Immediate Implant Placement Following a Modified Trephine/Osteotome Approach: Success Rates of 116 Implants to 4 Years in Function

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Purpose: A technique is presented which utilizes a trephine with a 3.0-mm external diameter followed by an osteotome to implode a core of maxillary posterior alveolar bone prior to immediate implant placement. **Materials and Methods:** The technique and its indications and contraindications are described in detail. **Results:** One hundred sixteen implants were placed and uncovered utilizing this technique. Two implants were mobile at the time of uncovering. **Discussion:** One hundred fourteen implants were restored and have been functioning successfully for up to 4 years according to the Albrektsson criteria, yielding a success rate of 98.3%. **Conclusion:** No implants have been lost or are failing in function. (INT J ORAL MAXILLOFAC IMPLANTS 2002;17:113–120)

Key words: guided bone regeneration, implants, osteotome, sinus augmentation, trephine

The combination of buccolingual and apico-occlusal resorption patterns following tooth loss, pneumatization of the maxillary sinus, the final sinus position relative to the residual alveolar bone, and the often poor quality of remaining alveolar bone in the posterior maxilla frequently mandate hard tissue augmentation therapy prior to implant placement and subsequent prosthetic reconstruction.[1] Although sinus augmentation procedures with or without autogenous bone grafting have been demonstrated to result in significant increases in the apico-occlusal bone volume of the atrophic posterior maxilla, such therapies require a substantial commitment of time and expense.[2–8]

In an effort to shorten the length of treatment, lessen the financial challenge to the patient and decrease patient morbidity, Summers introduced osteotome techniques with or without the addition of particulate materials to achieve apical displacement of the sinus membrane and afford adequate

dimension for implant placement.[9–10] Recent publications have discussed the utilization of modified osteotomes to simplify the technical aspects of the procedure, as well as use of the osteotome technique at the time of maxillary molar extraction.[11]

Utilization of osteotomes to apically displace the floor of the sinus generally begins in 1 or 2 ways. One approach has utilized the narrowest tapered osteotome to compress bone, lift the floor of the sinus, and create the initial path of access for subsequent wider osteotomes. When significant alveolar bone remains coronal to the floor of the sinus, a marked amount of force must be applied to compress the residual alveolar bone. Such repeated force application is often disconcerting to the patient. An alternative therapeutic approach employs a 2-mm twist drill to come within 1 or 2 mm of the floor of the sinus and then prepare a channel for the utilization of osteotomes. However, if a 2-mm drill is first utilized to lessen the trauma to the patient, alveolar bone is prepared and removed from the site, which might otherwise be imploded when the floor of the sinus is lifted.

A technique which would both lessen the trauma to the patient and conserve the maximum amount of alveolar bone at the precise site of anticipated implant placement would offer clinical benefits.

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MATERIALS AND METHODS

Patient Selection
Following a thorough review of medical histories, patients were deemed unsuitable to receive augmentation therapy based upon the following criteria:

1. The presence of uncontrolled diabetes, immune disease, or other contraindicating systemic conditions
2. Radiation therapy to the head and neck region in the 12 months prior to proposed therapy
3. Chemotherapy in the 12-month period prior to proposed therapy
4. Uncontrolled periodontal disease, or patient unwillingness to undergo needed periodontal therapy around remaining teeth
5. An active sinus infection, or a history of persistent sinus infections
6. A smoking habit of 1 package of cigarettes per day or greater
7. A psychologic problem that in the opinion of the author would have rendered the delivery of comprehensive therapy untenable, including depressed states and extreme nervousness or agitation that would preclude the patient undergoing numerous, lengthy treatment visits
8. An unwillingness to commit to a long-term, post-therapy maintenance program

A complete examination of oral hard and soft tissues was carried out for each patient, and an overall treatment plan was formulated in conjunction with the treating restorative dentists. Panoramic radiographs were obtained for all patients by a certified dental assistant. Diagnostic casts, face-bow mountings on articulators, diagnostic wax-ups, and surgical templates were also utilized. Surgical templates were potentially useful at 2 stages of therapy; at the time of augmentation (as a guide to the desired final ridge dimension buccolingually and apico-occlusally), and at the time of implant placement.

