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RESEARCH PAPER

Sinus Elevation with an Alloplastic Material and Simultaneous Implant Placement: A 1-Stage Procedure in Severely Atrophic Maxillae

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Abstract
Aims and objective The aim of the study is to evaluate clinically and radiographically the long term success of one-stage direct (lateral) sinus lift procedure using alloplastic bone graft material and bio-absorbable membrane in conjunction with two stage implant placement in atrophic partially edentulous posterior maxilla.
Materials and methods One stage direct maxillary sinus lift in conjunction with two stage implant placement was carried out in 12 patients at 13 sites. All the patients were partially edentulous with posterior maxillary alveolar ridge height of >5 mm and were in the age group of 20–50 years. Bioactive glass putty, bio-absorbable collagen membrane and 3.75 × 11.5 mm implants were used. Loading of implants was done 6 months after placement of implants. Patients were evaluated clinically and radiographically 6, 18, 30 months after placement of implants to assess increase in residual ridge height, peri-implant condition (marginal bone loss, plaque and gingival index) and implant stability.
Results Maxillary first molar was the most common site (69.23 %) for sinus lift and implant placement. Caries was the most common cause (76.92 %) for loss of tooth. Increase in residual ridge height ranged from (71.43 to 133.33 %) as measured by Denta-Scan. Implant survival rate was 100 %. Marginal bone loss ranged from 0.68 to 1.22 mm. Implant stability was measured by periotest (−2.7 to −3.6). Only one patient had perforation of sinus membrane, but it was sealed satisfactorily by bio-absorbable membrane.
Conclusion One stage lateral sinus lift procedure with alloplastic bone graft material in combination with 2 stage implant placement has a predictable outcome in patients with severe resorption of posterior maxilla.

Keywords Direct sinus lift · Single tooth implant · Sinus floor augmentation · Alloplastic bone graft

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Introduction

The goal of modern dentistry is to restore normal function, contour, comfort, esthetics, speech and health regardless of the atrophy, disease or injury of the stomatognathic system. As a result of research, advances in implant design, materials and techniques have lead to predictable success in their applications.

However, in partially edentulous patients, especially in the posterior maxilla, implant placement is most challenging and frequently complicated by unfavorable post extraction bone patterns, pneumatisation of the maxillary sinus, poor quality of the remaining alveolar bone and higher occlusal forces [1] making it insufficient for holding the implant; thereby arising the need to increase the vertical dimension of atrophic maxilla by surgical techniques.

Developments in the 1970s included subperiosteal implants, tuber blade, aluminum oxide wide-blade sinus implant and the sinus-bar implant which elevated the sinus membrane while engaging mesial and distal bone, but these required at least 7 mm of alveolar bone height to hold the implants. While some success was achieved with each of these, they did not provide an acceptable level of predictability because of poor stability and lateral displacement of the implant due to unfavorable bony ridge and higher occlusal forces.

Considering the drawbacks of the above mentioned techniques, subantral augmentation method with simultaneous implant placement was first presented by Tatum in 1976 at Alabama implant conference and published by Boyne and James in 1980 [2, 3]. It intended to increase the vertical bone dimension in the posterior maxilla where access to the maxillary sinus is obtained by drilling a bony window in the lateral sinus wall using a small round bur, while ensuring that the sinus membrane remains intact; and is of use when the remaining alveolar bone height ranges from 1 to 6 mm.

In 1986, Misch [1] described a treatment approach to the posterior maxilla based on the amount of bone below the antrum. The treatment plan was divided into four alternative treatment options amongst which the subantral option three (SA-3) is indicated when 5–8 mm of vertical bone height is present between the crest of the ridge and the antral floor with a ridge width greater than 2.5 mm where the sinus membrane can be elevated by lateral window technique with immediate placement of an implant.

Considering the above facts, a study was conducted in the Department of Oral and Maxillofacial Surgery, Government Dental College and Hospital, Ahmedabad from November 2009 to November 2010. It evaluated both, clinically and radiographically, the efficacy of the lateral sinus lifts along with simultaneous implant placement for the rehabilitation of the partially edentulous posterior maxilla deficient in residual alveolar bone height.

Materials and Methods

The study consisted of a sample of 12 patients who visited the Department of Oral & Maxillofacial Surgery, Government Dental College & Hospital, Ahmedabad and 13 implant sites. The patients were selected randomly irrespective of the sex and socioeconomic status. *Ethical committee approval was taken from college committee.*

Inclusion Criteria

Age between 20 and 50 years, residual alveolar bone height above 5 mm at the edentulous posterior maxillary region, buccolingual and mesiodistal bone dimension should be >6 mm, quality of bone D3 and D4, a delay of at least 6 months between tooth extraction and an implant placement, absence of maxillary sinusitis, presence of normal healthy adjacent teeth or restored teeth.

Exclusion Criteria

Uncontrolled systemic illness, presence of periapical pathology, h/o radiotherapy in maxillofacial region, oral destructive habit, debilitating temporomandibular joint pathosis, inadequate mouth opening which cannot allow placement of instruments necessary for implant insertion.

Preoperative Evaluation of Implant Site

Pre-operatively, each patient was subjected to a detailed clinical and radiographic examination of the soft and hard tissue which provided necessary diagnostic information for proceeding with implant therapy.

