Osteotome Sinus Floor Elevation without Bone Grafts – A 3-Year Retrospective Study with Astra Tech Implants

Robert Fermergård, DDS;* Per Åstrand, DDS, PhD†

ABSTRACT

Background: The bone support for implants in the posterior part of the maxilla is often poor. This condition may be treated with augmentation of the maxillary sinus floor. The most common technique used is to elevate the sinus floor by inserting a bone graft through a window opened in the lateral antral wall. In 1994, a less-invasive technique using osteotomes was suggested by Summers.

Purpose: The aim of this study was to evaluate the clinical and radiographic outcome of implants placed in the posterior maxilla with the osteotome sinus floor elevation (OSFE) technique without grafting.

Materials and Methods: The study population comprised 36 consecutive patients in whom 53 implants were inserted with the OSFE technique. The indication for sinus floor elevation was that the bone height below the maxillary sinus was considered to be 10 mm or less.

Results: The mean height of the alveolar process in the intended implant sites was 6.3 ± 0.3 mm, and the mean elevation of the sinus floor was 4.4 ± 0.2 mm. Two implants in edentulous patients were lost at the 1-year follow-up, and one more at the 3-year examination. The remaining 50 implants inserted were in function, giving a 3-year cumulative survival rate of 94%. Implants used in single-tooth replacements and in partially edentulous cases had a 100% survival rate.

The marginal bone level at the time of loading of the implants was 0.1 ± 0.04 mm below the reference point. One year later, the corresponding value was 0.5 ± 0.06 mm. The mean bone loss between the two examinations was 0.4 ± 0.05 mm. At the final examination after 3 years, the mean bone level was situated 0.6 ± 0.09 mm below the reference point, indicating a nonsignificant change between 1 year and 3 years.

Conclusions: The OSFE technique, without bone grafts, was found to produce predictable results in the treatment of 36 patients with restricted bone volume in the posterior part of the maxilla.

KEY WORDS: Astra Tech implants, dental implants, osteotome, posterior maxilla, sinus floor elevation

INTRODUCTION

Patients who are edentulous in the posterior maxilla often have a reduced alveolar bone height, which may complicate a conventional treatment with dental implants.[1] This condition may be treated with an augmentation of the maxillary sinus floor. Augmentation may be indicated when the distansce from the sinus floor to the top of the alveolar ridge is less than 8 to 10 mm.[2,3]

The most commonly used technique for augmentation is insertion of a bone graft through a window in the lateral antral wall, a technique first published by Boyne and James.[4] The surgical technique with grafting has since then been described by several authors.[2,5–8] This method involves a quite complex surgery, especially if an autogenous graft is desired. Ellegaard and colleagues[9] and Lundgren and colleagues[10] presented techniques without grafts.

*Consultant in oral surgery, Kalmar County Dental Service, Department of Oral and Maxillofacial Surgery, Västervik Hospital, Västervik, Sweden; †associate professor, Department of Oral & Maxillofacial Surgery, University Hospital Linköping, Linköping, Sweden

Reprint requests: Dr. Robert Fermergård, Kalmar County Dental Service, Department of Oral and Maxillofacial Surgery, Västervik Hospital, SE-593 81 Västervik, Sweden; e-mail: Robertf@ltkalmar.se

DOI 10.1111/j.1708-8208.2009.00254.x

A less-invasive procedure for sinus floor elevation with immediate implant placement was introduced by Summers[11] in 1994. The schneiderian membrane and the bony floor of the sinus are elevated with osteotomes from a crestal approach, without the preparation of a lateral window. Simultaneously, some kind of graft may be placed.[11,12] Fugazzotto[13] used a trephine bur in combination with osteotomes.

Clinical studies with the osteotome technique have shown good results.[12,14–16] A review and meta-analysis[17] of eight reports presented survival rates of 95.7 to 96.0%.

The osteotome sinus floor elevation (OSFE) procedure is less invasive than the conventional technique with a lateral window. The operation time is short, and the postoperative morbidity is reduced. If this less-invasive procedure can achieve similar results to the conventional procedure, then it must be beneficial to the patient, especially if an autogenous graft can be avoided. It was therefore considered interesting to investigate the results of this technique in a number of consecutive patients.

