Clinical Outcomes of an Osteotome Technique and Simultaneous Placement of Neoss Implants in the Posterior Maxilla

Stefano Volpe, MD, DDS;* Massimiliano Lanza, DDS;† Damiano Verrocchi, DDS;†‡
Lars Sennerby, DDS, PhD§¶

ABSTRACT

Background: Insufficient bone volume often hamper placement of dental implants in the posterior maxilla.

Purpose: The aim of the present clinical study was to evaluate retrospectively the clinical outcome of implant placement in the resorbed posterior maxilla using an osteotome technique without adding any grafting material.

Materials and Methods: Twenty patients with 5 to 9 mm of residual alveolar bone height in the posterior maxilla received twenty-nine implants (Neoss Ltd., Harrogate, UK) using an osteotomy technique without bone grafts. Intraoral radiographs were taken before and after implant placement, at the time of loading and after 11 to 32 months of loading (mean 16.4 months), to evaluate bone formation below the sinus membrane and marginal bone loss. Implant stability measurements (Osstell™, Gothenburg, Sweden) were performed after implant installation and at abutment connection 5 months later. All implants were installed with the prosthetic platform level with the bone crest.

Results: No implant was lost giving a survival rate of 100% after a mean follow-up time of 16.4 months. The average vertical bone height was 7.2 ± 1.5 mm at placement and 10.0 ± 1.0 mm after 11 to 32 months. The average increase of 2.8 ± 1.1 mm was statistically significant. There was a statistically significant improvement in implant stability from 70.7 ± 9.2 implant stability quotient (ISQ) at placement to 76.7 ± 5.7 ISQ at abutment connection, 5 months later. The mean marginal bone loss amounted to 0.7 ± 0.3 mm after 11 to 32 months of loading.

Conclusion: It is concluded that the osteotome technique evaluated resulted in predictable intrasinus bone formation, firm implant stability, and good clinical outcomes as no implants were lost and minimal marginal bone loss was observed.

KEY WORDS: clinical study, dental implants, maxillary sinus floor augmentation, radiography, resonance frequency analysis

INTRODUCTION

Insufficient bone volumes often hamper placement of dental implants in the posterior maxilla and bone augmentation may be needed. In 1996,[1] a consensus conference on maxillary sinus grafting procedures proposed different treatment strategies depending on the amount of available bone: (i) in case of residual bone height (RBH) of classes C (4–6 mm) and D (1–3 mm), a lateral sinus lift approach with grafting material and immediate or delayed implant placement was recommended[2] (ii) for class B sites (RBH 7–9 mm), a *trans*-crestal approach using osteotomes was proposed, and (iii) in cases of class A (≥10 mm), no sinus procedure was regarded as necessary.

With the osteotome sinus floor elevation (OSFE) technique, a crestal approach is used to fracture and lift the sinus floor, where bone graft material and an implant can be inserted. During the osseointegration healing period (usually 6 months), bone will be formed

*Private practice, The Feltre/Fiera Implant Research Group, Feltre and Fiera Di Primiero, Rome, Italy; †private practice, The Feltre/Fiera Implant Research Group, Feltre and Fiera Di Primiero, San Dona di Piave, Italy; ‡private practice, The Feltre/Fiera Implant Research Group, Feltre and Fiera Di Primiero, Fiera Di Primiero, Italy; §private practice, The Feltre/Fiera Implant Research Group, Feltre and Fiera Di Primiero, Feltre, Italy and ¶Dept Biomaterials, Institute for Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden

Reprint requests: Dr. Stefano Volpe, Piazza del Fante n.10, 00195 Rome, Italy; e-mail: stefanovolpe@tiscali.it

