Original Article - Prospective Study

Indirect Sinus Floor Elevation Technique with Simultaneous Implant Placement without Using Bone Grafts

Aditi Rawat, Himanshu Thukral, Anson Jose

Department of Oral and Maxillofacial Surgery, Army Dental Centre (Research and Referral), Delhi, India

Abstract

Context: Maxillary posterior region is a problem area for the placement of implants. The advanced resorption of alveolar bone is combined with an increase in pneumatization of maxillary sinus because of higher intra-antral pressure, giving rise to severely atrophied alveolar ridges with reduced bone height. **Materials and Methods:** A total of 26 implants were placed in 21 patients using indirect sinus lift with simultaneous implant placement without using bone grafts. Intra-oral periapical radiographs were taken to determine residual bone height, endosinus bone (ESB), and crestal bone level. **Results:** All the implants were clinically and radiographically stable at the end of 6 months follow-up. All the implants showed ESB gain, with mean being 1.97 mm and 1.99 mm on mesial and distal sides, respectively. **Conclusion:** The findings of this study indicate that successful osseointegration is predictable using osteotome sinus floor elevation without bone graft. Spontaneous new bone formation seemed to be expected with implants placed using indirect sinus lift.

Keywords: Indirect sinus floor elevation, osseointegration, osteotomes

Introduction

Today, dental implants provide a predictive treatment for prosthetic rehabilitation of edentulous patients. Sufficient volume and density of the alveolar bone for implant integration and load bearing are factors of utmost importance for a good result. Reduced bone height below the maxillary sinus in the posterior maxillary region is a hinderance to successful implant placement. Not only there is bone resorption but also increased pneumatization of the maxillary sinus which renders the ridge inadequate for implant procedures.[1] Thus, the amount of bone beneath the maxillary sinus is often very limited. The technique of sinus floor elevation has expanded prosthetic options by enabling the placement of additional implant support in maxillary segments with atrophic ridges and pneumatized sinuses.

Augmentation of the maxillary sinus was first described by Tatum and published as a clinical study by Boyne and James.[2] In the technique described by Tatum access to sinus was through the crest. This technique was later replaced with lateral sinus osteotomy which was considered to be more versatile and practical.[3] After elevating the sinus lining from the floor, bone graft was placed (autogenous is considered to be a gold standard). Implant can then be installed immediately or at a later stage depending on residual bone height (RBH). Summers described an alternative technique for sinus floor elevation using osteotomes. With this technique, the floor of the maxillary sinus is elevated using access through the alveolar ridge utilizing different osteotomes. Bone graft is added followed by implant placement.[3,4]

The use of bone grafts for sinus augmentation, irrespective of the technique utilized has been associated with high success rate, although it has certain demerits such as second surgical site for autogenous bone harvesting, increased rate of complications, higher cost, and increased surgical time. It was a report by Lundgren *et al*. which pointed toward spontaneous bone formation below the sinus floor after the cyst enucleation exhibiting a tendency in the Schneiderian membrane potential for bone formation.[5] What followed this were a number

Address for correspondence: Dr. Aditi Rawat,
Department of Oral and Maxillofacial Surgery, Army Dental Centre (Research and Referral), Delhi, India.
E-mail: dr.aditi.rawat@gmail.com

Access this article online

Quick Response Code:

Website: www.amsjournal.com

DOI: 10.4103/ams.ams_11_19

How to cite this article: Rawat A, Thukral H, Jose A. Indirect sinus floor elevation technique with simultaneous implant placement without using bone grafts. Ann Maxillofac Surg 2019;9:96-102.

of studies, in which successful implant placement and rehabilitation were carried out without using bone grafts. These studies have shown that new bone formation occurs after sinus augmentation due to the creation of void with the presence of blood clot which induces bone deposition based on the principles of guided tissue regeneration.[4,6-8] Furthermore, the osteogenic potential of maxillary sinus membrane has come into the picture.[9-11]

With more studies indicating the successful implants placement below the sinus floor without additional bone grafting procedures, the focus was shifted to develop a technique which was quicker and less invasive. Graftless sinus lift is applicable to both lateral and crestal approach for sinus lifting with high success rate.[6-8,12-14] The advantage of the crestal procedure is not only more conservative, easier, and less invasive but also causes lateral compression and expansion of the adjacent bone. Added advantage is superior manual control in determining the implant axis which prevents dehiscence and fenestration.[15] With these points in the background, the study was aimed to evaluate osteotome sinus floor elevation (OSFE) without using bone graft.

