Original Article

Evaluation of Immediate Implant Placement with Osteotome Sinus Floor Elevation without Graft Material

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Abstract

Background: Significant difficulties can be encountered when installing posterior maxillary implants. Osteotome sinus floor elevation (OSFE) enables insertion of implants with insufficient bone height at the posterior maxilla using a special instrument known as the "osteotom." **Aim:** This study aimed to evaluate the implant survival rates and radiographical bone gain data after OSFE with simultaneous implant placement performed without grafting material. Further, we have discussed whether the osteotom tapping distance to sinus floor affects the amount of new bone gain (NBG). **Materials and Methods:** Forty dental implants were inserted in 36 patients (20 women and 16 men) aged between 24 and 80 years (mean = 55.7 years). Residual bone height and NBG were analyzed using a commercially available software program on panoramic films. **Results:** The mean residual bone height at the intended implant sites was 5.4 mm ± 2.2 mm, ranging from 3.5 mm to 6.9 mm. The mean NBG was 1.5 mm ± 0.87 mm, ranging from 0.1 mm to 4 mm. At 64.4 months of follow-up, one implant had been lost in the osseointegration period. The remaining 39 implants were in function, with a survival rate of 97.5%. No significant difference was seen between the osteotome tapping distance to sinus floor and NBG at the implant apex (P = 0.395). **Conclusion:** OSFE without using bone grafts with simultaneous implant installation is a safe and reliable method with successful long-term results for he rehabilitation of edentulous posterior maxillae.

Keywords: *Implants, osteotom sinus floor elevation, posterior maxilla, sinus lift*

Introduction

Installing posterior maxillary implants due to resorption of the alveolar bone following maxillary molar extraction and/or secondary to pneumatization of the maxillary sinus in edentulous patients may present substantial difficulties, including the challenge of insufficient bone height for implant insertion in the posterior maxillary area.[1] Various surgical techniques have been developed to overcome this challenge. Lateral approach sinus floor elevation and osteotome sinus floor elevation (OSFE) techniques are the two most commonly implemented modalities. Additional options include the use of angulated, zygomatic, or pterygoid implants.[2]

The OSFE technique was first performed by Tatum with an instrument known as the "osteotom," implemented to fracture the sinus floor.[3] The Schneiderian membrane can be delicately elevated using osteotomes to move the membrane in a more apical direction without perforation and without preparing a lateral window. The elevated Schneiderian membrane is supported by the implant dome, and this enables space for bone regeneration.[4] Additionally, using an osteotome may increase the density and volume of the spongios bone through compression, subsequently enabling the placement of a larger and wider implant.[5] The operation is less invasive, less time-consuming, and has a lower postoperative discomfort rate compared with a sinus lift.[6] Grafting materials fill the elevated area, maintaining space for new bone formation, though the

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concept of placing grafting material in OSFE procedures is questioned as no meaningful differences have been reported with respect to implant survival installation within the OSFE procedure with or without grafting.[5,7] The quantity and quality of residual bone greatly affect the success of dental implants.[8] OSFE aims for new bone gain (NBG) in the space between the sinus membrane and sinus base, according to the principles of guided bone regeneration.[9] This procedure involves tapping the osteotom approximately 1–2 mm away from the sinus floor.[10,11] However, no studies have evaluated the effect of the osteotomy tapping distance on the amount of newly formed bone at the sinus floor.

This study evaluated implant survival rates and radiographic bone gain data after OSFE with simultaneous implant placement and without grafting. We also evaluated the effects on new bone formed at the implant apex as the amount of bone block sent to the sinus increased with tapping distance. The null hypothesis was that there would be no differences tapping distance of implants placed in combination with an OSFE and gained NBG.

Materials and Methods

Patients were enrolled according to the following inclusion criteria:

(1) OSFE procedure performed without grafting material;
(2) patients presenting with residual bone height (RBH) between 3 and 8 mm;
(3) patients requiring implant treatment in the posterior maxilla due to reduced RBH, thus making standard implant placement impossible; and
(4) implant stability achieved through a two-stage surgical approach patients with sinus infections, systemic chronic conditions, treatment with bisphosphonates, peri-apical disease, or previous implants and/or bone grafting at the surgical site were excluded from the current study.