One hundred sixteen sites in 103 patients were treated. Of these patients, 61 were women (59.2%) and 42 were men (40.8%). Patient age ranged from 31 to 72 years. All surgical therapy and preoperative and postoperative measurements were documented by the author.

Surgical Technique
A midcrestal incision was made at the anticipated site of implant placement. The mesiobuccal, distobuccal, mesiopalatal, and distopalatal aspects of the crestal incision were connected to 4 vertical releasing incisions. Buccal and palatal mucoperiosteal flaps were reflected in a full thickness approach. Ten

sites were treated without a reflected flap. In these sites, a circle of soft tissue was removed with a scalpel and curette from the alveolar crest at the anticipated site of implant placement.

A calibrated trephine bur (Ace Surgical Supply, Brockton, MA) with the largest external diameter of 3.0 mm was placed on the crest of the alveolar ridge at the anticipated site of implant placement. Utilizing preoperative radiographs and residual ridge morphology as a guide, the trephine was used to prepare the site to within approximately 1 to 2 mm of the sinus membrane at a maximum cutting speed of 500 rpm (Figs 1a and 1b). Following removal of the trephine bur, if the alveolar bone core was found to be inside the trephine, the bone core was gently removed from the trephine and replaced in the alveolar bone preparation. Such an occurrence was noted at 11 sites (Fig 1b).

A calibrated, offset osteotome (Bio Horizons, Birmingham, AL) was selected to correspond to the diameter of the trephine preparation (Fig 2a). The osteotome was utilized under gentle malleting forces, to implode the trephine bone core to a depth approximately 1 mm less than that of the prepared site (Fig 2b). Such measurements were possible because of the calibration on both the trephine and the osteotome.

Depending upon the diameter of the implant to be placed, therapy proceeded by 1 of 3 protocols:

1. If a self-tapping implant of 3.75 mm or 4.0 mm diameter (Implant Innovations, West Palm Beach, FL) was to be placed, it was placed at 30 rpm (Fig 3a). Seven implants of this type were placed.
2. If a non-self-tapping implant of 4.1 mm diameter was to be placed (Straumann, Waltham, MA), the 3.5-mm tap was first utilized at 30 rpm to a depth of 2 bur revolutions (Fig 3b). The implant was placed at 30 rpm. Seventy-two implants were placed in this manner.
3. If a non–self-tapping implant of 4.8 mm was to be placed (Straumann, Waltham, MA), successively sized osteotomes were utilized to enlarge the osteotomy site and apically displace bone from the walls of the osteotomy as it was enlarged, to a diameter of 4.0 mm (Fig 3c). The 4.2-mm tap was utilized at 30 rpm to a depth of 2 revolutions. The implant was next placed with a handpiece of 30 rpm (Figs 3d and 3e). Thirty-nine implants were placed in this manner.

Titanium healing caps were placed and the soft tissues were trimmed and sutured around the necks of the implants, so that the implants were placed in a nonsubmerged manner. Interrupted Gore-Tex
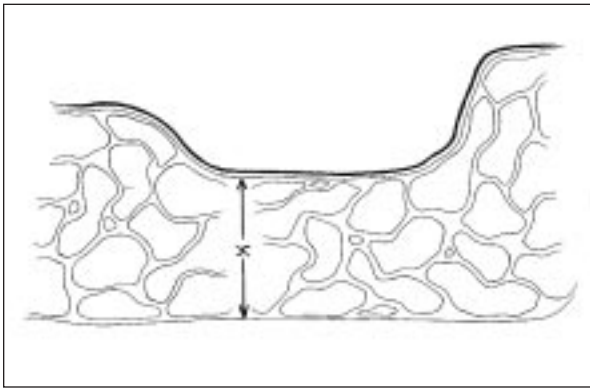
Fig 1a   Diagram of a pneumatized sinus area. X indicates the residual alveolar bone coronal to the floor of the sinus.
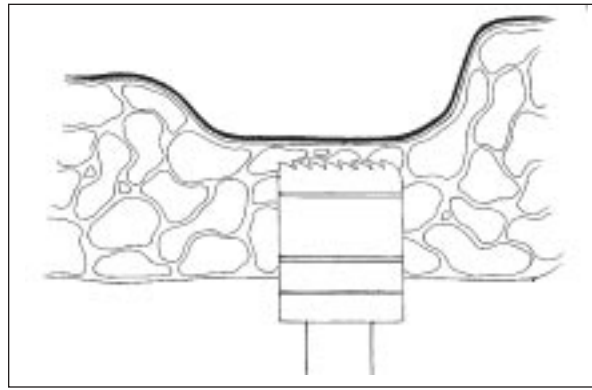

