



## EVALUATION OF TRANS-ALVEOLARCRESTAL MAXILLARY SINUS LIFT WITH SINUS BALLOON TECHNIQUE AND IMPLANT PLACEMENT

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### ABSTRACT

**Objective:** To evaluate the efficacy of the sinus balloon technique via transcresal maxillary sinus floor elevation. **Subjects and Methods:** The current study was conducted on 12 patients with their age ranged from 16 to 45 years, with limited bone height below the floor of the maxillary sinus. they were divided into two groups. Group A patients received dental implants after sinus lifting using ballooning technique, while in group B patients received dental implants after transcresal sinus lifting using Osteotomes. The bone density and bone height were measured by cone beam computed tomography (CBCT). **Results:** Successful sinus lifting with balloon technique and osteotome technique with superior clinical and radiographic results of balloon technique. The radiographic examination showed the mean elevated height after 6 months in group A was  $11.72 \pm 2.16$ mm. While in group B was  $8.05 \pm 1.90$  mm. **Conclusion:** Balloon technique and osteotome technique are successful methods for sinus membrane lifting with superior clinical and radiographic results balloon technique.

**KEY WORDS:** Balloon technique; osteotome technique; transcresal sinus lifting.

### INTRODUCTION

Dental implants are successfully used to replace both the form and function of missing teeth. The volume of the bone in the edentulous ridge should be sufficient to support the implant placement. Posterior maxillary implant placement is often complicated by the lack of quality and volume of available bone. The bone type of this area generally type 3 and 4 bone which generally exhibit the least dense bone and quality<sup>(1)</sup>. Also the bone volume of this area always not enough to support dental implant due to bone resorption and sinus pneumatization<sup>(2-4)</sup>.

So that the maxillary sinus elevation procedure has become an important preprosthetic surgical procedure for the creation of bone volume in this area for the placement of dental implants<sup>(5)</sup>.

The challenge of bone augmentation of this segment has been traditionally addressed either by lateral maxillary window or transcresal technique<sup>(6)</sup>. Sinus floor elevation surgery via lateral approach produce a huge elevation  $\geq 10$ mm<sup>(7)</sup>. The success of this approach varied from 61.7% to 100% with mean average of 91.8%<sup>(8)</sup>. The disadvantage of this technique may be membrane tear, bleeding,

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infection and sinus obstruction, in addition to peri-procedural swelling and discomfort. Relative contraindications of this technique may be sinus convolution septum, narrow sinus and previous sinus surgery. Also this technique requires considerable surgical skills, equipment and time<sup>(9)</sup>.

Conventional transcresal approach is used to lift the sinus using osteotomes or sinus lift system which has fewer complications either during surgical procedure or after the completion of surgery. Less membrane perforation was recorded during surgery, less sinus problems like nasal congestion, pathologic secretion and headache<sup>(10)</sup>. This procedure requires a minimum of 6 mm of residual crestal bone<sup>(11)</sup>. The osteotome technique (bone-added osteotome sinus floor elevation) (BAOSFE), is an alternative approach for sinus elevation used with missing of a small amount of bone height. But membrane perforation and tear may be observed with this technique<sup>(12,13)</sup>.

Recently, antral membrane balloon elevation (AMBE) used as minimal invasive method of sinus lift<sup>(14)</sup>. AMBE technique was used to lift the sinus membrane with minimal trauma and is particularly useful in areas that are difficult to reach. It is beneficial when teeth are adjacent to the edentulous area that requires augmentation. The AMBE technique is accomplished with a limited incision, minimal mucoperiosteal flap reflection and small window. The membrane is elevated to the medial wall of the sinus cavity avoiding sharp dissection around the roots of adjacent teeth. Thus complication such as morbidity, blood loss, operative time, and postoperative pain may be reduced when compared with the conventional procedure<sup>(15-22)</sup>. Transcresal approach with AMBE used for membrane elevation up to 10 mm<sup>(23)</sup>.

