Original Article - Prospective Study

# Clinical and radiological evaluation of implants placed with osteotome sinus lift technique: 19-month follow-up

Access this article online
Website: www.amsjournal.com
DOI: 10.4103/ams.ams_7_16
Quick Response Code:

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## ABSTRACT

**Aims:** Implant placement in the posterior region of the maxilla might be problematic due to poor regional bone quality. The aim of this study was to clinically and radiologically evaluate implants which were placed in the posterior region of the maxilla (with insufficient bone height) with osteotome sinus lift technique after 19-month follow-up. **Materials and Methods:** Twenty-four patients with posterior maxillary alveolar height ranging from 5 to 8 mm were chosen for this prospective study. After breaking of the cortical bony sinus floor, sufficient bone substitute was placed, and sinus floor was elevated. In this way, a new sinus floor was created, which was designated for further implants placement. Fifty implants were placed immediately after osteotomy sinus lift technique. The mean clinical and radiological follow-up period was 19 months (with a range of 14–24 months). Success factors such as the absence of mobility, pain, infection, and the amount of crestal bone loss were determined in this study. For data analyzing, Kruskal–Wallis and Mann–Whitney tests were used. **Results:** After 19 months, results showed 96% success rate. Two out of fifty implants failed due to mobility. The mean depth of implants in sinus, mean height of residual crestal bone before surgery, and the mean rate of crestal bone loss were 3.8, 7.9, and 0.71 mm, respectively. **Conclusion:** Osteotome sinus lift technique is a noninvasive surgical method for enhancing a desired length. Furthermore, implants insertion was successful after osteotome sinus lift technique in cases with insufficient bone height.

**Keywords:** Dental implant, maxillary sinus, sinus lift

## INTRODUCTION

Dental implants have achieved a high rate of success in the field of dentistry, but not all areas of jaws have the same anatomical conditions. The best area for successful implant insertion is the highly mineralized bone of the anterior mandible. In contrast, the least appropriate area is the posterior maxilla,[1] with the poorest bone quality among other intraoral regions.[2] According to the literature, the posterior maxilla has Type IV (D4) bone quality, and the bone–implant contact is the least in D4 bone quality compared with other bone densities.[3-5] These anatomical shortcomings pose challenges that may affect successful osseointegration and success rate of implants in that region.



**Cite this article as:** Attar BM, Alaei S, Badrian H, Davoudi A. Clinical and radiological evaluation of implants placed with osteotome sinus lift technique: 19-month follow-up. Ann Maxillofac Surg 2016;6:190-4.

Unfortunately, despite the limitations mentioned above, partial or complete posterior maxilla edentulism is one of the most common occurrences in dentistry which might occur 35 times more frequent than the complete mandibular edentulism.[6] The quantity and quality of available bone are the primary determinants in predicting implant success.[4] The posterior maxillary alveolar bone loses its volume faster than other regions, which is mainly due to previous periodontal diseases.[5] After tooth loss, the periosteum of the Schneiderian membrane can exhibit increased osteoclastic activity that can cause a rapid resorption of the bone, in both the horizontal and vertical dimensions.[7] Tatum described two different approaches: the lateral bone window (Caldwell–Luc) and the crestal approach for compensating this phenomenon, which were both successful.[8]

In 1994, Summers introduced a less invasive alternative approach for sinus floor elevation, with simultaneous grafting, to increase the primary stability of implants at the posterior maxilla, which is called the osteotome technique.[9] The main goal of this technique was to preserve maximum quantity of residual crestal bone, which is critical for primary stability, as opposed to Tatum, who eliminated this residual bone.[10] In the osteotome technique, a specific set of round end osteotomes is used to expand posterior maxilla horizontally and vertically, especially in cases which are not amenable to conventional preparation using drills with increasing diameters. In this technique, the harvested bone graft materials are implanted after breaking of the cortical bony sinus floor with the concave tips of Summer's osteotomes. Subsequently, osteotomes are used to compress the bone laterally and condensing bone particles toward the sinus floor. Given a lack of sufficient studiers on the success rate of implants placed immediately after the osteotome sinus lift technique, the purpose of this prospective study was to clinically and radiographically evaluate implants placed in the posterior region of the maxilla with osteotome sinus lift technique after 19 months of follow-up.

## MATERIALS AND METHODS

This experimental prospective study was carried out with the cooperation of Dental Implant Research Center, Isfahan, Iran. Twenty-five edentulous patients (11 females and 14 males; mean age: 47.2 years) were referred to the Dental Implant Clinic in Isfahan in 2010–2013, who were candidates for implant placement in the posterior maxilla with insufficient bone height. Different phases of the procedure were explained by a clinician, and an informed consent was signed by all the patients. All the procedures of this research were approved by the Ethics Committee of Isfahan University of Medical Sciences (registration code: 387142).