The aim of this study was to evaluate clinically and radiographically the outcome of implants placed into the posterior maxilla with the OSFE technique without grafting and with an observation period of 3 years.

MATERIALS AND METHODS

At the Department of Oral and Maxillofacial Surgery, Västervik Hospital, patients were treated with implants inserted with the OSFE technique.

The patients were treated between October 2003 and April 2005.

The study group comprised 36 patients with 53 implants and has been described earlier.[18]

The indication for sinus floor elevation was that bone height below the maxillary sinus, at the primary examination, was considered to be 10 mm or less. The patients, at the time of treatment, were mainly healthy, with a mean age of 64 ± 12 (SD) years.

The patients were divided into three groups with regard to the extension of the implant therapy:

- Single-tooth reconstructions (9 patients with 11 implants)
- Partially edentulous jaws (18 patients with 26 implants)
- Edentulous jaws (9 patients with 16 implants)

Surgical Methods

All the surgical procedures were performed under local anesthesia by one of the authors (R.F.). After flap elevation, the optimal fixture site was selected. The preparation of the implant site involved several steps (Figure 1). Initially, a round bur was used to open a defect through the marginal cortical bone. The preparation was continued with two consecutive osteotomes (Astra Tech 2–2.5 mm and 2.3–3.2 mm). Then the sinus floor was elevated with a 3.2 mm osteotome, taking care not to violate the sinus mucosa. Finally, the marginal bone was prepared with a 3.2 mm straight drill and a 4.5 mm conical drill.

Astra Tech 4.5 mm implants were inserted and closed with cover screws before the flap was repositioned and sutured. The implant lengths between 9 mm and 13 mm were used (Table 1).

The procedures all followed a two-stage protocol, with abutment connection performed 3 to 4 months later.

All patients received prophylactic antibiotics (penicillin V 2 g bid) for 5 days from immediately before surgery.

Prosthetic Methods

The prosthetic reconstruction was made by the referring dentist, and was completed and loaded about 1 month later.

Follow-Up and Data Collection

All patients took part in examinations at baseline and after 1 year and 3 years.

Data from the patient records were inserted in case record forms specially constructed for the study.

Panoramic x-ray examinations were performed preoperatively and in connection with implant insertion. Intraoral radiographs were obtained at abutment installation (baseline), 1 year, and 3 years later. The height of the alveolar process and the extent of the sinus floor elevation were measured in the panoramic x-rays; the magnification factor being calculated by measurement of the known length of the implants (Figure 2).

The intraoral radiographs were used for measurement of the marginal bone level at abutment connection and at the 1-year and 3-year follow-up.

