

## Implant placement in posterior atrophic maxilla using direct and indirect sinus augmentation- a comparative study

Debiprasad Ghatak<sup>1\*</sup>, Krishan Kumar Tyagi<sup>2</sup>, Eshna Tiwari<sup>3</sup>

<sup>1</sup>MDS oral & maxillofacial surgery, Dipti general nursing home, 227 Barakar Road, Raghunathpur, Purulia, West Bengal 723133, India.

<sup>2</sup>Department of Oral Pathology and Microbiology, M.B. Kedia Dental college, birgunj, Nepal

<sup>3</sup>Bachelor of dental surgery, D.J. College of Dental Science and Research, Modinagar, Uttar Pradesh, India.

### ABSTRACT

**Objective:** To evaluate the most efficacious method for implant placement in posterior atrophic maxilla by assessing morbidity, bone height gained around implants and ability to load after 3 months based on ISQ values. **Material & Method:** 20 partially edentulous patients were selected and divided into 2 groups equally. Residual bone height at least 5 mm or less was selected for direct sinus lift in Group I and more than 5 mm for indirect sinus lift in Group II. In Group I sinus augmentation was performed using lateral window technique using Surgiwear xeno graft and in Group II indirect sinus augmentation technique without using bone graft. Implants were submerged and left for 3 months before evaluating. **Results:** The comparison of bone height post-operative to 3 month showed mean bone loss of 0.49 mm in Group I, whereas Group II showed mean bone height gain, 1.43 mm, indicating in indirect sinus lift new bone was formed around the implant. Values of RFA in Group I showed mean ISQ 45 after 3 month. Group II showed mean ISQ 74 after 3 months which is superior to the Group I values (P value 0.001) showing osteointegration was adequate in indirect sinus lift after 3 months. **Conclusion:** In atrophic maxilla bone height  $\geq 5$  mm indirect sinus augmentation is better technique for implant placement and for loading within 3 months and more than 3 months of waiting period is needed for implant placed in a bone height of 5 mm or less using direct sinus augmentation.

**Keywords:** Group I- Direct Sinus Augmentation, Group II- Indirect Sinus Augmentation, ISQ- Implant Stability Quotient, MPI- Micro Precision Implant, RFA- Resonance Frequency Analysis, GTR guided tissue regeneration

### Introduction

Bone atrophy in the maxilla is a physiological process, which gets accelerated in case of tooth extraction[1]. In post-extraction phase initially there is decrease in bone width due to the resorption of the buccal bone plate causing a continuing loss of bone height and density and an increase in antral pneumatization because of the increased osteoclastic activity of the periostium of the Schneiderian membrane, furthermore increase in positive intra antral pressure[2]. Anatomical limitations associated with implant placement in the posterior maxilla are flat palatal vault, deficient alveolar height, inadequate posterior alveolus, increased

pneumatization of maxillary sinus causing close approximation of sinus to crestal bone which limit implant placement in these conditions[3]. The sinus augmentation technique was first presented in the late 1970s in a series of lectures by Tatum and first published by Boyne and James in 1980[4-6]. Sinus elevation using this lateral window approach require extensive surgical manipulation and prolonged waiting period. To overcome the disadvantages of lateral window method and to augment the bone for implant placement in a simpler less invasive manner Summer's 1994 proposed the osteotome technique or the indirect sinus lifting. This method provides a conservative surgical entry, more localized augmentation of the sinus with less degree of post-operative morbidity, and an ability to load the implants in a shorter time period[7]. Misch recommends that when 1) bone height is  $>12$  mm, conventional implant placement, 2) bone height 8-12mm, indirect sinus lift, 3) bone height 6-8mm, direct sinus lift with immediate implant

\*Correspondence

**Debiprasad Ghatak**  
MDS oral & maxillofacial surgery, Dipti general nursing home, 227 Barakar Road, Raghunathpur, Purulia, West Bengal 723133, India  
E Mail: [ghatak2105@gmail.com](mailto:ghatak2105@gmail.com)

placement, 4) bone height <5 mm, direct sinus lift with more delayed implant placement[8]. To overcome the disadvantage associated with increased postoperative waiting phase after sinus augmentation which ranges from 6-8 months when implant can be loaded, we are loading the implants in 3 months irrespective of the method used for sinus augmentation. The aim of this prospective study is to compare the outcomes in terms of surgical complications, amount of bone augmented and implant stability and survival after a period of 3 months.