Materials and Methods

This prospective controlled clinical trial was conducted on randomly selected patients who had reported to our department. Approval from the Institutional Ethical Committee was obtained to carry out the study. A total of 26 implants were placed in 21 patients and evaluated clinically and radiographically over a period of 6 months. Intra-oral periapical radiographs were taken to determine RBH, endosinus bone (ESB), and crestal bone level (CBL). All the patients were explained about the procedure and written informed consent was obtained.

Inclusion criteria

Inclusion criteria were as follows:

- Patients who required implant treatment in the posterior maxilla
- Bone height between the crest and sinus floor was not ≥8 mm at least on one side of the implant.

Exclusion criteria

Exclusion criteria were as follows:

- Patients with a history of maxillary sinus disease
- Immunocompromised conditions
- Unrealistic expectations and psychological problems.

For clinical evaluation following criteria were considered:

a. Implant stability: Evaluated clinically using instruments on each side of implant to determine if the mobility is present
b. RBH which was measured on both mesial and distal sides of each implant. It was determined by measuring the distance between the most apical bone level contacting the implant and alveolar crest level on each side
c. ESB which was measured by a line parallel to implant axis drawn from most coronal implant thread to most apical implant-bone contact
d. CBL which was determined by a line parallel to implant between the most apical implant thread and most coronal implant-bone contact.[5,6]

The vertical bone height below the sinus floor was measured radiographically using a paralleling kit and metal grid with 1 mm × 1 mm box for measurement.

Lignocaine hydrochloride 2% with adrenaline 1:80,000 was used for local anesthesia. A mid crestal incision without any releasing incisions was placed for flap elevation [Figures 1 and 2]. Full thickness muco-periosteal flap was raised to expose the edentulous area. Cortical bone perforation was done using an initial perforator drill followed by the pilot drill. Proper angled osteotomes were used in increasing diameter to prepare the site for implant placement [Figure 3]. With the help of sinus osteotomes, sinus floor was then broken by gentle malleting and pushed axially elevating the Schneiderian membrane. Implants were placed in the prepared osteotomy site [Figure 4]. The flap was sutured back for submerged healing [Figure 5]. Post operative radiographs were taken at 7th postoperative day [Figure 6] and then after the 3rd [Figure 7] and 6th month [Figure 8]. At the end of the 6th month, the cover screw was removed, and the gingival former was placed. The gingival former was removed after 10 days, the impression post was screwed, and the impression was made with addition silicon and sent to the dental laboratory for the fabrication of metal-ceramic prosthesis. The implants were radiographically evaluated for the changes in RBH, ESB, and CBL, 1 week, 3 months, and 6 months, respectively, after implant placement. These radiographs were taken using a 1 mm^2 metallic grid kept over the X-ray film while taking the radiographs with a long-cone paralleling technique.

Radiographic analysis

All the three parameters, RBH, ESB, and CBL were measured on both mesial and distal sides of each implant immediately and after 3 months and 6 months of implant placement. These radiographs were taken using a 1 mm^2 metallic grid kept over the X-ray film while taking the radiographs with a long-cone paralleling technique. To provide uniformity in the procedure for taking radiographs, the following steps were carried out:

- Film holder (Rinn-Dentsply) was used for all the patients
- The distance of the focus to dental film was regulated by the apparatus itself
- 0.8 s exposure time in all cases
- Each imaging session was performed using the same dental X-ray apparatus.

All the three parameters, RBH, ESB, and CBL were measured on both mesial and distal sides of each implant after implant placement, 3 months and 6 months after implant placement. For precise measurements, the distance between the squares of the grid was counted.

- The RBH was measured at the mesial and distal implant sides on the radiographs. It was determined by measuring

