Original Article

Direct vs. indirect sinus lift procedure: A comparison

Department of Oral and Maxillofacial Surgery, CSM Medical University, [1]Department of Prosthodontics, Chandra Dental College, Lucknow, India

U. S. Pal, Nanda Kishor Sharma, R. K. Singh, Shadab Mahammad, Divya Mehrotra, Nimisha Singh, Devendra Mandhyan[1]

ABSTRACT

Background: There are different techniques for the sinus augmentation; the factors that contribute to the survival rate of sinus augmentation and dental implant placement are still the subject of discussion. So we compare the two different ways of sinus floor elevation: a) Lateral antrostomy as a one or two step procedure as direct method. b) Osteotome technique with a crestal approach as indirect method. **Materials and Methods:** A total of twenty partially edentulous patients in maxillary posterior region who opted for implant retained prosthesis but had a low sinus and deficient alveolar ridge within the age group of 20-55 years were taken up, 25 implants were placed in combination with bone grafting material for sinus augmentation. The final bone height was measured from Orthopantomogram. Post-operative Clinical Evaluation was based on pain, gingival inflammation status, stability, swelling and bone height. Statistical analysis was done by using Statistical Package for Social Sciences (version 15.0) (SPSS Inc., Chicago, IL, USA). **Results:** The gain in bone height was significantly greater in direct procedure through lateral antrostomy (mean 8.5 mm) than in indirect method through crestal approach by osteotome technique (mean 4.4 mm). **Conclusions:** Osteotome technique can be recommended when more than 6 mm of residual bone height is present and an increase of 3-4 mm is expected. In case of more advanced resorption direct method through lateral antrostomy has to be performed. Both sinus elevation techniques did not seem to affect the implant success rate.

Address for correspondence:
Dr. U. S. Pal,
Department of Oral and Maxillofacial Surgery, CSM Medical University, Lucknow, India.
E-mail: druspalkgmc@gmail.com

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Introduction

Dental implants are used to replace both the form and the function of missing teeth. The actual dental implant is a metal screw designed to thread into the jawbone and allow for the attachment of a variety of prosthetic dental replacements. Most of the time, the implant is made of medical grade titanium or a titanium alloy. Titanium is used due to its excellent compatibility with human biology.

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To be a candidate for the dental implant procedure, a patient must have sufficient bone in the maxillary and mandibular ridge to support these implants. Anatomic limitations often associated with the posterior maxilla are flat palatal vault, deficient alveolar height, inadequate posterior alveolus, increased pneumatization of the maxillary sinus, and close approximation of the sinus to crestal bone. Maxillary bone, primarily medullary and trabecular, has less quantity and bone density than the premaxilla or mandible. Adjacent cortices of compact bone are generally very thin, providing minimal strength.[1]

To increase the amount of bone in the posterior maxilla, the sinus lift procedure, or subantral augmentation, has been developed in the mid 1970s.[2] It is well-accepted techniques to treat the loss of vertical bone height (VBH) in the posterior maxilla performed in two ways: A lateral window technique and an osteotome sinus floor

elevation technique and placing bone-graft material in the maxillary sinus to increase the height and width of the available bone. Experience in the rehabilitation of severely resorbed maxilla is growing.[3] Autogenic bone graft are used most often.[4-7] The bone seems to be harvested from the iliac crest most often,[4,7] although several anatomic areas have been used.[5,7,8]

Various bone-grafting materials have been studied for use in maxillary sinus grafts to accelerate the bone healing process and prevent repneumonization of the maxillary sinus after grafting,[4,9] autogenous bone from the iliac crest or maxillary tuberosity, frozen bone, freeze-dried bone, xenogeneic bone, demineralized freeze-dried bone, and hydroxyapatite.

Although these techniques are used to regenerate lost bone, the factors that contribute to the survival rate of sinus augmentation and dental implant placement are still the subject of discussion. The recent literature concerning sinus grafts has shown differing long-term results depending on which type of bone-graft material was used.[10-12] An ideal maxillary sinus bone-grafting material should provide biologic stability, ensure volume maintenance, and allow the occurrence of new bone infiltration and bone remodeling. Over time, bone-grafting materials and implants should achieve osseo integration. After the restoration of the upper part of the implant has been completed, there should be no bone loss and the materials should be stable; there should be a predictable success rate.[13]

So we performed the lateral (direct) sinus lift procedure and compared it with osteotome (indirect) technique. Bio-Oss (xenograft) was the standard graft material in both the technique.

