

Xenograft Versus Graftless Crestal Sinus Lift with Simultaneous Implant Placement

Original
Article

Sally Elsayed Abdelsameaa^a, Fakhreldin Hassan Abdel-Rahman^a,
Ahmed Adel Elbahnasi^b and Heba Abo-Elfetouh Elsheikh^a

Department of ^aOral Surgery, ^bFixed Prothodontics, Faculty of Dentistry,
Mansoura University, Mansoura, Egypt

ABSTRACT

Objectives: The aim of our study was to compare the viability of graftless sinus floor augmentation with sinus augmentation using xenograft material in crestal sinus lifting procedure.

Materials and Methods: A total of twelve patients who received fourteen dental implants were included in this study for replacement of missed single tooth or multiple teeth in the maxillary posterior region after crestal sinus lifting procedure. The average age was 38 years (ranged from 21 to 55 years). The patients were randomly divided into two groups. In the first group, patients underwent crestal sinus floor elevation with simultaneous implant placement using graftless technique, while in the second group, patient underwent crestal sinus floor elevation with simultaneous implant placement using xenograft. Patients were evaluated clinically and radiographically at regular time intervals immediately, 3 months and 9 months after surgery. All clinical and radiographic parameters were subjected to statistical analysis.

Results: Fourteen implants were stable. There was no significant difference in implant stability between group I (64.14 ± 3.13 , 70.43 ± 3.95 , 78.0 ± 2.71) and group II (67.57 ± 5.06 , 73.43 ± 4.31 , 79.86 ± 2.91) through the whole study period, while there was significant difference in bone height gain between group I (4.60 ± 0.95) and group II (6.16 ± 0.49) after 9 months ($P = 0.002$).

Conclusions: This study confirms the validity of graftless sinus lifting procedure when simultaneous implant placement is performed.

Key Words: Crestal Sinus Lift, Graftless, Xenograft.

Received: 01 September 2021, **Accepted:** 29 September 2021.

Corresponding Author: Sally Elsayed Abdelsameaa, Department of Oral Surgery, Faculty of Dentistry, Mansoura University, Mansoura, Egypt, **Tel.:** +20502507099, **Mobile:** +201069650000, **E-mail:** sallyabdelsamie@mans.edu.eg.

ISSN: 2090-097X, April 2021, Vol. 12, No. 2

INTRODUCTION

The use of dental implants for the rehabilitation of missing teeth has increased treatment options for patients^[1]. Implant placement in posterior maxilla is a challenging procedure due to bone resorption with maxillary sinus pneumatization and poor bone quality^[2]. Several techniques have been used to overcome these problems such as sinus floor elevation using crestal or lateral approach and the use of short implants^[3].

Conventionally, two main techniques have been described in the literature to elevate the maxillary sinus floor before or during implant placement. The amount of residual bone height often dictates the technique of choice and whether or not implants are placed simultaneously or after a healing period to allow bone formation^[4,5].

The sinus augmentation procedure was first described by Tatum and was subsequently redesigned by Boyne and James^[4, 6]. Depending on the clinical situation, such as the height and width of the alveolar ridge, different types of the procedure can be pursued. For example, in cases with a height over 6 mm, transcresal techniques can be

conducted^[7]. In contrast, when the bone level is insufficient, procedures with an approach from the lateral side of the sinus cavity are most commonly used^[8].

Crestal sinus lift was introduced by Summers in 1994^[9]. The crestal approach is the elevation of the sinus membrane through the osteotomy by osteotomes, piezosurgery, or Densah burs^[10]. In comparison to the lateral window approach, the crestal approach is less invasive, accompanied with less complications and operation time^[11,12].

Both lateral and crestal approaches allow the space beneath the membrane to be grafted using several different materials or left to heal spontaneously with the blood clot alone^[13-16].

Nowadays, many graft materials have been used in sinus lifting procedures^[17]. Although autogenous bone is the gold standard among graft materials as it is osteogenic, osteoinductive and osteoconductive^[18-20], it has many disadvantages such as a second surgical site and post-operative morbidity. So, different bone graft materials have been developed^[21].

Xenograft has a similar tissue structure to that of human bones. It is osteoinductive and osteoconductive^[22]. Result from different studies stated that implant survival with xenograft was equal or better than autogenous bone^[23]. Xenograft has many advantages such as no need for a secondary surgical site. The histologic results with xenografts present a pattern that has been called “bone bridging”. Residual xenograft particles are surrounded partly by new vital bone, and are joined to nearby particles through this mechanism^[24]. There are many studies which used xenograft in maxillary sinus augmentation and achieved high successful results^[25 – 29].

New bone formation after graftless sinus floor elevation has been reported in human and animal studies^[30 – 32]. In 2003, Lundgren et al. reported spontaneous bone formation in the maxillary sinus three months after extirpating an intrasinus cyst, having had to raise the sinus membrane to stitch^[33]. In 2006, Palma et al. found new bone formation after sinus floor elevation in goats with and without use of autogenous bone after 6 months^[31]. In 2007, Thor et al. placed implants in the sinus without grafting, arguing that the implants’ titanium surface provided sufficient thrombogenicity in activating the coagulation system and platelets and stimulating cell and bone growth thereby^[30].