DOI 10.1111/j.1708-8208.2011.00378.x

in the sinus to cover the apex of the implant. This technique was first described by Tatum in 1977 but was not published until several years later.[2] The Tatum technique required instruments such as burrs, curettes, and osteotomes. After drilling, a small osteotome was used to fracture the sinus floor and the membrane was lifted with curettes to create a space for graft material. The implant was most often placed after some period of healing.[2] In 1994, Summers reported on a modified and less invasive technique[3] using a set of osteotomes with increasing diameters. The osteotomes displaced the bone laterally and towards the sinus floor. The last osteotome was used to fracture the sinus floor and to push added graft and bone from the site under the sinus membrane. Finally, an implant was placed to push the membrane up to the desired height. Autogenous, allogenic, or xenogenic grafting materials could be added to fill the space created below the elevated sinus membrane. Clinical studies have reported high-implant survival rates after OSFE. In an 8-year retrospective study of 1557 implants using the osteotome technique, Chen and Cha underlined the importance of grafting materials together with osteotome technique exerting localized hydraulic pressure on the sinus membrane.[4] Recently, the necessity of placing filling material for sinus elevation with the OSFE procedure has been questioned. Winter and colleagues, suggested that when a space for a blood clot is maintained between the Scheiderian membrane and the sinus floor, this blood becomes bone.[5] Studies on primates reported that implants protruding into the maxillary sinus following elevation of the sinus membrane, without grafting material, exhibited spontaneous bone formation below the sinus membrane.[6] In a clinical study, Pjetursson and colleagues[7] radiographically evaluated tissue remodeling of 252 implants placed using the *trans*-alveolar technique with or without grafting material. It was concluded that only a moderate increase of new bone could be detected surrounding the implants placed without grafting material. Whereas a substantial increase of new bone was seen when grafting material was used.[7] The aim of the present retrospective study was to evaluate the clinical success of dental implants (Neoss Ltd., Harrogate, UK) installed using the osteotome technique in the posterior maxilla without adding any grafting material.

MATERIALS AND METHODS

Patients

The retrospective study group consisted of 20 patients (15 females and 5 males, mean age 48 years) who underwent installation of 29 implants (Neoss Ltd., Harrogate, UK) in the posterior maxilla from January 2007 to March 2008. The osteotome technique was used without additional bone grafts. Ten molar and 19 premolar sites were rehabilitated with crowns or short bridges. All patients were in good general health and with healthy periodontal conditions. Exclusion criteria included any medical condition generally contraindicating dental surgery, unchecked hypertension, insulin-dependent diabetes or cardiovascular disease. Smokers were not excluded from the study. All patients were thoroughly informed about the treatment and gave signed informed consent. The study followed the principles for human trials as described in the declaration of Helsinki. Intraoral radiographs, orthopantomographs, and (where relevant) computer tomography were used for presurgical examinations. The inclusion criteria were implant treatment required in the posterior maxilla and 5 to 9 mm of residual vertical bone height (VBH) below the maxillary sinus.

Clinical Techniques and Follow-Up

Local anesthesia (Mepivacain 2%, Saint-Maur-des-Fossès Cedex, France) was administered in the buccal and palatal regions of the surgical area. A crestal incision was made and extended in the buccal and palatal directions through the sulcus of the neighboring teeth. A full-thickness mucoperiostal flap was raised with no vertical release incision to avoid damage of the vascularization of the soft tissue. The implant site preparation started with the 2.2 mm pilot drill to a distance of 1 mm below the sinus floor. A radiograph was taken to confirm ideal position. Thereafter, osteotomes of increasing diameters of 1.6 mm, 1.9 mm, and 2.9 mm were used for preparation of sites for 4 mm wide implants. For 4.5-mm wide implants a final osteotome of 3.3 mm was used. The sequence of osteotomes increased the fracture area gradually and the concave tip pushed the bone/blood mix under the sinus membrane. The osteotomes were manipulated with one hand and continuously rotated to reduce friction. The final step before placing the implant was to check for membrane perforation by a Vasalva test. Subsequently, implants were placed without

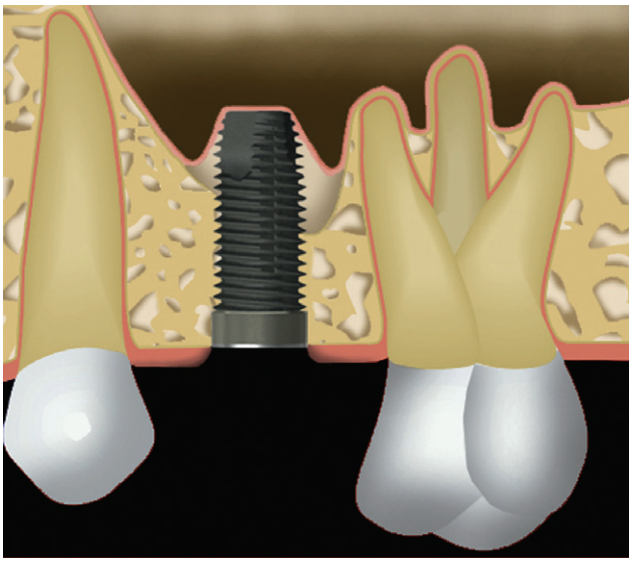

Figure 1 Schematic showing an implant placed into the maxillary sinus, lifting the sinus membrane, and bone debris after the use of osteotomes.