Materials and Methods

The present study enrolled 20 subjects of age group 20–55 years irrespective of gender having maxillary posterior edentulous region and opted for implant retained prosthesis but had a low sinus and deficient alveolar ridge. Patients with chronic sinusitis, long standing nasal obstruction, smokers, pregnant, and psychologically ill patients were excluded from the study.

Assessment of maxillary sinus was done by Orthopantomogram (General Medical Equipment, USA) as per Misch criteria.[14]

1. 12 mm or more of residual ridge remaining – SA-1 site
2. 10 mm to 12 mm of residual ridge remaining – SA-2 site
3. At least 5 mm of residual ridge remaining – SA-3 site
4. Less than 5 mm of residual ridge remaining – SA-4 site

Ethical clearance was taken from institutional ethical committee. Written informed consent was obtained from the enrolled patients and necessary routine hemogram investigation (BT, CT, TLC, DLC, HB%, RBS, viral markers for HCV, HIV, and HBSAG) was done.

Apically tapered, commercially pure titanium implants (LifeCare Devices Private Limited Mahim, West Mumbai, India) were used. The length of implant was 8, 10, 11.5, 13, and 16 mm and diameter was 3.3, 3.75, 4.2, and 5 mm. Bio-Oss (Geistlich Biomaterials, Switzerland) a xenograft was used as the standard graft material for the study because the organic material is completely removed to leave the mineralized bone architecture, which renders it nonimmunogenic and presumably safe from possibility of infection.

The surgical procedures were performed under local anesthesia and under medication. Patients were randomly and equally divided into two groups, group A (direct sinus lift) and group B (indirect sinus lift). Preoperative antibiotic therapy (amoxycillin and clavulanic acid 625 mg three times a day) was started a day before surgery for all patients.

Surgical procedure in Group A

An incision was made a few millimeters above the muco-gingival junction from the canine eminence anteriorly to the zygomatic buttress posteriorly. A mucoperiosteal flap was elevated from the incision buccally and superiorly and a rectangular window was created in the canine fossa with the help of 4 mm, 6 mm chisels and mallet. The inferior osteotomy cut was made about 4–5 mm above the floor of the maxillary sinus, followed by anterior, posterior, and superior osteotomy cuts. The osteotomy size created was 1 × 1 cm approximately, sufficient to allow good access for easy dissection, sinus membrane elevation, and insertion of graft. The sinus membrane was dissected intact from the underlying bone starting from the inferior and lateral cuts and thus sufficient mucosa had been freed to allow tension free reflection from the sinus floor. The dissection was continued till the osteotomy window could be reflected inward and superiorly to the height necessary. No perforation of the sinus membrane occurred in any of the cases. 5 ml of whole blood was drawn from the patients antecubital fossa, graft material (Bio-Oss) was opened and poured in dish; graft was mixed with sufficient amount of whole blood. The osteotomy site was exposed and elevated sinus membrane was lifted superiorly. The particulate graft mixed with patient's whole blood

was placed in the sinus cavity and was packed after achieving adequate elevation. A barrier membrane of collagen was placed over the grafted site. The incision was closed with 4-0 silk.

Surgical procedure in Group B

Incision was placed palatal to the alveolar crest and carried a sufficient length to expose all implant sites. Two vertical releasing incisions were made at the anterior and the posterior extent of the initial incision to allow adequate tension free buccal reflection of the soft tissue flap. The mucoperiosteal flap was elevated from the incision buccally and superiorly taking care not to perforate the flap at the alveolar crest. The antrostomy was performed with speed reduction gear hand piece and internal irrigation was used for bone drilling. Surgical twist drills various diameters ranging from 2.0 to 4.8 mm were used in sequence to prepare site. The palatal osseous lid was completely removed and the sinus membrane was meticulously dissected and lifted by sequential use of various sinus osteotomes and metal mallet. In all cases after complete elevation, the sinus cavity was grafted with an organic bovine bone (Bio-Oss) (Geistlich biomaterials, Switzerland). The biomaterial was mixed with blood gained from the patients antecubital fossa and was densely packed into the cavity. No additional autogenous bone blocks or chips were used. After filling up the whole prepared space, the implant of selected size was placed. Implant holder was pulled and the fixture insertion tool was engaged to the implant and gentle pressure was applied. Hex ratchet was used to screw the implant tightly into the bone till all the sides of the implant came in alignment with crest of alveolar bone. Excessive particles of the graft material were removed and the palatal flaps were repositioned without any periosteal horizontal releasing incisions. Primary interrupted tension free wound closure was accomplished with 4-0 silk suture material.

