A Simple, Custom-Made Osteotome for Sinus Floor Elevation

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INTRODUCTION

The practice of endosseous dental implant surgery has evolved over the past several decades. While greater emphasis has been placed on the dental implant design1 and on the subsequent prosthetic rehabilitation,2 the addition of newer instruments to the surgical armamentarium has greatly improved the chances of success in implant placement.3

Insufficient bone volume is a common problem encountered in the edentulous posterior maxillae, and the sinus floor elevation technique is a relatively common procedure allowing the placement of longer implants in an ideal axial orientation.4,5 Summers introduced the bone-added osteotome sinus floor elevation (BAOSFE) technique in which vertical bone height is gained by retaining and relocating all the existing bone by incorporating bone graft into the osteotomy site prior to sinus elevation.6,7

In the classic BAOSFE technique, osteotomes of increasing diameters are gently introduced sequentially to expand the implant site with particulate graft added to the site prior to advancing each osteotome.5 However, the use of a series of osteotomes in advancing the floor of the sinus is not without its disadvantages.8 If the succeeding Summer’s osteotome does not passively fit in a previously prepared osteotomy site, a potential loss of parallelism between the osteotomy site and the osteotome can lead to membrane rupture. Additional crestal bone might have to be compromised just to obtain the correct path of insertion.9 Furthermore, tapping of the expansion osteotomes with the surgical mallet may induce benign paroxysmal positional vertigo in patients.9

Modern sinus lift procedures are heavily based on extensive surgical resources and expansive sinus lift kits and devices. Simplifying the procedure as well as the armamentarium also means faster surgery, less intra-operative discomfort and postoperative pain, a reduced risk of surgical trauma, and contamination and a quicker recovery time. Keeping these principles in mind, the objective of the present report is to describe the design of a simple and custom-made dental osteotome and its use in two cases requiring bone-added sinus floor elevation.

DESCRIPTION

Instrument design

The instrument was designed as a straight blunt-end convex osteotome to raise the floor of the maxillary sinus by facilitating the addition of bone graft into the osteotomy prior to sinus elevation. The important design mandate was that the instrument should be sufficiently able to expand and compact the ridge thus providing an ideal site for implant placement.

The custom-made osteotome comprises an elongated body, which tapers into a head with an intermediate connecting portion. The body has a has a hexagonal cross section, which progresses to a circular cross section into the head through an intermediate connecting portion (Figures 1 and 2). The head of the osteotome is conically tapered and has 2 circumferential notches in 5-mm increments from the tip of the cone which functions as a depth scale. The cone angle is about 104° and, if introduced into the osteotomy site until the second notch, has an ability to displace and create a space of 212 cubic millimeters. The surgical-grade stainless steel (conforming to IS 5583:1970, Bureau of Indian Standards) used in manufacturing this instrument was thermally treated to improve its mechanical properties, and was subjected to a passivation and polishing process in order to make the steel as stainless and smooth as possible.

Case reports

Case 1

A 26-year-old female presented for implant consultation for replacement of the maxillary right first molar. Her medical history was noncontributory. Radiographic measurement revealed bone height of approximately 7 mm at the implant site (Figure 3).

Case 2

A 48-year-old male desired replacement of missing maxillary right canine, premolars and molars. The average bone height available in the first molar region was 5 mm (Figure 8) and the patient was informed of the need for sinus elevation. A similar protocol was followed in both surgeries. Upon administration of local anesthetic, a crestal incision was made, followed by full-thickness flap elevation. Starting with the 2.2-mm initial drill, osteotomy was initiated to a depth 1 mm short of the sinus floor and then widened up to 3.4 mm...
corresponding to the width of the osteotome. The bone graft was driven by gently tapping the osteotome with a surgical mallet (Figures 4 and 9). Using the osteotome with the allogenic cancellous bone graft (Rocky Mountain Tissue Bank, Aurora, Colo), approximately 4–6 mm of sinus floor elevation was achieved (Figures 5 and 10). As soft low density (D4) bone was encountered, the final drilling sequence was skipped to achieve bone compaction and to improve the initial implant stabilization. Implants measuring 5 mm × 10.5 mm and 4.5 mm × 10.5 mm (BioHorizons Implant Systems, Katara Dental, India) were placed (Figures 6 and 11). The healing of the surgical site was uneventful and a significant bone gain and adequate sinus augmentation was observed in subsequent radiographs (Figures 7 and 12).