Forty dental implants were inserted in 36 patients (20 females and 16 males) aged between 24 and 80 years (mean = 55.7 years; 2014–2017). Implants were of varying lengths, and with widths of 4.1 mm, 4.5 mm, or 4.8 mm. The follow-up period was 48 + months (mean: 64.4 months). Patients in the current study received a total of 13 implants Bego (Bego implant system, Bremen, Germany) and 27 implants Nucleoss (Nucleoss implant system, Izmir, Turkey).

This retrospective study was conducted in accordance with the World Medical Association Declaration of Helsinki and was approved by the Başkent University ethical committe (project number: D KA: 21/19 approval date May 24, 2021).

Surgical technique

All surgeries were performed by the same surgeon. The full-thickness flap was elevated after a mid-crestal incision. If necessary, extravertical releasing incisions were placed to raise the flap to the mucogingival junction. Initially, the implant site was marked with a round bur to determine the location of the implant socket as well as bone stiffness according to the classification system developed by Lekholm and Zarb.[12] Osteotomes were used instead of drills in types III and IV bone (80 implants were placed in this manner), with the osteotome pushed axially toward the sinus floor. Osteotomy diameter started at 3.0 mm; a 3.5- or 4.2-mm osteotome was used in the presence of sufficient bone. In types I and II bone, the sinus floor was approached by drilling. The pilot drill ended at approximately half of the RBH, as calculated from presurgical panoramic radiographs. The drilling length was recorded, and the apical bone was tapped with an osteotome at the sinus floor [Figure 1]; 22 implants were placed in this manner. The Schneiderian membrane was carefully elevated. The cavity was rinsed with sterile saline solution, and any potential membrane perforation was recorded. The diameter of the implant was wider than the osteotomy site, such as the 3.5-mm osteotome used for a 4.1-mm diameter implant; for a 4.2-mm osteotome, a 4.8-mm implant was used. The length of the implant was determined based on the RBH. Implants penetrated

Table 1: New bone gain according to RBH and TD after OSFE without grafting

	RBH (mm)				TD (mm)					
	3-4 mm	4-5 mm	5-6 mm	6-7 mm	0-1	1-2 mm	2-3 mm	3-4 mm	4-5 mm	5-6 mm
Mean Sd (mm)	3.8±0.24	4.6±0.25	5.5±0.27	6.7±0.19	0.5±0.3	1.47±0.3	2.5±0.27	3.5±0.2	4.4±0.28	5.7±0.28
Subject number	5	12	10	12	16	6	7	3	3	4
NBG (mm)	2.08±1.32	1.57±0.9	1.28±0.73	1.36±0.70	1.67±0.94	1.52±0.69	1.27±0.77	1.4±0.4	1.53±1.55	1.22±1.03
partial correlation coefficent	0,10				0,14					
P value	0.529				0.395					

RBH; residual bone height, TD;Tapping distance, NBG; Newly bone gain

into the sinus cavity, and no bone graft material or membrane was used at the implant site. In all surgical sites, flaps were sutured with 4–0 silk sutures to obtain primary closure. All patients were prescribed antibiotics 3 times per day for 5 days (amoxicillin, 500 mg). We prescribed chlorhexidine mouth rinse twice a day for 5 days, and analgesics (paracetamol) were prescribed when required. Sutures were removed 5–7 days after the operation. After a healing period of >6 months, healing caps were placed and tightened with a 35-N cm torque and impressions were taken.

Analysis of panoramic radiographs

Panoramic radiography has been frequently implemented as a standard radiographic examination for the evaluation and preparation of implant treatment protocols. All radiographs were obtained using a dental panoramic X-ray apparatus (Morita, Veraviewepocs 2D, Kyoto, Japan) and standard parameters (standard patient head and neck localization, 25% magnification, 74 kV, 10 mA, 12 s). Radiographs were analyzed by a computerized measuring technique with image analysis software (Clear Canvas; ClearCanvas Inc., Toronto, Canada). Radiographic analysis and measurements were made by one examiner, and each height was measured twice to get an average. Radiographic images were examined by an investigator not involved in the surgical procedure; images were analyzed twice, with a >20-day interval (Cohen's Kappa 0.92, data not shown).

