



EVALUATION OF TRANS-ALVEOLARCRESTAL MAXILLARY SINUS LIFTING WITH HYDRAULIC PRESSURE TECHNIQUE AND IMPLANT PLACEMENT

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ABSTRACT

Objectives: The current study is designed to compare between hydraulic pressure technique and osteotome technique for maxillary sinus lifting with dental implant placement via trans-crestal approach. **subjects and Methods:** Twelve patients with average age (18 to 45) years old with inadequate bone height below the maxillary sinus floor were randomly divided into two groups: group (A): Patients received dental implants after sinus lifting using hydraulic pressure technique. Group (B): Dental implants were placed after trans-crestal sinus lifting using Osteotomes. Follow up: done immediate after implant placement and after six months by cone beam computed tomography (CBCT) to measure bone density and gained bone height. Paired t-test, and descriptive statistics were used to evaluate the gained bone height and bone density. **Results:** Sinus lifting with hydraulic technique and osteotome technique were effective with superior clinical and radiographic results of hydraulic technique. Twelve implants were placed. Follow up CBCT showed, mean bone height after 6 months in group A was 12.07 ± 2.22 . while in group B was 8.29 ± 1.96 mm. **Conclusions:** hydraulic technique and osteotome technique are successful methods for sinus lifting with superior clinical and radiographic results of hydraulic technique.

KEY WORDS: Hydraulic technique; osteotome technique; trans-crestal sinus lifting.

INTRODUCTION

Dental implants successfully used to replace both form and function of missing teeth. The bone in the edentulous ridge should be sufficient to support the implant placement. In the posterior maxilla, the residual ridge resorption after teeth loss that accompanied by pneumatization of the maxillary sinus and low bone density (D3 and D4) leads to lack of adequate bone height and implant placement without bone regeneration is not possible ⁽¹⁻⁴⁾.

So that, the maxillary sinus floor elevation is important surgical procedure for the creation of bone volume adequate for dental implants placement ⁽⁵⁾.

Lateral and trans-crestal approaches were used for maxillary sinus floor elevation⁽⁶⁾. Sinus floor elevation surgery via lateral approach produce adequate elevation ≥ 10 mm⁽⁷⁾ with mean success rate of 91.8%⁽⁸⁾. Disadvantage of this technique included membrane tear, infection, sinus obstruction, patient discomfort, more cost and requires surgical skill.

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Relative contraindications of this technique are narrow sinus and previous sinus surgery^(9, 10).

Conventional trans-crestal approach It is the first choice when there is sufficient bone width and height that allow for a good primary stability as it is less invasive procedure, improve density of the maxillary bone and allow the use of less autogenous grafting material⁽¹¹⁾. Disadvantage of this approach comprised of increased risk of misaligning of the long axis of the osteotome during the sequential osteotomy⁽¹²⁾. This procedures requires a minimum of 5-6 mm of residual bone height⁽¹³⁾.

Recently, hydraulic pressure technique utilizing bone putty introduced as minimally invasive method of sinus lift by hydraulic detachment of sinus membrane. Bone putty injected in prepared osteotomy with fitted tip where the insertion pressure exerted by the putty results in an atraumatic elevation of sinus membrane⁽¹⁴⁾. This technique decrease possibility of sinus membrane perforation and reduce time as the membrane is lifted and the space filled with graft material simultaneous, thus complications such as morbidity, blood loss, increase operative time, and postoperative pain are reduced when compared with the conventional procedure. Trans-crestal approach with hydraulic pressure elevate the membrane up to 10 mm⁽¹⁵⁾.

The present study evaluated the hydraulic pressure technique via DBM putty available in syringe for sinus lift simultaneous with implant placement clinically and radiographically.

SUBJECTS AND METHODS

I. Ethical considerations

The study was approved by the ethical committee at Faculty of Dental Medicine (Boys, Cairo) Al-Azhar University with ethical code 820/3938.

II. Study design

It is prospective, randomized clinical study. The study was conducted on 12 patients in need for

dental implants in posterior maxilla. Patients were selected from the outpatient maxillofacial surgery clinic at faculty of dental medicine, Cairo, Boys, Al-Azhar University.

III. Sample size

Sample size of 12 patients divided randomly into two equal groups with two different techniques of sinus membrane lifting, sinus membrane lifting with hydraulic technique and conventional osteotome technique. All patients were assessed for gained bone height and differences in bone density. Statistical analysis was done for each technique.