The gingival health was assessed for color, consistency, texture, bleeding on probing and pocket depth, presence of sufficient inter-occlusal space. The bone topography was evaluated with ridge mapping technique. Presurgical measurement of the alveolar ridge height to the sinus floor, buccolingual and mesio-distal width of edentulous space was measured using standard IOPA, OPG and CT Scan/Dentascans. Pre-operative, intra-operative and post-operative photographs were taken for record maintenance and documentation.

Implant, Bone Graft and Membrane Used

In our study we have used Self threaded, Tapering, Double thread, Acid etched and sand-blasted, selective Integrated surfaced Implants, Sinus lift kit, Alloplastic bone graft (Bioactive glass putty), resorbable collagen membrane.

Preoperative Preparation of Patient

Tab Augmentin (625 mg tds) was administered 24 h before surgery to achieve adequate blood concentrations. Nasal decongestant in the form of tablet was started twice a day. A day before surgery, nasal decongestant drops (Otrivin) was started as 2 drops twice a day. All patients were told to rinse with 0.2 % Chlorhexidine gluconate mouthwash preoperatively (Figs. 1, 2, 3).

Surgical Technique

Stage 1 Lateral Sinus Lift and Simultaneous Placement of Implant

Posterior superior alveolar nerve, infraorbital nerve and greater palatine nerve blocks were given with bupivacaine and local infiltration was done with 2 % Lignocaine HCL

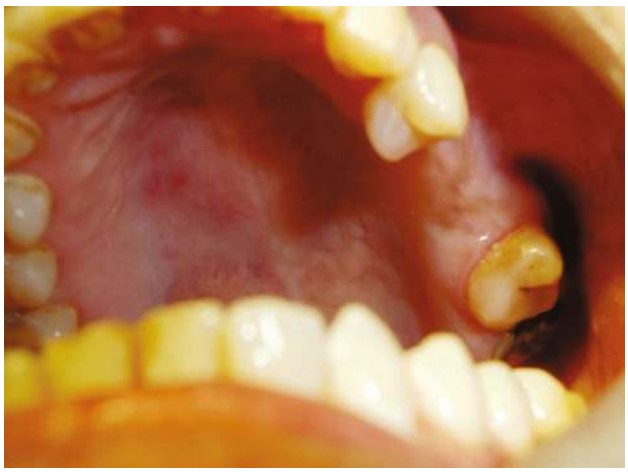

Fig. 1 Pre-operative maxillary occlusal photograph showing missing left second premolar and first molar

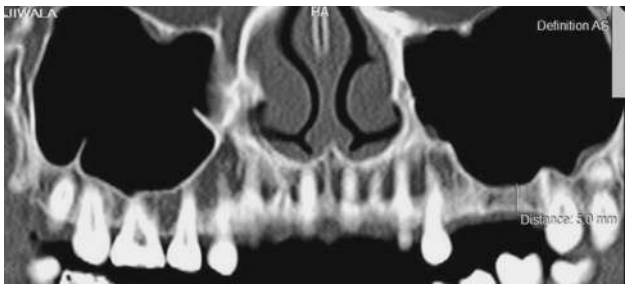

Fig. 2 Pre-operative CT PNS showing height of residual ridge 5 mm at left maxillary first molar region

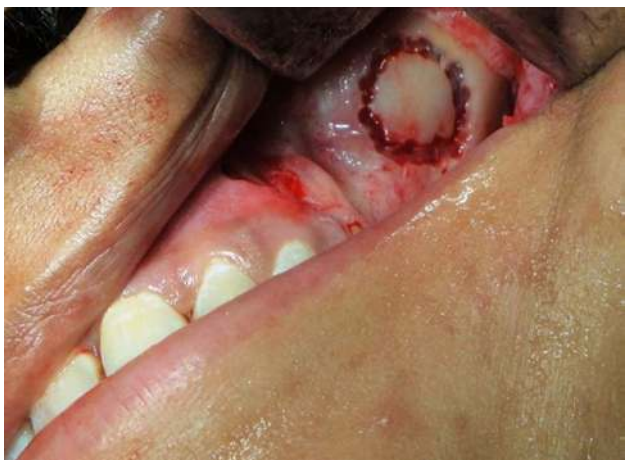

Fig. 3 Preparation of circular window in lateral wall of maxillary sinus

with 1:100,000 concentration. Under the effect of local anaesthesia, an incision was made, 2–3 mm on the palatal side of the crest of the ridge with a releasing incision at least 15 mm mesial to the antral opening. With the help of 3 mm diameter round bur and surgical handpiece with 40,000 rpm speed, a bony window, round to elliptical in shape, was cut. With a surgical curette, the underlying membrane was lifted from the inside wall of the sinus. When the sinus membrane was intact, a bellows effect was observed as the patient breathed. In case of a tear occurring in the membrane, a small piece of resorbable collagen membrane could be placed against the tear, where it would easily adhere. If a larger perforation were to occur in the membrane, laminar bone (membrane like sheets of DFDB) could be used for repair or it could be sutured with 6–0 resorbable sutures. Then the osteotomized bone segment was stabilized with the membrane elevators to prevent perforation of the sinus membrane during drilling for implant insertion. 1:20 reduction handpiece was used at the low speed (800–1,200 rpm) high torque (35 Ncm) along with copious irrigation (external and internal) of normal saline to prevent thermal injury to the bone. A self tapping implant was placed in the prepared site and then the osteotomized segment was supported on the implant head. Alloplastic bone graft (Bioactive glass, Novabone putty) was placed in the lateral window and the implant surface was covered with the same. The lateral window was then covered with the collagen membrane to avoid the fibrous adhesion between the inner surface of the flap and bone graft. After the placement of the membrane, the muco-periosteal flap was repositioned and sutured with the help of (3–0) 2328 Vicryl. Post-operative instructions such as refraining from nose blowing and sucking with a straw were given to the patients (Figs. 4, 5, 6).