The radiographic analysis aimed to determine the following parameters: RBH immediately after implant placement and NBG at the implant apex. Panoramic radiographs were taken immediately after implant placement as well as 1 year following panoramic radiographs and were marked over linear lines and points. RBH was measured on panoramic radiographs taken immediately after implant placement. The length of the dental implant was used as a calibration tool. The mean RBH value was measured from the SF point (sinus floor) to RC points (residual crest) on the mesial and distal sides [Figure 2a]. NBG was measured immediately after implant placement and 1 year later using panoramic radiographs taken for control. Differences in distance between the SF points and the *Z* line (parallel to the *x* line) were measured as NBG on the mesial or distal sides [Figure 2b]. Implant survival criteria were determined as the absence of clinically detectable implant mobility, pain, or any subjective sensation; recurrent peri-implant infection; and radiolucency around the implant.[13,14] Implant loss, mobility, or removal (in the case of progressive marginal bone loss), severe peri-implant infection, or implant fracture were considered as implant failure.

Statistical analysis

Data analysis was conducted using IBM SPSS 21.0 (IBM Corp., Armonk, NY). Quantitative (i.e., numerical) variables are presented as means ± standard deviations [Table 1]. Distributions of the quantitative variables were evaluated using the Shapiro–Wilk test for normality. Spearman correlation coefficients were calculated to determine associations between quantitative variables.

Results

We evaluated 36 patients receiving 40 implants. The majority of the surgical sites for implant placement were molar regions (61%; premolar regions: 39%). There was one failed implant at the osseointegration period (first molar), which was hence only included in survival data. Thirty-nine implants fulfilled the survival criteria, representing a survival rate of 97.5% at 64.6 months. No other complications or lost implants occurred during the course of the study. None of the patients reported sinus-related pathology pre- and/or postsurgery. The implants were loaded following a 6-month initial healing period.

All patients showed peri-implant bone formation. The mean bone gain was 1.5 mm ± 0.87 mm. The bone gain on the mesial side was 1.7 mm ± 1.35 mm, with a bone gain of 1.4 mm ± 0.87 mm on the distal side. The highest bone gain observed was 4.0 mm (3.5 mm RBH and 0.5 mm TD). Tapping distances ranged from 0 to 6 mm below the floor of the maxillary sinus, with a mean of 3.01 mm ± 1.72 mm. The mean RBH was 5.4 mm ± 2.2 mm (3.5–6.9 mm). We found negative correlations between RBH–NBG ($r = -0.10$) and TD–NBG ($r = -0.14$), whereas NBG and TD showed no statistically significant associations. The

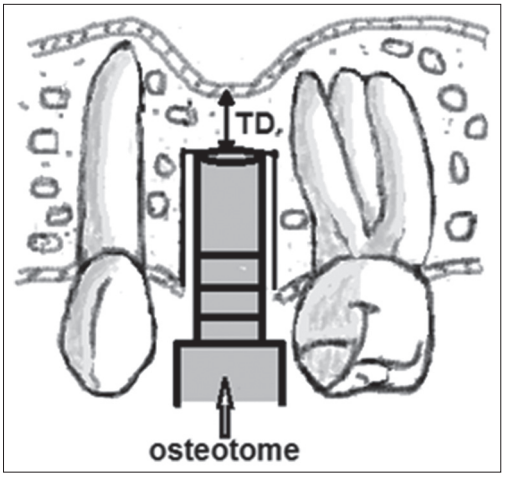

Figure 1: Schematic drawing of Type I and Type II bone. The sinus floor was approached by drilling the bone. The apical bone (TD) was tapped up to the sinus floor with an osteotome

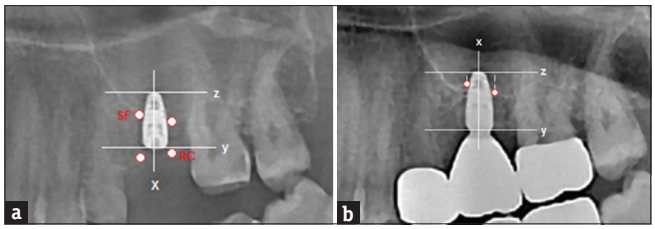

Figure 2: (a) Panoramic radiographs obtained immediately after implant placement. Reference lines and points for radiographic assessment were drawn as follows: x line, implant longitudinal axis (known length); y line, the most coronal level of the implant collar, vertical to x line; z line, at the most apical level of the implant and parallel to the y line. SF point, the most apical bone-to-implant contact at the sinus floor cortical line (mesial site or distal site); RB point, the most coronal residual bone point on the SF point and parallel to the x line. (b) Panoramic radiographs at the 1-year follow up

distribution of NBG in relation to RBH and TD is detailed in Table.