The aim of this study was clinical and radiographic evaluation of using ballooning technique for sinus lift simultaneous with implant placement.

## SUBJECTS AND METHODS

**I. Ethical considerations:** The study was approved by the Oral and Maxillofacial scientific Committee and department council, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University. The objectives of the study were discussed with the patients and informed consent form and a copy of the instructions of the surgical patients were signed before starting the orthodontic treatment.

**II. Study design:** Prospective randomized clinical trial study.

**III.1. Study setting and population:** The current study was conducted on 12 patients (3 males and 9 females). All patients received treatment at the outpatient clinic at department of Oral and Maxillofacial surgery, Faculty of Dental Medicine, (Boys - Cairo) Al-Azhar University, Egypt. **III.2. Sample size.** Sample size of 12 patients divided into two equal groups with two different techniques of sinus membrane lifting. Sinus membrane lifting with balloon technique and conventional osteotome technique. Based on sample size calculation, 12 patients were assessed for gained bone height and differences in bone density and statistical analysis was done for each technique.

## IV. Eligibility criteria of population

### *Inclusion criteria:*

Patients were selected in this study according to specific criteria as healthy person with no history or clinical evidence of specific systemic diseases that may affect the bone healing, dental implant osseointegration and the maxillary sinus. All the patient' age ranged from 16 –45 years with Good oral hygiene. All patients have a missing tooth (teeth) in the sinus zone of atrophied maxilla in which the subantral distance < 6 mm.

### *Exclusion criteria*

In this study some patients was excluded, such as heavy smokers, uncontrolled medically

compromised patients that affect bone healing, pregnant cases and patients with occlusion discrepancies (cross bite and deep bite) and parafunctional habits (clenching and bruxism).

### **Intervention**

Local anesthesia was injected after extra and intra oral disinfection. A crestal incision was used to expose the bone at the crest of the ridge. A full thickness mucoperiosteal flap was reflected buccally to expose the alveolar ridge at the implantation site. In group (A): Drilling was done with a low speed high torque externally irrigated contra-angle hand piece with surgical motor unit. Drilling was performed at 600-800 rpm to maintain the vitality of bone surrounding the implantation site. The implant position was marked with a round bur. All drilling procedures were done in a vertical direction and moved up and down during drilling with light intermittent finger pressure. Initial osteotomy was done with pilot drill up to 1 mm below the sinus floor that was determined from CBCT. A guide pin was placed in the osteotomy site to confirm the position and the angulation of the osteotomy. Normal drilling sequence was followed to further widening the osteotomy site to the 3.7 mm or more according to selected implant size.

The remaining subantral bone of 1 mm was broken by graduated osteotome. The latex balloon was fitted to a catheter used to insufflate the balloon. the correct functioning of the balloon was checked by insufflating it several times. The balloon was inserted in the subantral space, performing progressive, slow and controlled insufflations with saline solution. This step was repeated for several times with increasing amount of insufflated saline every time. Each 0.5 cc of the saline has an elevated sinus membrane of 6 mm according to the manufacturer's instructions, so the sinus membrane was detached to the desired height in each case. The balloon was left inflated for 5 min to reduce the ability of the sinus membrane recoil, and then the balloon removed from the osteotomy site. Figure (1)

The integrity of the sinus membrane was evaluated by asking the patients to blow through the nose after pinching the nostrils and looking for air bubbles or mist on the mirror. After sinus membrane elevation using ballooning technique was done, the grafting material was introduced after mixing with saline and pressed into implant site using bone graft carrier and condenser. The sealed sterile implant package was opened and the implant with its attached insertion tool were removed from the inner vial and carried to the prepared osteotomy site. Cover screw was immediately screwed to the head of implant. Patients were instructed to avoid traumatization of the implant site. The surgical site was irrigated with sterile saline solution and the mucoperiosteal flap was repositioned to its original site and sutured Fig 1A & B.

