Osteotome Sinus Floor Elevation and Simultaneous Placement of Implants – A 1-Year Retrospective Study with Astra Tech Implants

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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, although less invasive techniques with osteotomes have been used since 1994.

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. At the 1-year follow-up, two implants had been lost, both in edentulous patients. The remaining 51 implants inserted were in function, giving a 1-year cumulative survival rate of 96%. Implants used in single-tooth replacements and in partially edentulous cases had a 100% survival rate. The mean 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.

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 generally display enlarged sinuses and reduced alveolar bone. Consequently, bone support for implants in this region is often poor.[1] This condition may be treated with an augmentation of the maxillary sinus floor.

Augmentation may be indicated when the distance from the sinus floor to the top of the alveolar ridge is less than 8–10 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 quite complex surgery, especially if an autogenous graft is desired. Ellegaard and colleagues[9] and Lundgren and colleagues[10] presented techniques without grafts, and Cosci and Luccioli[11] described a method with a crestal approach using special drills.

A less invasive procedure for sinus floor elevation with immediate implant placement was introduced by Summers[12] in 1994. The Schneiderian membrane and the bony floor of the sinus are elevated with osteotomes

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DOI 10.1111/j.1708-8208.2007.00062.x

from a crestal approach, without the preparation of a lateral window. Simultaneously, some kind of graft may be placed.[12,13] Fugazzotto[14] used a trephine burr in combination with osteotomes.

Clinical studies with the osteotome technique have shown good results.[13,15,16] A review and meta-analysis[17] of eight reports presented survival rates of 95.7–96.0%. 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, 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.

MATERIALS AND METHODS

At the Department of Oral and Maxillofacial Surgery, Västervik Hospital, Sweden, 37 patients were consecutively treated with implants inserted with the OSFE technique. The indication for sinus floor elevation was that bone height below the maxillary sinus was, at the primary examination, considered to be 10 mm or less. The patients were treated between October 2003 and April 2005. In all cases, Astra Tech Microthread® (Astra Tech AB, Mölndal, Sweden) 4.5-mm dental implants were used, and altogether, 54 implants were inserted in the sinus with the OSFE technique.

One of the inclusion criteria for this study was that the patients attended the 1-year follow-up. As one patient did not want to take part in the follow-up, the study group was thus 36 patients with 53 implants.

The patients were mainly healthy, with a mean age of 64 years (range 34–85). Eight out of 36 patients were smokers. 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 implant site was selected. The preparation of the implant site involved several steps (Figure 1). Initially, a round burr was used to open a defect through the marginal cortical bone. The preparation was continued with two concave consecutive osteotomes (Astra Tech 2.0–2.5 and 2.3–3.2 mm). Then, the sinus floor was elevated with a 3.2-mm concave osteotome. 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 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 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 the baseline and in the final examination. The baseline examination was performed in connection with the abutment insertion. The final examination was performed about 1 year after loading (15 to 16 months after implant insertion).

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) and 1 year 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 the measurement of the marginal bone level at abutment connection and at the 1-year follow-up.