the addition of any graft material (Figures 1 and 2, A–D). Resonance frequency analysis (RFA) (Osstell™, Osstell AB, Gothenburg, Sweden) was used to measure the primary stability of the implants in implant stability quotient (ISQ) units. All patients received appropriate postoperative instruction, prescription of Amoxicillin (500 mg twice daily for 7 days), Ketaprofene 80 mg (twice daily for 3 days), and oral antiseptic. The sutures were removed after 10 days.

The implants were uncovered after 5 months of healing and checked for stability with RFA measurements. One month later the implants were loaded with provisional restorations and were restored a further 2 months later with a fixed metal-ceramic prosthesis (Figure 2E). The patients were re-called for follow-up checks after 3, 6, and 12 months (Figure 2F), and then annually after final restoration when intramural radiographs were taken with a paralleling technique.

Radiographic Analyses

Marginal bone levels (MBL) were evaluated in the intraoral radiographs taken at the day of surgery and at the latest checkup examination, after 11 to 32 months of loading. The distance from the prosthetic platform to the first bone contact was measured on distal and mesial aspects of the implants using a magnifying lens (×4.5, Carl Zeiss, Oberkochen, Germany) and a caliper. A mean MBL was calculated for each implant based on mesial and distal measurements. The VBH at each implant site was measured in preoperative radiographs by superimposing the position of the implant from postoperative radiographs taken at the latest follow-up visit. VBH was measured on mesial and distal aspects and given as a mean value for each implant site.

TABLE 1 VBH Immediately after Implant Placement and after 11–32 Months of Loading (Mean ± SD)

VBH at implant placement	7.2 ± 1.5 mm
VBH after 11–32 months of loading	10.0 ± 1.0 mm
Gain from placement to follow-up	2.8 ± 1.1 mm
Statistics	$p = .0001$

VBH = vertical bone height.

Statistics

The Wilcoxon signed-rank test was used for evaluation of VBH before and after surgery. The Spearman correlation test was used to find possible correlations between MBL and implant diameter. A statistically significant difference and correlation was considered if $p < .05$ (Stata 10.0, Stata Corp., College Station, TX, USA).

RESULTS

Healing was uneventful and no implant was lost during the loading period of 11 to 32 months, giving a cumulative survival rate (CSR) of 100%. The mean VBH was 7.2 ± 1.5 mm prior to surgery and 10.0 ± 1.0 mm after 11 to 32 months of loading. The gain of 2.8 ± 1.1 mm was statistically significant ($p = .0001$) (Table 1) (Figure 1). Implant stability was 70.7 ± 9.2 ISQ after placement and 76.7 ± 5.7 ISQ after 5 months of healing ($p = .0001$) (Table 2) (Figure 2). Only one implant showed poor primary stability, 49 ISQ, which increased to 68 ISQ during healing. The mean MBL after 11 to 32 months was 0.7 ± 0.3 mm. There was a significant inverse correlation between implant diameter and MBL ($r_s = -0.41$, $p = .027$).

TABLE 2 Implant Stability after Implant Placement and at Abutment Connection

	ISQ
Implant placement	70.7 ± 9.2
Second stage surgery (5 months)	76.7 ± 5.7
Statistics	$p = .0001$

ISQ = implant stability quotient.