The efficacy of graftless sinus elevation as a method for sinus augmentation has been confirmed by many studies^[34]. Graftless sinus elevation has many advantages such as no immunogenic response, reduced cost, reduced operation time and no need for second surgical site to get the graft, so reduced patient morbidity^[30].

As a consequence of above mentioned studies, it was interesting to compare between efficacy of graftless sinus floor elevation and maxillary sinus augmentation with xenograft.

The aim of our study was to compare the efficacy of graftless sinus floor elevation with sinus elevation using xenograft material in crestal sinus lifting procedures with simultaneous implant placement.

MATERIALS AND METHODS

Patient Selection:

Fourteen implants were placed in twelve patients. Patients were selected from outpatient clinic of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University for replacement of missed single tooth or multiple teeth in posterior maxillary region after crestal sinus lifting procedure.

The study followed the Declaration of Helsinki on medical protocol and ethics. It was approved by the Ethical Review Board of Mansoura University.

The purpose of the present study was explained to the patients and informed consents were obtained from all patients.

Criteria for Patient Selection:

Inclusion Criteria:

1. Patient with good oral hygiene.
2. Patients’ age was from 20 – 60 years.
3. Presence of missed single tooth or multiple teeth in posterior maxillary region.
4. Minimum 4 mm residual bone height was present.
5. Patent ostium of maxillary sinus.
6. 5 mm or more ridge width was present.
7. Crown height space of at least 8 mm.
8. Patients prepared to comply with the follow-up and maintenance programme.

Exclusion criteria:

1. Smokers patients.
2. Presence of any sinus pathosis.
3. A medical history that would absolute contraindicate implant surgery.

Preoperative preparation:

Clinical evaluation:

A thorough medical and dental history, followed by clinical examination was carried out for all patients (Figure 2A). Impressions were taken and a diagnostic wax-up was performed on the study cast to evaluate teeth inclination, mesiodistal width of missing tooth, crown height space and occlusion.

Radiographic evaluation:

Preoperative panoramic x ray was done first, then Cone Beam Computed Tomography (CBCT) was used to assess the bone volume in the three dimensions if the patient was indicated for crestal sinus lifting procedure.

Patient Classification:

Patients were divided randomly into two equal groups using computer software; numbers were concealed in closed envelopes. The patients were not aware of the type of surgery done.

The first group included six patients that were subjected to graftless crestal sinus lifting procedure with simultaneous implant placement, while the second group included six patients that were subjected to crestal sinus lifting procedure with simultaneous implant placement using xenograft. (Creos xenogenic®, Nobel Biocare, Zürich-Flughafen, Switzerland)

Surgical procedure:

After administration of local anesthesia (Mepivacaine HCL 2 % with Levonordefrin 1:20,000. Alexandria Co. for Pharmaceuticals and Chemical Ind., Alexandria, Egypt) (buccal and palatal infiltrations), a full thickness

muco-periosteal flap was reflected to expose the crestal bone (Figure 1A). Subsequently, a pilot drill followed by sequential drill in the kit was used to prepare the implant site, reaching approximately 1.0 mm short of the sinus floor (Figures 1B and 2B), then an osteotome consistent with the diameter of the last drill of osteotomy was inserted into the osteotomy and advanced with light malleting to fracture the sinus floor. The osteotome was tapped gently to elevate the sinus floor to the desired depth (Figure 1C).

Sinus membrane perforation was checked using Valsalva maneuver. For the first group, implants (Dentium® System, Superline, Seoul, Korea) were inserted simultaneously without use of any bone graft, while in the second group, xenograft was condensed by the osteotome, then implants were inserted (Figure 2C). Wound closure was achieved using 4 - 0 resorbable suture.

Postoperative instructions:

- A liquid or semi-liquid diet for the first 3 days post surgically and then gradually return to a normal diet.
- Administration of post-operative antibiotic. (Augmentin 1 gm film coated tablets. Manufactured by Novartis pharma, Egypt)
- External application of ice packs for 24 to 48 hours.
- Local nasal decongestant for a week at least. (Afferin nasal drops. Decongestant. 3 times daily. Manufactured by Novarts, Egypt)
- Suture removal after 7 days.

Second stage surgery:

Second stage surgery was performed 3 months after surgery by placing the healing abutment for soft tissue

healing around implant for 10 days.

Prosthetic rehabilitation:

Impression was made by indirect impression technique. The final coverage was made from porcelain fused to metal and the crown was cemented after checking the occlusion and margin.

Evaluation:

All patients were seen at regular time interval for evaluation immediately, 3 months and 9 months after surgery.

A. Clinical Evaluation:

Implant Stability:

Implant stability was measured at the time of implant placement, 3 months and 9 months after surgery. Smart peg was placed on the implant and the Ostell (Osstell AB, Gothenburg, Sweden) was used to measure implant stability quotient (ISQ).

B. Radiographic Evaluation:

Bone Height Gain:

- The residual bone height was measured from the level of the crestal bone to the cortical sinus floor from cross sectional view of pre-operative CBCT (Figures 3A and 4A).