Fig 1b   A 3.1–mm–wide trephine is utilized at 500 rpm to prepare a site approximately 1 mm from the floor of the sinus.
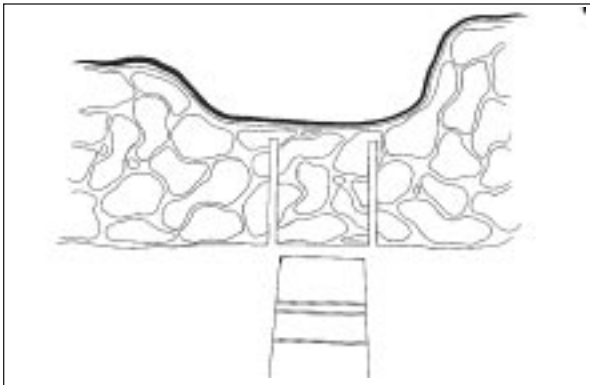

Fig 2a   A calibrated osteotome is chosen which corresponds to the diameter of the trephined core.
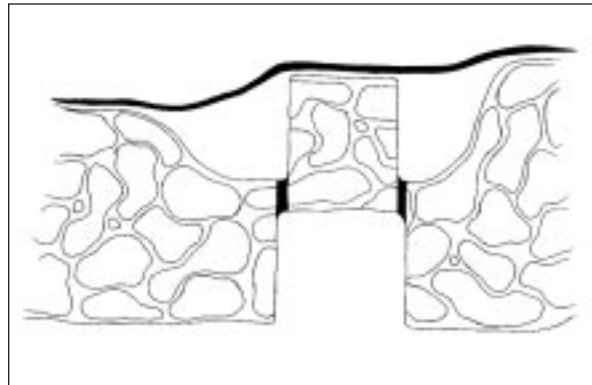

Fig 2b   The osteotome is utilized to implode the trephined core to a depth of 1 mm less than the initial trephine cut. Sequentially sized osteotomes are utilized to the same depth. The widest osteotome utilized will be 1 drill size narrower than the normal implant site preparation.

sutures (WL Gore, Flagstaff, AZ) were utilized to attain passive flap closure.

Postoperative Management

Medications prescribed included chlorhexidine rinses twice a day for 21 days, amoxicillin 500 × 40, 4 times daily (enteric coated erythromycin 400 × 30, 3 times daily was utilized in penicillin-sensitive patients), ibuprofen 600 × 20, 4 times daily unless medically contraindicated and pain medication (Tylenol with Codeine III or Percocet) as needed for pain.