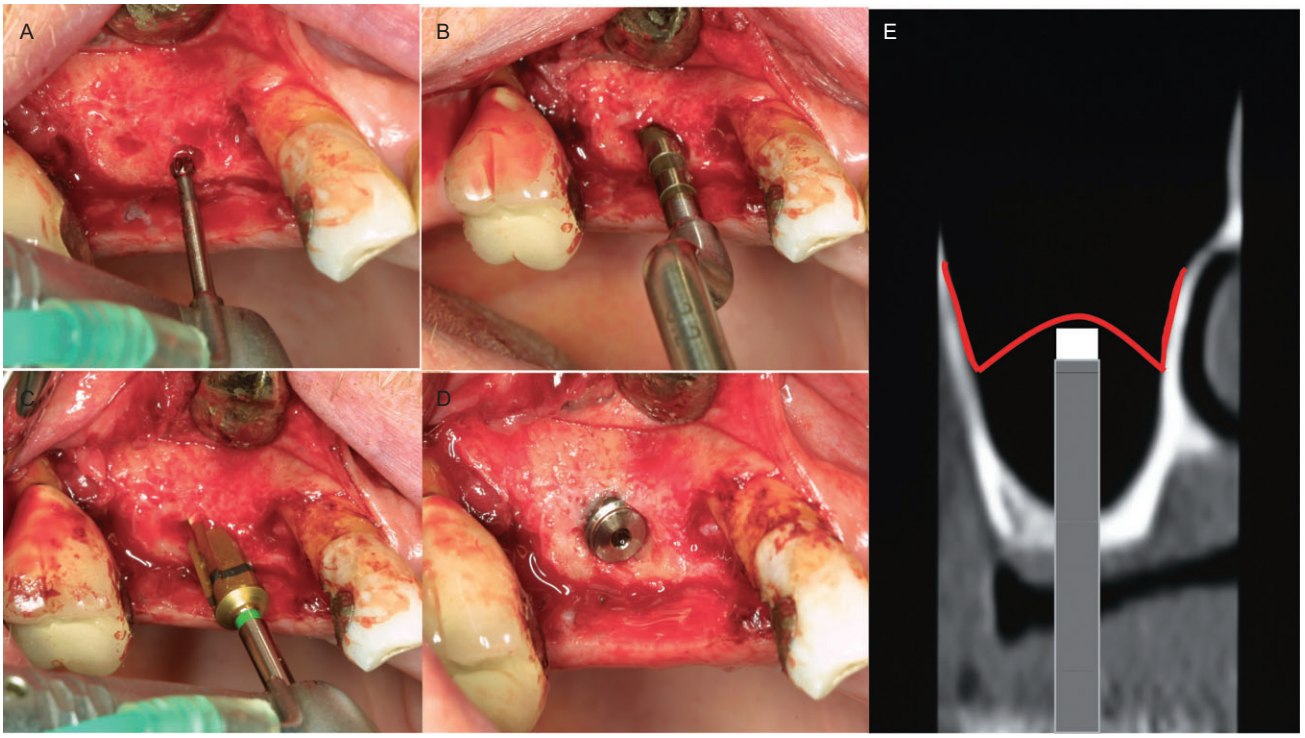

Figure 1 Surgical procedure. The implant site is enlarged to 3 mm through the marginal cortex with a guide drill (A). The sinus floor and the schneiderian membrane are elevated with the 3.2 mm osteotome (B). The marginal bone is prepared with a 4.5 mm conical drill (C). An Astra Tech 4.5 mm implant is installed (D). Schematic drawing of the surgical procedure demonstrating the sinus floor and the schneiderian membrane being elevated with an osteotome (E).

Analyses of Radiographs

The marginal bone level was assessed at the mesial and distal implant surfaces by measuring the distance between a reference point on the implant (Figure 3) and the bone level using a magnifying lens (×7) with a measuring scale with 0.1 mm graduations. Radiographs were independently measured by the two authors. If the difference between the observers was 0.5 mm or less, then the mean value of these measurements was used. In cases of discrepancies >0.5 mm, the radiographs were reexamined and consensus was sought.

In order to measure the amount of sinus floor elevation, the distance from the compact border of the sinus floor to the top of the implant was measured (see Figure 2). The distance was measured separately by the two investigators, using the methods applied to the intraoral films.

Implant Survival Rate

In the estimation of the implant survival rate, the following criteria were used:

TABLE 1 Distribution of Implants by Implant Length and Implant Position

	Implant Positions						
Implant Length, mm	14	15	16	24	25	26	Total
9	2	2	1	1 (1)	4	1	11
11	6	9	3	7 (1)	8	1	34
13	2	1	0	1	4	0	8
Total	10	12	4	9	16	2	53

Note: Failed implants in parentheses.

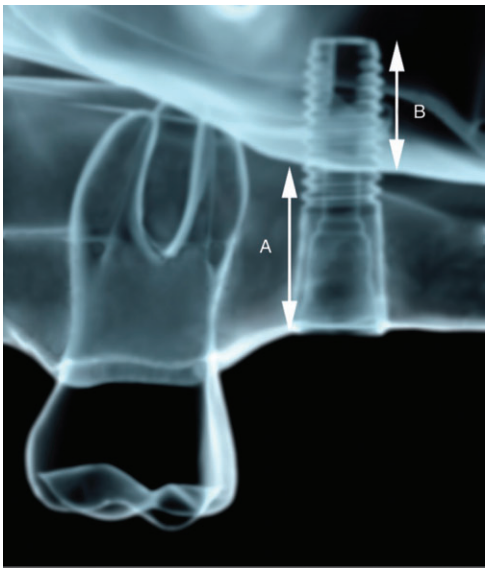

Figure 2 Measurements of alveolar bone height (A) and sinus floor elevation (B).