Before surgery, a comprehensive medical history was taken from all the patients. Selection criteria consisted of the absence of any systemic health problem such as uncontrolled diabetes mellitus and intravenous bisphosphonate use that could interfere with wound healing and osseointegration process. Furthermore, patients who had a history of corticosteroid consumption were excluded from the study. The plaque index was measured for partially edentulous patients and patients with an index of >35% were excluded from the study. The presence of serious systemic diseases, acute maxillary sinusitis, or a history of heavy smoking (more than 1 pack/day) was also considered as exclusion criteria. It should be mentioned that the presence of other sinus pathologies such as sinus polyps or mucoceles was not contraindications for the surgical process. Panoramic and periapical radiographs with parallel technique were taken before surgery to determine quality and quantity of bone and residual height of alveolar ridge. To assess sinus-related pathologies, any sign of maxillary pathology was investigated, including a sense of pressure, pain and fullness, and drainage of a foul-smelling mucopurulent lesion into the nasal cavity. In addition, panoramic radiographs were evaluated for each patient. In case of a suspected sinus pathologic condition, a supplementary Waters radiograph was taken. The residual height of the alveolar ridge in all the patients was measured, which was in the range of 4.8–11 mm.

### Surgical technique

Before surgery, the patients rinsed their mouth with 0.2% chlorhexidine for 1 min. Under local infiltration anesthesia, full-thickness flaps were elevated following mid-crestal incision. The first and second drillings were followed according to manufacturer's instructions. The depth of drilling was limited to 0.5–1-mm distance from the sinus floor. Then, an osteotome was used to make a fracture on the sinus floor. Furthermore, a suitable size of osteotome was selected to expand the alveolar bone to reach the proper diameter (both in the buccolingual and apicocoronal dimensions), and care was taken not to penetrate or tear the sinus membrane. Beta-tricalcium phosphate bone substitute (Kasios, L'Union, France) was compacted into the sinus which was elevated with the use of the osteotome. In this manner, a new sinus floor was created, which was suitable for the placement of an implant with a desirable length [Figure 1].

Three types of implant were used in this study: ITI with a diameter of 4.1–4.8 mm (ITI Dental Implant System, Institut Straumann, Basel, Switzerland), Biohorizons with a diameter of 3.5–5 mm (Biohorizons Dental Implant Birmingham, AL, USA), and Xive with a diameter of 3.8–5.5 mm (Xive Implant, Dentsply Friadent, Mannheim, Germany). The mean length of the implants was 10 mm, and all of them were placed immediately after osteotome sinus lift technique. Subsequently, the flaps were sutured, and radiographs were taken.

The Schick Dental software program (version 3.5) (Sirona Dental System, NY, USA) was used to measure the distance between the bone crest and the implants' shoulder.

### Postoperative considerations

After the first surgery, the patients were asked to use ice packs to prevent edema for 3–4 h. In addition, the patients were asked not to blow their nose and suck on strews to prevent increases or decreases in the maxillary air pressure. To prevent secondary infection of the sinuses and surgical site, 500 mg of amoxicillin antibiotic and 0.2% chlorhexidine mouthwash were prescribed for 7 days.

### Radiographic evaluation

The patients were requested to refer 4 months later for loading the dental implants.