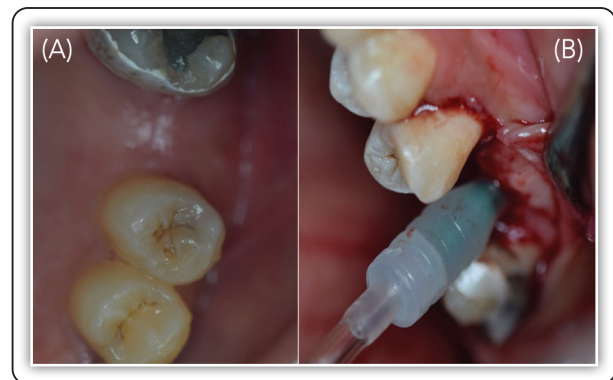


FIG (1) (A) clinical preoperative photograph showing missing upper left first molar. (B) Insertion of the sinus balloon for lifting of the sinus membrane

While group (B): The implant position was marked with a round bur. Initial osteotomy was done with pilot drill up to 1 mm below the sinus floor that was determined from CBCT. A guide pin was placed in the osteotomy site to confirm the position and the angulation of the osteotomy. Normal drilling sequence to further widening the osteotomy site to the final drill. The remaining subantral bone of 1 mm was broken by graduated osteotome suitable with the osteotomy size. The grafting material was introduced to osteotomy by using bone carrier and condenser. The sealed implant package was

opened and the implant with its attached insertion tool were removed from the inner vial and carried to the prepared osteotomy site. Cover screw was immediately screwed to the head of implant.

**Data management and analysis:** Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA).

**RESULTS**

Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage Chi-square ( $\chi^2$ ) test of significance was used in order to compare proportions between qualitative parameters. Independent-samples t-test of significance was used when comparing between two means. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the significance level was set to  $P \leq 0,05$ . The statistical analysis was performed on 12 patients (3 males, 9 females) with their age ranged from 16-45 years.

**Clinical evaluation**

*The pain* was evaluated at first, third and seven days after implant insertion and recorded in Visual Analogic Scale (VAS of 10). In the first day of the operation, the pain ranged from (0- 2) in both groups. The Pain decreased to (0-1) at third day of operation and no pain recorded at seventh day of operation in both groups, without statistically significant difference between two groups at all time of follow up.

**Implant stability:** It was measured by Resonance Frequency Analysis (RFA) with Osstell to assay the implant stability Quotient scale (ISQ). The mean values of ISQ were  $55.82 \pm 6.65$ ,  $54.70 \pm 6.52$  immediate postoperative in group A and B respectively. After six months the mean value of implant stability was  $60.81 \pm 6.62$ ,  $59.60 \pm 6.60$  in group A and B respectively. There wasn't any statistically significant

difference between both groups in all time of follow up Table (1).

**TABLE (1)** Comparison between pre and post according to implant stability in each group.

Implant stability	Group A (n=6)	Group B (n=6)
Immediate after insertion	$55.82 \pm 6.65$	$54.70 \pm 6.52$
After six months	$71.36 \pm 6.73$	$69.93 \pm 6.60$
Mean Diff.	15.54	15.23
Paired Sample t-test	4.281	3.796
p-value	0.021*	0.033*

**Sinus membrane perforation**

Schneiderian membrane perforation occurs in one case of this study, and this was confirmed clinically in all cases by valvula maneuver this case was excluded from the study.

**Radiographic evaluation**

**Bone Height**

Bone was assessed preoperative, immediate postoperative and six months post-operative in both groups from CBCT scan in group A, the mean original bone height was  $4.45 \pm 0.72$  mm preoperatively, immediate postoperative the mean bone height was  $12.22 \pm 2.00$  mm and six months after sinus floor augmentation, the mean alveolar bone height was  $11.72 \pm 2.16$  mm. In group B, the mean original bone height was  $4.45 \pm 0.90$  mm preoperatively, immediate postoperative the mean bone height was  $9.33 \pm 0.75$  mm and six months after sinus floor augmentation. Thus, the final bone gained was in the range of 2.5-5 mm at six months. The increase in vertical bone height was found to be statistically significant in both groups ( $p$ -value  $< 0.001$ ) Figure 2 and 3 & Table (2).