Stage 2 Surgical Uncovering and Loading of Implants

Surgical exposure of the implant and placement of the healing cap was done 6 months after placement of the implant. After 15 days of stage II, an abutment was attached to the implant and prosthesis was fabricated. All

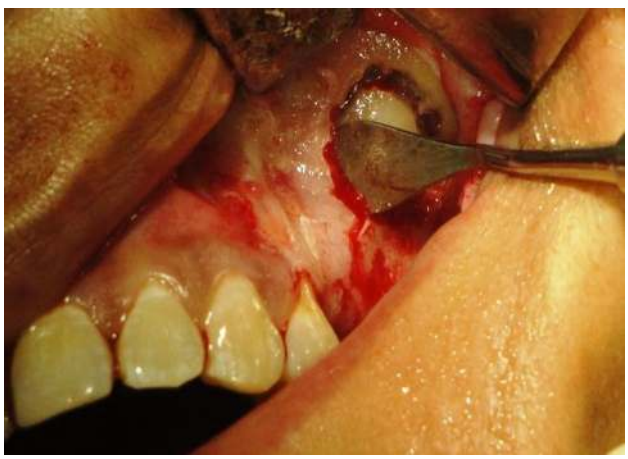

Fig. 4 Lifting of sinus membrane along with osteotomized bone segment

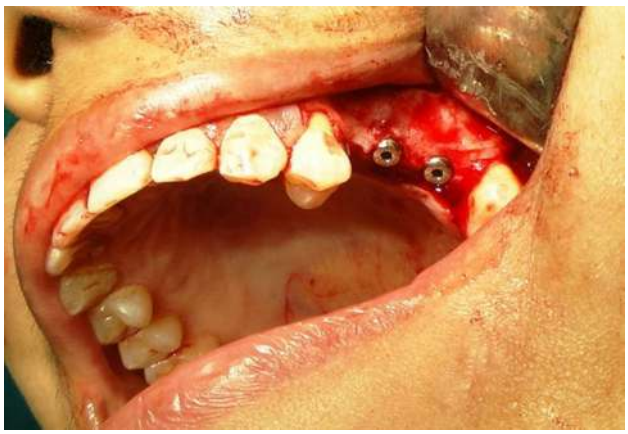

Fig. 5 Placement of implants into elevated sinus floor at left second premolar and first molar region

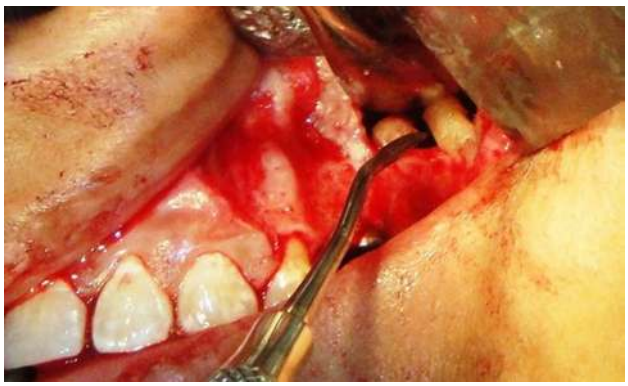

Fig. 6 Bio-active glass graft material in putty form used for sinus floor augmentation

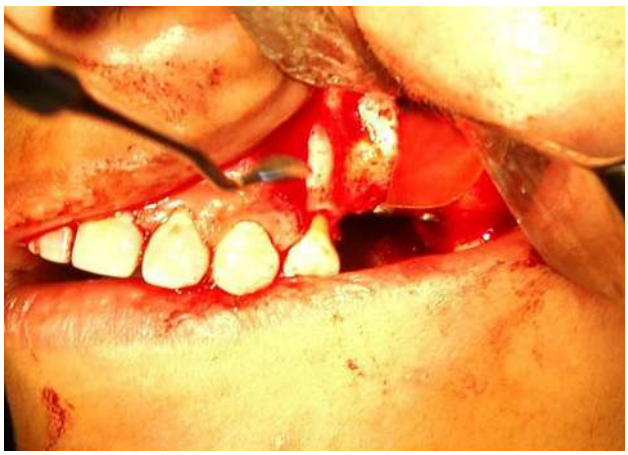

Fig. 7 Bioabsorable collagen membrane used to cover window on lateral wall of sinus

the patients were kept on regular follow-up and evaluated clinically and radiographically 1 and 2 years after loading (Figs. 7, 8, 9).