#### Material & method

In this prospective comparative clinical study 20 patients were included requiring sinus augmentation for placing implants in posterior maxilla using direct and indirect sinus lift procedure.

#### Inclusion Criteria:

1. Patients requiring posterior maxillary implants for prosthetic rehabilitation.
2. Preoperative residual bone height between maxillary antral floor and alveolar crest at least 5 mm or less for direct sinus lift and more than 5 mm for indirect sinus lift.

Patients suffering from chronic sinusitis, smokers & non-smoking tobacco chewers, lactating mother, patient suffering from any kind of systemic illness and patient not willing for consent to surgical procedure were excluded from the study.

A total 20 patients were selected for the study and these patients were divided into 2 groups-

**Group I** for patients receiving direct sinus lift- 10 patients.

**Group II** for patients receiving indirect sinus lift- 10 patients.

After proper clinical examination, impression was taken using alginate impression material; cast was poured using dental stone. Patient's occlusion was determined both clinically and on the cast. Measurements of bone width were done both clinically and on cast by using caliper. Casts were articulated and a stent was prepared taking occlusion as guideline and using artificial tooth as in case of removable partial denture. The artificial tooth replacing the missing tooth was later drilled at its center using a surgical bur. This hole was used for positioning the guide drill for implant placement. Intra-oral periapical radiograph was taken pre and post operatively using parallel technique in all the cases with all radiographic safety precautions. Implant size and diameter were determined based on measurements made on the patient's mouth and also bone height seen on radiograph. All the patients were operated under proper aseptic condition using sterile

instruments and drapes. 2% lignocaine with adrenaline local anesthetic was used in all cases. Prior to surgery patient's mouth was rinsed with 0.2% Chlorhexidine mouth wash. Resonance frequency measurements were taken in all the patients immediate post-operatively, at 3 months. Intra oral periapical radiographs were taken preoperatively, immediate postoperatively, at 3 months.

#### GROUP I - (DIRECT SINUS LIFT GROUP)

After securing anesthesia, a mid-crestal incision was given which was combined with a releasing incision at its both arms creating a trapezoidal flap. Flap was raised using Molt's no.9 periosteal elevator on both buccal and palatal side. The raised buccal flap was then retracted using Langenbeck's retractor. Now using a no.8 round surgical bur in very slow speed with copious amount of cold saline irrigation a small round gutter was created carefully on the lateral wall of maxilla, the level of which corresponds to the level of the floor of the sinus predetermined by radiograph. With bone gutter deepening underlying bluish hue of sinus membrane was evident and bone cutting was stopped. Now using special sinus curette bone window was fractured. Sinus curettes were used to detach the sinus membrane off the sinus floor completely. Surgiware G-Graft a xenograft material available in syringe containing 1cc was mixed with patient's blood and was packed into the sinus cavity thus elevating sinus membrane. Stent was applied over alveolar crest and guide drilling was done. Over that same drilled hole, implant specific drills were used sequentially. Final drill to be used was a size smaller than the implant diameter selected. Then MPI implant was placed and tightened. After getting satisfactory torque the lateral window is then covered with "HEALIGUIDE GTR" membrane, flap was repositioned and transducer of the resonance frequency analyzer (OSTELL) was tightened at the place of cover screw on the implant and measurements were recorded before suturing. Finally cover screw was screwed and water tight closure was achieved using 3-0 silk. Medications and postoperative instructions were given.

#### GROUP B-(INDIRECT SINUS LIFT)

After securing anesthesia, a mid-crestal double Y incision was given over the edentulous area. Using a Molt's no 9 periosteal elevator flap was reflected both buccally and palatally. Stent was placed over the reflected bone and using guide drill an initial punch was made on the alveolar bone. Then using sequential drills site was prepared to a size less than the diameter of implant selected and also vertically drilling was

done so as to leave at least 2 mm of bone under sinus cavity. Now using appropriate osteotomes and mallet gently sinus floor was fractured and elevated. The selected MPI implant was then placed into the prepared site and tightened. After getting adequate torque RFA transducer was tightened and ISQ value was recorded. Finally cover screw was placed and suturing was done.