- After 9 months, the distance between the crestal bone to the newly formed sinus floor was measured along the surface of the implant from cross sectional view of CBCT that was taken coinciding with the long axis of each implant (Figures 3B and 4B).

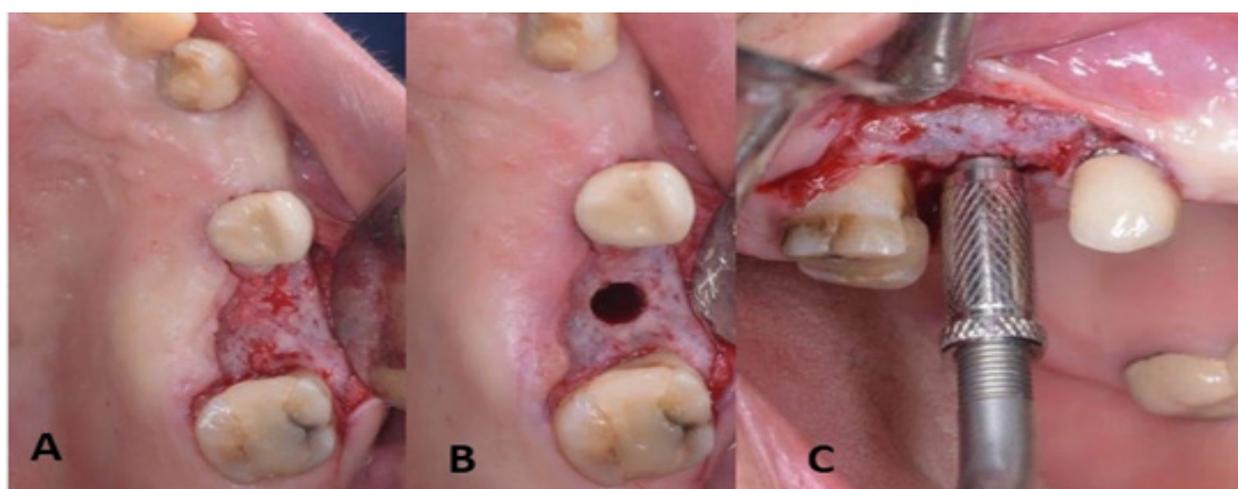


Figure 1: Graftless Group:

A: Reflection of the flap to expose the bone. B: The osteotomy after preparation with implants' drills. C: The osteotome reaches the desired depth.

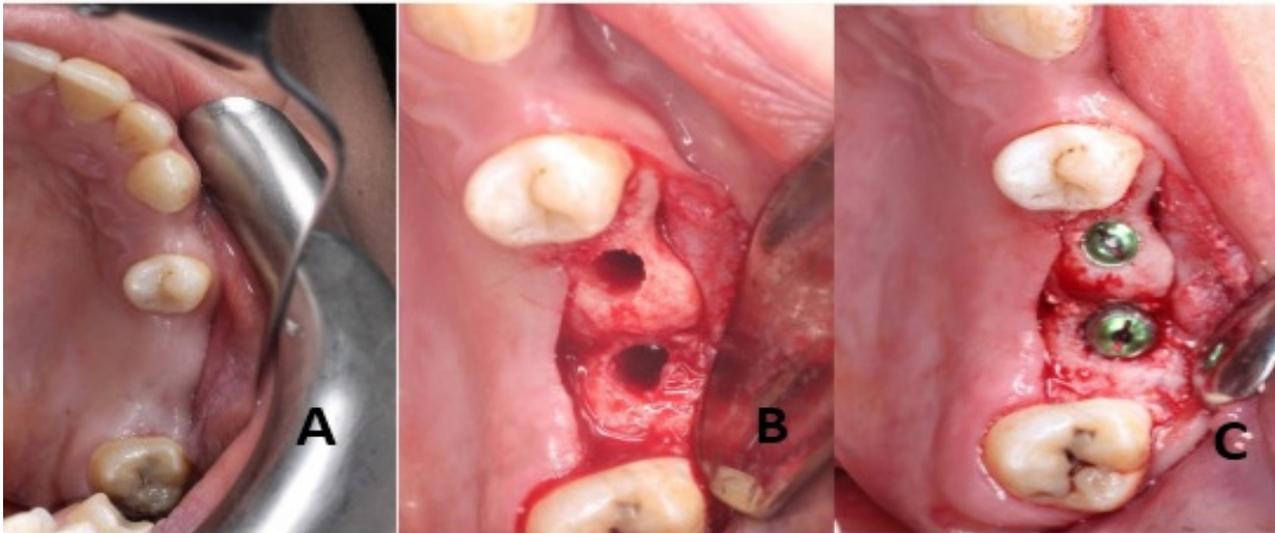


Figure 2: Xenograft Group:

A: Preoperative intraoral occlusal view of the planned implant site

B: The osteotomy after preparation with implants' drills.

C: The dental implants after complete installation after condensation of xenograft.