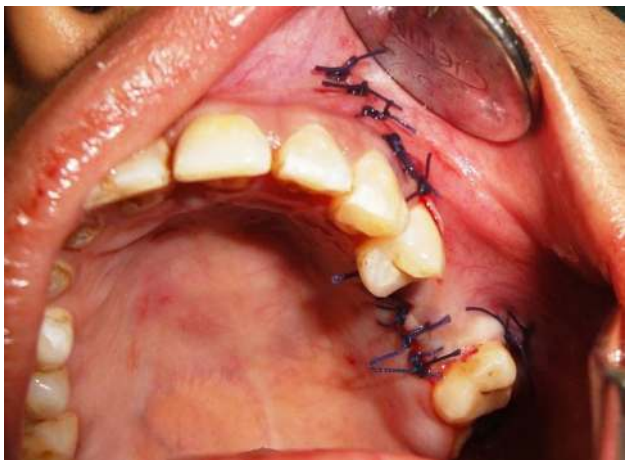

Fig. 8 Primary closure of flap

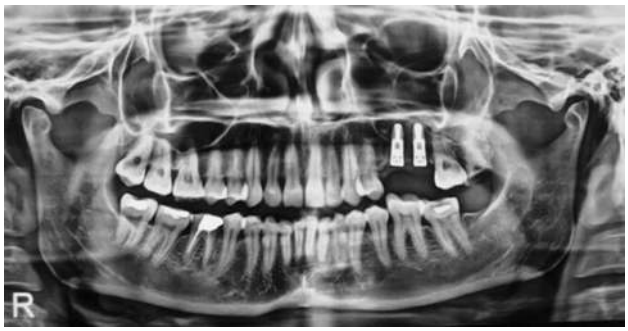

Fig. 9 Immediate post-operative OPG showing good position of implant at planned surgical site and radio-opaque graft material

Results

The present study was conducted in the Department of Oral and Maxillofacial Surgery, Government Dental College and Hospital, Ahmedabad. It was conducted on 12 patients with 13 implant sites, to evaluate clinically and radio graphically survival rate of the Self threaded, Tapered, Double thread, EZ Selective Integrated surfaced Implants placed simultaneous with direct sinus lift technique (Lateral approach) with alloplastic bone graft (A Bio-active glass) as the graft material for sinus augmentation and resorbable collagen membrane as the barrier membrane. Loading of implants was done 6 months after placement. Follow up was done 6 months after sinus lift and simultaneous implant placement (time allowed for graft maturation and implant healing) and at the interval of 1 and 2 years after final prosthesis. Standardized IOPA, Digital OPG and CT scan/Dentascan were taken preoperatively and at various follow-up intervals (Figs. 10, 11, 12, 13).

At all implant sites except one, there was absence of local inflammation/infection, pain and soft tissue dehiscence after surgery. Maxillary sinusitis was observed in

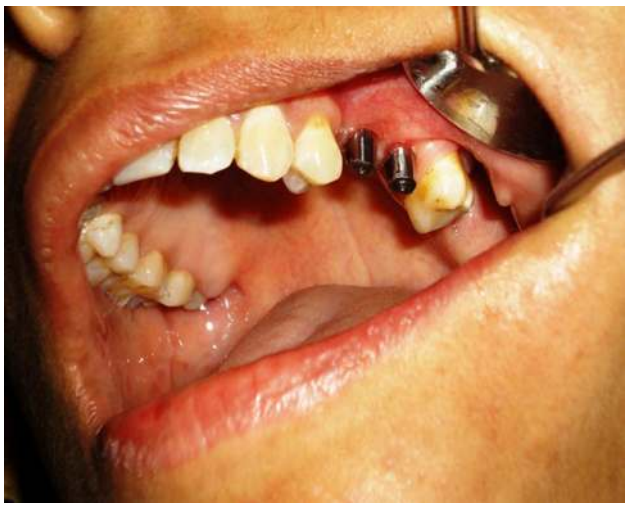

Fig. 10 Surgical uncovering and placement of abutment 6 months after sinus lift surgery

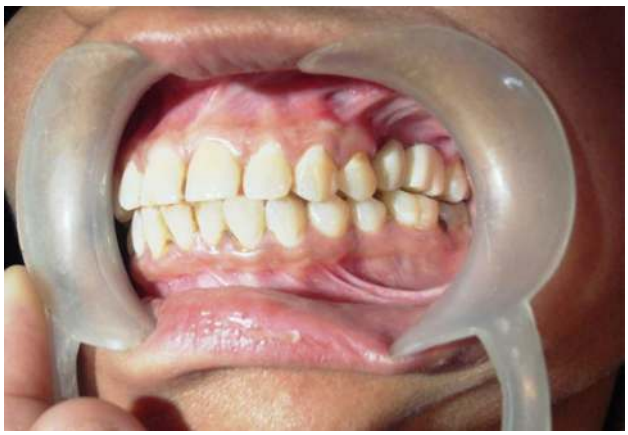

Fig. 11 Final prosthesis over implant is given

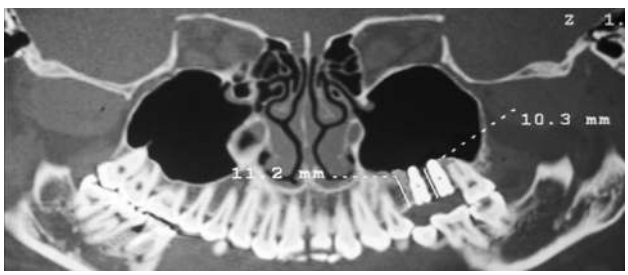

Fig. 12 CT PNS 6 months after sinus floor augmentation showing increase in height of sinus floor