**DISCUSSION**

An instrument serves to extend the skill of a surgeon and ideal parameters that should be considered are hardness, edge retention, wear resistance, corrosion resistance, and biocompatibility.10,11

The main features of Summers osteotomes are a concave tip to deliver the bone graft, a sharpened edge to add shaved bone as an autogenous graft material, and a continuous taper to compact the layers of bone adjacent to the osteotomy.8 Concave osteotomes have sharp edges and tend to cause submicroscopic bone damage if used injudiciously.12 As opposed to concave osteotomes, which are sharp at the apex and transmit their dislocating force vertically, the convex osteocompressors laterally disperse the forces that tend to
Methods of osteotomy preparation using alternating concave and convex tips in progressive lengths allowing for both the vectors of osteocompression. However, we have utilized a convex, round-ended osteotome as, anecdotally, it minimizes puncture of the membrane even when it is in direct contact with it.

A revised surgical protocol was followed, which involved the initial preparation of the osteotomy site to a width corresponding to that of the custom osteotome and to a length 1 mm short of the sinus floor. The custom osteotome was used in a single-step procedure to intentionally lift the sinus floor and to deliver bone grafts into the osteotomy preparation. The osteotomy site was subsequently widened to accommodate the implant. This technique, which involves using a single osteotome with a diameter equal to the diameter of the osteotome burs to elevate the sinus is used in hydropneumatic sinuslift and sinus balloon techniques. In the hydropneumatic sinuslift technique, a tip called a “Trumpet” with a diameter equal to the diameter of the previous instrument expands the osteotomy site by pushing out the Schneiderian membrane by inserting a cooling solution from a piezosurgery unit. The technique followed is closer to Cosci’s technique of sinus elevation wherein the sinus membrane is exposed with the help of special lifting drills with a small cutting angle of 30° and a graft is placed into the site using a special “body-lifting” instrument.

During osteotome-assisted procedures, the lateral condensation of bone spongiosa is more critical than vertical condensation as it reduces pressure on the Schneiderian membrane reducing the risk of perforation. The compaction and condensation effect of multiple osteotomes alternatively used to raise the sinus floor results in an increase in the bone density around the osteotomy site. This leads to a higher percentage of bone-implant surface contact and is considered as one of the critical factors contributing to the success of implants placed in the maxillary posterior region. Whether or not a single osteotome can deliver the same results as using a series of osteotomes can be a function of the osteotome design, surgical technique and the bone quality encountered during implant surgery. Several factors might have contributed to the successful outcome in both the cases. The most important factor influencing implant survival with the BAOSFE is the preexisting bone height between the sinus floor and crest and implants placed in sites with preoperative bone of >5 mm show a success rate of almost 96%. The residual bone height in both the situations was >5 mm. As soft low density bone was encountered in both the situations, expansion by the custom osteotome and additional expansion achieved by “undersized drilling” during implant placement may have contributed to the successful osseointegration.

The department maintains a regular sinus lift kit; the custom-made osteotome, used in surgeries performed at a rural clinic maintained by the institution, where the residual bone height was between 7 mm to 9 mm facilitates a BAOSFE with simultaneous implant placement. This osteotome should not be considered as a substitute for the usual sinus lift armamentarium. Rather, we feel that it can be used in indicated situations with the aim of reducing the surgical inventory to permit easy cleaning, sterilization and mobility of the implant surgery kit. We conclude that we were able to fashion a simple instrumenMaybnt that fulfilled the surgical requirements of this specific case. Simplification of the armamentarium used in this procedure permitted the execution of sinus lift procedures at locations with limited resources with the same success rates and predictability as observed in the literature.
ABBREVIATION

BAOSFE: bone-added osteotome sinus floor elevation

REFERENCES