an additional degree of cortical bone compression, thus aiding in primary stability.[14,15] Tapered implants dissipate forces into the surrounding bone more uniformly than parallel-walled implants; therefore, they are associated with bone being compacted more uniformly in the adjacent osteotomy walls.[16] Olate et al[16] found histologic evidence of increased apical bone formation in tapered implants. These advantages become even more crucial in sinus floor elevation procedures where simultaneous implant placement is desired because in these cases primary stability is provided by a reduced amount of residual alveolar bone.[18]

In the present article we describe a novel technique that was developed specifically to improve primary stability of implants that are performed in conjunction with internal sinus floor membrane elevation. Implant length has been shown to be critically important in achieving primary stability.[19,20] Consequently, in cases where maxillary sinuses have become pneumatized and require sinus floor and membrane elevation, surgeons have to optimize as many parameters as possible to improve primary stability in reduced residual alveolar bone height in addition to low-density bone. Thus, we present a modified osteotome technique that is used to perform internal sinus floor and membrane elevation and to





Figures 1 and 2. Figure 1. Difficulties in preserving crestal bone and maintaing proper angulation without the use of intermediary (Salvin/Drew) osteotomes. **Figure 2.** Illustration of the sequencing of the intermediary (Salvin/Drew) and divergent (Salvin) osteotomes.

simultaneously place tapered implants. The modified Summers' technique[8] takes advantage of the parameters that can be controlled in order to improve primary stability (surgical technique and implant design). Martinez et al[21] recommended a protocol for implant placement in low-density bone in which they emphasized the importance of preserving a precise implant direction during osteotomy preparation. It is pertinent to point out here that the intermediary osteotomes used in the novel technique we introduce in this article help prevent deviation from the intended path because of their "piloting" quality (Figure 1). The modified osteotome technique was first described in 2007 by Drew et al.[22] The technique is based on the idea of using pilot drills as the operator increases the sizes of the standard drill dimensions to prevent deviation from the intended path and to avoid damaging the crestal cortical bone.

Countersink/pilot osteotomes are used in conjunction with tapered osteotomes to ensure that the initial pathway is maintained, condense the thin cortical plate, and provide ridge expansion. The crestal bone is enhanced, rather than compromised, as the osteotomy is widened (Figure 2). We hypothesize that this novel technique, in addition to improving primary stability, will allow for a more optimal osteogenesis.[9,23] Controlled histologic and clinical studies will be needed to further support this hypothesis.

Case Presentation

The proposed technique is schematically illustrated in Figure 3. Initially, accurate radiographic measurements are made from the crestal cortical bone to the floor of the sinus. Using a surgical guide the initial osteotome is tapped approximately 1 mm coronal to the base of the sinus floor. Salvin/Drew osteotomes (Charlotte, NC), along with Salvin sinus lift osteotomes, are then used in alternating sequence. When the operator is at the desired depth, a radiograph with parallel pins (directional indicators) is taken to verify the position. If the depth is correct the entrance of the osteotomy is widened and compacted with the use of the countersink/pilot osteotome. The 2.6 countersink/pilot osteotome will widen the entrance to accept a Salvin 3.1 osteotome. The graft material is then placed in the osteotomy, and the same 3.1 osteotome is tapped or pushed to the same final depth measurement. Keeping the same measurement enables the graft material to raise the sinus membrane and prevent perforations. This procedure is repeated multiple times to raise the sinus floor to the desired depth. In the case of placing a tapered fixture, the final shaping drill is used to prepare the osteotome before implant insertion. The shortest shaping drill should be used so as to not extend into the sinus and. thus, essentially only prepare the walls where virgin bone is found. Slight penetration into the grafted bone is allowed.