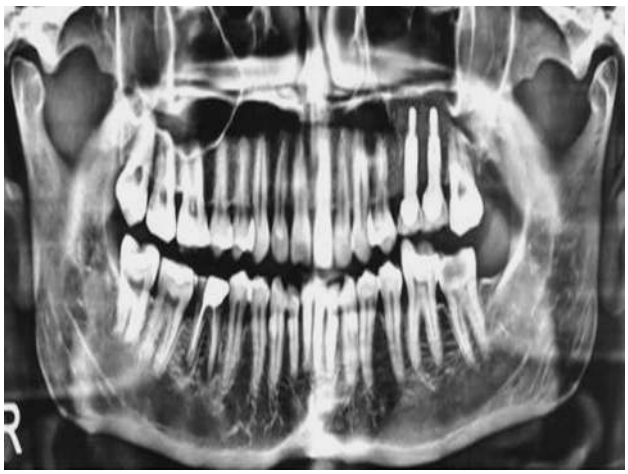

Fig. 13 CT PNS 18 months after sinus floor augmentation showing complete maturation of graft

one patient (7.69 %) with pain at local site, which may be secondary to perforation of sinus membrane which had occurred in the same patient (Table 1).

There is significant increase in residual bone height over a period of 6 months following sinus floor augmentation, in the range of 3.7–6.1 mm (on an average 4.5 mm). One year after loading of implant (18 months after one stage lateral sinus lift) reduction in graft height was 0.3–0.7 mm and 2 years after loading of implant (30 month after one stage lateral sinus lift postoperatively) was around 0.2–0.3 annually (Table 2). Paired *t* test was applied to find the statical difference in residual ridge height preoperatively and 6 and 30 months post-operatively. It was found statically significant (*p* value <0.001). Difference in residual ridge height 18 and 30 months post-operatively was found to be statically non-significant (*p* value 0.0503) (Table 3).

Implant stability was measured with perio-test device at the level of abutment. Implant stability when measured with perio-test device varies in the range of −9 to +8 from highest to lowest respectively. It was in the range of −2 to −3.7 1 year after loading and in the range of −3 to −3.6 2 years after loading (Table 4). Difference in stability between 1 and 2 years after loading was statically non-significant (Table 5).

Marginal bone loss was measured at mesial and distal aspect of implant as distance between crest of alveolus and implant shoulder using IOPA with parallel cone technique. One year after implant loading it was in the range of 0.68–0.85 and 0.69–0.86 mm and 2 years after loading it was in the range of 1.06–1.2 and 1.02–1.22 mm on mesial and distal aspect of implant respectively (Tables 6, 7).

Out of thirteen implant sites, one site (7.69 %) had plaque index 1 i.e., plaque disclosed after running the periodontal probe along the gingival margin and one site (7.69 %) had plaque index 2 i.e., visible plaque. Moderate inflammation, redness, edema, and glazing, bleeding on probing (Gingival index 2) was present at one site. One implant site (7.69 %) showed pocket depth of 3 mm and rest of sites (92.3 %) showed pocket depth ranges 1–2 mm which was considered normal pocket depth around implant.

Table 1 Evaluation of soft tissue at site of surgery 7 days post-operatively

Case no.	Site of sinus lift with simultaneous implant placement	Local inflammation	Pain	Soft tissue dehiscence	Maxillary sinusitis
1.	Maxillary right first molar	A	A	A	A
2.	Maxillary left second premolar	A	A	A	A
3.	Maxillary left first molar	A	A	A	A
4.	Maxillary left first premolar	A	A	A	A
5.	Maxillary right first molar	A	P	A	P
6.	Maxillary left first molar	A	A	A	A
7.	Maxillary right first molar	A	A	A	A
8.	Maxillary right first molar	A	A	A	A
9.	Maxillary left second premolar	A	A	A	A
10.	Maxillary right first molar	A	A	A	A
11.	Maxillary left first molar	A	A	A	A
12.	Maxillary right second premolar	A	A	A	A
13.	Maxillary right first molar	A	A	A	A

A = absent, P = present

Table 2 Residual ridge height before and after direct sinus floor lift and augmentation

No.	Site of sinus lift with simultaneous implant placement	Preoperative residual ridge height in posterior maxilla (mm)	Residual ridge height after augmentation (mm)		
			6 months (mm)	18 months (mm)	30 months (mm)
1.	Maxillary right first molar	6.1	11.3	10.6	10.3
2.	Maxillary left second premolar	5.1	11.2	10.5	10.2
3.	Maxillary left second molar	4.8	10.3	10	9.6
4.	Maxillary left first premolar	7.0	12	11.6	11.3
5.	Maxillary right first molar	5.5	9.5	9.1	8.9
6.	Maxillary left first molar	5.1	8.8	8.2	8.0
7.	Maxillary right first molar	5.8	10.8	10.3	9.9
8.	Maxillary right first molar	5.7	10.7	10.4	10
9.	Maxillary left second premolar	6.5	11.5	11	10.8
10.	Maxillary right first molar	6	11	10.4	10.1
11.	Maxillary left first molar	5.9	10.8	10.3	10
12.	Maxillary right second premolar	6.4	11.3	10.8	10.6
13.	Maxillary right first molar	5.4	9.5	8.8	8.5

Table 3 Paired *t*-test to compare difference in ridge height preoperatively and post-operatively

Time interval after sinus lift	Mean	N	Std. deviation	Mean difference	*p* value	Results
Preoperative to 6 month	5.792	13	0.624	−4.877	<0.0001	S
	10.669	13	0.915			
6–18 months	10.669	13	0.915	−0.515	<0.0001	S
	10.154	13	0.935			
18–30 months	10.154	13	0.935	−0.523	0.0503	NS
	9.631	13	1.294			
Preoperative to 30 months	5.792	13	0.624	−3.838	<0.0001	S
	9.631	13	1.294			

N = no of implant site, S = statistically significant, NS = statistically non-significant

None of the cases showed prosthesis loosening and peri-implant radiolucency. Clinical and radiographic evaluation of peri-implant soft and hard tissue at last follows-up (2 1/2 years) visit is shown in Table 8 (Figs. 14, 15, 16).