**TABLE (2):** Comparison between groups according to bone height (ml).

Bone height (ml)	Group A (n=6)	Group B (n=6)	t-test	p-value
<b>Pre</b>				
Range	3.5-5.5	3.5-5.8	0.541	0.130
Mean ±SD	4.45±0.72	4.45±0.90		
<b>Immediate</b>				
Range	9-14.5	8.5-10	3.731	0.017*
Mean ±SD	12.22±2.00	9.33±0.75		
<b>After 6months</b>				
Range	8-14	5-9.8	2.629	0.026*

**Bone density**

CBCT scan was used to evaluate bone density preoperative and six months postoperative using Hounsfield units (HU). The density of the new bone formed around implants in group A after 6 months ranged from 417.2 HU – 780 HU with mean value 291.48±52.04 HU and with a significant change in bone density around the implants when compared with the preoperative bone density that ranged from 212.8HU – 357.2 HU with the mean value 603.85±158.26HU. While, in the group B, bone density around the implants after 6 months postoperatively ranged from 417.3 HU –779 HU with the mean value 588.06±168.81 HU and with a significant change in bone density around the implants when compared with the preoperative bone density that ranged 217.6 HU – 358.2 HU with the mean value 292.12±67.34 HU. There was no significant difference between the two groups, and both groups were comparable to that of bone normally present in the maxilla Table (3).

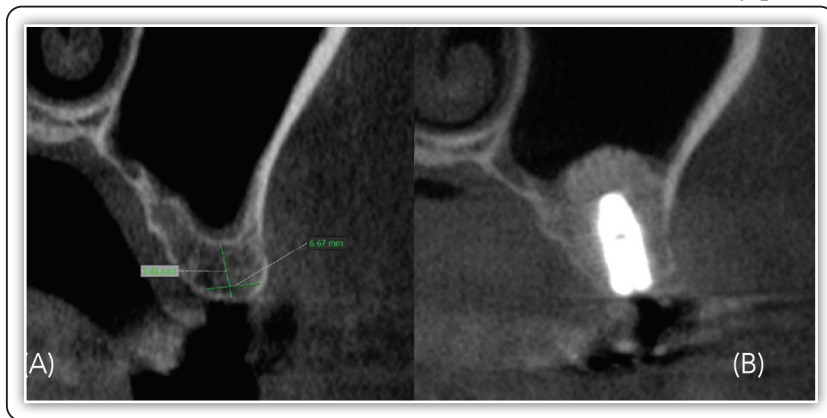


FIG (2) CBCT of group A, (A) showing preoperative bone height. (B) CBCT after six months of sinus lifting by balloon (B).

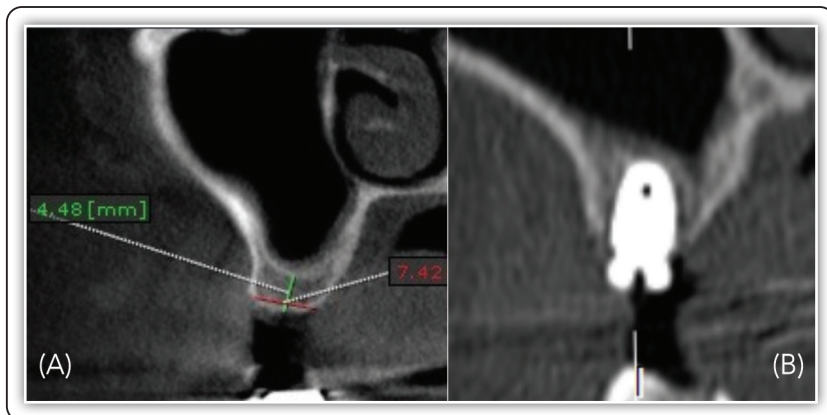


FIG (3) CBCT of group B, (A) showing preoperative bone height. (B) CBCT after six months of sinus lifting by osteotome(B).