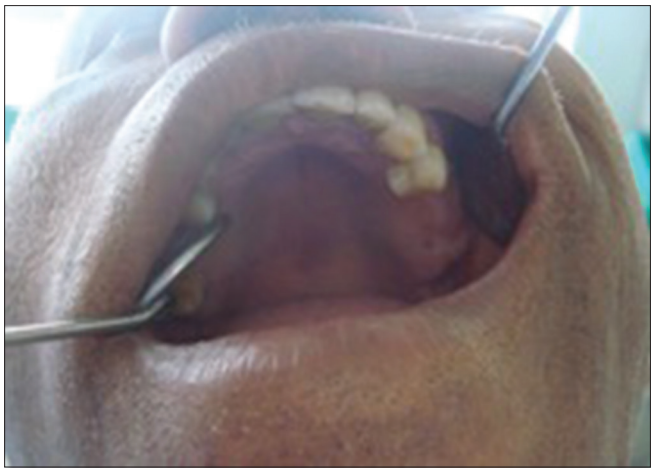


Figure 1: Site of implant placement

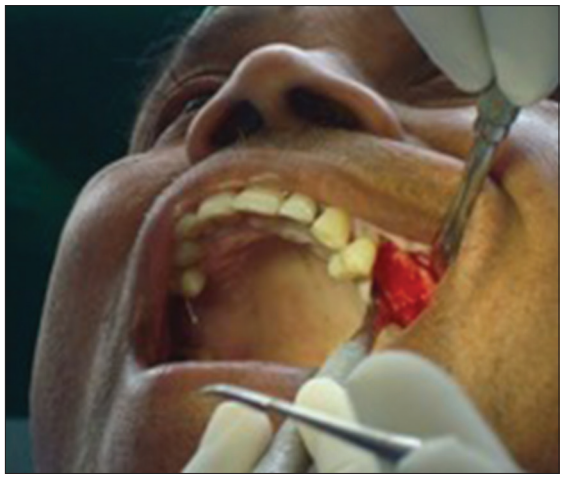


Figure 2: Flap reflection

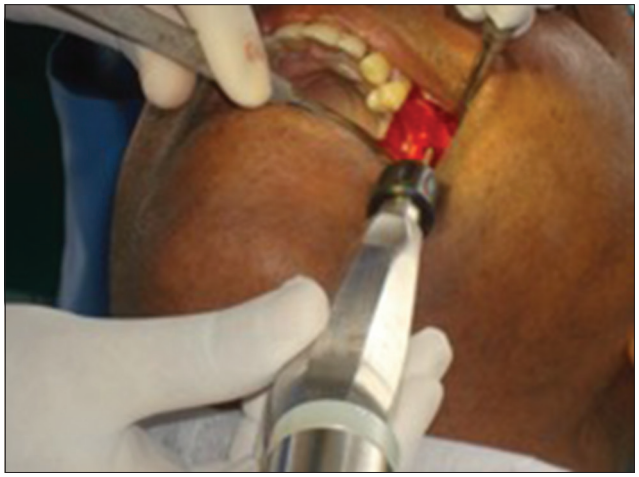


Figure 3: Preparation of osteotomy using osteotome

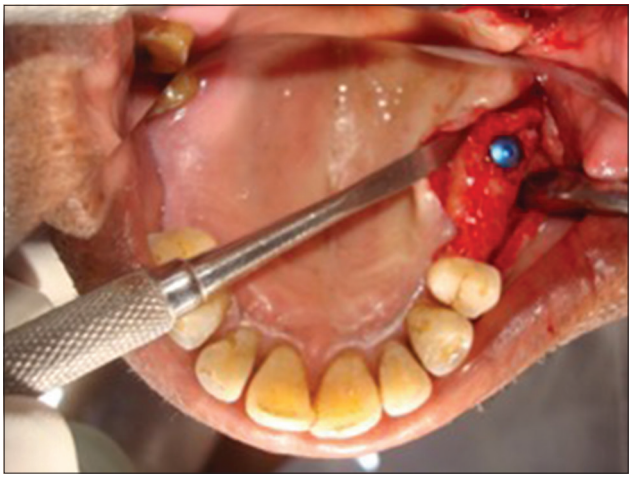


Figure 4: Placement of implant

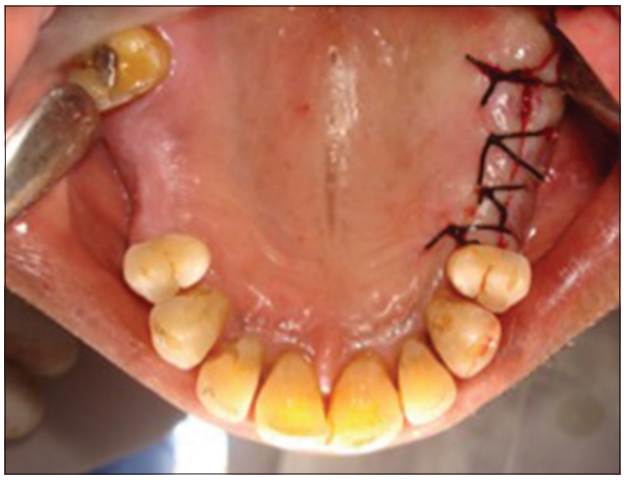


Figure 5: Area sutured

the vertical distance between the most apical bone level contacting the implant and the alveolar crest level on each side