Discussion

To overcome the limitations of other methods used for restoring the partially edentulous posterior maxilla, the

Table 4 Implant stability 1 and 2 years after loading of implant evaluated by periotest

No of implant site	Site of sinus lift with simultaneous implant placement	Implant stability after loading of implant	
		1 year	2 years
1.	Maxillary right first molar	−3.4	−3.6
2.	Maxillary left second premolar	−3.3	−3.5
3.	Maxillary left first molar	−2.9	−3.2
4.	Maxillary left first premolar	−3.4	−3.7
5.	Maxillary right first molar	−2.8.	−3.1
6.	Maxillary left first molar	−2.7	−3.
7.	Maxillary right first molar	−3.3	−3.5
8.	Maxillary right first molar	−2.9	−3.1
9.	Maxillary left second premolar	−3.2	−3.4
10.	Maxillary right first molar	−3.4	−3.6
11.	Maxillary left first molar	−3.1	−3.3
12.	Maxillary right second premolar	−3.6	−3.2
13.	Maxillary right first molar	−3	−3.1

Table 5 Paired *t*-test to evaluate statistics value of implant stability after loading of implant

Time interval after loading of implant	Mean	N	Std. deviation	Mean difference	*p* value	Results
1 year	−3.154	13	0.276	0.077	0.156	NS
2 years	−3.231	13	0.232			

N = no of implant site, S = statistically significant, Ns = statistically non-significant

present study was conducted to determine and evaluate the efficacy of the lateral approach (Direct technique) for augmentation of the antral floor with simultaneous placement of an implant; and also to evaluate the implant placed, both clinically and radiographically following antral floor augmentation.

The bone quality was D3 in all cases except one i.e., 12 out of 13 sites (92.3 %). In all patients, the Self threaded, tapered, double thread, selective integrated surfaced Implants of 3.75 mm diameter were used.

There are 2 basic variations of the sinus floor augmentation technique i.e., Tatum's Lateral approach (Direct technique) and summer's crestal approach (Indirect technique). If the residual alveolar bone height is less than 6 mm in the posterior maxilla, then the crestal approach (Indirect technique) may not provide adequate stability to the implant placed simultaneously, so it has to be performed only when the residual alveolar bone height is more than 6 mm [4]. In contrast, the lateral approach is best employed for sinus floor augmentation with simultaneous implant placement even in the patient with 4 mm residual alveolar bone height.

Implants are placed either simultaneously with the graft (1-stage lateral antrostomy) or after a delayed period of up to 12 months to allow for graft maturation (2-stage lateral antrostomy) [5]. The initial bone thickness at the alveolar ridge seems to be a reliable indicator in deciding between these 2 methods. If the bone thickness is 4 mm or less, initial implant stability would be jeopardized. Therefore, a 2-stage lateral antrostomy should be carried out. The reverse holds true for a 1-stage procedure [5].

Implants of 3.75 mm diameter were used because 1 mm of cortical bone is required on both buccal and lingual sides, 1 mm between the implants and 1.5 mm between the implant and natural tooth for adequate stability of the implants and also to prevent future bone resorption of the crestal bone surrounding the implants.

In 1976, Tatum introduced the technique that increased the maxillary bone height by placing the graft material under the maxillary sinus and the Schneiderian membrane. It intended to increase the vertical bone dimension in the maxilla, where access to the maxillary sinus was obtained by drilling a bony window in the lateral sinus wall using a small round bur, while ensuring that the sinus membrane remained intact.

Though autografts are widely considered the "Gold standard" for osseous reconstruction, there are some practical difficulties in clinical use like secondary surgery, morbidity of the donor site, surgery under general anesthesia etc. [6].

In this study, an alloplastic bone graft material, a bioactive glass was used for the sinus floor augmentation, containing calciumphosphosilicate (CPS-55 %), a smaller CPS particulate, Polyethylene glycol (PEG) and Glycerine as a binder. Bioactive glass has several advantages like its cohesive and graft retentive properties, easy manipulation during surgery, no risk of immunogenic response and infection transmission and very low chances of graft infection because antibiotics readily penetrate into it due to its hydrophilic nature. Also, there is formation of bony tissues noted in the bone graft [7]. Its only disadvantage is its high cost.