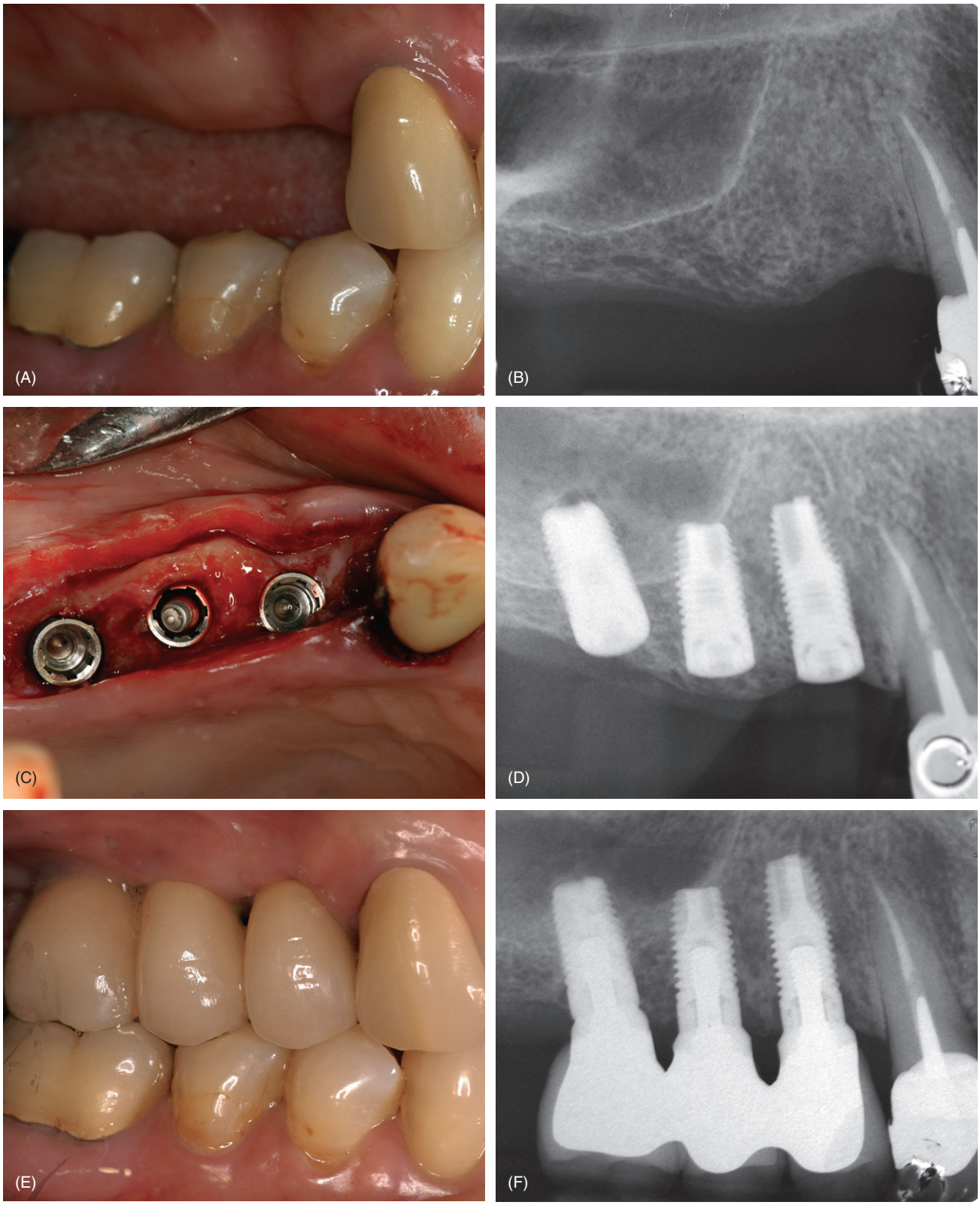

Figure 2 (A) Clinical photo prior to treatment. (B) Preoperative radiograph. (C) Showing three implants where the most distal was placed using the osteotome technique. (D) Postoperative radiograph. (E) Showing final prostheses. (F) Follow-up radiograph after 1 year. Note bone formation at the apex of the distal implant.