- The implant is in function in a clinically stable bridge (routine removal of the supra-construction and individual stability evaluation of the fixtures was not carried out).
- There is no pain from the implant.
- Radiographs do not demonstrate periapical bony defects or signs of peri-implant bone loss indicative of peri-implantitis.

Statistical Considerations

Statistical analyses were undertaken to determine

- the extent of sinus floor elevation,
- the cumulative survival rate after 1 year and 3 years, and

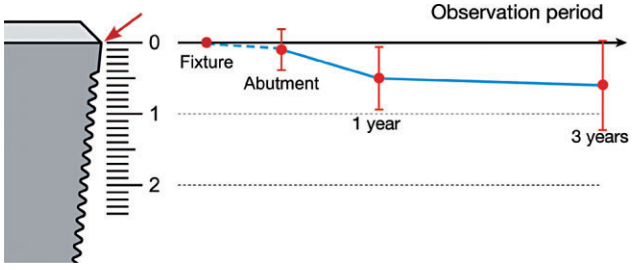

Figure 3 Diagram illustrating the reference point (*arrow*) and the marginal bone level demonstrated in the radiographs, at abutment connection and at the 1-year and 3-year follow-up. The bone level at implant insertion was not measured radiographically, but the position is indicated by the dotted line.

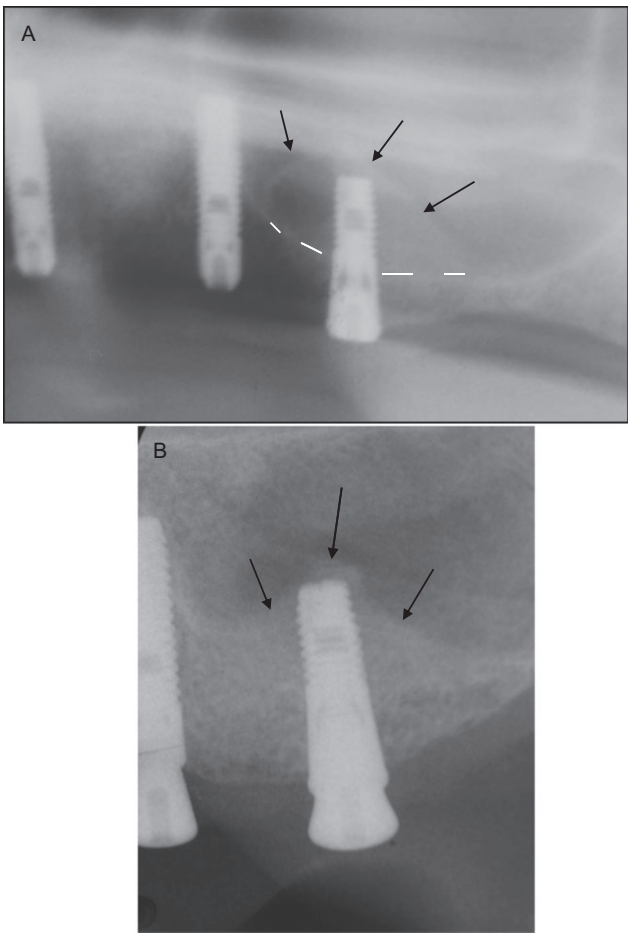

Figure 4 Radiographs of a 75-year-old edentulous man who received an implant in the left second premolar region. The elevation of the sinus floor was 5.5 mm. The hematoma under the antral mucosa is indicated by *arrows*, and the preoperative position of the sinus floor is indicated by a *line* (A). Radiograph at the abutment connection (B).

- the marginal bone level and bone level changes adjacent to the implants at abutment connection, at the 1-year and 3-year follow-up.

RESULTS

The surgical procedure with osteotome technique could be performed without difficulties. Good primary stability was obtained for all implants but one. However, this implant displayed good stability at the abutment connection.

At the 1-year examination, two implants had been lost, leaving 51 of the 53 inserted implants still in function. At the 3-year follow-up, one more implant had failed, giving survival rates of 96% after 1 year and 94% after 3 years. Typical outcomes of edentulous cases are illustrated by radiographs (Figure 4).