Postoperatively the same medication (amoxyclav 625 mg) was continued along with metronidazole 400 mg thrice a day, a combination of aciclofenac 100 mg, paracetamol 500 mg, and a nasal decongestant for 5 days in all group A and group B patients.

Patients were advised to follow standard postoperative instructions, which included ice-pack, soft high nutrient diet, thorough rinsing with antiseptic mouthwash (chlorhexidine gluconate 0.2%). The patients were instructed to avoid sneezing, nose blowing, or other actions that might create high intranasal pressure or vacuum. The patients were instructed to avoid drinking with straws for a week. The patients were instructed not to wear any prosthesis over the surgical site for at least a week after surgery to reduce the risk of wound dehiscence.

The patients from both groups were followed up post-operatively at 1st week, 3rd week, 6th week, and 12th week and for implant stability checking, follow-up was done at 1, 2, and 3 months of implant insertion.

Postoperative assessment of the patient was done under following parameters:

1. Pain (by Visual Analogous Scale)
   - 0 – No pain
   - 1 to 3 – Mild pain
   - 3 to 7 – Moderate pain
   - 7 to 10 – severe pain
2. Gingival inflammation status: Gingival index[15]
   - 0 – No inflammation
   - 1 – Mild inflammation
   - 2 – Moderate inflammation
   - 3 – Severe inflammation
3. Swelling (Present/Absent)
4. Stability – Present/Absent (Glickman Method)[16]
5. Patient Compliance (four point Likert scale)
   - Satisfaction/Good/Satisfactory/Poor
6. Complication – If any

Radiological assessment

1. Intraoral periapical radiograph (IOPA) at regular intervals at 1st week, 3rd weeks, 6th weeks, and 12th weeks postoperatively to assess bone implant relation.
2. Orthopantomogram was done at regular interval intervals at 1st week, 3rd weeks, 6th weeks, and 12th weeks postoperatively to assess graft uptake and implant relationship to graft.
3. Preoperatively Dentascan (GE Electronics, USA) to assess availability and status of bone.

Statistical analysis

Statistical analysis was done by using Statistical Package for Social Sciences (version 15.0) (SPSS Inc., Chicago, IL, USA). Significance of percentage error of two groups was tested by Student '*t*' test and for level of significance "*P*" value was used. "*P*" value of less than 0.05 was considered statistically significant.

Results

The present study was undertaken to compare the direct and indirect sinus lift procedures in edentulous resorbed posterior maxilla with the use of an organic bovine bone Bio-Oss.

Postoperatively assessment was done for pain, gingival inflammation, swelling, and increase in bone height at 1 week, 3 weeks, 6 weeks, and 12 weeks. Stability of implants was observed at 1 month, 2 months, and 3 months of implant insertion in both groups. No graft and implant failure occurred in any group.

No significant difference in pain reduction with time in both groups but more number of patients reported pain in group A than group B in 1st day and 1st week. No patients had pain after 1st week, 3rd, 6th, and 12th weeks.

In group "A" 90% patients had gingival inflammation at 1st day, whereas it was in 70% patients in group "B." In group "A" 50 % patients had inflammation at 1st week and group "B" 30% patients had inflammation at 1st week. In both groups, inflammation was absent at 3rd, 6th, and 12 weeks follow-up. There was significant reduction in gingival inflammation with time. There was no significant difference in gingival inflammation in group A and group B.

Swelling reduced in 1 week in both group "A" and group "B" but more number of patients had swelling in group A than in group B. There was no significant difference in incidence of swelling in group A and group B.

On comparing the bone height gained in group A and group B, the average bone height gained in group A was more (average 8.5 mm) than in group B (average height gained was 4.4 mm) and the difference was statistically significant.

Stability was equal in both group "A" and group "B" and no loss of stability noted in designed period of time.