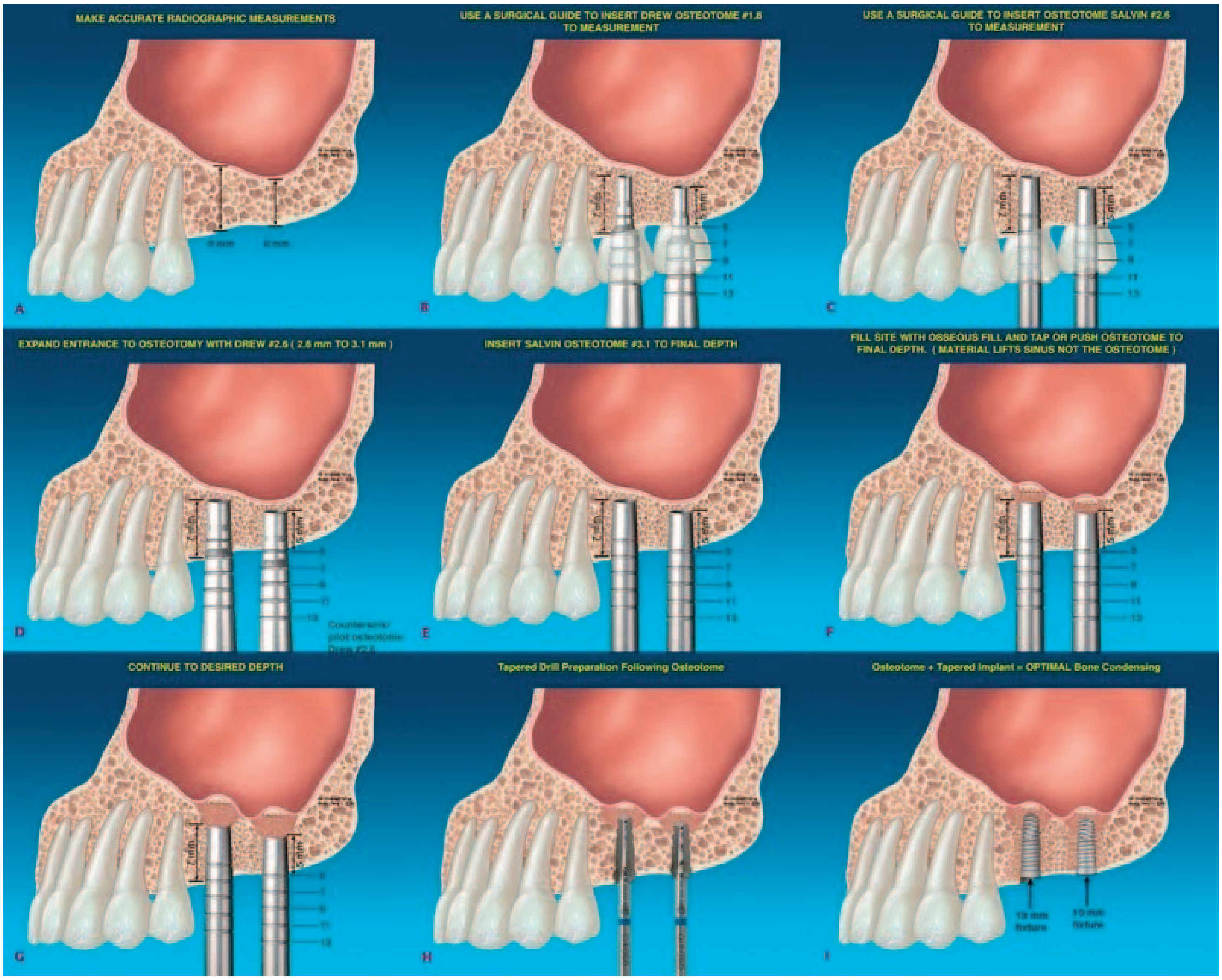


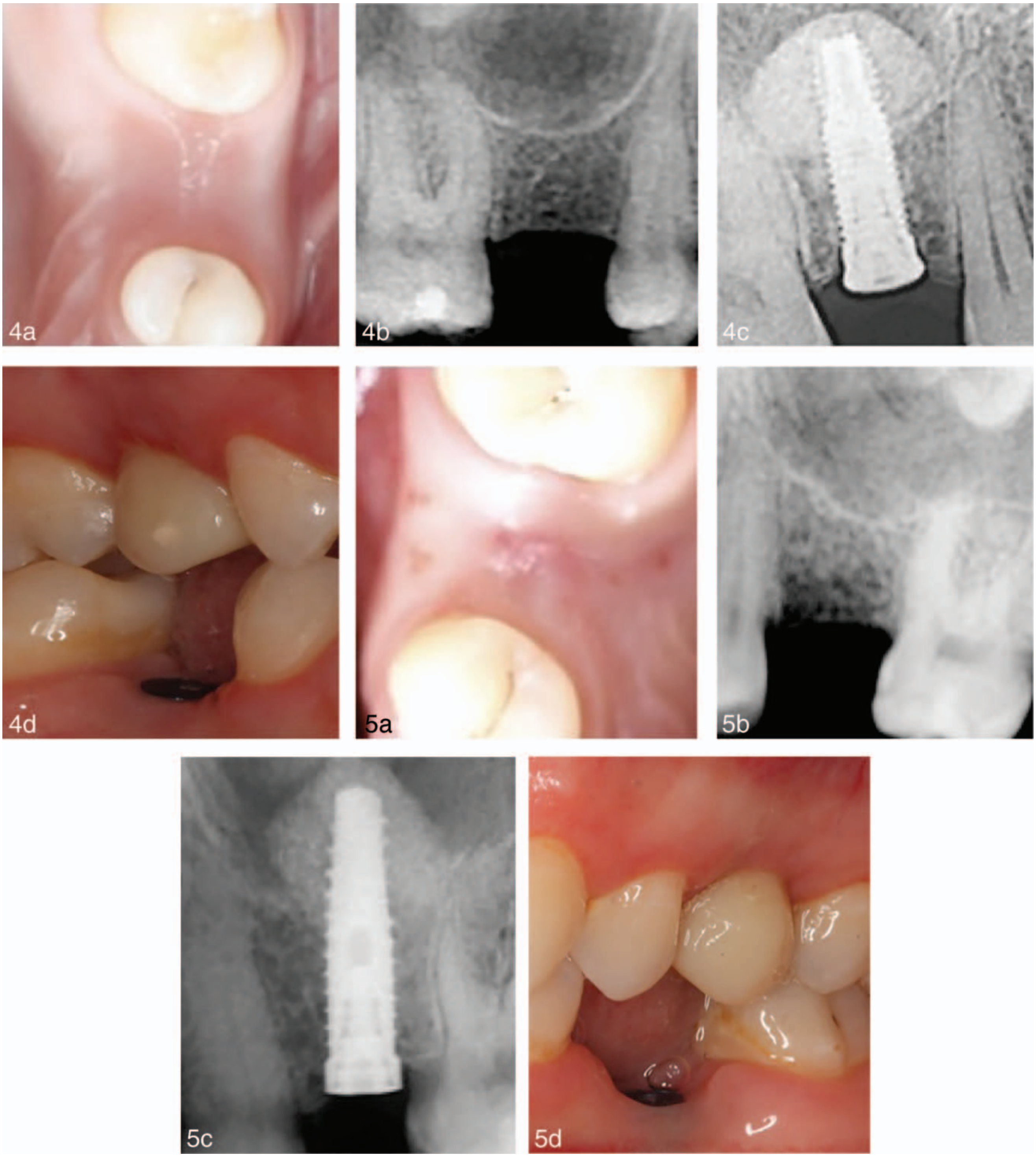
FIGURE 3. A combination of divergent and intermediary osteotomes is used to prepare the osteotomy during crestal sinus floor elevation. A surgical stent is used to mark the proposed osteotomies. Radiographic measurements are taken from the osseous crest to the floor of the sinus, and the osteotomies are prepared 1 mm short of the sinus floor to allow the bone graft to lift the floor of the sinus. The final shaping drill is used primarily in virgin bone before placing the tapered implant fixture.

In our case study a 35-year-old, healthy, partially edentulous female patient presented with bilaterally missing maxillary second premolars (Figure 4a and b). There was radiographic evidence of bilateral sinus pneumatization, and approximately 5 mm of residual alveolar ridge was present (Figures 4b and 5b).

The patient was examined using standardized clinical procedures, including medical and dental history, clinical examination, and necessary radiographs. Phase I therapy was completed with nonsurgical therapy, including full mouth scaling and oral hygiene instructions based on initial periodontal status. The patient gave informed consent according to the New Jersey Dental School Implant protocol.

The surgical procedures were performed under local anesthesia and aseptic conditions at the New Jersey Dental School periodontics clinic (Figures 4 and 5).

A custom-made surgical stent was used to guide the ideal restorative position of the implant sites. A flapless surgical protocol was performed with adequate keratinized tissue and adequate crest width upon bone sounding. Initial implant positions were marked with a #6 round bur. The osteotomy preparation, sinus augmentation, and implant insertion were performed as depicted in Figure 3.