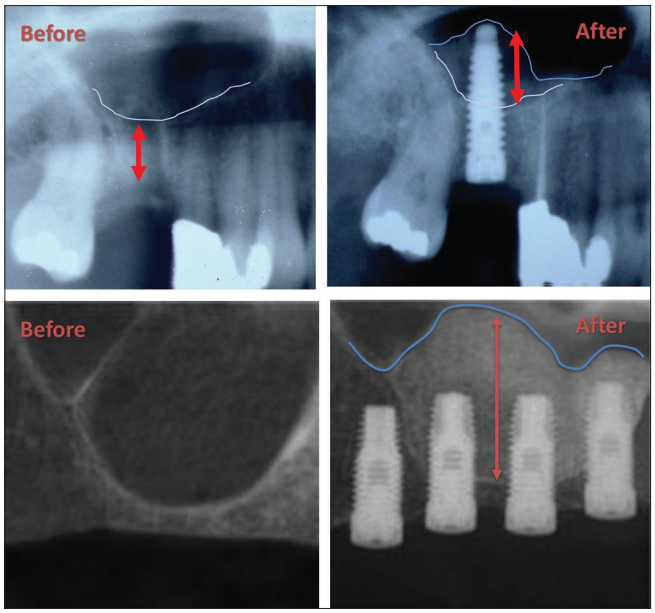


**Figure 1:** Bone formation phenomenon beneath sinus elevated membrane after osteotome sinus lift technique

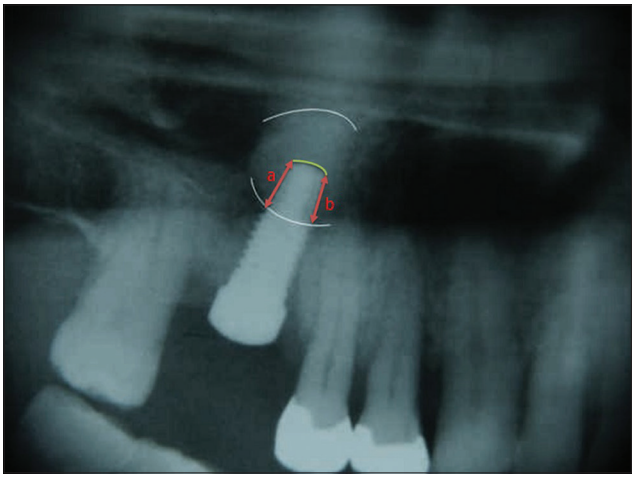


**Figure 2:** Distance from initial floor of sinus to the most apical part of implant at the distal site (a); distance from floor of sinus to the most apical part of implant at the mesial site (b)

Radiographs were taken before immediately and at the end of the follow-ups (14–24 months) after implant placement. The standardized parallel technique, with XCP film holders (Dentsply-Rinn Co., NY, USA), was ordered to eliminate the biases at each interval. The following parameters were measured in each radiograph:

a. Residual crestal bone height in the mesial and distal site before surgery
b. Amount of implant entering the sinus from the mesial and distal surfaces of each implant (the distance between the implant apex and the initial sinus floor) [Figure 2]
c. The amount of vertical crestal bone loss in the mesial and distal sides of implants (it was measured as the vertical distance of the first bone–fixture contact to the abutment shoulder)
d. The presence of radiolucencies (abnormality).

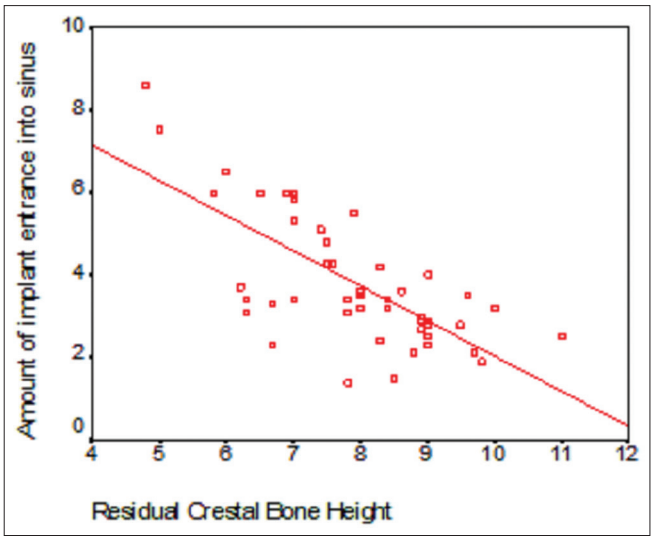


**Figure 3:** Reverse correlation between residual crestal bone height and amount of implant entrance into sinus

To standardize the exact marginal bone loss, the actual length of the implant was used to determine the amount of magnification for both the radiograph and implant.

### Success criteria

Success criteria used in the present study were based on reliable published studies:[11-14]

a. Absence of detectable implant mobility
b. Absence of pain or recurrent peri-implant infection
c. Absence of continuous radiolucency around the implant
d. Amount of marginal bone loss (or absence of significant marginal bone loss).

### Statistical analysis

Kruskal–Wallis and Mann–Whitney tests were used to analyze data using SPSS software ver.16 (IBM Corporation, Armonk, NY, USA) ($\alpha = 0.05$).

## RESULTS

Twenty-four patients (11 females, 13 males) with a mean age of 47.2 ± 10.7 years received 50 implants in the posterior region of the maxilla. Twenty-four implants were inserted in the right maxilla and 26 were inserted in the left maxilla. The majority of the surgical sites were upper second premolar region (32%), followed by the first molar (28%), second molar (20%), first premolar (18%), and canine (2%) regions.

Most of the implants used were ITI (42%), followed by Biohorizon (36%) and Xive (22%). The mean follow-up period was 19 months. None of the patients reported sinus-related pathology or complications such as bleeding.