Patients were recalled as per schedule and suture removal was done after 7 days.

All the implants were evaluated after 3 months and ISQ value were recorded before taking decision of permanent crown placement. Postoperatively the following parameters were evaluated for determining the better method for sinus augmentation among the two groups.

- Pain and discomfort Using Numeric Rating Scale.
- Infection Assessed as per Guidelines of CDC up to 90 Days checking the following parameter Purulent discharge/ Local swelling/ Redness/Pyrexia.
- Graft success after 3 months using Intra oral periapical radiograph.
- Bone height achieved after 3 months using intra oral periapical radiograph.
- Stability of implant immediate and on 3<sup>rd</sup> month postoperatively using Resonance Frequency Analysis.

**Clinical Photographs :Direct Sinus Augmentation**



Direct Case 1/Fig 1:preoperative radiograph



Direct Case 1/Fig 2: armamentarium



Direct Case1/Fig 3: Lateral Window Site



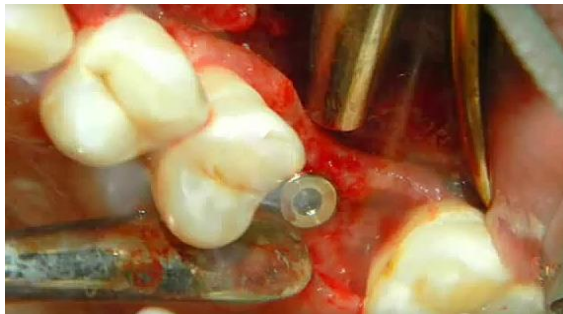
Direct Case1/Fig 4: Infrafractured Lateral Window



Direct Case 1/ Fig 5 :Graft being placed



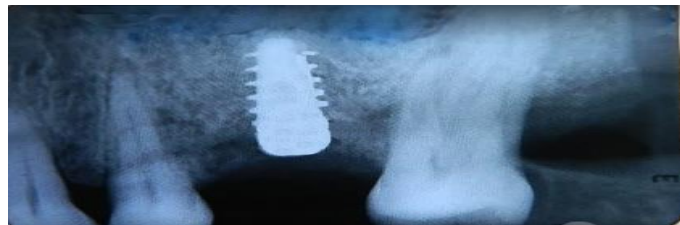
Direct Case 1/ Fig 6: GTR membrane placed



Direct Case 1/ Fig 7: Implant Intraoral View



Direct Case 1/ Fig 8: Iopa. Immediated Postoperative View



Direct Case 1/ Fig 9: Iopa. View After 3 Months



Direct Case 2/ Fig 1: Preoperative Opg



Direct Case 2/ Fig 2: Preoperative Iopa





Direct Case 2/ Fig 3: Armamentarium



Direct Case 2/ Fig 4: Incision



Direct Case 2/ Fig 5: Lateral Window Site Exposed      Direct Case 2/ Fig 6: Marking Implant Site Using Acrylic Stent



Direct Case 2/ Fig 7: Implant Postoperative View



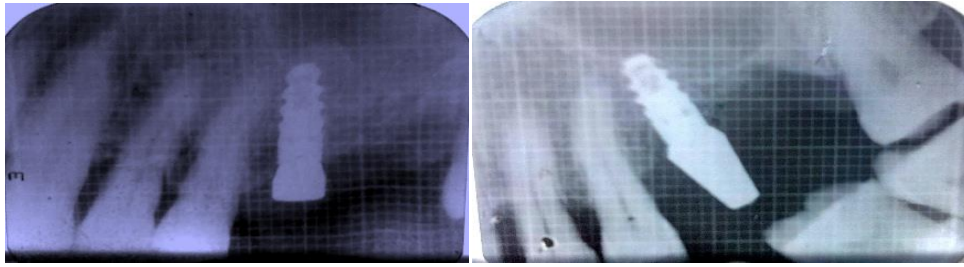
Direct Case 2/ Fig 8: Implant Uncovered After 3 Months