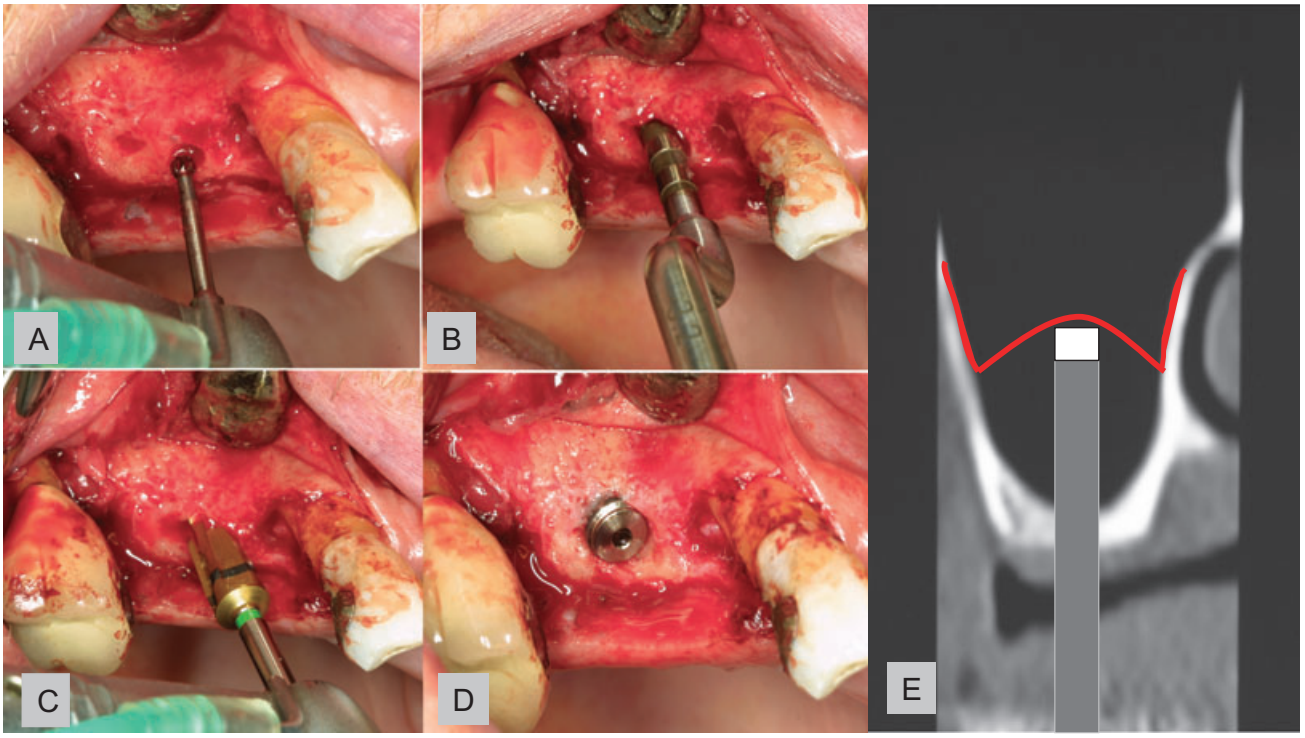

Figure 1 Surgical procedure. The implant site is enlarged to 3 mm through the marginal cortex with a guide drill (A). The sinus floor and the Schneiderian membrane are elevated with the 3.2-mm osteotome (B). The marginal bone is prepared with a conical drill 4.5 mm (C). An Astra Tech 4.5-mm implant is 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, 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 (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

Failed implants within parentheses.

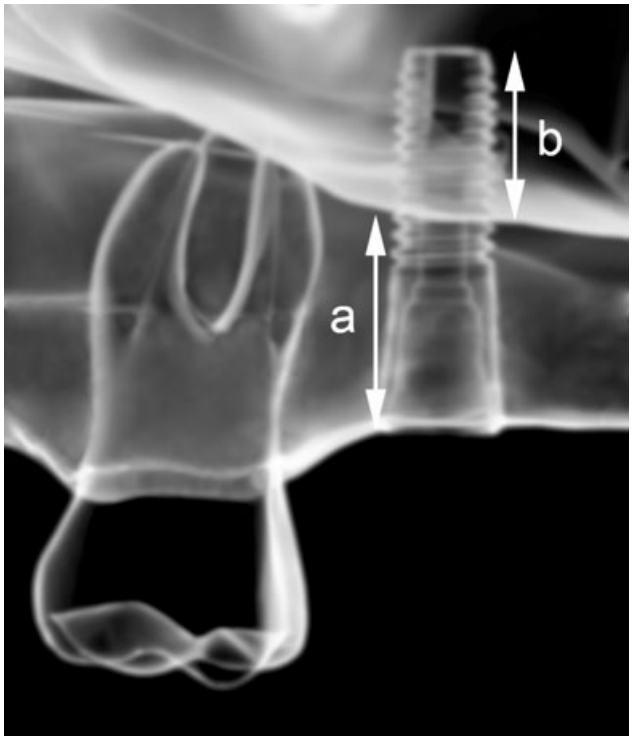

Figure 2 Measurements of alveolar bone height in "a" and sinus floor elevation in "b."