Discussion

In this study, dental implants were placed using two different techniques of sinus augmentation and both of them were successful with survival of implants at an observation period of 3 months. It is interesting to note that there was significant difference in changes of the crestal bone level and between subjects with osteotome implant placement and those with delayed implant placement in the subantral areas previously augmented by deproteinized bovine bone.

The dental implant has a role in the replacement of lost tooth, especially when it is desirable to avoid preparing adjacent teeth that have no caries, restorations. The direct and indirect sinus lift procedure could be used to augment the sinus floor thereby augmenting the alveolar ridge to place implant of sufficient length.

The present study was therefore undertaken to evaluate the results of direct and indirect sinus lift procedures with an organic bovine bone graft (Bio-Oss) and implant placement. The results of this study were observed under the following parameters:

1. Pain
2. Swelling
3. Inflammation
4. Gingival status
5. Bone height augmentation
6. Stability

Pain

In group "A" (direct sinus lift through lateral antrostomy) at 1st day, all the 10 patients had mild pain (as per VAS scale) and none had moderate or severe pain. At 1st week follow-up, 6 patients presented with mild pain while none had moderate or severe pain. Pain was absent in all patients after 1st week at 3rd, 6th, and 12th weeks observation.

In group "B" (indirect sinus lift procedures through crestal approach) at 1st day of follow-up, 8 patients had mild pain, none had moderate or severe pain. At 1st week follow-up, 5 patients complaint of mild pain, while none had moderate or severe pain. Pain was absent in all patients after 1st week at 3rd, 6th, and 12th weeks of observation. On comparing both groups, pain was found to be absent after 1st week and significant reduction of pain was noticed with time. On the 1st day, pain was higher in both groups because of soft tissue elevation, drilling of bone, pressure effect of implant insertion, bone cutting, and sinus membrane elevation.

Similar findings were observed by Kent and Block [1989],[4] who evaluated clinical outcomes of dental implant placement and sinus floor elevation and observed that there was no significant pain after sinus lift surgery post operatively.

Wiltfang *et al.*[17] observed pain reduction after sinus lift surgery with time but found 2 patients with sinusitis related pain which they found to be due to migration of cancellous bone sequestra into maxillary sinus for which they performed sinuscopy and removal of sequestrum. Our study correlates to their study in having minimal pain post surgery.

Swelling

The present study shows that there was swelling in both groups at 1st day (group A, 8 patients, and group B, 6 patients), which subsided with time. In group A, at 1st week 5 (50%) patients had swelling, whereas in group B, it was present in 3 (30%) patients. In both groups, there was significant improvement in swelling with time. Swelling was not seen after 1st week in any patient of either group. The difference in swelling in both groups was not significant.

The similar finding was also reported by Rodoni *et al.*[18] Alkan *et al.*[19] observed that in patients who has maxillary sinus disease preoperatively, they have post surgery complication such as pain, swelling, disturbed wound healing, transient maxillary sinusitis, and implant failures but observed nonsignificant post

operative swelling in normal healthy patients which correlates to our study.

Gingival status

In the present study, there was mild inflammation in group A in 9 out of 10 patients on 1st day and 5 out of 10 patients in 1st week which subsided and later no inflammation was noticed in 3rd, 6th, and 12th week follow-up.

In group B, gingival inflammation was present in 7 patients on 1st day and 3 patients on 1 week. Gingival inflammation was absent after 1st week on 3rd, 6th, and 12th week. Changes in gingival inflammation at different time intervals in group A and group B were found to be not significant.

Our study correlates with the study of Zitzmann *et al*.,[20] when evaluated the gingival status around sinus augmentation and implant and after 3 weeks observed no sign of gingival inflammation, which is similar to our study.

In our study, we found quick healing excellent and soft-tissue response, which is similar observation of Block *et al*.[21] who also reported similar findings.

Bone height augmentation

In the present study, the preoperative mean bone height of 4.5 mm, as per calculations of residual bone height taken from preoperative Orthopantomagram. The postoperative bone height gained was 13 mm (8.5 mm of bone height gain), which was statistically significant at 3 months of the study in group A and no change in bone height could be recorded at 1, 3, 6, and 12 weeks, but radio-opacity of the graph increased.

The initial mean bone height is 7.39 mm, as per calculations of residual bone height taken from preoperative Orthopantomagram. The final mean bone height gained was 12 mm (4.4 mm of bone height gain), which was statistically significant at 3 months of the study in group B. There was no change in bone height recorded at 1, 3, 6, and 12 weeks, but radio-opacity of the grafted bone increased with time.