Direct Case 2/ Fig 9: RFA Transducer Intraoral View



Direct Case 2/ Fig 10: Rfa Being Recorded After 3 Months



Direct Case 2/ Fig 11: Iopa Immediate Postoperative View

Direct Case 2/ Fig 12: Iopa After 3 Months



Direct Case 3/ Fig 1: Iopa Preoperative View



Direct Case 3/ Fig 2: Armamentarium



Direct Case 3/ Fig 3: Flap Reflected



Direct Case 3/ Fig 4: Graft Mixed With Normal Saline



Direct Case 3/ Fig 5: Sinus Elevated And Graft Is Packed



Direct Case 3/ Fig 6: Healguide Gtr Membrane





Direct Case3/Fig 7: GTR Membrane In Place



Direct Case 3/Fig 8: Suturing Done



Direct Case3/Fig 9: Iopa Immediate Postoperative View



Direct Case 3/Fig 10: Iopa After 3 Months



Indirect Case1/Fig 1: Iopa Preoperative View



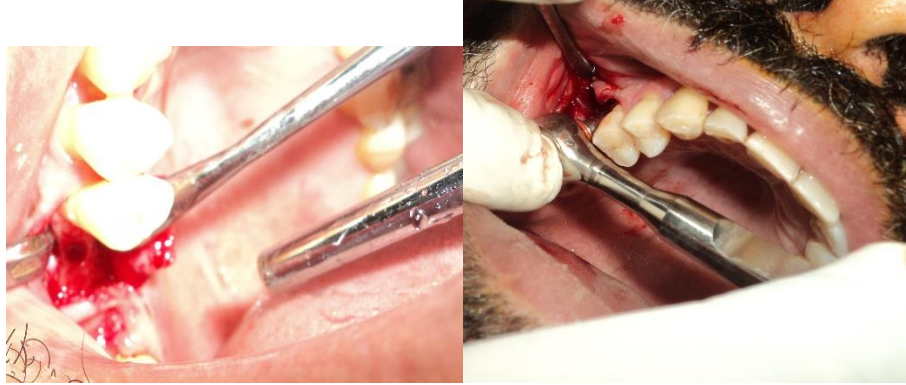
Indirect Case1/Fig 2: Mid Palatal Incision Placed



Indirect Case1/Fig 3: Flap Reflected

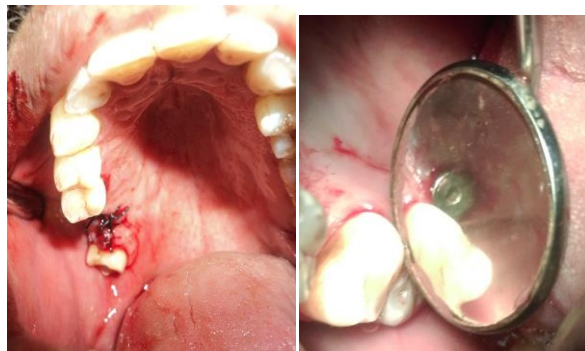


Indirect Case1/Fig 4: Osteotomy Site



Indirect Case 1/ Fig 5: Osteotomy Site Showing Drill Hole

Indirect Case 1/ Fig 6: Implant Being Tightened



Indirect Case 1/ Fig 7 :Suture Placed

Indirect Case 1/ Fig 8: Healing Abutment Placed After 3 Months



Indirect Case1/ Fig 9: RFA Being Recorded





Indirect Case1/Fig 10: Iopa Immiediate Postoperative View



Indirect Case1/Fig 11: Iopa After 3 Months



Indirect Case2/Fig 1: Iopa Preoperative View



Indirect Case2/Fig 2: Iopa Preoperative View 2<sup>nd</sup> Site



Indirect Case 2/Fig 3: Bilateral Incisions Given



Indirect Case2/Fig 4: Implant Site Drilled



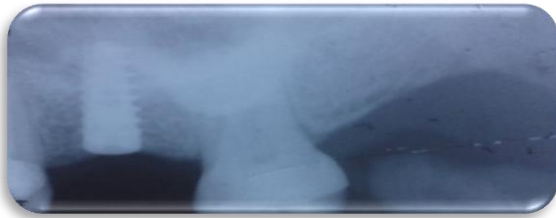
Indirect Case2/Fig 5: Sinus Lifted Using Osteotome