Inclusion criteria

Inclusion criteria included patients in need of dental implants in atrophied posterior maxilla in which the sub-antral bone height < 6 mm, with no history or clinical evidence of systemic diseases that may affect the bone healing or dental implant osseointegration. Also, the patients age ranged from 18 –45 years with Good oral hygiene.

Exclusion criteria

Exclusion criteria included heavy smokers, uncontrolled medically compromised patients that affect bone healing, pregnancy and patients with occlusion discrepancies (deep bite) and parafunctional habits (bruxism). In addition to patients unable to sign the informed consent.

Intervention

Local anesthesia was injected after intra oral disinfection. A crestal incision was done to expose the crestal bone. A full thickness mucoperiosteal flap was reflected buccally to expose the alveolar ridge at the implant site. The implant site was marked with a round bur then drilling was done with a low-speed high torque contra-angle hand piece with surgical motor unit. Drilling was performed at 600-800 rpm under saline irrigation to maintain bone vitality. All drilling procedures were done in a vertical direction

with up and down motion 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. Guide pin was placed in the osteotomy site to confirm the position and the angulation of the osteotomy. Sequential drilling was done to further widening the osteotomy site according to selected implant size up to 1 mm below the sinus.

In group (A): The remaining sub-antral 1 mm of bone was broken by graduated osteotome, the DBM putty is directly injected into the prepared sinus cavity via the well fitted syringe (syringe tip can be adjusted to be fitted to the osteotomy site with different catheter size). Once the syringe tip fits tightly in the osteotomy, allowing the insertion pressure to be delivered directly to the fractured inferior border of the sinus floor. The pressure exerted by the putty results in an atraumatic elevation of the sinus floor. For every 0.5 cc injected into the sinus, the floor is elevated approximately by 1 mm^(16,17). The integrity of the sinus membrane was evaluated by using a gently performed Valsalva maneuver after elevation of the membrane by asking the patients to blow through the nose after pinching his nostrils and looking for air bubbles or bone putty extruded from the osteotomy. Sealed sterile implant package was opened, implant was removed and placed to the prepared osteotomy site.

Cover screw was screwed to the implant and mucoperiosteal flap was repositioned and sutured. While in group (B): The remaining sub-antral bone of 1 mm was broken by graduated osteotome suitable with the osteotomy size and sinus lift was completed by osteotomes. The integrity of the sinus membrane also evaluated by Valsalva maneuver. The grafting material was introduced to osteotomy by bone carrier and condenser. The implant was carried to the prepared osteotomy site, then Cover screw was screwed to implant, flap reposition and suturing. (Figure 1)



FIG (1) (A) injection of DBM putty for sinus lift; (B) Flap suturing after implant placement.

Data management and analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean \pm standard deviation (SD). Qualitative data were expressed as frequency and percentage.

RESULTS

Clinical evaluation

Pain: was evaluated at first, third and seventh days after implant insertion for all patients and recorded by Visual Analogic Scale (VAS of 10). In the first day of the operation, the pain ranged from (0- 2) which decreased at third day and no pain recorded at seventh day in both groups without statistically significant difference.

Sinus membrane perforation: occurs in one patient (positive Valsalva maneuver) in group B. In this case implant treatment was completed without bone augmentation, and the case was excluded from the study.

Radiographic evaluation

Bone Height: data were collected regarding the vertical bone height preoperatively, immediate after surgery and 6 months postoperatively for all implants from CBCT scan. In group A, the mean bone height was 4.58 ± 0.74 mm preoperatively, 12.59 ± 2.06 mm

immediately after surgery and 12.07 ± 2.22 mm after six months. Thus, the final bone gained was in the range of 4.3-9.2 mm. In group B, the mean bone height was 4.57 ± 0.93 mm preoperatively, which increased to 9.61 ± 0.77 mm immediately after surgery and was 8.29 ± 1.96 mm after six months. Thus, the final bone gained was in the range of 2.6-5.4 mm. The increase in vertical bone height was found to be statistically significant in both groups (p -value < 0.001). (Figure 2 & Table 1)

TABLE (1) Comparison between groups according to bone height (ml).