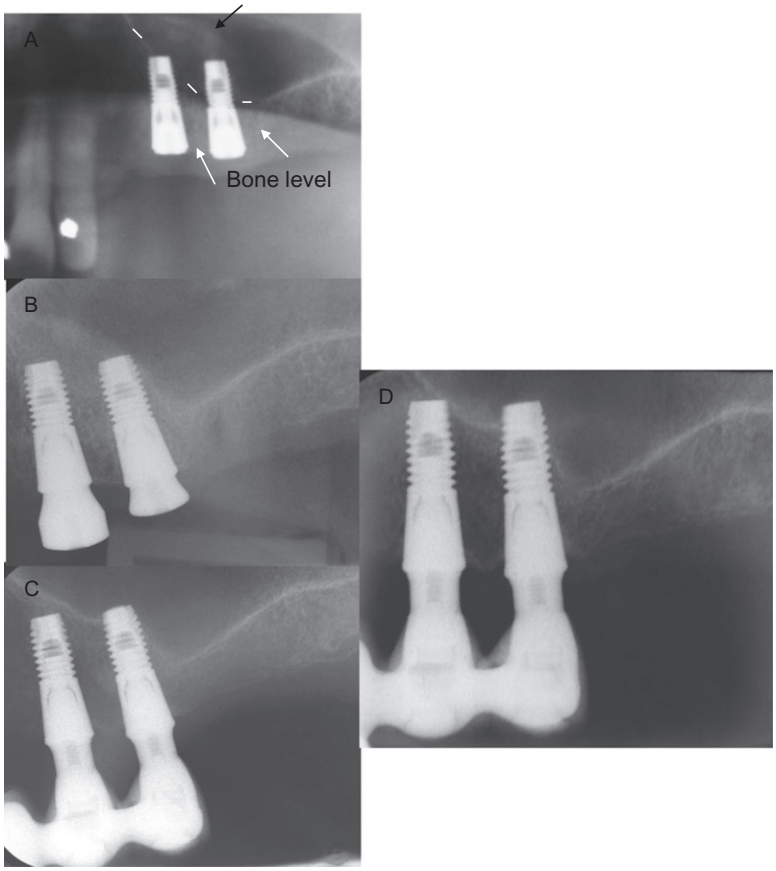

Figure 5 Radiograph of a 79-year-old female patient with a residual dentition and a need for a fixed prosthesis in the left upper jaw. Two implants were inserted with the osteotome sinus floor elevation technique, and the sinus floor elevation was 2.7 mm and 5.1 mm, respectively, at the implant sites. Radiographs immediately postoperative (A), at abutment connection (B), at the 1-year follow-up (C), and at the 3-year follow-up (D).

The implant failures were found in edentulous cases, while no implants were lost in single-tooth replacements and in partially edentulous cases (Figures 5 and 6).

The mean height of the alveolar process in the intended implant sites was 6.3 ± 0.3 mm, and the mean elevation of the sinus floor was 4.4 ± 0.2 mm.

The marginal bone level (Table 2) at baseline (abutment connection) was situated 0.1 ± 0.04 mm below the reference point. One year later, the corresponding value was 0.5 ± 0.06 mm, and at the 3-year examination, it was 0.6 ± 0.09 mm.

The mean bone loss between the baseline and 1-year examinations was 0.4 ± 0.05 mm.

The mean bone loss between the 1- and 3-year examinations was 0.1 ± 0.08 mm, and between the baseline and 3-year examinations was 0.5 ± 0.08 mm.

DISCUSSION

All patients enrolled completed the follow-up program, and adequate radiographic examinations were obtained.

At the 1996 consensus conference on sinus grafts,[3] a sinus floor elevation was recommended for consideration in cases with 8 mm of bone or less. Chiapasco and Ronchi[2] included cases with residual bone of 10 mm or less, while other authors[19,20] treated cases with 5 to 6 mm bone or less.