Indirect Case 2/Fig 6: Implant Placed



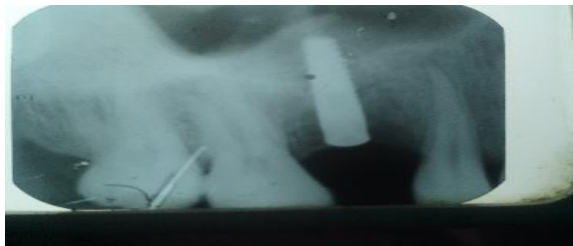
Indirect Case 2/Fig7: Implant Intraoral View Bilaterally



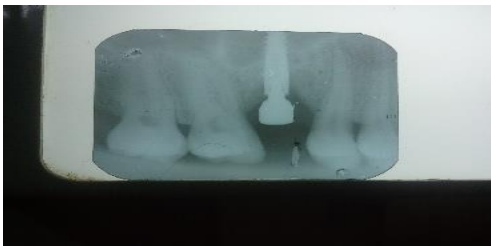
Indirect Case 2/Fig 8: Iopa Immediate Postoperatively Site 26



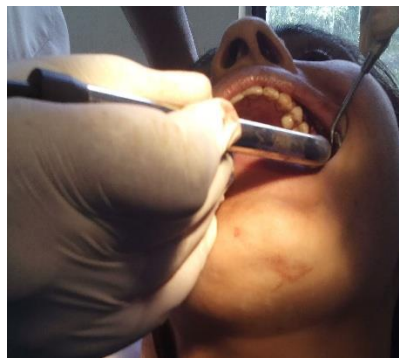
Indirect Case2/Fig 9: Iopa After 3 Months Site 26



Indirect Case 2/Fig 10: Iopa Immediate Postoperative Site 16



Indirect Case2/Fig 11: Iopa After 3 Months Site 16



Indirect Case2/Fig 12: RFA Being Recorded



Indirect Case3/ Fig 1: Implant Site Preoperative View      Indirect Case3/ Fig 2: Iopa Preoperative View



Indirect Case3/ Fig 3: Mid Palatal Incision

Indirect Case3/ Fig 4: Flap Being Reflected



Indirect Case3/ Fig 5: Implant Site Drilled

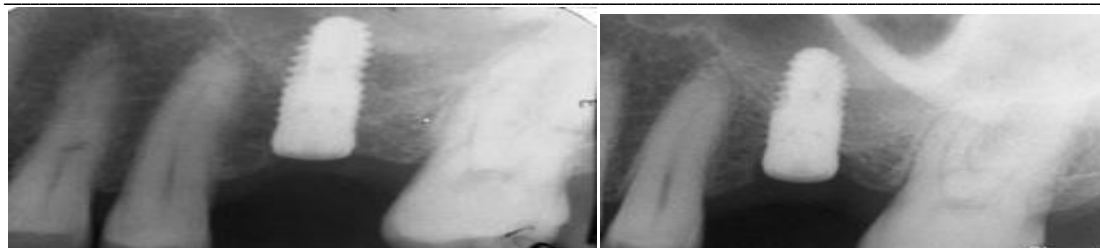
Indirect Case3/ Fig 6: Osteotome Inserted Sinus Lifted



Indirect Case3/ Fig 7: Implant Site Uncovered

Indirect Case3/ Fig 8: RFA Being Recorded





Indirect Case3/Fig 9: Iopa Immediate Postoperative

Indirect Case3/Fig10: Iopa 3 Months Postoperative

## Results

In total 20 patients, 20 implants were placed using direct (Group I) and indirect (Group II) sinus augmentation. Mean age for Group I was  $26.30 \pm 3.71$  years and for Group II was  $27.48 \pm 4.75$  years where male to female ratio was 7:3 in Group I and 3:2 in Group II. No correlation was found between age and gender affecting the outcome of sinus elevation. Postoperative pain values were obtained using numeric rating scale ranging from 0-10 where 0 equals no pain and 10 is worst pain. Pain was evaluated immediate postoperatively, on post-operative 1<sup>st</sup> day, 1<sup>st</sup> week and 3<sup>rd</sup> week. Results showed that postoperatively Group I reported higher pain than Group II, also on the next postoperative day Group I