- The implant is in function in a clinically stable bridge (routine removal of the supra-constructions and individual stability evaluations of the fixtures were not carried out).
- There is no pain from the implant.
- Radiographs do not show 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;
- marginal bone level adjacent to the implants at abutment connection and at the 1-year follow-up.

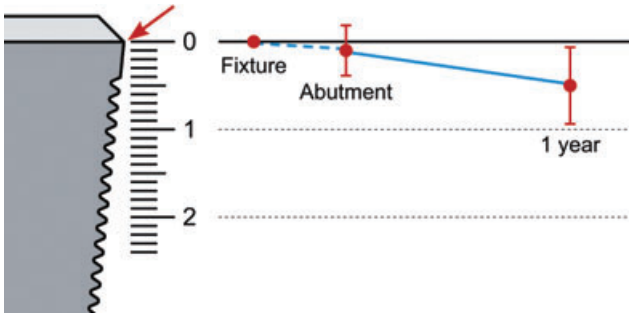

Figure 3 Diagram illustrating the reference point (arrow) and the marginal bone level demonstrated in the radiographs, at abutment connection, and at the 1-year follow-up (means and SDs). The bone level at implant insertion was not measured radiographically, but the position is indicated by the dotted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

RESULTS

The surgical procedure with osteotome technique could be performed without difficulties. The moment of induced fracture of the sinus floor was easily recognized. In a few cases, small rifts of the Schneiderian membrane were noted when performing a Valsalva's test. However, no disturbance of the healing process was observed in these cases. 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 for a cumulative survival rate of 96%. Typical outcomes of edentulous cases are illustrated by radiographs (Figure 4).

Implants used in partially edentulous cases and in single-tooth replacements (Figures 5 and 6) demonstrated 100% survival.

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 at baseline (abutment connection) was 0.1 ± 0.04 mm below the reference point. One year later, the corresponding value was 0.5 ± 0.06 mm (Figure 3 and Table 2). The mean bone loss between the two examinations was 0.4 ± 0.05 mm (range 0–1.8 mm). Only at one implant, there was a bone loss of more than 1 mm.

DISCUSSION

All patients enrolled completed the follow-up program, and adequate radiographic examinations were obtained. Few reports have been published on the use of OSFE, and none with the nongrafted technique at the start of this project.

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[18,19] treated cases with 5- to 6-mm bone or less.

According to the research protocol of this study, the intention was to limit the OSFE therapy to patients with