According to the research protocol of this study, the intention was to limit the OFSE therapy to patients with residual bone in the posterior maxilla of 10 mm or less. However, radiographic evaluation disclosed that one patient had a bone thickness of 11.2 mm. All the others presented with alveolar bone height of 10 mm or less. The mean value was 6.3 mm (range 1.5–11.2 mm).

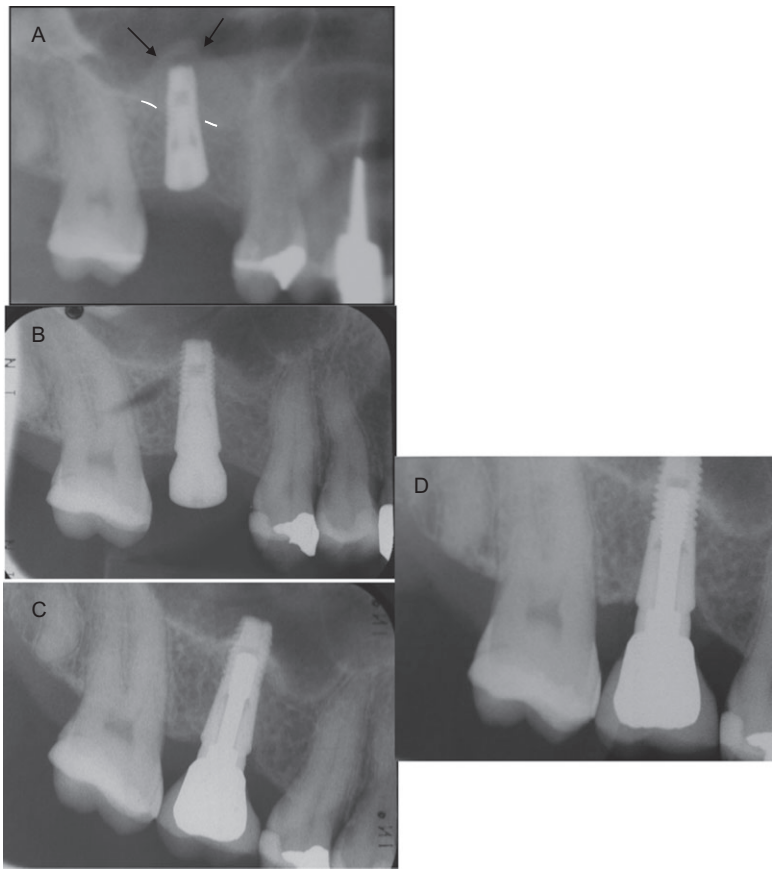

Figure 6 A 52-year-old female patient who received a single implant in the right molar region. Radiographs immediately postoperatively (A), where the hematoma under the antral mucosa is indicated by *arrows*, at abutment connection (B), at the 1-year follow-up (C), and at the 3-year follow-up (D).

Three implants failed, all inserted in edentulous jaws. A provisional denture was also used in this cases, and there was probably undue pressure from these dentures. In one of these cases, the mucosa was damaged and the cover screw was exposed during the healing period. The other patient in whom the implant loss occurred later was a smoker (eight cigarettes per day) who was unfortunately supplied with long cantilevers despite exhibiting bruxism. Besides the failing implant described here, this patient received a second implant that was stable at the 1-year follow-up, but was subsequently lost. The overall cumulative survival rate after 1 year was thus 96%, and 94% after 3 years, which can be considered as very good and compares well with studies of the conventional sinus lift procedure as well as other studies describing the osteotome technique. The

TABLE 2 Marginal Bone Level and Marginal Bone Level Changes. Means and Standard Error of the Means.

	Baseline	1 Year	3 Years
Mean marginal bone level	0.1 ± 0.04 *n* = 52	0.5 ± 0.06 *n* = 51	0.6 ± 0.09 *n* = 50
Bone level change	**Baseline to 1 year**	**1 to 3 years**	**Baseline to 3 years**
	−0.4 ± 0.05 *n* = 51	−0.1 ± 0.08 *n* = 50	−0.5 ± 0.08 *n* = 50

n = number of observations.

conventional sinus lift technique used by Chiapasco and Ronchi[2] produced a survival rate of 93.5%. In the report from the consensus conference in 1996, Jensen and colleagues[3] found a general mean survival rate of 90%.