reported greater pain than Group II which was significant, implying direct sinus lift is more painful than indirect sinus lift. Only few patients in Group I reported mild pain after 1 week but none reported pain after 3 weeks which was non-significant for either group. None of the patients on either group displayed any sign of purulent discharge, fever or sign of abscess throughout our study period. Only in Group I, 9 patients showed mild swelling postoperatively and one patient suffered sinus perforation and developed sinusitis subsequently which was managed early by antibiotics, implying that Group II patients suffered lesser postoperative impediments, thus proving less invasiveness of indirect sinus augmentation.

**Table 1: Preoperative and postoperative groups**

Preoperative and post operative						
	Preop	Post op	Gain in bone height	% gain in bone height	P value	Significance
<b>Group I</b>	4.40±1.36	6.70±1.22	2.30±0.71	61.70±37.71	0.001	Significant
<b>Group II</b>	7.60±1.66	8.10±1.29	0.50±0.89	8.36±15.40		

\*\* Group I- Direct Sinus Lift Group, Group II - Indirect Sinus Lift Group\*\*

Table-1 Shows comparison of bone height changes between the two groups from preoperative to postoperative time period. In Group I mean preoperative bone height is  $4.40 \pm 1.36$  mm where as in Group II bone height is  $7.60 \pm 1.66$  mm. Immediate postoperatively Group I showed mean bone height of  $6.70 \pm 1.22$  mm having mean height gain  $2.30 \pm 0.71$  mm,  $61.7 \pm 37.71\%$  gain. Group II showed postoperatively mean height  $8.10 \pm 1.29$  mm, having mean height gain of  $0.50 \pm 0.89$  mm,  $8.36 \pm 15.40\%$  (p value 0.001, significant). Hence result shows postoperatively Group I gained more bone height compared to Group II.

**Table 2: Preoperative and 3 months**

Preoperative and 3 Months						
	Pre Op	3 Mos	Gain In Bone Height	% Gain In Bone Height	P Value	Significance
<b>Group I</b>	4.40±1.36	6.20±1.31	1.80±0.76	48.48±31.68	0.001	Significant
<b>Group II</b>	7.60±1.66	9.53±1.45	1.93±1.05	27.82±20.02		

\*\* Group I- Direct Sinus Lift Group, Group II - Indirect Sinus Lift Group\*\*

Table- 2 shows comparison of bone height in between Group I and Group II from Preoperative to 3 month interval. Result shows that Group I had mean bone height gain of  $1.80 \pm 0.76$  mm after 3 month,  $48.48 \pm 31.68\%$  bone height gain compared to the mean preoperative bone height. In Group II mean height gain was  $1.93 \pm 1.05$  mm after 3 month,

27.82±20.02% of its mean original bone height. Height gain from preoperative to 3 month interval was more and significant (p value 0.001) for Group I than Group II.

**Table 3: Post-operative and 3 months**

Post operative and 3 months						
	Post op	3 mos	Change in bone height	% change in bone height	P value	Significance
<b>Group a</b>	6.70±1.22	6.20±1.31	-0.49±0.32	-7.78±5.12	0.001	Significant
<b>Group b</b>	8.10±1.29	9.53±1.45	1.43±0.48	17.89±6.65		

\*\* Group I- Direct Sinus Lift Group, Group II - Indirect Sinus Lift Group\*\*

Table- 3 shows the comparison of bone height from post-operative period which is after sinus augmentation to 3 month, at the time of loading implying the actual bone height gained or lost in the entire process. Here Group 1 showed mean bone loss of 0.49±0.32 mm, 7.78±5.12% of its original height gained after sinus augmentation whereas Group 2 showed bone height gain, 1.43±0.48 mm, and 17.89±6.65% greater than post-operative height obtained after surgery. This indicates that in indirect sinus lift after 3 month new bone was formed around the implant and in direct sinus lift bone was lost around augmented implants.