Bone height (ml)	Group A (n=6)	Group B (n=6)	t-test	p-value
Pre				
Range	3.6-5.7	3.6-5.9	0.021	0.984
Mean \pm SD	4.58 ± 0.74	4.57 ± 0.93		
Immediate				
Range	9.3-14.9	8.7-10.0	3.319	0.008*
Mean \pm SD	12.59 ± 2.06	9.61 ± 0.77		
After 6 months				
Range	8.2-14.4	5.2-9.1	3.127	0.011*
Mean \pm SD	12.07 ± 2.22	8.29 ± 1.96		

t-Independent Sample *t*-test; p -value > 0.05 NS

Bone density: Bone density was assessed by CBCT scan pre-operatively and at six months postoperatively using Hounsfield units (HU). In group A the mean value of bone density was 299.22 ± 53.60 HU preoperatively and 620.97 ± 163.01 HU after six months. In group B the mean bone density preoperatively was 299.88 ± 69.36 HU, and 604.70 ± 173.87 HU after six months. There were statistically significance change between pre-operative and after six months in the increased bone density with no significant difference between the two groups, and both groups were comparable to bone normally present in the maxilla. (Figure 2 & Table 2)

TABLE (2) Comparison between groups according to bone density.

Bone density	Group A (n=6)	Group B (n=6)	t-test	p-value
Pre-operative				
Mean \pm SD	299.22 ± 53.60	299.88 ± 69.36	0.018	0.986
Range	219.2-367.9	224.1-3698.9		
After six months				
Mean \pm SD	620.97 ± 163.01	604.70 ± 173.87	0.167	0.871
Range	429.7-792	429.8-785		

t-Independent Sample *t*-test; p -value > 0.05 NS

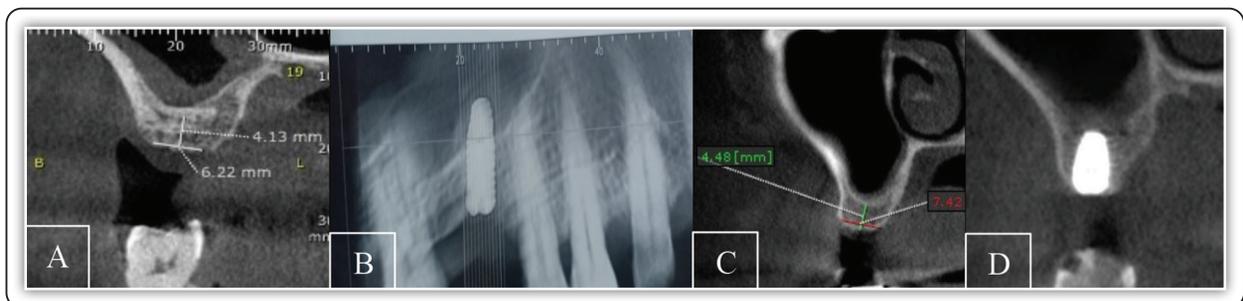


FIG (1) (A) CBCT of group A showing preoperative bone height; (B) CBCT of group A after six months of sinus lifting by DBM putty; (C) CBCT of group B showing preoperative bone height; (D) CBCT of group B after six months of sinus lifting by osteotome.

DISCUSSION

Different treatment options were introduced for treatment of atrophied posterior maxilla, one of them was Sinus floor elevation⁽¹⁸⁾. Sinus lifting with hydraulic pressure technique was introduced as simple, efficacious, minimally invasive approach for sinus elevation that can be recommended for sites with at least 3 mm of residual bone height⁽¹⁷⁾.

The hydraulic pressure technique for sinus lifting was compared to osteotome technique in this study clinically and radiographically. Sinus lifting with hydraulic pressure technique was done with minimal complication or sinus membrane perforation. Sinus lift with hydraulic pressure technique can afford sinus membrane elevations up to 10 mm⁽¹⁴⁾, while the sinus lift with osteotomes affords a height gain of 4 ± 0.8 ⁽¹⁹⁾. In the present study, hydraulic technique elevate the sinus membrane up to 9 mm while sinus membrane lifting in osteotome technique was up to 5mm.

Careful assessment were done to all patients by history taking and CBCT to be free from any sinus pathosis. Torretta et al in 2013⁽²⁰⁾, recommended that, careful preoperative assessment is useful in patients undergoing sinus membrane elevation to obtain favorable results.