FIGURES 4 AND 5. FIGURE 4. Osteotome sinus lift and simultaneous placement of parallel-wall fixture in the #4 edentulous area. (a) Preoperative intraoral view of the #4 area. (b) Preoperative radiograph shows inadequate vertical bone height in the #4 area. (c) Postoperative radiographic evidence of well-contained graft material and parallel wall implant fixture 4 × 13 mm. (d) Temporization of the #4 implant after 3 months of healing. **FIGURE 5.** Osteotome sinus lift and simultaneous placement of natural taper fixture in the #13 edentulous area. (a) Preoperative intraoral view of the #13 area. (b) Preoperative radiograph shows inadequate vertical bone height in the #13 area. (c) Postoperative radiographic evidence of well-contained graft material and tapered implant fixture 4/3 × 13 mm. (d) Temporization of the #13 implant after 3 months of healing.

Table

Implant stability quotient (ISQ) and insertion torque values at the time of implant placement

Implant Sites	Insertion Torque (Ncm)	Buccal/ Palatal (ISQ)
#4	40	73/72
#13	40	70/70

Although the preoperative computed tomography scans were not indicated in this clinical situation, the tactile sense of bone in both surgical sites resembled balsa wood, which corresponds to D3 (porous cortical and fine trabecular) Misch bone classification.[1]

The patient received a parallel-wall fixture (Nanotite 4 × 13 mm, 3i Biomet, Palm Beach Gardens, Fla) on the right side (Figure 4b) and a tapered fixture (Nanotite 4/3 × 13 mm, 3i Biomet) on the left side (Figure 5b). Implants were inserted by the conventional technique with a handpiece and, for the last 2 mm of threads, by using the manufacturer's torque wrench. Implants were placed with an insertion torque of 40 Ncm. Implant stability quotient (ISQ) values were measured using resonance frequency analysis at the time of placement (Table).

Postoperative medications consisted of amoxicillin (500 mg 3 times per day for 1 week) and ibuprofen (600 mg 3 times per day as needed for pain). The patient was instructed to rinse with 0.12% chlorhexidine gluconate mouthrinse twice a day for 30 seconds. Postoperative appointments were at 1 week, 2 weeks, 4 weeks, 8 weeks, and 12 weeks.

Discussion

In an attempt to improve bone quality and quantity at the implant site, we have introduced a novel technique that combines the use of intermediary/divergent osteotomes to internally lift maxillary sinus and the simultaneous insertion of the tapered implant fixture.

In 2001, Albrektsson[24] raised an important question: "Is surgical skill more important for clinical success than changes in implant hardware?" In an attempt to delineate the surgical skill factors from the implant design factors, we decided to use different implant designs for right and left sides. Consequently, in addition using a tapered implant to illustrate our proposed technique, we presented a contralateral case of parallel wall implant. Although we cannot draw any conclusions from this case report, based on our ISQ values, we can hypothesize that bone condensation with osteotomes might be a stronger contributing factor to implant stability than the implant design. Bone movement during osteotomy preparation is an important issue that needs to be considered when comparing this new technique to conventional techniques that use drills during the crestal approach to sinus floor elevation.[25,26] In contrast to the drilling technique, no bone is being removed by the osteotomes; thus, the compression of bone in the apicolateral direction contributes to local increase in peri-implant bone density. It is crucial to emphasize that in order to prevent bone necrosis[25] and benign paroxysmal positional vertigo,[27] the authors recommend that only divergent osteotomes be used while performing this technique.[8,13,21,28] With current technological advances that have led to recent improvements in implant hardware,[29,30] clinicians should not forget that the key factor for the long-term success of the implant is the stress distribution to the surrounding bone after loading, which depends largely on the quality of the surrounding bone.[31]

Although the precise mechanisms are not completely understood, it is clear that properly designed divergent osteotomes should be the key player in dealing with low-density bone. In view of that, Shalabi et al[32] showed that "densification" of bone at the apex of the implant was observed after the osteotome technique was performed. In addition, it was recently shown that the loosened bone fragments act as miniature autografts when they are incorporated into the newly formed peri-implant trabecular bone, thus contributing to osteogenesis.[33] We hypothesize that during the osteotome technique this effect is maximized because all bone is shaved by the osteotome and compressed in the apicolateral direction. However, more controlled clinical and histologic studies are needed to further investigate this.

Conclusion

Optimization of surgical techniques and implant design can synergistically contribute to improving both that quality and quantity of peri-implant bone in the posterior maxilla, thus improving success of the implants placed. In this article, we describe how a modified osteotome technique (intermediary and divergent osteotomes) can be used to internally lift the sinus by preserving crestal bone and condensing trabecular bone as well as how tapered implants can be simultaneously inserted to further contribute to improving the primary stability and minimizing the implant penetration into the maxillary sinus because of the geometric divergence of the implant design.

Abbreviation

ISQ: implant stability quotient

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