With the osteotome technique, survival rates between 93.5% and 100% have been reported.[12,13,16,21,22] Nedir and colleagues[21] reported on 25 implants inserted with the osteotome technique without bone graft and demonstrated 100% survival after 1 year. However, there was a mean marginal bone loss of 1.2 mm, which compares poorly with the present study with only 0.4 mm bone loss. The difference may perhaps be because of the use of a one-stage instead of a two-stage surgical technique.

In the study by Rosen and colleagues,[15] the survival rate dropped to 85.7% when the pretreatment bone height was 4 mm or less. Summers[23] recommended the use of a two-stage technique in such cases, which he called "future site development." A similar tendency was found in the present investigation. Six implant sites displayed preoperative height of the alveolar process of 4 mm or less, and three of these implants were lost. Among patients with single-tooth replacements or reconstruction of partial edentulism, there were nine implants inserted in sites with a preoperative bone height of 5 mm or less; none of which was lost. In contrast to fully edentulous cases, the use of a temporary denture could be avoided, and perhaps this fact is more important than the presence of a small preoperative height. Decreased implant stability has been reported in connection with the use of osteotomes.[24] With the use of a conical drill in the preparation of the marginal bone in the present study, this problem seems to have been avoided. The conical shape of the Astra Tech 4.5 mm implant has also contributed to good stability.

In order to avoid the use of autogenous bone and the morbidity of a donor site, bone substitutes have been used, of which the most common has been Bio-Oss (Geistlich Pharma AG, Wolhusen, Switzerland). Good clinical results were reported by Hallman and Nordin,[25] who used it in connection with a conventional sinus lift, and Brägger and colleagues,[26] who used it with OSFE.

Another possibility is to use no graft at all. Ellegaard and colleagues[9] did not use any graft but simply allowed the sinus membrane to settle over the implants. Their good results agree also with other results.[10,27] The present study lends support to the theory that there is a great potential for healing and bone formation in the maxillary sinus.

With the OSFE technique, it seems possible to avoid the use of autogenous bone and the associated morbidity from a donor site, which sometimes can be very uncomfortable for the patient.[28,29]

CONCLUSION

The OSFE technique has demonstrated predictable results in the treatment of 36 patients with restricted bone volume in the posterior maxilla. Good support for the implants was established without the use of bone graft. The good results described after 1 year were confirmed after 3 years. This less-invasive method must therefore be regarded as a good alternate to the conventional sinus lift techniques.

ACKNOWLEDGMENT

The authors are grateful to Astra Tech Co. for the financial support of the study.

REFERENCES

1. Jaffin RA, Berman CL. The excessive loss of Brånemark fixtures in type IV bone. A 5-year analysis. J Periodontol 1991; 62:2–4.
2. Chiapasco M, Ronchi P. Sinus lift and endosseous implants – preliminary surgical and prosthetic results. Eur J Prosthodont Restor Dent 1994; 3:15–21.
3. Jensen OT, Shulman LB, Block MS, Iacono VJ. Report of the sinus consensus conference of 1996. Int J Oral Maxillofac Implants 1998; 13(Suppl):11–41.
4. Boyne PY, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. J Oral Surg 1980; 38:613–616.
5. Khoury F, Pingel D, Joos U. Die Sinusbodenelevation mit simultaner implantation unter Verwendung von Knochentransplantaten aus dem Unterkiefer. Zahnärztl Implantol 1993; 9:175–180.
6. Smiler D, Holmes R. Sinus lift procedure using porous hydroxyapatite: a preliminary clinical report. J Oral Implantol 1987; 13:239–253.
7. Wheeler SL, Holmes RE, Calhoun CHJ. Six-year clinical and histologic study of sinus lift grafts. Int J Oral Maxillofac Implants 1996; 11:26–34.
8. Lazzara RJ. The sinus elevation procedure in endosseous implant therapy. Curr Opin Periodontol 1996; 3:178–183.
9. Ellegaard B, Kölsen-Petersen J, Baelum V. Implant therapy involving maxillary sinus lift in periodontally compromised patients. Clin Oral Implants Res 1997; 8:305–315.
10. Lundgren S, Andersson S, Gualini F, Sennerby L. Bone reformation with sinus membrane elevation: a new