DISCUSSION

The placement and restoration of dental implants in the edentulous posterior maxilla can potentially be compromised by the lack of adequate residual alveolar bone. A minimum of 10 mm VBH has been considered as a requirement for predictable implant success.[8,9] Different grafting techniques using a lateral approach to the maxillary sinus and inlay with autogenous bone, allografts, xenograft, alloplastic materials, and mixture of various materials have been described in the literature.[10]

However, when the RBH is 7 to 9 mm, an osteotome technique can be used to provide bone to cover the implants. With this less invasive procedure, access to the sinus floor is created with sinus osteotomes through a crestal approach and the implant is usually inserted in conjunction with the procedure.[11,12]

The present study showed that careful elevation of the sinus membrane with osteotomes without additional grafting material resulted in predictable bone formation at the maxillary sinus floor. No implants were lost and the marginal bone resorption was 0.7 mm after 11 to 32 months of loading. The osteotomes are used to gradually expand the implant site, compressing and apically pushing bone, thus improving localized bone density. The improved density of the implant site enhances the implant's primary stability.[13] In fact, a clinical study has suggested that the osteotome technique significantly improves the success rate of implants in type 4 bone.[14]

Although no control group was used in the present study, the ISQ measurements showed firm stability of the implants with a mean of 70.5 ISQ at placement, which increased to 76.7 ISQ after 5 months of healing. Low-primary stability was only experienced in one case of low-bone density. In spite of underpreparation and using a wider implant, a stability of 49 ISQ was achieved. However, after 5 months of healing the ISQ value had increased to 68, which indicated a favorable tissue response.

The RBH seems to be the most important factor influencing implant survival with the OSFE technique. In a retrospective analysis of consecutive cases from nine clinicians in eight centers, 147 implants placed in 101 patients with a loading period from 6 months to 66 months were evaluated. The survival rate was 96% when bone height was 5 mm or more and dropped to 85% when the pretreatment bone height was 4 mm or less.[15] In another study, it was observed that the implants placed with an RBH ≤ 4 mm had a failure rate of 26.7% compared with 5.1 to 5.5% for implants placed in 5 to 7 mm of bone.[16] In the present study, RBH was 5 mm or more, which may explain the good clinical result.[17,18]

The main disadvantage of this technique is that perforation of the Scheiderian sinus membrane may occur.[19,20] However, several clinical studies reported that the perforation did not increase the risk for implant failure.[21,22] In a recent study evaluating 588 implants placed in 323 consecutive patients with RBH ranging from 6 mm to 9 mm, only 13 perforations were detected, resulting in a perforation rate of 2.2%.[23] In another study of 252 implants in 181 patients, the prevalence of membrane perforation detected by the Valsalva test was 10.8% while postoperative infection was rare (0.8%).[7] In our study, one perforation was detected by the Valsalva test on the site where we had 5 mm of RBH, but no further complications occurred and the implant was loaded with success. The advantages of this technique are clear. It is less invasive and results in less postoperative discomfort for the patient than a conventional lateral sinus lifting approach. Historically, clinicians have used different graft materials in conjunction with maxillary sinus floor augmentation, such as autogenous bone and allogenic or xenogenic grafting material, which has resulted in high-implant survival rates.[24–27] Graft materials have also been used with the OSFE technique; Summers used a mixture of 40% autogenous bone chips, 40% demineralized bone allograft, and 20% resorbable hydroxyapatite.[11] Recently, clinical studies have shown that bone can be gained at the maxillary sinus floor without the use of any additional bone grafts, as the mere elevation of the sinus membrane results in predictable bone formation.[28,29] In a similar way, Nedir and colleagues[30] reported good outcomes for OSFE without graft material as a 100% implant survival rate after 3 years was reported. In that study, 25 implants were placed in 17 patients to rehabilitate 16 molar and 9 premolar sites with a mean RBH of 5.4 ± 2.3 mm. After 3 years of loading, the mean gain of bone was 3.1 ± 1.5 mm.[30] Their results are in line with those of the present study as no implants were lost and a bone gain of 2.8 ± 1.1 mm was observed after a mean follow-up time of 16.4 months.

Pjetursson and colleagues[7] evaluated bone remodeling after maxillary sinus floor elevation using an osteotome technique with or without grafting material. A total of 181 patients received 252 implants; 88 (35%)

were placed with graft material and the remaining 164 (64%) without any material. They concluded that bone remodeling was more pronounced when graft material was not used.[7] It has been shown that the human maxillary sinus membrane has an osteogenic potential as histology showed bone formation at ectopic sites following transplantation of cells derived from the sinus membrane and in conjunction with an osteoconductive scaffold.[31] In an experimental study in primates on membrane elevation and simultaneous insertion of implants, an intimate relation was seen between the membrane and newly formed bone.[32]

The purpose of the present study was also to evaluate the marginal bone loss from fixture installation to the last checkup examination (mean 16.4 months). The mean bone loss was 0.7 mm, which is within the ranges previously reported for this and other implant systems.[33–36] The wider implants with diameter 4.5 or 5.0 mm showed an unchanged bone level or minor bone loss, which is in accordance with recent studies.[34,37]

It is concluded that Neoss implants and the osteotome technique described can be simultaneously used to augment the maxillary sinus floor without additional grafting materials.