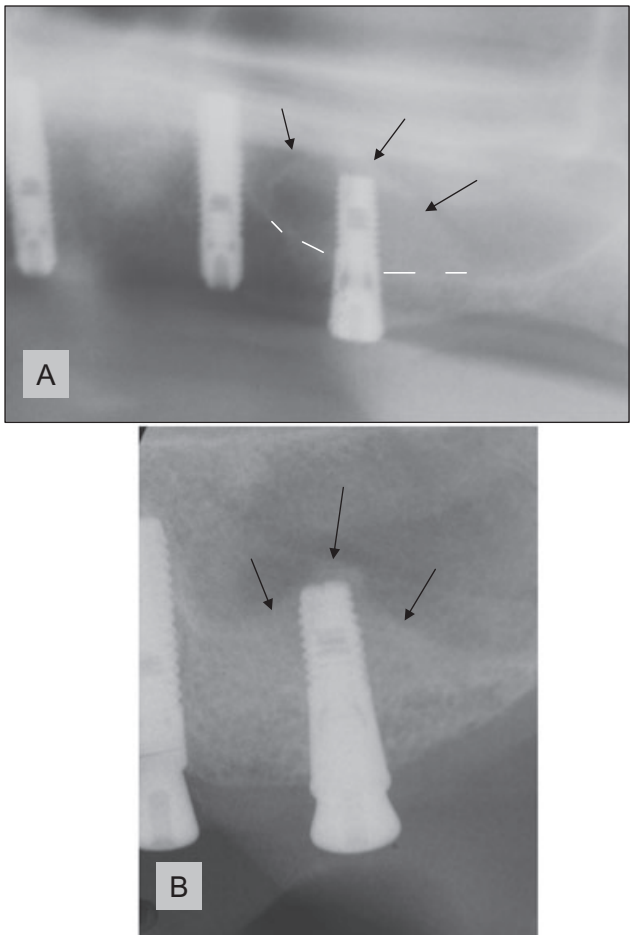

Figure 4 Radiographs of a 75-year-old edentulous man who received an implant in the left second premolar region. The elevation of the sinus floor was 5.5 mm. The hematoma under the antral mucosa is indicated by arrows, and the preoperative position of the sinus floor is indicated by a dotted line (A).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

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).

Two implants failed, both inserted in edentulous jaws. A provisional denture was also used in both 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 which was stable at the 1-year follow-up, but was subsequently lost. The overall cumulative survival rate after 1 year was thus 96%, 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. With the osteotome technique, survival rates between 93.5% and 96% have been reported.[12,13,16,20]

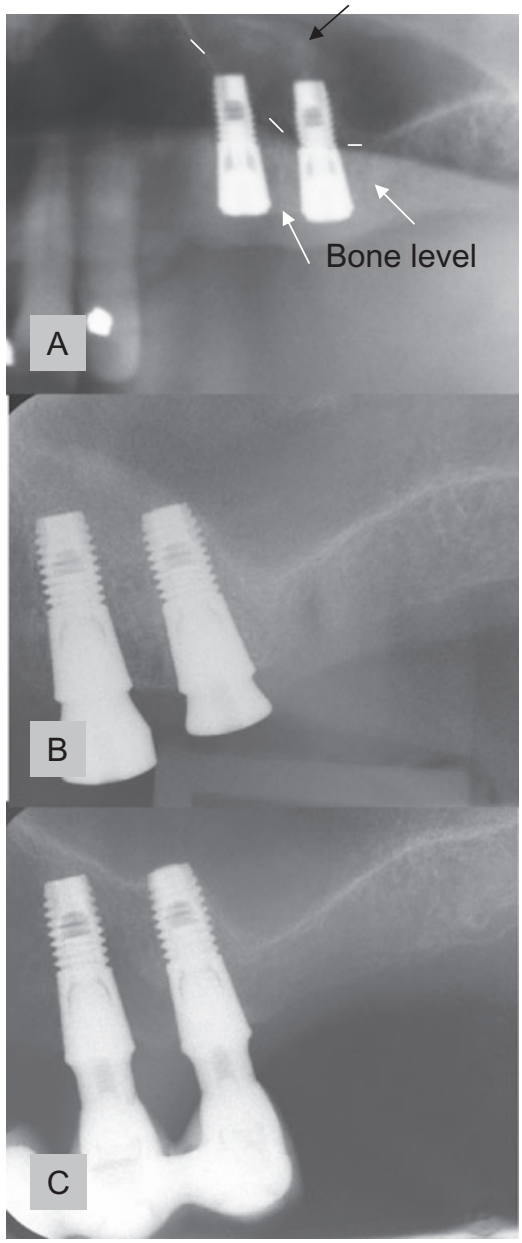

Figure 5 Radiographs of a 79-year-old female patient with a residual dentition and a need for a fixed prosthesis in the left upper jaw. Two implants were inserted with the osteotome sinus floor elevation technique, and the sinus floor elevation was 2.7 and 5.1 mm, respectively, at the implant sites.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