**Table 4: RFA Scores**

RFA SCORES (ISQ)				
	GROUP I	GROUP II	P value	Significance
<b>POST OP –IMMEDIATE</b>	31.40±4.99	51.70±8.69	0.001	Significant
<b>POST OP -3 month</b>	45.70±4.80	74.00±5.75	0.001	Significant

\*\* Group I- Direct Sinus Lift Group, Group II - Indirect Sinus Lift Group\*\*

Group I showed mean ISQ of 31.40±4.99 postoperatively and 45.70±4.80 after 3 month. Group II showed mean ISQ of 51.70±8.69 postoperatively and 74.00±5.75 after 3 months which is superior to the Group I values and is significant (P value 0.001). Results shows that osteointegration was more in indirect sinus lift in Group II after 3 months as compared to direct sinus lift in Group I.

**Table 5: Graft Used And Implant Survival**

GRAFT USED and IMPLANT SURVIVAL				
	Group I		Group II	
	Yes	(No)	Yes	(No)
<b>Graft Used</b>	10 (100%)	00 (0%)	00 (00%)	10 (100%)
<b>Implant Survival</b>	00 (00%)	10 (100%)	10 (100%)	00 (00%)

In Group I all the implants failed to achieve adequate ISQ for loading in 3 month, thus failure rate 100% while in Group II all implants survived after loading, success rate 100%. This makes the overall survival rate of implants 50%.

## Discussion

Maxillary edentulism potentiates progressive resorption of alveolar ridge which may reduce the bone to a thickness of less than 1 mm. Teeth and the masticatory loads stimulate the alveolar bone and limit its resorption. Immediately after the avulsion of a tooth, significant bone modeling typically occurs. The sinus floor tends to lower craniocaudally as the

alveolar ridge is resorbed in the opposed direction[9]. Maxillary sinus lift is an established surgical procedure indicated to improve the posterior maxillary bone height when sufficient bone is not present for implant installation. This procedure involves placement of bone graft material in the maxillary sinus to increase the height and width of the

alveolus[13].Misch categorized the treatment options for implant placement in maxillary posterior region into following – 1) bone height > 12 mm conventional implant placement, 2) bone height 10-12 mm indirect sinus augmentation, 3) bone height 5- 10 mm , direct sinus lift and delayed implant placement, 4) bone height < 5 mm, direct sinus lift and delayed implant placement[8].Various studies performed sinus augmentation using different bone height criteria e.g. Kunal Jodia et al[10] recommended direct sinus augmentation in patients with residual bone height > 5 mm whereas Rabah Nedir et al[14] performed indirect sinus augmentation with residual alveolar bone height between 1-6 mm. Direct sinus augmentation in either one stage or two stage can be performed when bone height was less than 6 mm and indirect sinus augmentation when bone height was 6-8 mm[15].In this study patients with bone height 5 mm or less were opted for direct sinus augmentation and patients with bone height of > 5 mm were opted for indirect sinus augmentation which is consistent with the patient selection criteria of studies conducted by S.M Balaji<sup>11</sup>, Ramanuj C Tandel et al[7].The ideal healing time when prosthesis can be constructed as described by Misch<sup>8</sup>- 1) SA1 when bone height is 12 mm or more, 4-8 months before abutment placement, 2) SA 2 when bone height is 8-12 mm, 6-8 months before abutment placement, 3) SA 3 when bone height is 5-8 mm, 6-10 months before implant placement, 4) SA 4 when bone height is <5 mm, healing period is 4- 10 months after 1<sup>st</sup> surgery followed by another 4-10 months after 2<sup>nd</sup> surgery. This presents a major drawback as it adds an undesirable longer waiting period for the patient to get permanent prosthesis after a standard sinus lift[1]Study by Cannizzaro et al[16]revealed that it is possible to load implants as early as 7 weeks when placed with initial torque of 35 Ncm in 4- 4.5 mm of mean residual bone height below the maxillary sinus. This observation arises question whether sinus lift procedure adds any additional benefit to implant success as graft cannot be transformed in supporting bone in less than 2 months. Nedir et al[17] in their study loaded implants as early as 3.1 month (mean) which was shorter than the healing time of 6 months recommended by Lundgren et al. and Bragger et al. In this present study we had load the implants as early as 3 month in order to improve patient's satisfaction towards the treatment by avoiding longer waiting periods and sinus augmentation was performed simultaneously with implant placement in a single step as seen in study by S.M Balaji[11].The major criteria for evaluating the efficacy of either technique is to check the bone height gained from postoperative period to the time of loading i.e. 3 month in our case. On comparing bone height