- The ESB height was measured on both sides of the implant parallel to the implant axis from the most coronal implant thread to the most apical visible implant-bone contact. An increase in the distance between the coronal reference point and the most apical bone contact after 6 months indicated ESB gain
- The CBL was determined on the mesial and distal implant sides parallel to the implant axis, between the most apical implant thread and the most coronal bone–implant contact. A decrease in this vertical distance between the reference point and the most coronal bone-implant contact on consecutive radiographs indicated loss of crestal bone. An increase in this distance indicated a crestal bone gain.

Results

All the implants were clinically and radiographically stable at the end of 6 months of follow-up. Twenty implants were Pitt Easy Puretex of 10 mm length and six were 12 mm in length. Eighteen implants (69.23%) were standard implants with a diameter of 4 mm, 6 (23.1%) were wide-body implants with a diameter of 4.9 mm, and the 2 (7.6%) implants were with a reduced diameter of 3.25 mm. The most common site was the first molar with 40%. The second most common position

was the second molar with 33%, and the third most common position was second premolar with 26% of the implants. The mean healing time for abutment tightening was 6 months, by which time, all implants were clinically stable. Radiographs taken 6 months after implant placement showed that all implants had gained ESB. Pre- and postoperative RBH, ESB, and CBL were compared using the *t*-test.

Residual bone height

Mean RBH immediately after implant placement was 6.80 ± 1.89 mm on mesial side and 5.93 ± 1.33 mm on distal side which increased to 7.93 ± 1.16 mm on mesial side and 7.52 ± 1.46 mm on distal side after 6 months [Tables 1 and 2]. This increase of RBH was found to be statistically significant [Graph 1].

Endosinus bone height

The mean ESB was 5.13 ± 1.41 mm on mesial side and 5.0 ± 1.85 mm on distal side. Postoperatively, ESB increased to 6.27 ± 1.21 mm and 7.10 ± 1.14 mm after 3 months and 6 months, respectively, on mesial side, and 6.07 ± 1.02 mm and 6.99 ± 1.04 mm after 3 months and 6 months, respectively, on distal side [Tables 3 and 4]. This postoperative increase in ESB was found to be statistically significant. At the end of 6-month follow-up, all implants had gained ESB [Graph 2].

Table 1: Residual bone height mesial side (comparison at different time intervals)

RBH	Mean±SD	SEM	Mean difference	*t*	*P*
7 days	6.80±1.69	0.44	−0.400	−1.492	0.158
3 months	7.20±1.61	0.42			
7 days	6.80±1.69	0.44	−1.133	−2.939	0.011*
6 months	7.93±1.16	0.30			
3 months	7.20±1.61	0.42	−0.733	−2.323	0.036*
6 months	7.93±1.16	0.30			

*Statistically significant. SD=Standard deviation; SEM=Standard error of the mean; RBH=Residual bone height

Table 2: Residual bone height distal side (comparison at different time interval)

RBH	Mean±SD	SEM	Mean difference	*t*	*P*
7 days	5.93±1.33	0.34	−1.133	−2.656	0.019*
3 months	6.30±1.70	0.44			
7 days	5.93±1.33	0.34	−2.067	−6.254	<0.001*
6 months	7.52±1.46	0.38			
3 months	6.30±1.70	0.44	−0.933	−3.836	0.002*
6 months	7.52±1.46	0.38			

*Statistically significant. SD=Standard deviation; SEM=Standard error of the mean; RBH=Residual bone height

Table 3: Endosinus bone mesial side (comparison at different time interval)

ESBH	Mean±SD	SEM	Mean difference	*t*	*P*
7 days	5.13±1.41	0.36	−1.133	−4.076	0.001*
3 months	6.27±1.21	0.31			
7 days	5.13±1.41	0.36	−2.233	−7.751	<0.001*
6 months	7.10±1.14	0.29			
3 months	6.27±1.21	0.31	−1.100	−4.172	0.001*
6 months	7.10±1.14	0.29			

*Statistically significant. SD=Standard deviation; SEM=Standard error of the mean; ESBH=Endo Sinus Bone Height