**TABLE (3)** Comparison between groups according to bone density (ml).

Bone density(ml)	Group A (n=6)	Group B (n=6)	t-test	p-value
<b>Pre</b>				
Mean±SD	291.48±52.04	292.12±67.34	0.015	0.988
Range	212.8-357.2	217.6-358.2		
<b>Post</b>				
Mean±SD	603.85±158.26	588.06±168.81	0.168	0.869
Range	417.2-780	417.3-779		

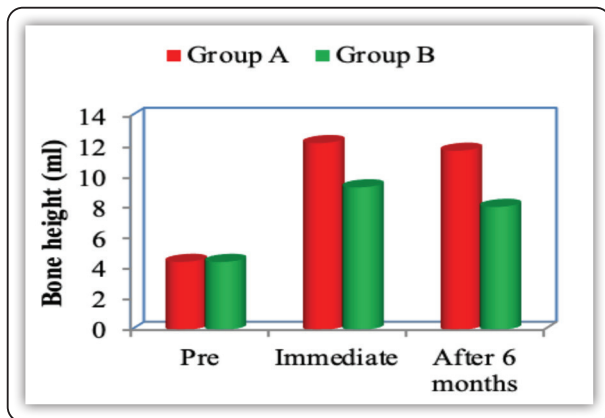


FIG (4) Bar chart between groups according to bone high

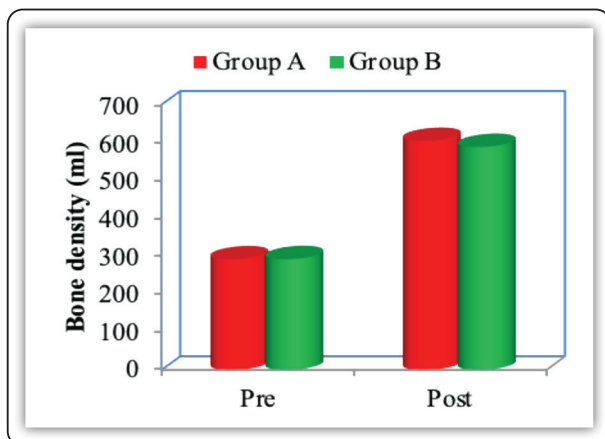


FIG (5) Bar chart between groups according to bone density.

**DISCUSSION**

In the present study the antral membrane balloon elevation (AMBE) technique was selected as minimal invasive technique lifts the sinus membrane with minimal trauma particularly in areas that are difficult to reach with a limited incision, minimal mucoperiosteal flap reflection, less morbidity, blood loss, operative time, and postoperative pain and complications when compared with the conventional technique with predictable results as the balloon technique can afford sinus membrane elevations of up to 10 mm while the sinus lift with osteotomes affords a height gain of  $3 \pm 0.8^{(24)}$ .

This study was aimed to clinical and radiographic evaluation of sinus membrane elevation simultaneous with implant placement using sinus balloon technique. The sample was classified into two groups.

**Group A:** sinus membrane lifting using ballooning technique with implant placement.

**Group B:** Conventional transcresal sinus membrane lifting using Osteotomes with implant placement.

In the current study, cone-beam computed tomography was used to determine the bone density, gain bone height and confirm sinus membrane integrity, preoperative, immediate postoperative and after six months of implant insertion. The bone density was measured with Hounsfield units (HU) at region of interest using the OnDemand3D™ software. Also, OnDemand 3D™ software was used to evaluate vertical height gained.

In the current study, there was no significant postoperative pain with minimal edema in both groups throughout the follow up phase. The Pain indices in both groups were ranging from 0-2 during 24 hours to 0-1 at the 3<sup>rd</sup> post-operative day, and while no pain was recorded since the 7th day postoperatively till the rest of the follow up period. This was coinciding with Hu X et al <sup>(25)</sup> in

2017, in their study where they observed minimal postoperative swelling and pain, resulting in patient comfort and reduction of analgesic use.