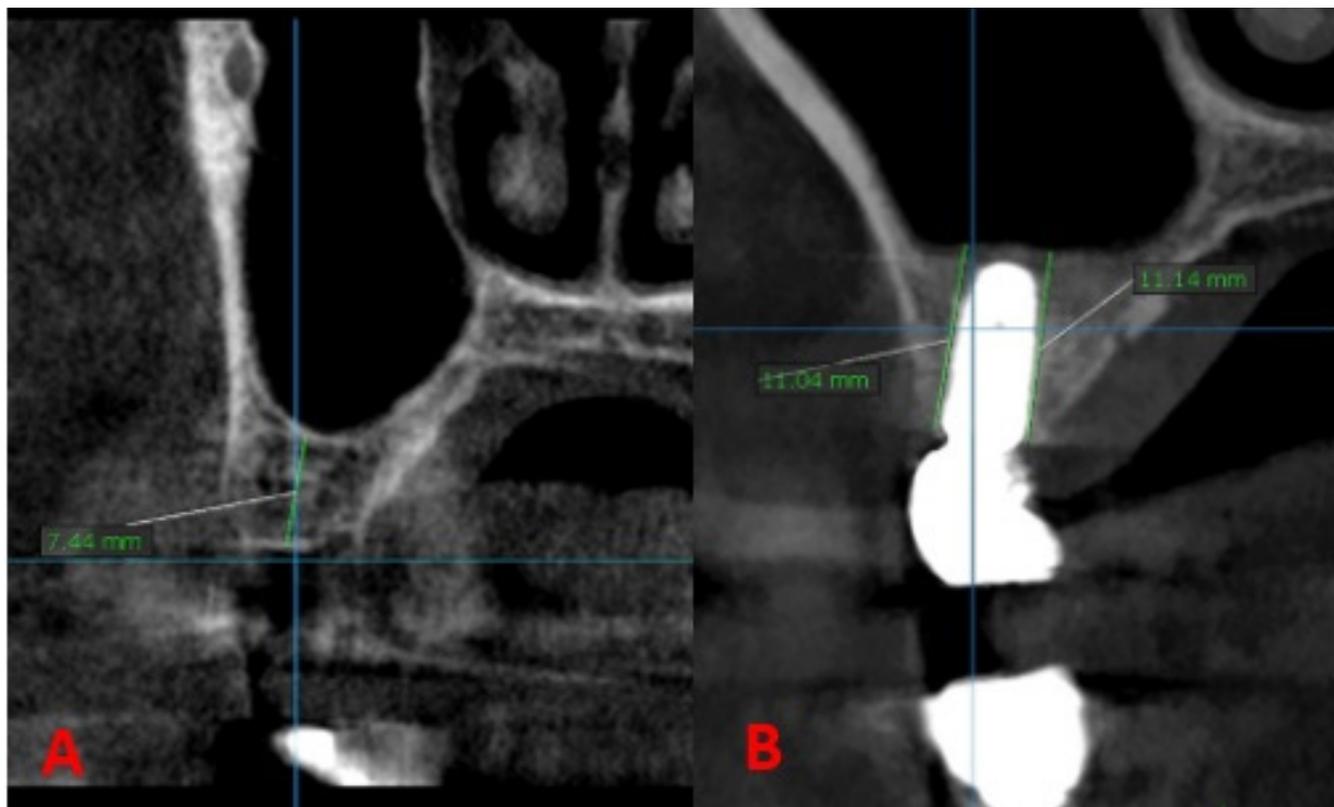


Figure 3: Graftless Group:

A: The residual bone height.

B: The bone height after 9 months.