surgical technique for maxillary sinus floor augmentation. Clin Implant Dent Relat Res 2004; 6:165–173.
11. Summers RB. A new concept in maxillary implant surgery: the osteotome technique. Compend Contin Educ Dent 1994; 15:152–160.
12. Komarnyckyj OG, London RM. Osteotome single-stage dental implant placement with and without sinus elevation: a clinical report. Int J Oral Maxillofac Implants 1998; 13:799–804.
13. Fugazzotto PA. Immediate implant placement following a modified trephine/osteotome approach: success rates of 116 implants to 4 years in function. Int J Oral Maxillofac Implants 2002; 17:113–117.
14. Rake A. Retrospective analysis of osseointegration utilizing osteotomes versus a sequential drilling technique. Report at American Association of Oral and Maxillofacial Surgery, Boston. J Oral Maxillofac Surg 1999; 57(Suppl):60–61.
15. Rosen PS, Summers R, Mellado JR, et al. The bone-added osteotome sinus floor elevation technique: multicenter retrospective report of consecutively treated patients. Int J Oral Maxillofac Implants 1999; 14:853–858.
16. Ferrigno N, Laureti M, Fanali S. Dental implants placement in conjunction with osteotome sinus floor elevation: a 12 years life-table analysis from a prospective study on 588 ITI implants. Clin Oral Implants Res 2006; 17:194–205.
17. Emmerich D, Att W, Stappert C. Sinus floor elevation using osteotomes: a systematic review and meta-analysis. J Periodontol 2005; 76:1237–1251.
18. Fermergård R, Åstrand P. Osteotome sinus floor elevation and simultaneous placement of implants – a 1-year retrospective study with Astra Tech implants. Clin Implant Dent Relat Res 2008; 10:62–69.
19. Kahnberg K-E, Ekestubbe A, Gröndahl K, Nilsson P, Jirsch J-M. Sinus lifting procedure I. One-stage surgery with bone transplant and implants. Clin Oral Implants Res 2001; 12:479–487.
20. Saadoun AP, Le Gall MG. Implant site preparation with osteotomes: principle and clinical application. Pract Periodontics Aesthet Dent 1996; 8:453–463.
21. Nedir R, Bischof M, Vazquez L, Szmukler-Moncler S, Bernard JP. Osteotome sinus floor elevation without grafting material: a one year prospective pilot study with ITI implants. Clin Oral Implants Res 2006; 17:679–686.
22. Schmidlin PR, Muller J, Bindl A, Imfeld H. Sinus floor elevation using an osteotome technique without grafting materials or membranes. Int J Periodontics Restorative Dent 2008; 28:401–409.
23. Summers RB. Sinus floor elevation with osteotomes. J Esthet Dent 1998; 10:164–171.
24. Buchter A, Kleinheinz J, Wiesmann HP, et al. Biological and biomechanical evaluation of bone remodelling and implant stability after using an osteotome technique. Clin Oral Implants Res 2005; 16:1–8.
25. Hallman M, Nordin T. Sinus floor augmentation with bovine hydroxyapatite mixed with fibrin glue and later placement of nonsubmerged implants: a retrospective study in 50 patients. Int J Oral Maxillofac Implants 2004; 19:222–227.
26. Brägger U, Gerber C, Joss A, et al. Patterns of tissue remodelling after placement of ITI dental implants using an osteotome technique: a longitudinal radiographic case cohort study. Clin Oral Implants Res 2004; 15:158–166.
27. Thor A, Sennerby L, Hirsch J-M, 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 Maxillofacial Surg 2007; 7(Suppl 1):64–72.
28. Lundgren S, Clavero J. Ramus or chin grafts for maxillary sinus inlay and local onlay augmentation: comparison of donor site morbidity and complications. Clin Implant Dent Relat Res 2003; 5:154–160.
29. Weibull L, Widmark G, Ivanoff C-J, Borg E, Rasmusson L. Morbidity after chin bone harvesting – a retrospective long-term follow up study. Clin Implant Dent Relat Res 2009; 11:149–157.