gain from preoperative to postoperative period and from preoperative to 3 month, direct sinus lift showed better bone height gain, mean  $2.30\pm 0.71$ mm and  $1.80\pm 0.76$  mm respectively as compared to indirect sinus lift where mean height gain was  $0.50\pm 0.89$  mm and  $1.93\pm 1.05$  mm respectively which is significant ( p value 0.001). This finding is analogous to the studies conducted by U. S. Pal et al.<sup>3</sup> and S. M. Balaji<sup>11</sup>.Comparative study done by Daniel and Rao<sup>12</sup>showed similar result as our study with mean bone gain from preoperative to postoperative period was 9.5 mm for direct sinus lift group and 5.5 mm for indirect sinus lift group which is significant (p<0.01).The difference in bone height gain between either techniques probably comes from two factors, 1) the placement of graft in all direct sinus lift cases and none in indirect sinus lift cases and 2) the residual bone height itself which is comparable to the results of S.M Balaji[11]. But from postoperativeperiod to 3 month time indirect sinus lift showed  $1.43\pm 0.48$  mm bone height gain as compared to direct sinus lift where  $0.49\pm 0.32$  mm bone loss was evident in our study implying new bone was formed in indirect sinus lift group and bone height was lost in direct sinus lift group . It is statistically significant (p value 0.001). Study by Cannizzaro et al.<sup>16</sup>showed that less bone was lost for crestal sinus lift group than lateral window or direct sinus lift group over a period of 5 years after loading which is comparable to our study.

On comparing postoperative complications only one patient in direct sinus lift group had sinus perforation and suffered sinusitis which was managed early by antibiotics and analgesics.Cannizzaro et al reported that more failures and complications were seen with direct sinus augmentation. They reported 2 postoperative sinus complication in direct sinus lift group. 12 out of 17 patients in their study declined direct sinus augmentation and opted for less invasive crestal sinus lift[16].We have used resonance frequency analysis to detect implant stability both postoperatively and at 3 months. In our study implant stability scores were significant (p value 0.001) between direct and indirect sinus lift groups. In direct sinus lift group mean RFA score postoperatively was  $31.40\pm 4.99$  and after 3 months was  $45.70\pm 4.80$ . In indirect sinus lift group mean RFA score was  $51.70\pm 8.69$  postoperatively and  $74.00\pm 5.75$  after 3 months. Cannizzaro et al[16]found that RFA values progressively increased over time which is suggestive of progressively increased implant to bone contact which is consistent with the findings of our study. As observed in this study all implants in direct sinus lift group failed to achieve the minimal required ISQ for loading, having a mean RFA value of  $45.70\pm 4.80$  and were regarded as failure. Huwiler et al.



applied RFA at early stages of osseointegration and reported that ISQ values of 57-70 indicate stability[18]. Similarly O'stman et al. reported values above implant stability quotient 65 indicate a favorable response to immediate loading, whilst low implant stability quotient values may be indicative of overload and ongoing failure[19] These findings are in agreement with our study results and also explains the reason for not being able to load implants indicating failure in direct sinus lift group as the ISQ values were less than 65, however in indirect sinus lift group all implants exhibited mean ISQ value above 65, were successfully loaded and exhibited excellent stability after prosthesis placement.

### Conclusion

After statistically analyzing the data we conclude that indirect sinus augmentation is better technique for implant placement and for loading within a time span of 3 months as it is associated with significantly lower pain and postoperative sequel, less invasiveness as less access is needed, showed endo sinus bone formation and implant stability was sufficient for loading within 3 months without using bone graft which reduces the cost of overall treatment.

Hence it can also safely be stated that more than 3 months of waiting period is needed for implant placed in a bone height of 5mm or less using direct sinus augmentation and in such cases implants should not be loaded as early as 3 months.

So in terms of patient satisfaction with treatment, cost effectiveness and ability to achieve functional prosthesis indirect sinus augmentation holds great possibilities.

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