Discussion

The quality and quantity of surrounding bone are important factors for the success of implant treatment.[15] The OSFE technique aims to increase the amount of new bone in the implant apex by raising the membrane and increasing bone quality. Raising the sinus membrane has a potential for bone formation in the maxillary sinus.[16] The OSFE procedure involves tapping the osteotome approximately 1 or 2 mm away from the sinus floor. Using a drill to prepare a channel for the initial osteotome removes a large amount of alveolar bone from the site.[10,17]

There is a lack of literature evaluating of the effect of osteotome tapping distance on NBG, and it is unclear if a greater apical bone distance (TD) could provide a better tent effect, more bone tissue, and/or more space. The results of this study suggest that TD does not affect new bone formation. No statistically significant changes in NBG (P = 0.395) were observed due to the TD. The reason for the lack of increase in new bone may be because the apical bone is condensed with osteotomy and its volume consequently shrinks.

The necessity of sinus grafting in the OSFE technique is debatable. Several studies have reported that OSFE and simultaneous implant installation without grafting materials yield favorable results.[18,19] No statistically significant differences in implant survival rates have been found with and without grafting.[20] NBG was elevated in patients who received a graft (first procedure), and bone gain based on the 3-year radiographic evaluation reached the same level as that without a graft. Grafting material underwent notable shrinkage, which thus yielded the same level of NBG with or without grafting.[19] Clinical studies on OSFE performed without the use of bone grafts have demonstrated bone gain ranging from 1.7 to 2.5 mm.[18,21] Our findings in this study are in accordance with those of the aforementioned studies. The sinus membrane perforation rate was higher with grafting than without grafting because of the additional pressure caused by the grafting material.[20] When grafting material is not used, acquiring allografts becomes unnecessary and the procedure is more affordable.

No grafting material was used in this study, and we report an implant survival rate of 97.5%; this is similar to survival rates described in literature.[22,23] Only one implant failed after 5 months due to lack of osseointegration in the early healing stage before loading. A second intervention after 6 months of healing resulted in the successful placement of another implant, which was subsequently restored with a single crown. The reason for the success of the second implant is that the RBH, which was 3.5 mm in the first application, was revisited 5 months after the failure. In the panoramic measurement performed in the second application, the RBH was measured as 4.8 mm. Although there was no osseointegration, new bone was formed due to the implant that formed the floor of the sinus membrane. The increased RBH may have heightened the success of the second implant.[24] When OSFE is used for RBH insufficiency, the support of the implant from the cortical bone at the sinus base increases the anchorage of the implant.[19] Additionally, osteotomes may increase bone density by laterally compressing the bone.[25]

A consensus conference on sinus lifting held in 1996 made recommendations for the surgical approach for cases in which the RBH is between 7 and 9 mm. It was recommended to apply the osteotome technique in combination with immediate implant placement.[26] The minimum alveolar bone height recommended for the osteotome technique has changed over time.[27,28] Some studies demonstrated that OSFE is a viable technique for RBH ≤4 mm in the atrophic posterior maxilla bone (without the need for a traditional bone graft).[29,30] However, some publications have reported a lower survival rate when the pretreatment RBH was 4 mm or less.[22,31,32] Fermergard and Astrand[16] reported that, among 53 implants inserted with OSFE, six implant sites displayed a preoperative alveolar process height of ≤4 mm and two of these implants were lost. A similar tendency was found in the present investigation; four implants were inserted in sites with an RBH <4 mm, one of which was lost.

Panoramic radiography is frequently implemented as a standard radiographic examination for the evaluation

and preparation of implant treatment protocols. The limitations of this study included the measurement of three-dimensional changes in bone using panoramic radiographs, which provide two-dimensional imaging. Two-dimensional technique does not give information about the amount of new bone which occurs on the buccal and palatal sides of the implant. Known limitations encountered in a retrospective study and a small sample size was another weakness of the study. Linear magnification, one of the disadvantages of panoramic radiographs, was reduced by calibration to the known implant length.[33]

In conclusion, this study showed that OSFE without grafting material creates space for predictable and effective bone formation beyond the sinus floor. Additionally, the osteotome tapping distance has no effect on the amount of NBG. This technique provides high implant survival in the presence of insufficient bone in the posterior maxilla and low-cost and short prosthetic rehabilitation compared to the lateral approach sinus floor elevation.

Abbreviations

OSFE: Osteotome sinus floor elevation

NBG: New bone gain

RBH: Residual bone height

SF: Sinus floor

RC: Residual crest

CBCT: Cone-beam-computed tomography

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Conflicts of interest

There are no conflicts of interest.

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