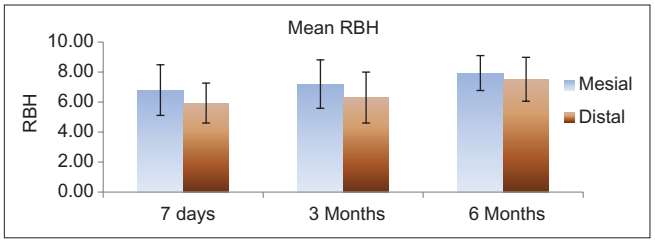
Crestal bone level

CBL after implant placement on mesial and distal sides was 8.27 ± 1.55 mm and 7.83 ± 1.46 mm, respectively. CBL 6 months after implant placement was 7.67 ± 1.11 mm mesially and 7.37 ± 1.56 mm distally. This decrease in CBL in the 6 months span was not found to be statistically significant [Tables 5 and 6]. The mean crestal bone loss in the period of 6 months was found to be 0.6 mm mesially and 0.46 mm distally [Graph 3].

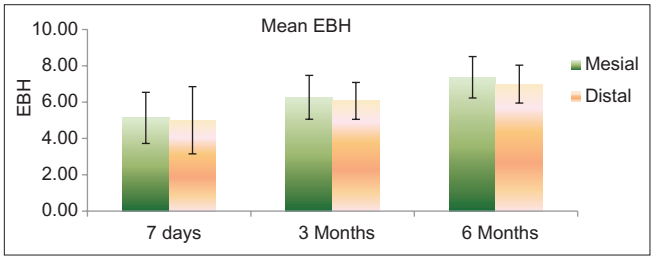
Discussion

An adequate quantity and quality of bone are extremely indispensable for successful implant therapy. The posterior edentulous maxilla presents special challenges for implant placement. Most important among these is the presence of the maxillary sinus. After extraction, it is frequently observed that the sinus floor is close to the alveolar crest. The rehabilitation of the posterior maxilla depends on the amount of bone present below the sinus.[1]

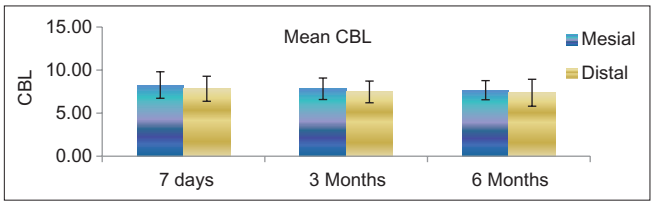
The present study evaluated ESB formation and crestal bone loss after OSFE without using a bone graft.



Graph 1: Residual bone height



Graph 2: Endosinus bone height



Graph 3: Crestal bone level

Table 4: Endosinus bone distal side (comparison at different time interval)

ESBH	Mean±SD	SEM	Mean difference	*t*	*P*
7 days	5.00±1.85	0.48	−1.067	−2.268	0.040*
3 months	6.07±1.02	0.26			
7 days	5.00±1.85	0.48	−1.533	−3.976	0.001*
6 months	6.99±1.04	0.27			
3 months	6.07±1.02	0.26	−0.467	−2.168	0.050
6 months	6.99±1.04	0.27			

*Statistically significant. SD=Standard deviation; SEM=Standard error of the mean; ESBH=Endo Sinus Bone Height

Table 5: Crestal bone level mesial side (comparison at different time interval)

CBL	Mean±SD	SEM	Mean difference	*t*	*P*
7 days	8.27±1.55	0.40	0.433	1.992	0.066
3 months	7.83±1.25	0.32			
7 days	8.27±1.55	0.40	0.600	2.500	0.025*
6 months	7.67±1.11	0.29			
3 months	7.83±1.25	0.32	0.167	0.813	0.430
6 months	7.67±1.11	0.29			

*Statistically significant. SD=Standard deviation; SEM=Standard error of the mean; CBL=Crestal bone level

Table 6: Crestal bone level distal side (comparison at different time intervals)

CBL	Mean±SD	SEM	Mean difference	*t*	*P*
7 days	7.83±1.46	0.38	0.367	1.018	0.326
3 months	7.47±1.26	0.33			
7 days	7.83±1.46	0.38	0.467	1.156	0.267
6 months	7.37±1.56	0.40			
3 months	7.47±1.26	0.33	0.100	0.494	0.629
6 months	7.37±1.56	0.40			