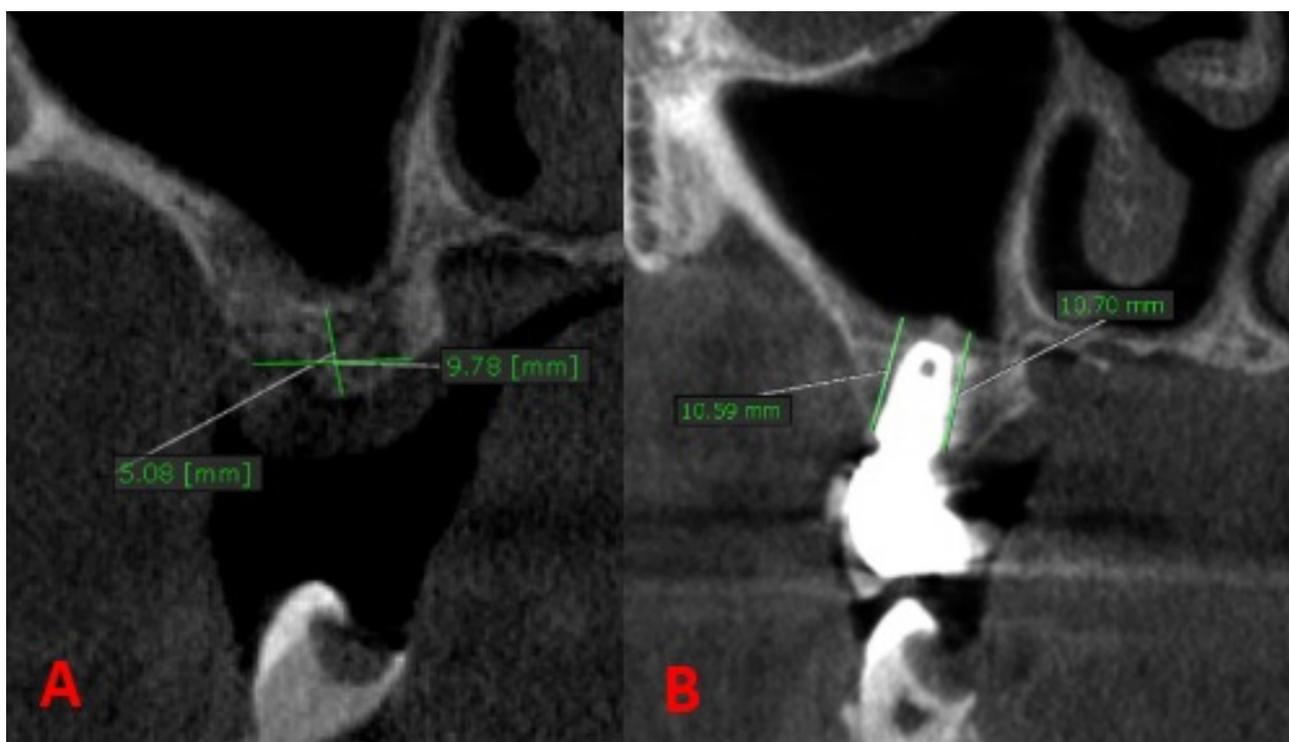


Figure 4: Xenograft Group:

A: The residual bone height.

B: The bone height after 9 months.

• To get the amount of bone height gain for each implant, we subtracted the measures of residual bone height from the measures taken after 9 months^[35].

Statistical analysis and data interpretation:

The obtained data were analyzed using IBM SPSS Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. Qualitative data were represented by number and percent. Quantitative data were represented in terms of mean, standard deviation for parametric data after testing normality using Shapiro-Wilk test. The significance level was set at $P \leq 0.05$. Student t test is used to compare continuous parametric variables between 2 groups.

RESULTS

Demographic data:

A total of twelve patients (6 females and 6 males) who received fourteen dental implants were included in this study for replacement of missed single tooth or multiple teeth in posterior maxillary region after crestal sinus lifting procedure. The average age was 38 years (ranged from 21 to 55 years).

A total of fourteen implants ranging from 4 mm to 4.8 mm in diameter, and 8.5 mm to 10 mm in length were placed in first molar ($n = 6$ implants), and second molar ($n = 8$ implants) areas. All of the implants were placed according to the 2-stage system. No patients developed sinusitis or infection.

According to the survival rate criteria, fourteen implants were stable without loss of any implant.

Comparison of implant stability between the two groups:

Data for implant stability are presented in Table (1).

Table 1: Implant stability at different time intervals between the 2 groups:

	Group I (Graftless Group) mean \pm SD	Group II (Xenograft Group) mean \pm SD	Test of significance
At the time of implant placement	64.14 \pm 3.13	67.57 \pm 5.06	t = 1.52 P = 0.153
3 months	70.43 \pm 3.95	73.43 \pm 4.31	t = 1.36 P = 0.20
9 months	78.0 \pm 2.71	79.86 \pm 2.91	t = 1.24 P = 0.240

t: Student t test *statistically significant if $P \leq 0.05$ SD: standard deviation.

Results related to Group I (Graftless Group) showed that the mean ISQ values were 64.14 \pm 3.13 at the time of implant placement, 70.43 \pm 3.95 after 3 months and 78.0 \pm 2.71 after 9 months.

Results related to Group II (Xenograft Group) showed that the mean ISQ values were 67.57 \pm 5.06 at the time of implant placement, 73.43 \pm 4.31 after 3 months and 79.86 \pm 2.91 after 9 months.

There was no significant difference between Group I and Group II at all follow up intervals.

Comparison of bone height gain between the two groups:

Data for Bone Height Gain are presented in Table (2).

Table 2: Bone height gain after 9 months between the 2 groups:

	Group I (Graftless Group)	Group II (Xenograft Group)	Test of significance
Bone gain /mm mean \pm SD	4.60 \pm 0.95	6.16 \pm 0.49	t = 3.85 P = 0.002*

t: Student t test *statistically significant if $P \leq 0.05$ SD: standard deviation.

Results related to Group I (Graftless Group) showed that the mean bone height gain was 4.60 ± 0.95 mm.

Results related to Group II (Xenograft Group) showed that the mean bone height gain was 6.16 ± 0.49 mm.

There was significant difference between Group I and Group II in bone height gain after 9 months ($P = 0.002$).

DISCUSSION

Both crestal and lateral sinus lifting procedures aim to obtain a bone reconstruction to allow placement of dental implants^[17]. The lateral sinus lifting procedure has many complications such perforation of the membrane, epistaxis, pain, swelling, bleeding, hematoma, and sinus infections, beside its higher cost^[36]. While crestal sinus lifting procedure has many benefits such as shorter treatment time of the procedure, the shorter healing period, and higher primary stability of the implant^[37]. Also, it is less invasive than lateral approach, which reduces its complications^[38].