Patients were not allowed to use any removable prosthesis until after the sutures were removed 10 to 12 days postoperatively. At that time, removable prostheses were adjusted, relined, and placed for cosmetic purposes only. Patients were not allowed to function with these restorations throughout the regenerative phase. Patients undergoing concomitant buccolingual or apico-occlusal ridge augmentation procedures with a nonresorbable membrane at no time were allowed to use removable prostheses over operated sites until regeneration had been deemed complete through radiographic and clinical examination. Chlorhexidine rinses continued for the total course of membrane retention when membrane exposure occurred. Gore-Tex membrane exposure occurred at 3 of the 109 sites treated. However, no membrane exposure was considered extensive enough to necessitate premature removal of the membrane.
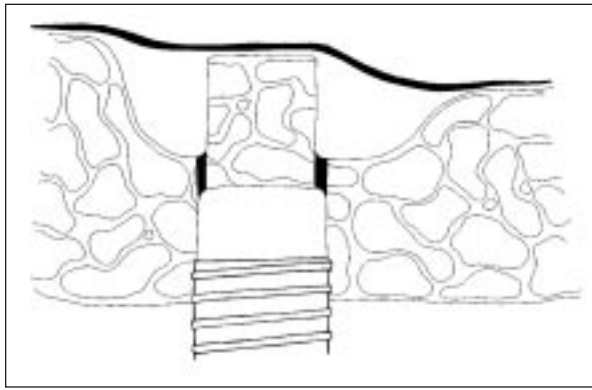
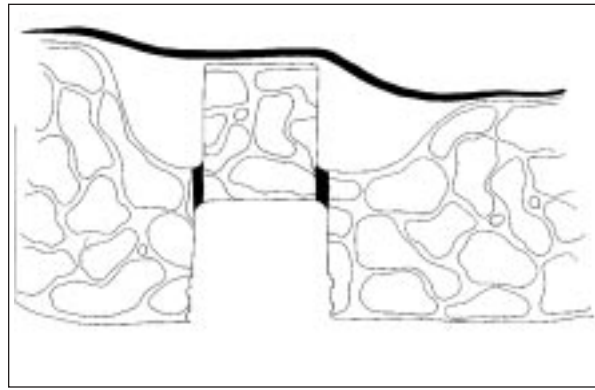**Fig 3a** The conventional sized bone tap is utilized at a speed of 30 rpms, to a depth of 2 revolutions.

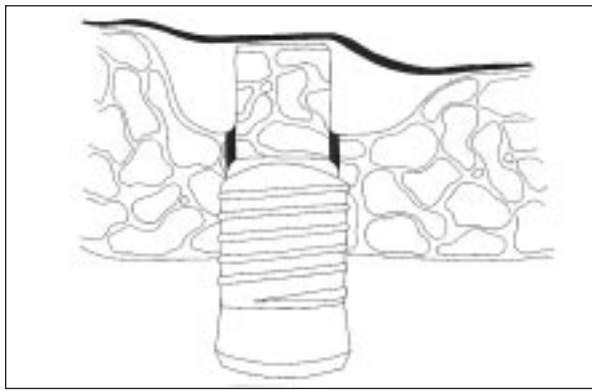**Fig 3b** Note the wider bone tapped coronal aspect of the undersized osteotomy site.

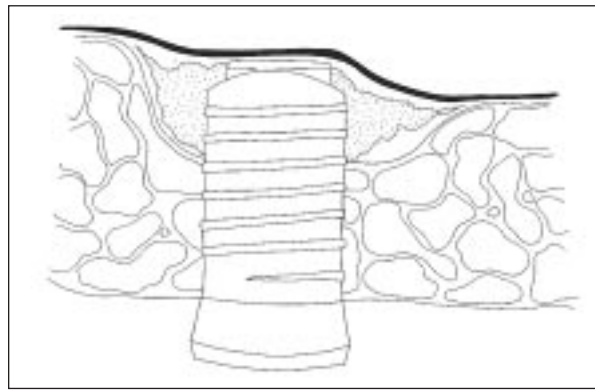**Fig 3c** The implant is placed at 30 rpm.

Fig 3d Implant placement results in dissipation or lateral dispersion of the imploded alveolar core with only gently, controlled displacement.
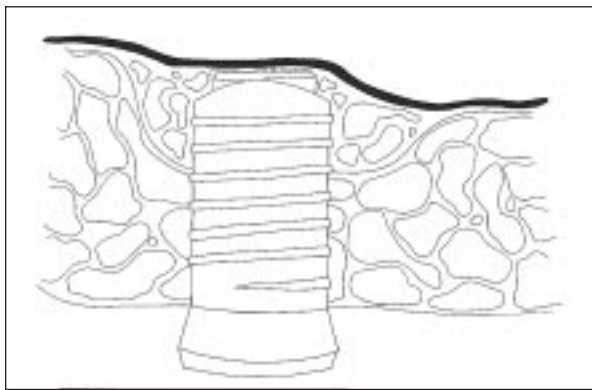
Fig 3e The implant is ensconced in bone following completion of regeneration.