In the present study, the implant stability was measured using the Resonance Frequency Analysis (RFA) via the Osstell ISQ system. RFA was chosen as a non-invasive and reliable method to assess variation in implant stability over time. RFA registrations are directly related to the stiffness of the implant in the surrounding bone: during healing an increase in implant stability quotient (ISQ) values presumably reflect new bone apposition at the implant-bone interface. All implants were stable during implant placement, and the mean value in group A was  $55.82 \pm 6.65$ . While, the mean in group B was  $54.70 \pm 6.52$  immediate postoperative. All implants were stable and implant stability was increased in the two groups after six months of sinus augmentation. These results were in agreement with the study performed by Maria et al in 2017<sup>(26)</sup> which demonstrated that in study of ten cases after sinus floor elevation with different two biomaterials there was an increase in the ISQ values after six months.

In presented study, Schneiderian membrane perforation occur in one case during osteotomy which excluded from the study and this was confirmed clinically by valvula maneuver and treated with collagen membrane without using bone graft to prevent leakage of bone graft to sinus cavity. This finding was supported by López-Quiles, J<sup>(27)</sup> in 2018 during study of Maxillary sinus balloon lifting and deferred implantation of 50 Osseointegrated implants in 27 patients sinus membrane perforation occurred in one case.

Absence of Schneiderian membrane perforation during sinus floor elevation with balloon technique in all cases could be attributed to the non-traumatic surface of the balloon and gentle slow inflation of sinus balloon.

In this study, in group A the mean original bone height was  $4.45 \pm 0.72$  mm preoperatively. which

was increased after six months after sinus floor augmentation with the mean bone difference 7.27 mm. At 6 months the increase in vertical bone height was found to be statistically significant (p-value < 0.001). Similar results were obtained by Kfir et al<sup>(28)</sup> in 2009, in a multicenter study of 112 patients subjected to transcresal sinus lift using the sinus balloon technique.

In this study, in group B the mean original bone height was  $4.45 \pm 0.90$  mm preoperatively. Which was increased after six months after sinus floor augmentation with the mean bone difference 3.60 mm. At 6 months the increase in vertical bone height was found to be statistically significant (p-value < 0.001). Similar results were obtained by Jing Y<sup>(29)</sup> in 2018, study of 51 implants placed in 40 patients subjected to transcresal sinus lift using the osteotome technique with or without graft material. The mean of endo-sinus bone gain was  $2.55 \pm 2.24$  mm

Regarding to postoperative infection in the present study, no signs of infection was present post operatively in both groups and radiographic evaluation by CBCT 6 months postoperatively revealed the absence of any fluid level or inflammatory process. This is in agreement with a study conducted by Mazor.Z<sup>(30)</sup> in 2012, where they observed that the use of antral membrane balloon elevation minimizes the postoperative swelling and infection.

In the present study, in group A the mean value of bone density was  $291.48 \pm 52.04$  which was increased after 6 months of sinus augmentation. While, in the group B, the mean value of bone density was  $292.12 \pm 67.34$  which was increased after 6 months of sinus augmentation. There was significant difference in bone density between preoperative and after six months in the two groups without significant difference between two groups, and both groups were comparable to that of bone normally present in the maxilla. This is in agreement with the results of Sogo et al<sup>(31)</sup> in 2012, who studied the

bone density of the posterior maxilla in 30 patients, and they concluded that the bone in the posterior maxilla was classified as D3 (350–850 HU) or D4 (150–350 HU) according to Misch's classification.

## CONCLUSIONS

1. The present study showed that both balloon technique and conventional osteotome technique are promising methods for sinus membrane lifting.
2. Both have significant success rates with superior clinical and radiographic results balloon technique over conventional osteotome technique after a follow up period up to 9 months.
3. Follow-up period of 9 months following implant placement seems to be not enough to determine definitive superiority of sinus membrane lifting technique on the other.

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