Bone graft material is an important factor for the clinical success of maxillary sinus augmentation. In the current clinical study, it was found that new bone can be formed directly on and around inserted dental implants without the use of any bone graft. So, implants can be placed at the time of sinus lifting and left to osseointegrate without any bone graft that needs long time for remodelling^[30, 39]. Also The simultaneous implant insertion acts to retain the elevated sinus lining by tenting. It also reduces treatment time^[35].

Boyne^[40] published the first experimental study regarding simple elevation of the membrane without bone grafting. The new bone formation around implants in the maxillary sinus without the use of graft is reported by Lundgren *et al.*^[33]. It has been suggested that a prerequisite for the peri-implant bone formation is that the implant apex serves as a tent pole for the sinus membrane.

In graftless sinus elevation technique, space created by elevation of Schneiderian membrane is occupied by blood clot around the dental implant. Tenting effect by the dental implant placement maintains the space created^[41]. After sinus tenting, blood clot is considered as an autologous osteogenic graft material, to which osteoprogenitors can migrate, differentiate, and regenerate bone^[42].

Measurement of implant stability using Ostell is a non-invasive method^[43]. In the present study, implant stability was measured with resonance frequency analysis by the use of the Ostell device immediately after implant placement, at 3 months and at 9 months postoperative. Although, Xenograft group had superior values compared to graftless group, but there was no significant difference at all time intervals between the two groups. Both groups had a higher implant stability (> 70 ISQ) after 3 months which was a prerequisite for successful loading of the dental implant.

Our result is in line with Luongo R, who found that no significant differences in terms of implant stability compared with techniques including autogenous bone graft, indicating the osteoinductive potential of the sinus membrane^[44]. Browaeys H *et al.* stated that initial osseointegration of dental implants seems to be independent of the biomaterial used in grafting procedure^[45].

In our study, the mean of bone height gain in the xenograft group was 6.16 mm, while the mean of bone height gain in graftless group was 4.60 m, so there was significant difference between the two groups. This showed that bone formation after crestal sinus floor elevation using xenograft is greater than graftless technique.

Our result is in line with Fouad W *et al.*^[46] who found that there was a significant difference in bone height gain between xenograft group and graftless group in guided maxillary sinus floor elevation.

This significant difference in bone height gain can be explained by the fact that it takes time for new bone to arise from the blood clot on the graftless side when compared to the bone substitutes, which already possess bone-like properties and immediately show opacity on a radiograph^[47].