ACKNOWLEDGMENT

The authors acknowledge Dr. Emanuele Leoncini for his assistance with the statistical analysis.

REFERENCES

1. Jensen OT, Shulman LB, Block MS, Iacone UJ. Report of the sinus consensus conference of 1996. Int J Oral Maxillofac Implants 1998; 13 (Suppl):11–32.
2. Tatum H Jr. Maxillary and sinus implant reconstructions. Dent Clin North Am 1986; 30:207–229.
3. Summers RB. A new concept in maxillary implant surgery: the osteotome technique. Compend Contin Educ Dent 1994; 15:152–160.
4. Chen L, Cha J. An 8-year retrospective study: 1100 patients receiving 1557 implants using the minimally invasive hydraulic sinus condensing technique. J Periodontol 2005; 76:482–491.
5. Winter AA, Pollack AS, Odrich RB. Placement of implants in the severely atrophic posterior maxilla using localized management of the sinus floor: a preliminary study. Int J Oral Maxillofac Implants 2002; 17:687–695.
6. Boyne PJ. Analysis of performance of root-form endosseous implants placed in the maxillary sinus. J Long Term Eff Med Implants 1993; 3:143–145.
7. Pjetursson BE, Rast C, Bragger U, Schimidlin K, Zwahlen M, Lang NP. Maxillary sinus floor elevation using the (transalveolar) osteotome technique with or without grafting material. Part I: implant survival and patients' perception. Clin Oral Implant Res 2009; 20:667–676.
8. Misch CE. Divisions of available bone in implant dentistry. Int J Oral Implantol 1990; 7:17–21.
9. Misch C. Density of bone: effect on treatment plan, surgical approach and healing. In: Misch C, ed. Contemporary implant dentistry. St. Louis, MO: Mosby, 1993:469–485.
10. Wheeler SL. Sinus augmentation for dental implants: the use of alloplastic materials. J Oral Maxillofac Surg 1997; 55:1287–1293.
11. Summers RB. The osteotome technique. Part 3. Less invasive methods in elevation of the sinus floor. Compend Contin Educ Dent 1994; 15:698–708.
12. Fugazzotto PA. Immediate implant placement following a modified trephine/osteotome approach: success rate of 116 implants to 4 years in function. Int J Oral Maxillofac Implants 2002; 17:113–120.
13. Yildirim M, Edelhoff D, Hanisch O, Spiekermann H. The internal sinus lift-an adequate alternative to the conventional sinus floor elevation. Zeitschr Zahnärztl Implantol 1998; 14:124–135.
14. Glauser G, Naef R, Scharer P. The osteotome technique-a different method of implant placement in the posterior maxilla. Implantologie 1998; 2:103–120.
15. Rosen RP, Summers R, Mellado JR, et al. The bone-added osteotome sinus floor elevation technique: multi center retrospective report of consecutively treated patients. Int J Oral Maxillofac Implants 1999; 14:853–858.
16. Toffler M. Osteotome-mediated sinus floor elevation: a clinical report. Int J Oral Maxillofac Implants 2004; 19:266–273.
17. Deporter D, Todescan R, Caudry S. Simplified management of the posterior maxilla using short, porous- surfaced dental implants and simultaneous indirect sinus elevation. Int J Periodontics Restorative Dent 2000; 20:477–485.
18. Cavicchia F, Bravi F, Petrelli G. Localized augmentation of the maxillary sinus floor through a coronal approach for the placement of implants. Int J Periodontics Restorative Dent 2001; 21:475–485.
19. Jensen OT, Shulman LB, Block MS, Iacono VJ. Report of the sinus consensus conference of 1996. Int J Oral Maxillofac Implants 1998; 13:11–41.
20. Tonetti MS, Hammerle CH. Advances in bone augmentation to enable dental implant: Consensus Report of the Sixth European Workshop on Periodontology. J Clin Periodontol 2008; 35 (Suppl 8):168–172.
21. Shlomi B, Horowitz I, Kahn A, Dobriyan A, Chaushu G. The effect of sinus membrane perforation and repair with lambone on the out come of maxillary sinus floor augmentation: a radiographic assessment. Int J Oral Maxillofac Implants 2004; 19:559–562.