The use of bone putty for hydraulic sinus augmentation reducing intraoperative and postoperative complications. It is safe, easy, reduced patient discomfort and time. Pressure induced by injection of the graft material elevates the sinus membrane. In the present study 1cc of bone putty contributes to elevate the sinus membrane up to 9 mm in disagreement with study done in 2014⁽¹⁷⁾, that showed sinus membrane elevation 1 mm for every 0.5 cc and this may be depends on mesio-distal dimension of area filled with bone putty. For example, implant in patient with missing single tooth in comparing to patient has no teeth, or the sinus membrane was elevated more while implant was introducing.

Pain was evaluated at first, third, seventh day after implant insertion and recorded via Visual Analogic Scale (VAS of 10). Mild pain was recorded at the first day in both groups. Pain decreased at third day and no pain was recoded at seventh day. Also, edema was recoded at first day, after 48 hours and seven days postoperatively. Minimal edema was observed after 48 hours that was disappeared at seventh day. There were no statistically significant differences between both groups in the first week after operation. This was coinciding with study by Hu X et al in 2017⁽²¹⁾, where they observed minimal postoperative swelling and pain.

In the present study, the implant stability was measured using the Resonance Frequency Analysis (RFA) via the Osstell ISQ system^(22, 23). The mean of ISQ values was 57.49 ± 6.85 in group A and 56.34 ± 6.72 in group B at time of implant insertion. This value was increased in both group after 6 months post operatively. The implant stability reflected in ISQ was increased in hydraulic technique than in osteotome technique without any statistically significant differences between them. Also, increasing in ISQ value was detected after six months in the study performed by Maria et al in 2017⁽²⁴⁾, in ten cases of sinus floor elevation with different bone grafts .

In this study, CBCT were taken for each patient preoperatively, immediately post-operative and after 6th months follow-up period to measure the marginal bone level and to detect the changes in bone density surrounding dental implants and this in agreement with the studies conducted by Cassetta et al in 2013⁽²⁵⁾ and Bornstein et al in 2014⁽²⁶⁾,

In this study, CBCT obtained 6 months after implant placement revealed sufficient newly formed bone in all treated cases, the mean bone density in group A preoperatively was 299.22 ± 53.60 HU that increase to 620.97 ± 163.01 HU after six months and the mean bone density preoperatively was

299.88±69.36 HU, and increase to 604.70±173.87 HU after six months in group B. There were no significant changes between group A and B in agreement with Sogo et al in 2012⁽²⁷⁾, they studied the bone density of the posterior maxilla in 30 patients and concluded that, the bone in the posterior maxilla was classified as D3 (350–850 HU) or D4 (150–350 HU) according to Misch classification.

The mean bone height value in this study obtained from CBCT in group A was 4.58±0.74 mm preoperatively, 12.59±2.06 mm immediately after surgery and 12.07±2.22 mm after six months, Thus, the final bone gained was in the range of 4.3–9.2 mm with statistically significant differences (p-value < 0.001). These results were in agreement with a study with 29 dental implants placed in posterior maxilla with less than 6 mm of residual bone height as determined radiographically on CBCT. The mean gain in bone height postoperatively was 10.31±2.46 mm⁽¹⁴⁾. While the final bone gained in group B was in the range of 2.6–5.4 mm with statistically significant differences (p-value <0.001). Thus, Similar results were obtained by Jing Y in 2018⁽²⁸⁾. Their study conducted in 51 implants placed in 40 patients subjected to trans-crestal sinus lift using the osteotome technique with or without graft material.

Perforation of the Schneiderian membrane is one of the most frequent intraoperative complications of sinus lift procedures⁽²⁹⁾, in this study, Valsalva maneuver was used to evaluate membrane integrity clinically. Perforation was indicated when air bubbles or moist appear on mirror in front of the osteotomy site. Valsalva maneuver revealed sinus membrane perforation in one of the patients in group B, while absence of Schneiderian membrane perforation during sinus floor elevation with hydraulic technique could be attributed to the gentle non-traumatic sinus membrane lifting with bone putty, this finding was supported by Kher et al⁽¹⁴⁾.

CONCLUSIONS

Within the context of this study, the following conclusions can be listed:

1. Trans-crestal sinus lift using the hydraulic technique has been a highly successful, predictable and minimally invasive procedure. It facilitates lifting the sinus membrane gently.
2. Measurement of implant stability using resonance frequency analysis is a reliable non-invasive easy way to predict the healing of dental implants throughout the follow-up period.
3. Sinus lift through trans-crestal approach is efficient and can gain bone height similar and more safe than lateral approach.

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