SD=Standard deviation; SEM=Standard error of the mean; CBL=Crestal bone level

In the past 40 years, sinus elevation surgery has come a long way. With possibilities of new horizons thanks to better understanding and material knowledge, today more emphasis is laid on techniques which are conservative, cost effect, and proficient with higher success rate. The OSFE causes lateral compression and expansion of the adjacent bone. This is especially useful in thin atrophic ridges and type III and type IV bone quality (Lekholm and Zarb classification). This technique has documented reduced perioperative complications and patient discomfort and has shown a good success rates.[8,12-14,16-19]

A similar result was attained in our study, where the site selected for implant placement was maxillary posterior region. Osteotomes have desirable effect of preserving alveolar bone width and height. The spongy (or cancellous) bone present in the maxilla allows perforation, lateral compression, and expansion of the adjacent bone.[15]

All the implants in the present study using OSFE osseointegrated within 6 months of placement. This result is comparable

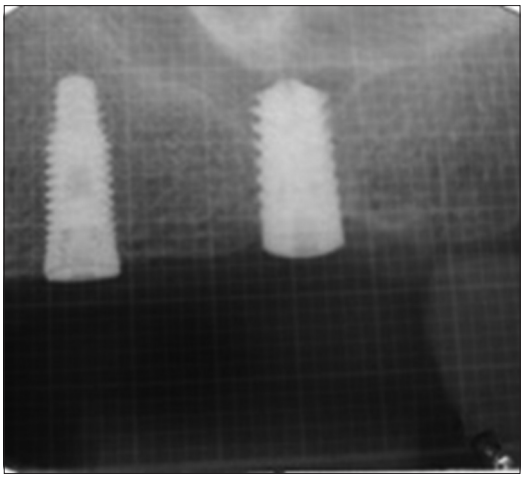


Figure 6: Immediately after implant placement

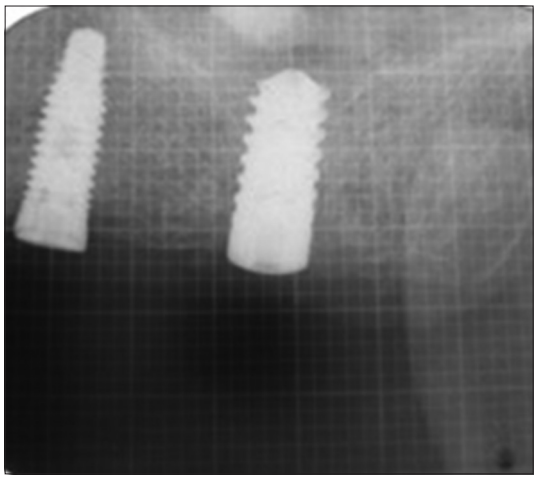


Figure 7: 3 months after implant placement

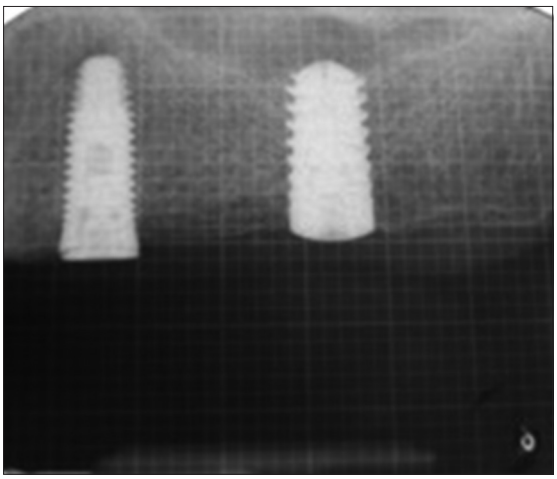


Figure 8: 6 months after implant placement

to a study by Nedir *et al*., where the same technique had a 100% survival rate after 1 and 3 years of follow-up.[12,13] Leblebicioglu *et al*. had a success rate of 97.3% after 25 months of loading.[20] A study by Lai *et al*. had cumulative survival rate of 95.71% and concluded that OSFE with and without

bone grafts gives similar result.[19] Similar cumulative survival rate was seen in a study by Pjetursson *et al*.[18] Winter *et al*. placed 58 implants using sinus/alveolar crest tenting and had a survival rate of 91%.[21] Fugazzotto placed implants using modified trephine/osteotome approach and got success rate of 98.3% after 4 years.[17] Gabbert *et al*. showed survival rate to be above 94% in implants placed with indirect sinus lift.[16]

The most commonly described intra-operative complication of sinus floor elevation using OSEF is perforation of the Schneiderian membrane because of the indirect view for the elevation of sinus floor. To check the membrane integrity, Valsalva maneuver is done. A perforation is indicated when air bubbles are found. Minor perforations do not usually need treatment, because the membrane folds on itself.[16] During elevation in this study, implant treatment was completed in all 26 sites. All patients were asked to do Valsalva maneuver after preparation of the osteotomy site. If membrane perforation was detected, the procedure was not abandoned and implants were placed. In the present study, it was recorded in 1 patient (3.8%). In a study by Nedir *et al*., membrane perforation was recorded to be 4.29%.