In two out of thirteen patients (15.38 %), Schneiderian membrane perforation occurred during surgery which was approximately 0.5 cm in size and was successfully repaired by sealing the perforation with resorbable collagen membrane. Although one patient (7.69 %) had experienced pain and a mild attack of maxillary sinusitis after 2 months, the next follow-up visits were absolutely normal. Post-operative healing was subsequently uneventful. The maxillary sinusitis was treated conservatively with the help of antibiotics, analgesics and decongestants. In the rest of the patients (84.62 %), there was no local inflammation/

Table 6 Marginal bone loss around implant 1st and 2nd year after loading of implant

Implant site	Site of sinus lift with simultaneous implant placement	Marginal bone loss after loading of implant			
		1 years		2 years	
		Mesial	Distal	Mesial	Distal
1.	Maxillary right first molar	0.72 mm	0.75 mm	1.06	1.02
2.	Maxillary left second premolar	0.70	0.65 mm	1.1	1.08
3.	Maxillary left first molar	0.69	0.71	1.14	1.1
4.	Maxillary left first premolar	0.80	0.86 mm	1.14	1.1 mm
5.	Maxillary right first molar	0.66	0.70 mm	1.16	1.2 mm
6.	Maxillary left first molar	0.71	0.65	1.14	1.18 mm
7.	Maxillary right first molar	0.74	0.79	1.1	1.16 mm
8.	Maxillary right first molar	0.73	0.7	1.16	1.1 mm
9.	Maxillary left second premolar	0.77	0.84	1.13	1.19 mm
10.	Maxillary right first molar	0.78	0.79	1.17	1.13 mm
11.	Maxillary left first molar	0.8	0.77 mm	1.19	1.18 mm
12.	Maxillary right second premolar	0.85	0.82 mm	1.2	1.22 mm
13.	Maxillary right first molar	0.68	0.69 mm	1.1	1.03 mm

Table 7 Paired *t*-test applied to evaluate statistics value of marginal bone loss after 1 and 2 years of implant loading

Site of marginal bone loss measurement	Time interval after loading (years)	Mean	N	Std. deviation	Mean difference	*p* value	Results
Mesial	1	0.7408	13	0.05575	−0.397	0.058	NS
Mesial	2	1.1377	13	0.03982			
Distal	1	0.7477	13	0.07002	−0.382	0.062	NS
Distal	2	1.1300	13	0.06442			

Table 8 Evaluation of peri-implant soft tissue at last follow up (21/2 after implant insertion)

Case no.	Teeth replaced with implants	Plaque index	Gingival index	Bleeding index	Implant mobility	Pocket depth (mm)
1.	Maxillary right first molar	0	0	0	A	1
2.	Maxillary left second premolar	0	0	0	A	1
3.	Maxillary left first molar	0	0	0	A	1
4.	Maxillary left first premolar	1	0	0	A	2
5.	Maxillary right first molar	2	2	1	A	3
6.	Maxillary left first molar	0	0	0	A	1
7.	Maxillary right first molar	0	0	0	A	1
8.	Maxillary right first molar	0	0	0	A	1
9.	Maxillary left second premolar	0	0	0	A	1
10.	Maxillary right first molar	0	0	0	A	1
11.	Maxillary left first molar	0	0	0	A	1
12.	Maxillary right second premolar	0	0	0	A	1
13.	Maxillary right first molar	0	0	0	A	1

infection, pain and soft tissue dehiscence after surgery. This data was compatible with several other studies (Mazor et al. [8], Ardekian et al. [9] and Pikos [10]).

The average residual alveolar bone height was 5.63 mm pre operatively and after sinus floor augmentation, the residual alveolar bone height was in the range of 8.8–12 mm (average 10.66 mm). The increase in residual ridge height was very significant in the range of 3.7–6.4 mm (average 4.93 mm) after sinus floor augmentation over the period of 6 months following surgery. These findings were compatible

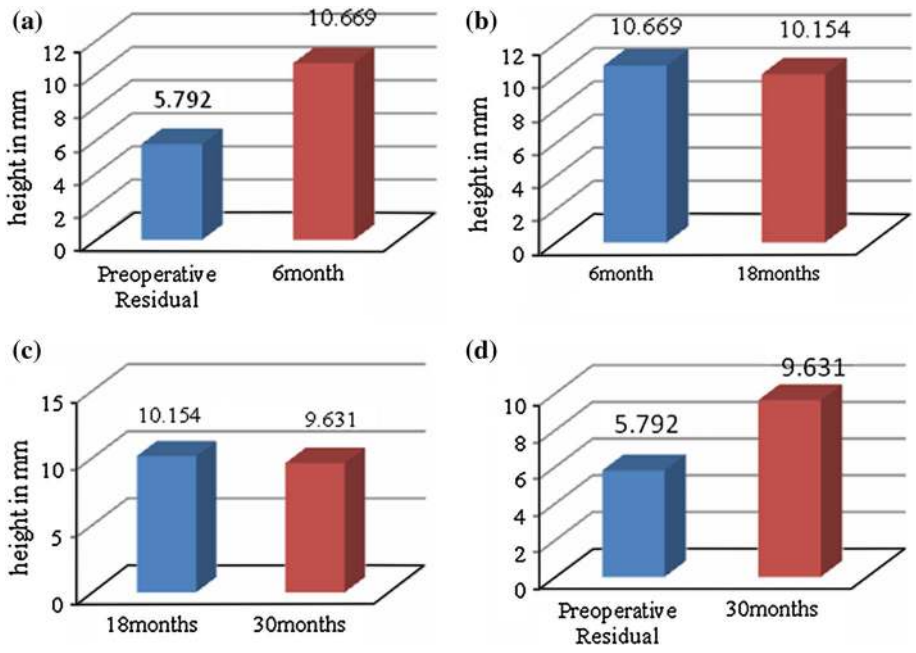

Fig. 14 **a** Alveolar ridge height pre-operatively and 6 months post-operatively, **b** alveolar ridge height post-operatively after 6 and 18 months, **c** alveolar ridge height post-operatively 18 and 30 months, **d** alveolar ridge height pre-operatively and 30 months post-operatively