During the follow-up period, two implants of fifty implants failed after 4 and 7 weeks because of implant mobility; therefore, the success rate was 96%. In the failed implants, the residual height of the alveolar ridge before surgery was reported to be <5 mm.

The mean marginal bone loss at the end of the observation period was reported 0.71 ± 0.13 mm (0.79 mm in the distal and 0.63 mm in the mesial site).

Before surgery, the residual height of the alveolar ridge ranged from 4.8 to 11 mm (a mean value of 7.9 ± 1.27). After implant insertion, the mean distance between the implant apex and the initial sinus floor (implant length in the sinus) was 3.8 ± 1.56 mm. These two values showed a significant inverse relation with each other ($P = 0.07$) [Figure 3].

As we moved toward the posterior maxilla, the amount of residual bone before surgery decreased. This amount showed a significant difference between the first premolar and the first molar, the first premolar and the second molar, and the second premolar and the second molar ($P < 0.05$).

## DISCUSSION

In the present study, the success rate of 50 implants placed in the posterior maxilla was 96% during 19 months of follow-up. Other studies, too, have reported success rates up to 90% for osteotome sinus lift technique[15-18] as the least and highest rates of success rates were 90.8% and 100%, respectively. Furthermore, in a study by Gabbert *et al*.,[19] a success rate of 94% was reported.

One of the major criteria, which plays an important role in implant success rate, is the amount of marginal bone loss. In the majority of clinical studies, the mean marginal bone loss of 1 mm is usual during the 1st year of implant placement. One of the criteria for a successful implant is marginal bone loss <2 mm.[5] In the study of Zhou *et al*.,[20] the mean marginal bone loss was reported to be <1 mm in 66 implants, and no resorption was observed in bone graft after 6 months. Simunek *et al*.[1] reported 0.9 mm of marginal bone loss for 45 implants after 12–23 months. In our study, the mean marginal bone loss was reported to be 0.71 ± 0.13 mm after the follow-up period, which is in an acceptable range according to the success criteria. In addition, in a systematic review by Cehreli *et al*.,[21] the amount of marginal bone loss was assessed in 4200 implants from 13 different manufacturers. It was concluded that there was no significant difference in the amount of marginal bone loss among different implants. Therefore, it can be pointed out that in our study, the use of three different implants did not have any significant effect on the amount of marginal bone loss.

From the analysis of the previously cited works and other recent published works,[16,22] it can be concluded that one of the most important factors which can highly affect the surgical technique (osteotome or lateral) and implant survival rate with the osteotome sinus floor elevation is the preexisting bone height between the sinus floor and the bone crest.

In our study, the mean residual bone height before surgery was 7.9 mm (4.8–11 mm), and all the implants were inserted immediately after the osteotome sinus lift technique.

In the present study, two of the implants with residual bone heights of 4.8 and 5 mm failed due to mobility. Furthermore, the least recommended amount of residual bone height in the osteotome technique is 5 mm.[10] According to Toffler,[16] as the residual bone height decreases, the success rate of implants decreases consequently. This can be a good reason why two implants with a minimum amount of residual bone height failed. As a result, it can be suggested that for the use of the osteotome technique, the amount of residual bone height should be more than 5 mm.

In a study by Ferrigno *et al*.,[13] the amount of implant insertion into the sinus was 2.6 mm at the mesial site and 3.1 mm at the distal site. Volpe *et al*.[15] reported a mean bone gain and sinus elevation of 2.8 mm. In the present study, the mean amount of implant entering the sinus was 3.8 mm, which is slightly more than that in other studies. Based on this correlation between the amount of residual bone height before surgery and the amount of implant entering the sinus in this study, it can be concluded that with the less preexisting bone height, the amount of implant insertion into the sinus is greater to achieve sufficient primary stability.

Although another technique, such as short implants, can be used to overcome problems in severely resorbed maxilla[23] and recent studies have shown a high success rate for this method compared to longer implants,[24] different techniques with their different success rates and their shortcomings make the comparison between these techniques impossible. Considering some limitations such as patient selection and follow-up period, it is recommended that further studies should be conducted to compare the results of different approaches which help clinicians select the most appropriate method.

## CONCLUSION

Considering the limitations of implant placement in the posterior maxilla, osteotome sinus lift technique is a noninvasive and predictable procedure, allowing implant placement. Furthermore, it is recommended that the residual bone height should be more than 5 mm for an ideal result following the osteotome technique.

### Financial support and sponsorship
Nil.

### Conflicts of interest
There are no conflicts of interest.

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