CONCLUSION

From the results of our study, it can be concluded that the presence of grafting material might increase the tenting effect of the implant apex in the sinus, by elevating the Schneiderian membrane. In addition, it might embed the implant apex in a solid structure. However, it is not needed to add bone graft as explained in this study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Ramírez Fernández MP, Mazón P, Gehrke SA, Calvo-Guirado JL, De Aza PN. Comparison of Two Xenograft Materials Used in Sinus Lift Procedures: Material Characterization and In Vivo Behavior. *Materials (Basel)*. 2017; 7; 10 (6): 623.
 2. Irinakis T. Efficacy of injectable demineralized bone matrix as graft material during sinus elevation surgery with simultaneous implant placement in the posterior maxilla: clinical evaluation of 49 sinuses. *J Oral Maxillofac Surg*. 2011; 69 (1): 134 - 141.
 3. Bechara S, Kubilius R, Veronesi G, Pires JT, Shibli JA, Mangano FG. Short (6-mm) dental implants versus sinus floor elevation and placement of longer (≥ 10 -mm) dental implants: a randomized controlled trial with a 3-year follow-up. *Clin Oral Implants Res*. 2017; 28 (9): 1097 - 1107.
 4. Tatum H Jr. Maxillary and sinus implant reconstructions. *Dent Clin North Am*. 1986; 30 (2): 207 - 229.
 5. Kent JN, Block MS. Simultaneous maxillary sinus floor bone grafting and placement of hydroxylapatite-coated implants. *J Oral Maxillofac Surg*. 1989; 47 (3): 238 - 242.
 6. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. *J Oral Surg*. 1980; 38 (8): 613 - 616.
 7. Esposito M, Felice P, Worthington HV. Interventions for replacing missing teeth: augmentation procedures of the maxillary sinus. *Cochrane Database Syst Rev*. 2014; 13; (5).
 8. Dominiak S, Karuga-Kuźniewska E, Popecki P, Kubasiewicz-Ross P. PRF versus xenograft in sinus augmentation in case of HA-coating implant placement: A 36-month retrospective study. *Adv Clin Exp Med*. 2021; 30 (6): 633 - 640.
 9. Summers RB. A new concept in maxillary implant surgery: the osteotome technique. *Compendium*. 1994; 15 (2): 152, 154 - 156, 158 passim; quiz 162.
 10. Tartaglia GM, Poli PP, Connelly ST, Maiorana C, Farronato D, Taschieri S. Clinical Outcome of Dental Implants after Maxillary Sinus Augmentation with and without Bone Grafting: A Retrospective Evaluation. *Materials (Basel)*. 2021; 14 (10): 2479.
 11. Zitzmann NU, Schärer P. Sinus elevation procedures in the resorbed posterior maxilla. Comparison of the crestal and lateral approaches. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1998; 85 (1): 8 - 17.
 12. Davarpanah M, Martinez H, Tecucianu JF, Hage G, Lazzara R. The modified osteotome technique. *Int J Periodontics Restorative Dent*. 2001; 21 (6): 599 - 607.
 13. Riben C, Thor A. The Maxillary Sinus Membrane Elevation Procedure: Augmentation of Bone around Dental Implants without Grafts-A Review of a Surgical Technique. *Int J Dent*. 2012; 2012.
 14. Marković A, Mišić T, Calvo-Guirado JL, Delgado-Ruiz RA, Janjić B, Abboud M. Two-Center Prospective, Randomized, Clinical, and Radiographic Study Comparing Osteotome Sinus Floor Elevation with or without Bone Graft and Simultaneous Implant Placement. *Clin Implant Dent Relat Res*. 2016; 18 (5): 873 - 882.
 15. de Oliveira GR, Olate S, Cavalieri-Pereira L, Pozzer L, Asprino L, de Moraes M, de Albergaria-Barbosa JR. Maxillary sinus floor augmentation using blood without graft material. Preliminary results in 10 patients. *J Oral Maxillofac Surg*. 2013; 71 (10): 1670 - 1675.
 16. Gonzalez S, Tuan MC, Ahn KM, Nowzari H. Crestal approach for maxillary sinus augmentation in patients with ≤ 4 mm of residual alveolar bone. *Clin Implant Dent Relat Res*. 2014; 16 (6): 827 - 835.
 17. Danesh-Sani SA, Loomer PM, Wallace SS. A comprehensive clinical review of maxillary sinus floor elevation: anatomy, techniques, biomaterials and complications. *Br J Oral Maxillofac Surg*. 2016; 54 (7): 724 - 730.
 18. Liu Y, Möller B, Wiltfang J, Warnke PH, Terheyden H. Tissue engineering of a vascularized bone graft of critical size with an osteogenic and angiogenic factor-based in vivo bioreactor. *Tissue Eng Part A*. 2014; 20 (23 - 24): 3189 - 3197.
 19. Kim JW, Cho MH, Kim SJ, Kim MR. Alveolar distraction osteogenesis versus autogenous onlay bone graft for vertical augmentation of severely atrophied alveolar ridges after 12 years of long-term follow-up. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2013; 116 (5): 540 - 549.
-