A systematic review of sinus floor elevation found nongrafted maxillary sinus floor elevation seems to be characterized by new bone formation as well as high implant survival rate which was comparable to bone graft-assisted maxillary sinus floor augmentation. It also quotes that the main rationale for bone grafting is to improve implant stability and act as a space maintainer. The key factor affecting the primary stability of dental implants is RBH and its quality could be improved independent of the presence of grafting materials through peri-implant bone condensation.[22]

Similarly, a recent individual and aggregate data meta-analysis evaluating prospective and retrospective studies of direct maxillary sinus elevation without bone grafting found it to safe and effective technique with high survival rates. The study also quotes the advantages of blood clot present under the Schneiderian membrane for new bone formation which includes no requirement of donor site for bone harvesting, no risk of failure of graft material, reduced cost of the surgical procedure, and better patient acceptance.[23]

In the present study, no alloplastic or autogenous bone graft was used. None of the implants failed during the follow-up period. All the implants gained ESB. Clinical observations of bone formation in sinus lifting procedure without grafting bone substitutes have been observed, but the biological nature of bone regeneration in sinus lifting procedures is largely speculative. A number of explanations have been proposed.

- A theoretical source of bone-forming cells is the periosteum of the lifted sinus membrane. An *in vitro* study by Srouji *et al*. has indicated that maxillary Schneiderian sinus membrane has innate osteogenic potential and its possible contribution to bone regeneration in sinus lifting procedures.[9,10] This is further supported by a case report by Jung *et al*. in which an impacted tooth was removed using sinus elevation and after 5 months of healing, the space between the sinus floor and the socket was filled with new bone. The author concluded that the osteogenic activity of sinus mucosa and the blood clot in the extraction socket beneath the elevated sinus would have been important factors in this spontaneous bone formation[11]
- Presence of blood clot beneath the sinus floor and tenting of the sinus by the implants. A retrospective evaluation of direct sinus lift without bone graft questioned the use of bone grafting materials for the same. The study summarized that the presence of an enclosed chamber with periosteum on lateral aspect and sinus membrane and bone superiorly with implant fixtures providing vertical stops for creation of space to the blood clot resulted in the formation of bone.[6] This blood clot releases a number of growth factors. The presence of growth factors and cytokines confers osteoinductive activity to the clot which promotes bone formation.[6-8,23,24]

This procedure showed that elevation of the sinus membrane alone, without additional grafting material in case of OSFE is able to create a space for predictable bone formation beyond the sinus floor. Despite a limited RBH, a healing period of 6 months was found to be sufficient to resist a torque of 35Ncm applied during abutment tightening. Radiologically, formation of a new bone structure delimiting the sinus floor was identified.