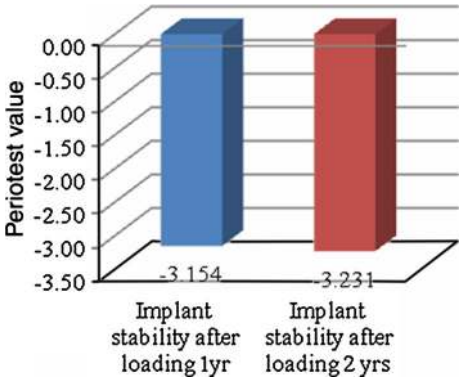

Fig. 15 Implant stability after loading of implant

with studies by Mazor et al. [8] who performed sinus floor augmentation for a single tooth replacement in the posterior maxilla. After loading of the implants, a slight reduction of ridge height was noted after the stabilization of bone graft (<1 mm after 1 year of loading), a finding coincidental with a study by Nystrom et al. [11].

The major criterion for evaluating implant success is change in marginal bone level around the implants. During follow-up period of 1 year after implant loading mesial and distal marginal bone loss was mean ± SD 0.74080 ± 0.055 and 10.75 ± 0.07 respectively and 2 years after loading it was mesially and distally 1.14 ± 0.39 and 1.13 ± 0.64 respectively. Implant stability was measured by periotest device. Periotest reading for implant stability −9 to +8 is considered as strongest to weakest. In our study implant stability was −3.15 ± −0.276 one year after loading and −3.23 ± −0.232 two years after loading. This coincides with study of Wallace et al. [12].

The success criteria suggested by Schmitt and Zarb [13] for edentulous patients were utilized and applied to the 13 implant sites which were examined during each recall visit. Each implant was examined and found to be asymptomatic and without any clinical evidence of mobility. Radiographically, all the implants showed absence of interfacial radiolucency. Bleeding on probing was present at one implant site (7.69 %) and probing

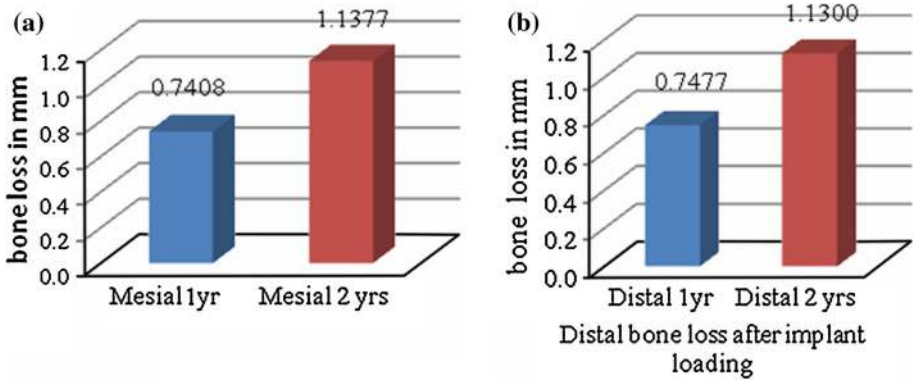

Fig. 16 **a** Mesial bone loss 1 and 2 years after loading of implant, **b** distal bone loss 1 and 2 years after loading of implant

depth was 3 mm mesially and distally at one implant site (7.69 %).

There was only a small proportion of soft tissue complications (14.29 %), which easily resolved with good oral hygiene practice; and without any compromise in osseointegration. This was consistent with the study of Rebaudi et al. [14].

The survival rate of implants placed in sinuses augmented with the lateral window technique varied from 61.7 to 100 %, with an average survival rate of 91.8 % in the literature. Survival rates of implants in the present study are compatible with those in the literature [15].

Meta analysis by Tong et al. showed that Implant survival was 90 % for autogenous bone (484 implants in 130 patients followed for 6–60 months), 94 % for the combination of hydroxyapatite (HA) and autogenous bone (363 implants in 104 patients followed for 18 months), 98 % for the combination of demineralized freeze-dried bone (DFDB) and HA (215 implants in 50 patients followed for 7–60 months), and 87 % for HA alone (30 implants in 11 patients followed for 18 months) [16].

No difference in measure of success such as plaque index, gingival index, pocket depth and implant stability were noted in various studies using different augmentation procedures such as with bovine hydroxyl-apatite mixed with fibrin glue [17], anorganic bovine bone [18] and autogenous bone graft [19].

Conclusion

The lateral sinus lift, despite having some disadvantages, such as in particular high demands on both surgeon and the patient and longer healing period, is in most cases, the best available solution for insufficient quantity of the alveolar bone during implant placement in the edentulous posterior maxilla. It offers several advantages compared to the crestal approach including access through a larger window into the sinus. The bone augmentation is expected to result in primary implant stability, promote osseointegration, prevent overloading and provide long term implant success. The use of this procedure is recommended in the posterior maxilla when the residual bone height >5 mm.

It is also possible to perform direct sinus lift and augmentation along with simultaneous implant placement, but the condition is that there should be enough marginal bone to achieve primary stability of implant. In case of thin marginal bone i.e., <5 mm, a two-stage sinus lift surgery, with later placement of implant is indicated [20]. The risk of complications in the former procedure remains low.

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Conflict of interest None.

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