22. Barone A, Santini S, Sbordone L, Crespi R, Covani U. A clinical study of the outcomes and complications associated with maxillary sinus augmentation. Int J Oral Maxillofac Implants 2006; 21:81–85.
23. Ferrigno N, Laureti M, Fanali S. Dental implants placement in conjunction with osteotome sinus floor elevation: a 12-year life- table analysis from a prospective study on 588 ITI implants. Clin Oral Implants Res 2006; 19:119–130.
24. Merkx MA, Maltha JC, Stoelinga PJ. Assessment of the value of inorganic bone additives in sinus floor augmentation: a review of clinical reports. Int J Oral Maxillofac Implants 2003; 32:1–6.
25. Pinholt EM. Branemark and ITI dental implants in the human bone-graft maxilla: a comparative evaluation. Clin Oral Implants Res 2003; 14:584–592.
26. Emmerich D, Att W, Stappert C. Sinus floor elevation using osteotomes: a systematic review and meta-analysis. J Periodontol 2005; 76:1237–1251.
27. Bruschi GB, Scipioni A, Calesini G, Bruschi E. Localized management of sinus floor with simultaneous implant placement: a clinical report. Int J Oral Maxillofac Implants 1998; 13:219–229.
28. Thor A, Sennerby L, Hirsch JM, Rasmusson L. Bone formation at the maxillary sinus floor following simultaneous elevation of the mucosal lining and implant installation without graft material – an evaluation of 20 patients treated with 44 Astra Tech implants. J Oral Maxillofac Surg 2007; 7 (Suppl 1):64–72.
29. Lundgren S, Andersson S, Sennerby L. Spontaneous bone formation in the maxillary sinus after removal of a cyst: coincidental or expected reaction? Clin Implant Dent Relat Res 2003; 5:78–81.
30. Nedir R, Bischof M, Vasquez L, Nurdin N, Szmukler-Moncler S, Bernard JP. Osteotome sinus floor elevation technique without grafting material: 3-year results of a prospective pilot study. Clin Oral Implant Res 2009; 20:701–707.
31. Sroji ST, Kizhner D, Ben David M, Riminucci P, Bianco P, Livne E. The Schneiderian membrane contains osteoprogenitor cells: in vivo and in vitro study. Calcif Tissue Int 2009; 84:138–145.
32. Palma VC, Magro-Filho O, de Oliveria JA, Lundgren S, Salata LA, Sennerby L. Bone reformation and implant integration following maxillary sinus membrane elevation: an experimental study in primates. Clin Implant Dent Relat Res 2006; 8:11–24.
33. Cardaropoli G, Lekholm U, Wennstrom JL. Tissue alteration at implant-supported single-tooth replacements: a I-year prospective clinical study. Clin Oral Implants Res 2006; 17:165–171.
34. Sennerby L, Andersson P, Verrocchi D, Viinamäki R. One-year outcomes of Neoss Bimodal implants. A prospective clinical, radiographic and RFA study. Clin Implant Dent Relat Res 2010 [Epub ahead of print]. DOI: 10.1111/j.1708-8208.2010.00273.x.
35. Bogaerde LV, Pedretti G, Sennerby L, Meredith N. Immediate/early function of Neoss implants placed in maxillas and posterior mandibles: an 18-month prospective case series study. Clin Implant Dent Relat Res 2010; 12:e83–e94.
36. Laurell L, Lundgren D. Marginal bone level changes at dental implants after 5 years in function: a meta-analysis. Clin Implant Dent Relat Res 2011; 13:19–28.
37. Lazzara RJ, Porter SS. Platform switching: a new concept in implant dentistry for controlling postrestorative crestal levels. Int J Periodontics Restorative Dent 2006; 26:9–17.