Healing Time

All implants had abutments placed at 35 Ncm, 6 to 12 weeks postoperatively. The implants were temporized at the time of abutment placement. Temporization and restoration were accomplished by the treating restorative dentists.

Implant Restoration

Implant restoration proceeded in one of the following ways:

1. Restoration with a single cemented ceramometal crown
2. Restoration of 2 implants with a fixed partial denture
3. Restoration of individual implants as freestanding abutments to help support a natural tooth and implant retained removable partial denture

The implants were deemed successful if they fulfilled Albrektsson and associates' criteria under function,[12] as ascertained in the following manners:

Table 1	Implant Distribution by Time in Function			
	Time in function (months)			
	0–12	13–24	25–36	37–48
No. of implants	31	43	29	11

No implants failed in function.
Two implants were mobile at uncovering.

Table 2	Success Rates of Implants in Function				
Months after abutment connection	Implants at beginning of interval	Implant failures during interval	Interval failure rate	Cumulative failure rate	Cumulative success rate
0–12	116	2	2.0	2.0	98.0
13–24	83	0	0	0	98.0
25–36	40	0	0	0	98.0
37–48	11	0	0	0	98.0

All implants restored with individual crowns, or individual overdenture attachments, were tested for mobility. All implants restored with fixed partial dentures were tested for individual mobility after removal of the fixed partial dentures which had been cemented with temporary cement. Clinical judgement was utilized to ascertain a presence or absence of exudate, persistent inflammation, patient discomfort, or bleeding upon probing at the time of statistical compilation. Radiographic examination at the time of statistical compilation was utilized to ascertain the presence or absence of periapical radiolucencies, and the presence or absence of progressive bone loss greater than 0.2 mm annually after the first year of implant placement. Such determination of the presence or absence of progressive bone loss was greatly assisted by the morphology of the ITI implants utilized in the vast majority of the cases. These implants were placed in such a manner as to have the junction of the smooth and rough titanium surfaces of the implants at the level of osseous crest.

RESULTS

One hundred sixteen implants were placed following apical positioning of the sinus membrane through a combined trephine/osteotome technique, in 103 patients. Of these implants, 2 were mobile at the time of abutment placement and were removed (Table 1). One of the mobile implants was a 3.75-mm-wide by 10-mm-long self-tapping implant (Implant Innovations, West Palm Beach, FL). The other mobile implant was a 4.8-mm-wide by 7-mm-long non-self-tapping implant (Straumann, Waltham, MA). All other implants were successful in function when evaluated according to the Albrektsson criteria, resulting in an absolute success rate of 98.3% and a cumulative success rate of 98.0% (Table 2). Implant distribution by implant time and function and restorative modality is documented in Table 3. Implant distribution by implant length and restorative modality is documented in Table 4.

DISCUSSION

The frequent need to augment the atrophic posterior maxilla in anticipation of implant prosthetic reconstruction is well documented.[2–8] Utilization of osteotomes to effect apical repositioning of the sinus floor, with or without concomitant placement of particulate material prior to implant placement, has been developed in an effort to simplify and hasten therapy and decrease patient morbidity.[9,10,13] While such a therapeutic approach may not be applicable if significant buccolingual hard tissue ridge augmentation is required for ideal implant positioning, there is no doubt that utilization of osteotomes has greatly enhanced the delivery of successful implant-supported prostheses to the posterior maxilla.