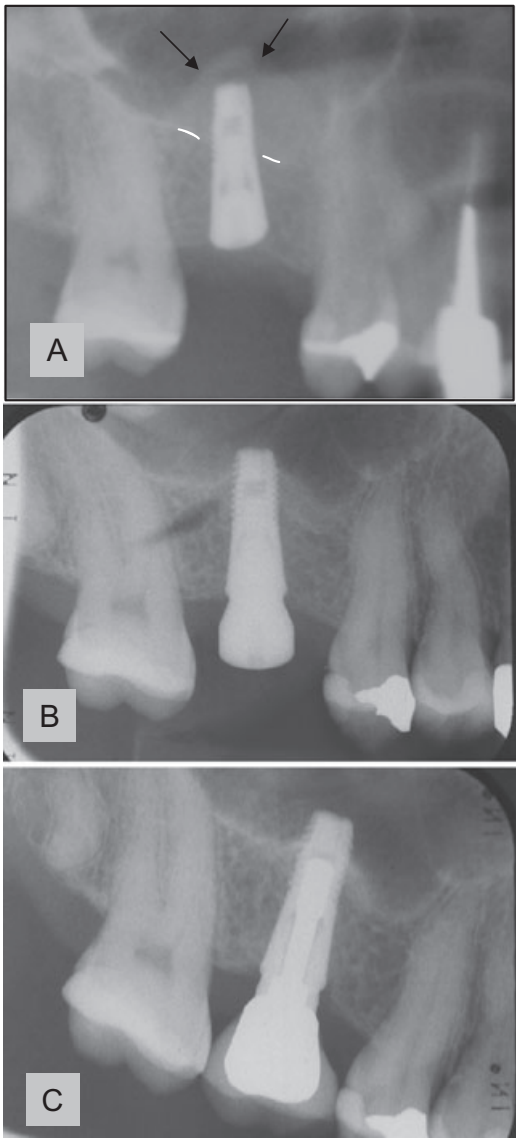

Figure 6 A 52-year-old female patient who received a single implant in the right molar region. Radiographs immediately postoperative. The hematoma under the antral mucosa is indicated by arrows (A), at abutment connection (B), and at the 1-year follow-up (C).

The conventional sinus lift technique used by Chiapasco and Ronchi[2] produced a survival rate of 93.5%. Ellegaard and colleagues[9] presented a study with and without sinus floor elevation using ITI and Astra Tech implants. In the sinus lift groups, the survival rate was 95% with Astra Tech implants and 86% with ITI implants. In the report from the consensus conference in 1996, Jensen and colleagues[3] found a general mean survival rate of 90%.

Nedir and colleagues[21] reported on 25 ITI 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.

In the study by Rosen and colleagues,[16] the survival rate dropped to 85.7% when the pretreatment bone height was 4 mm or less. Summers[20] recommended 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 a preoperative height of the alveolar process of 4 mm or less, and two 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 were 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.

Two possible problems have been discussed in connection with OSFE. One is whether the healing could be hindered by the use of osteotomes.

In an animal study,[22] inferior primary stability was found among implants inserted after site preparation

TABLE 2 Radiographic Measurements: Height of Alveolar Process, Amount of Sinus Floor Elevation, Marginal Bone Levels, and Marginal Bone Level Change

Variable	Number of Observations	Mean Value	SEM	Range
Height of alveolar process	53	6.3	0.29	1.5–11.2
Sinus floor elevation	53	4.4	0.17	1.8–6.9
Marginal bone level at abutment connection	52	0.1	0.04	0–2.2
Marginal bone level at 1 year	51	0.5	0.06	0–2.3
Marginal bone change 0–1 year	51	–0.36	0.05	0–1.8

Number of observations, mean values, and standard error of the mean (SEM).

with osteotomes compared to the conventional drilling technique. Histological analysis of these specimens revealed fractured trabeculae in the peri-implant bone. It was concluded that the decreased implant stability was due to micro-fractures in the peri-implant bone. Such fractures were avoided in the present study by the use of a conical drill in the preparation of the marginal bone. The conical shape of the Astra Tech 4.5-mm implant also contributed to good stability.

The other point of discussion has been whether a graft is necessary and, if so, which is the best kind of graft. 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 was Bio-Oss®. This type of grafting material was brought into question in an experimental study in rabbits.[23] However, good clinical results were reported by Hallman and colleagues,[24] who used it in connection with a conventional sinus lift, and Brägger and colleagues,[25] 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.[10,26] The present study lends support to the theory that there is a great potential for healing and bone formation in the maxillary sinus without the use of bone substitutes.

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.[27]

CONCLUSION

The OSFE 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. This less invasive method must therefore be regarded as a good alternative to the conventional sinus lift techniques.

ACKNOWLEDGMENT

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

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