20. Rickert D, Slater JJ, Meijer HJ, Vissink A, Raghoobar GM. Maxillary sinus lift with solely autogenous bone compared to a combination of autogenous bone and growth factors or (solely) bone substitutes. A systematic review. *Int J Oral Maxillofac Surg.* 2012; 41 (2): 160 - 167.
21. Song DS, Kim CH, Kim BJ, Kim JH. Tenting effect of dental implant on maxillary sinus lift without grafting. *J Dent Sci.* 2020; 15 (3): 278 - 285.
22. Tadic D, Epple M. A thorough physicochemical characterisation of 14 calcium phosphate-based bone substitution materials in comparison to natural bone. *Biomaterials.* 2004 Mar; 25 (6): 987 - 994.
23. Jensen T, Schou S, Stavropoulos A, Terheyden H, Holmstrup P. Maxillary sinus floor augmentation with Bio-Oss or Bio-Oss mixed with autogenous bone as graft: a systematic review. *Clin Oral Implants Res.* 2012; 23 (3): 263 - 273.
24. Froum SJ, Tarnow DP, Wallace SS, Rohrer MD, Cho SC. Sinus floor elevation using anorganic bovine bone matrix (OsteoGraf/N) with and without autogenous bone: a clinical, histologic, radiographic, and histomorphometric analysis--Part 2 of an ongoing prospective study. *Int J Periodontics Restorative Dent.* 1998; 18 (6): 528 - 543.
25. Nevins M, Camelo M, De Angelis N, Hanratty JJ, Khang WG, Kwon JJ, Rasperini G, Rocchietta I, Schupbach P, Kim DM. The clinical and histologic efficacy of xenograft granules for maxillary sinus floor augmentation. *Int J Periodontics Restorative Dent.* 2011; 31 (3): 227 - 235.
26. Traini T, Degidi M, Sammons R, Stanley P, Piattelli A. Histologic and elemental microanalytical study of anorganic bovine bone substitution following sinus floor augmentation in humans. *J Periodontol.* 2008; 79 (7): 1232 - 1240.
27. Traini T, Valentini P, Iezzi G, Piattelli A. A histologic and histomorphometric evaluation of anorganic bovine bone retrieved 9 years after a sinus augmentation procedure. *J Periodontol.* 2007; 78 (5): 955 - 961.
28. Cordaro L, Bosshardt DD, Palattella P, Rao W, Serino G, Chiapasco M. Maxillary sinus grafting with Bio-Oss or Straumann Bone Ceramic: histomorphometric results from a randomized controlled multicenter clinical trial. *Clin Oral Implants Res.* 2008; 19 (8): 796 - 803.
29. Orsini G, Traini T, Scarano A, Degidi M, Perrotti V, Piccirilli M, Piattelli A. Maxillary sinus augmentation with Bio-Oss particles: a light, scanning, and transmission electron microscopy study in man. *J Biomed Mater Res B Appl Biomater.* 2005; 74 (1): 448 - 457.
30. Thor A, Sennerby L, Hirsch JM, Rasmusson L. Bone formation at the maxillary sinus floor following simultaneous elevation of the mucosal lining and implant installation without graft material: an evaluation of 20 patients treated with 44 Astra Tech implants. *J Oral Maxillofac Surg.* 2007; 65 (7 Suppl 1): 64 - 72.
31. Palma VC, Magro-Filho O, de Oliveria JA, Lundgren S, Salata LA, Sennerby L. Bone reformation and implant integration following maxillary sinus membrane elevation: an experimental study in primates. *Clin Implant Dent Relat Res.* 2006; 8 (1): 11 - 24.
32. Lundgren S, Andersson S, Sennerby L. Spontaneous bone formation in the maxillary sinus after removal of a cyst: coincidence or consequence? *Clin Implant Dent Relat Res.* 2003; 5 (2): 78 - 81.
33. Lundgren S, Andersson S, Gualini F, Sennerby L. Bone reformation with sinus membrane elevation: a new surgical technique for maxillary sinus floor augmentation. *Clin Implant Dent Relat Res.* 2004; 6 (3): 165 - 173.
34. Stefanski S, Svensson B, Thor A. Implant survival following sinus membrane elevation without grafting and immediate implant installation with a one-stage technique: an up-to-40-month evaluation. *Clin Oral Implants Res.* 2017; 28 (11): 1354 - 1359.
35. Manekar VS. Graftless crestal hydraulic sinus lift with simultaneous implant insertion. *Natl J Maxillofac Surg.* 2020; 11 (2): 213 - 218.
36. Testori T, Weinstein T, Taschieri S, Wallace SS. Risk factors in lateral window sinus elevation surgery. *Periodontol 2000.* 2019; 81 (1): 91 - 123.
37. Toffler M. Minimally invasive sinus floor elevation procedures for simultaneous and staged implant placement. *N Y State Dent J.* 2004; 70 (8): 38 - 44.
38. Testori T, Weinstein RL, Taschieri S, Del Fabbro M. Risk factor analysis following maxillary sinus augmentation: a retrospective multicenter study. *Int J Oral Maxillofac Implants.* 2012; 27 (5): 1170 - 1176.

-
39. Hallman M, Sennerby L, Lundgren S. A clinical and histologic evaluation of implant integration in the posterior maxilla after sinus floor augmentation with autogenous bone, bovine hydroxyapatite, or a 20:80 mixture. *Int J Oral Maxillofac Implants.* 2002; 17 (5): 635 - 643.
 40. Boyne PJ. Analysis of performance of root-form endosseous implants placed in the maxillary sinus. *J Long Term Eff Med Implants.* 1993; 3 (2): 143 - 159.
 41. Chipaila N, Marini R, Sfasciotti GL, Cielo A, Bonanome L, Monaco A. Graftless sinus augmentation technique with contextual placement of implants: a case report. *J Med Case Rep.* 2014; 8: 437.
 42. Dubey S, Bhargava D. Evidence of bone formation after Schneiderian membrane tenting without bone grafting for dental implantology. 2017; 4 (7): 327 - 328.
 43. Alghamdi H, Anand PS, Anil S. Undersized implant site preparation to enhance primary implant stability in poor bone density: a prospective clinical study. *J Oral Maxillofac Surg.* 2011; 69 (12): e506 - e512.
 44. Luongo R, Sgaramella N, Traini T, Bugea C. Graftless Maxillary Sinus Floor Augmentation with Simultaneous Porcine Bone Layer Insertion: A 1- to 5-Year Follow-up Study. *Int J Oral Maxillofac Implants.* 2020; 35 (4): 808 - 815.
 45. Browaeys H, Bouvry P, De Bruyn H. A literature review on biomaterials in sinus augmentation procedures. *Clin Implant Dent Relat Res.* 2007; 9 (3): 166 - 177.
 46. Fouad W, Osman A, Atef M, Hakam M. Guided maxillary sinus floor elevation using deproteinized bovine bone versus graftless Schneiderian membrane elevation with simultaneous implant placement: Randomized clinical trial. *Clin Implant Dent Relat Res.* 2018; 20 (3): 424 - 433.
 47. Lie SAN, Claessen RMMA, Leung CAW, Merten HA, Kessler PAWH. Non-grafted versus grafted sinus lift procedures for implantation in the atrophic maxilla: a systematic review and meta-analysis of randomized controlled trials. *Int J Oral Maxillofac Surg.* 2021; S0901 - 5027 (21) 00126 - 0.