Table 3 Distribution of Implant Time in Function by Restorative Modality

Restorative modality	Time in function (months)				
	0–12	13–24	25–36	37–48	Total
Single crown	29	41	17	5	92
2 implant-supported fixed partial dentures	0	2	10	4	16
Free-standing abutment for implant—natural tooth retained partial denture	2	0	2	2	6
Total	31	43	29	11	114

Table 4 Implant Distribution by Length and Restorative Modality

Restorative modality	Implant length placed in bone (mm)					
	7	8	9	10	11	Total
Single crown	13	4	39	30	6	92
2 implant-supported fixed partial dentures	2	0	9	2	3	16
Free-standing abutment for implant—natural tooth retained partial denture	0	0	4	2	0	6
Total	15	4	52	34	9	114

The technique presented offers a number of potential advantages. When 4 to 5 mm of alveolar bone remains coronal to the floor of the sinus, utilization of a trephine and an osteotome is less traumatic and disconcerting to the patient than repeated malleting in an attempt to compact this 4 to 5 mm of bone and lift the floor of the sinus with the initial osteotome entry. While some practitioners have suggested the use of a 2-mm twist drill to prepare a channel for the initial osteotome, thus eliminating the need for extensive malleting, such an approach has the disadvantage of removing a significant amount of alveolar bone from the site. The results attained utilizing this technique compare favorably with those of a recent multicenter study evaluating the bone-added osteotome sinus floor elevation technique.[15] This study documented the survival rate of 95.4%. However, the survival rate when 4 mm or less of alveolar bone remain coronal to the floor of the sinus prior to surgical intervention was 85.7%. The difference in survival rates in this study, when less than or more than 4 mm of residual bone remained prior to intervention, may be related to the length of the final implant placed compared to the residual alveolar bone presurgically. If a longer implant is to be placed when minimal alveolar bone is present presurgically, then the residual alveolar bone will have to be apically displaced well beyond the confines of the residual alveolar ridge, thus sacrificing control over the final postsurgical position of the apically displaced alveolar core.

Utilization of the proposed technique only displaces the trephine core apically to a distance approximately 1 mm less than the depth of the trephine cut, so as to avoid imploding the core beyond the bounds of the residual alveolar ridge. Greater control is thus established over the position of the apically displaced bone core, lessening the possibility of imploding the bone core through the sinus membrane. Such an occurrence would create a free-floating core whose position would be difficult to control.

Once the core has been properly positioned, no further malleting of the core is carried out, and no twist drill is utilized to further prepare the site. The only pressure to the core will be an implant rotating at 30 rpm during placement, leading to gentle compression of the core and its partial dissipation and/or displacement laterally surrounding the implant which is being placed. The final result is autogenous alveolar bone surrounding the apical extent of the placed implant beneath a containing sinus membrane (Figs 4a to 4c).

When simultaneous augmentation and implant placement are desired, it should be noted that the size of the implant to be placed is limited by the extent of the residual alveolar bone coronal to the

Fig 4a Inadequate alveolar bone remains coronal to the floor of the sinus for implant placement without perforating the floor of the sinus.

Fig 4b Following placement according to the aforementioned protocol, and subsequent healing, the implant is ready for restoration.

Fig 4c A radiograph of the implant after 4 years in function. Note the molar has been extracted.

sinus at the initiation of the procedure. The author has utilized a formula of 2x-2 as the maximum size of an implant to be placed following trephine/osteotome core implosion, with x equaling the dimension of alveolar bone coronal to the floor of the sinus prior to initiation of the procedure. For example, if 5 mm residual alveolar bone is present coronal to the floor of the sinus, a maximum implant length of 8 mm will be contemplated. If a longer implant is desired, the osteotome/trephine technique is utilized to implode the floor of the sinus at the anticipated site of implant placement, particulate material is placed in the osteotomy site, and a membrane is utilized to help facilitate bone regeneration. An implant is subsequently placed following maturation of the regenerating tissues, once again utilizing an osteotome and trephine technique to attain further apicoocclusal dimension for implant placement as required. This technique has been described in a previous publication.[14]