Conclusion

Placing implants in the atrophic posterior maxillary region using OSFE without simultaneous grafting can be a predictable procedure. Healing was predictable and therefore, the procedure reduced the number of surgical interventions, treatment time, and cost of implant placement in the atrophic posterior maxilla. The procedure can be immensely gratifying to the clinician and especially to the patients as it reduces the total span of treatment. Due to the small sample size and short duration of the study, the long-term survival rate cannot be inferred, for which a long-term study and bigger sample size are warranted.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Raja SV. Management of the posterior maxilla with sinus lift: Review of techniques. J Oral Maxillofac Surg 2009;67:1730-4.
2. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenousnmarrow and bone. J Oral Surg 1980;38:613-6.
3. Rosen PS, Summers R, Mellado JR, Salkin LM, Shanaman RH, Marks MH, *et al*. The bone-added osteotome sinus floor elevation technique: Multicenter retrospective report of consecutively treated patients. Int J Oral Maxillofac Implants 1999;14:853-8.
4. 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;6:165-73.
5. 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;5:78-81.
6. Chen TW, Chang HS, Leung KW, Lai YL, Kao SY. Implant placement immediately after the lateral approach of the trap door window procedure to create a maxillary sinus lift without bone grafting: A 2-year retrospective evaluation of 47 implants in 33 patients. J Oral Maxillofac Surg 2007;65:2324-8.
7. Moon JW, Sohn DS, Heo JU, Shin HI, Jung JK. New bone formation in the maxillary sinus using peripheral venous blood alone. J Oral Maxillofac Surg 2011;69:2357-67.
8. Moraschini V, Uzeda MG, Sartoretto SC, Calasans-Maia MD. Maxillary sinus floor elevation with simultaneous implant placement without grafting materials: A systematic review and meta-analysis. Int J Oral Maxillofac Surg 2017;46:636-47.
9. Srouji S, Kizhner T, Ben David D, Riminucci M, Bianco P, Livne E, *et al*. The schneiderian membrane contains osteoprogenitor cells: *In vivo* and *in vitro* study. Calcif Tissue Int 2009;84:138-45.
10. Srouji S, Ben-David D, Lotan R, Riminucci M, Livne E, Bianco P. The innate osteogenic potential of the maxillary sinus (Schneiderian) membrane: An ectopic tissue transplant model simulating sinus lifting. Int J Oral Maxillofac Surg 2010;39:793-801.
11. Jung YS, Chung SW, Nam W, Cho IH, Cha IH, Park HS. Spontaneous bone formation on the maxillary sinus floor in association with an extraction socket. Int J Oral Maxillofac Surg 2007;36:656-7.
12. Nedir R, Bischof M, Vazquez L, Szmukler-Moncler S, Bernard JP. Osteotome sinus floor elevation without grafting material: A 1-year prospective pilot study with ITI implants. Clin Oral Implants Res 2006;17:679-86.
13. Nedir R, Bischof M, Vazquez L, Nurdin N, Szmukler-Moncler S, Bernard JP. Osteotome sinus floor elevation technique without grafting material: 3-year results of a prospective pilot study. Clin Oral Implants Res 2009;20:701-7.
14. Nedir R, Nurdin N, Szmukler-Moncler S, Bischof M. Osteotome sinus floor elevation technique without grafting material and immediate implant placement in atrophic posterior maxilla: Report of 2 cases. J Oral Maxillofac Surg 2009;67:1098-103.
15. Rambla-Ferrer J, Peñarrocha-Diago M, Guarinos-Carbó J. Analysis of the use of expansion osteotomes for the creation of implant beds. Technical contributions and review of the literature. Med Oral Patol Oral Cir Bucal 2006;11:E267-71.
16. Gabbert O, Koob A, Schmitter M, Rammelsberg P. Implants placed in combination with an internal sinus lift without graft material: An analysis of short-term failure. J Clin Periodontol 2009;36:177-83.
17. Fugazzotto PA. Immediate implant placement following a modified trephine/osteotome approach: Success rates of 116 implants to 4 years in function. Int J Oral Maxillofac Implants 2002;17:113-20.
18. Pjetursson BE, Rast C, Brägger U, Schmidlin K, Zwahlen M, Lang NP. Maxillary sinus floor elevation using the (transalveolar) osteotome technique with or without grafting material. Part I: Implant survival and patients' perception. Clin Oral Implants Res 2009;20:667-76.
19. Lai HC, Zhuang LF, Lv XF, Zhang ZY, Zhang YX, Zhang ZY. Osteotome sinus floor elevation with or without grafting: A preliminary clinical trial. Clin Oral Implants Res 2010;21:520-6.
20. Leblebicioglu B, Ersanli S, Karabuda C, Tosun T, Gokdeniz H. Radiographic evaluation of dental implants placed using an osteotome technique. J Periodontol 2005;76:385-90.
21. Winter AA, Pollack AS, Odrich RB. Sinus/alveolar crest tenting (SACT): A new technique for implant placement in atrophic maxillary ridges without bone grafts or membranes. Int J Periodontics Restorative Dent 2003;23:557-65.
22. Nasr S, Slot DE, Bahaa S, Dörfer CE, Fawzy El-Sayed KM. Dental implants combined with sinus augmentation: What is the merit of bone grafting? A systematic review. J Craniomaxillofac Surg 2016;44:1607-17.
23. Dongo V, von Krockow N, Martins-Filho PRS, Weigl P. Lateral sinus floor elevation without grafting materials. Individual- and aggregate-data meta-analysis. J Craniomaxillofac Surg 2018;46:1616-24.
24. Sohn DS, Moon JW, Moon KN, Cho SC, Kang PS. New bone formation in the maxillary sinus using only absorbable gelatin sponge. J Oral Maxillofac Surg 2010;68:1327-33.