Although none of the implants studied in this paper have been in function for a period greater than 4 years, implant success in regenerated bone is well documented.[1–3,9–10] No implants were lost or failing in function. There was no correlation between implant length and implant success. However, examination of the data demonstrates that implants shorter than 10 mm were only placed in a noncountersunk approach, as advocated by the ITI protocol. As a result, and as to be expected from the findings of Hermann and coworkers,[15] no crestal alveolar cupping occurred at the time of abutment connection. The occurrence of such cupping following abutment connection to countersunk implants is presently considered a result of the body's attempt to establish a soft tissue relationship around the implant apical to the implant abutment interface (ie, "biologic width"). It has been consistently demonstrated that such a phenomenon does not occur if the neck of the

implant is placed 2 or more mm coronal to the crestal bone. An 8-mm implant placed in the aforementioned manner still demonstrates 8 mm as the apical occlusal extent of implant to bone interface following abutment connection and restoration. Such considerations theoretically allow the placement of shorter implants than if a countersunk implant placement technique were utilized. The ability to place "shorter" implants greatly expands the applicability of the technique presented in this paper.

CONCLUSIONS

The utilization of a combined trephine/osteotome technique allows a relatively atraumatic implosion of an autogenous alveolar bone core and the apical displacement of the floor of the sinus, in preparation for immediate implant placement. Implants placed utilizing this technique have demonstrated a success rate in function for up to 4 years of 98.3%. This technique offers specific clinical advantages

over other proposed therapeutic approaches.

REFERENCES

1. Bahat O, Fontanesi RV, Preston J. Reconstruction of the hard and soft tissues for optimal placement of osseointegrated implants. Int J Periodontics Restorative Dent 1993;13:255–275.
2. Kahnberg KE, Nystrom E, Bartholdsson L. Combined use of bone grafts and Brånemark fixtures in the treatment of severely resorbed maxillae. Int J Oral Maxillofac Implants 1989;4:297–304.
3. Adell R, Lekholm U, Grondahl K, Brånemark P-I, Lindstrom J, Jacobsson M. Reconstruction of severely resorbed edentulous maxillae using fixtures in immediate autogenous bone grafts. Int J Oral Maxillofac Implants 1990;3:233–246.
4. Tatum H. Maxillary and sinus implant reconstructions. Dent Clin North Am 1986;30:207–229.
5. Williamson RA. Rehabilitation of the resorbed maxilla and mandible using autogenous bone grafts and osseointegrated implants. Int J Oral Maxillofac Implants 1996;11:476–488.
6. Hurzeler MB, Kirsch A, Ackermann KL, Quinones CR. Reconstruction of the severely resorbed maxilla with dental implants in the augmented maxillary sinus: A five-year clinical examination. Int J Oral Maxillofac Implants 1996;11:466–475.
7. Fugazzotto PA, Vlassis J. Long-term success of sinus augmentation using various surgical approaches and grafting materials. Int J Oral Maxillofac Implants 1998;13:52–58.
8. Keller EE, Eckert SE, Tolman DE. Maxillary antral and nasal 1 stage inlay composite bone grafts: Preliminary report of 130 recipient sites. J Oral Maxillofac Surg 1994;52:438–447.
9. Summers RB. A new concept in maxillary implant surgery: The osteotome technique. Compend Cont Educ Dent 1994;2:152–160.
10. Summers RB. The osteotome technique: Part III: Less invasive methods of elevating the sinus floor. Compend Cont Educ Dent 1994;15:698–708.
11. Fugazzotto PA. Sinus floor augmentation at the time of maxillary molar extraction: Technique and report of preliminary results. Int J Oral Maxillofac Implants 1999;14:536–542.
12. Albrektsson T, Zarb G, Worthington P, Eriksson RA. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1:11–25.
13. Bruschi GB, Scipioni A, Bruschi E. Localized management of sinus floor with simultaneous implant placement: A clinical report. Int J Oral Maxillofac Implants 1998;13:219–226.
14. Fugazzotto PA. Treatment options for augmentation of the posterior maxilla. Implant Dent 2000;9:281–287.
15. Hermann JS, Buser D, Schenk RK, Cochran DL. Crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged and submerged implants in the canine mandible. J Periodontol 2000;71:1412–1424.