The difference between the calculated initial bone height and final bone height was statistically significant in both group A and group B patients. The difference in increase was statistically significant in group A (8.5 mm) in comparison with group B (4.4 mm).

Zitzmann *et al*.[20] reported similar findings in their study. Our study reveals that lateral antrostomy allowed for a greater amount of bone augmentation to the atrophic maxilla but required a larger surgical access. The crestal approach is minimally invasive but permits only a limited amount of augmentation which is similar to the observations of Woo *et al*.[22]

The result of our study was similar to the study given by Milan *et al*.,[23] who showed that implants placed using three different techniques of sinus augmentation were successful, with equal survival rates after an observation period of at least 3 years.

Our study shows survival rates of implants placed in transalveolar sinus floor augmentation sites are comparable to those in nonaugmented sites. This technique is predictable with a low incidence of complications during and postoperatively. Tan *et al*.[24] showed similar result as our study.

We observed in our study with the panoramic view that the height of the available bone to be increased by the graft. The zones of soft-tissue density surrounding the graft were also revealed. The actual osteotomy in the anterior wall of the maxillary sinus was difficult to see because it was packed with the bone graft. Similar observations were made by Abrahams *et al*.[25]

Stability

In the present study, in group A in two patients who went for direct sinus lift and immediate implant placement, implant stability was present in 100% patients at 1 month, 2 months, and 3 months of implant insertion. In the rest of 8 patients with delayed implant placement at 3 months of sinus augmentation, implant stability was observed at 4th, 5th, and 6th months found 100% stability in all patients. In group B implant stability was present in 100% patient at 1 month, 2 months, and 3 months. There was no difference in stability in group A and group B. We uncovered the implants after a period of 3 months of insertion for loading and observed that none of the implants were mobile at the time of exposure. Similar was the observations made by Kent and Block.[4]

Similar inferences was drawn by Zitzmann *et al*.[20] in 1998 when comparing three different methods of sinus floor elevation in 30 patients designed for implant treatment in resorbed posterior maxilla.

Our study correlates to the study of Rodoni *et al*.[18] who reported implant anchorage provided by the bone capable of withstanding prosthetic loading regardless of whether it was derived from nonaugmented, partially augmented bone, or regardless of procedure chosen to augmentation after comparing the various techniques in 48 patients.

Sani *et al*.[26] documented the application of the sinus membrane elevation technique in combination with the placement of 3 blasted microthreaded implants in a patient who was clinically and radiographically

followed up for 3 years. During the follow-up period, the blasted implants were all stable and intraoral radiographs showed that the bone reformed in contact with the implants and remained stable. Similar is the outcome of our study.

We observed no statistical differences between direct and indirect sinus lift procedures regarding the stability of implants which correlates with the study by Atamni and Topalo[27] who studied to evaluate the secondary stability of implants placed in the posterior Maxilla according to different surgical techniques of sinus floor augmentation versus standard implantation in 128 patients. No statistically differences were found between the groups. Clinical evaluations of the results showed stable implants according to periotests value.

Marginal bone loss and stability in our study are also similar to the study of Kim *et al*.[28] who evaluated the sinus bone graft resorption and marginal bone loss around the implants when allograft and xenograft were used and concluded that a combination of bone graft with demineralized bone matrix for maxillary sinus bone grafting had no significant short-term merit in bone healing and stability of implants compared with an organic bovine bone alone. In his study, in group I, a total of 49 implants were placed in 23 maxillary sinus areas of 16 patients together with bone graft using xenograft (Bio-Oss) and a minimal amount of autogenous bone. In group II, 24 implants were placed in 13 maxillary sinus areas of 12 patients together with bone graft using a minimal amount of autogenous bone and equal amounts of allograft (Regenaform) and Bio-Oss in group II.

Due to small sample size and short duration of study, the long-term survival rate of implant and degree of resorption of bone graft (Bio-Oss) could not be studied for which a long-term study and bigger sample size is warranted.

Conclusion

There was no significant difference in pain, swelling, stability, and gingival status between both direct and indirect sinus lift procedure. Increase in bone height was significantly more in direct sinus lift procedure than indirect sinus lift procedure.

Clinical importance

Osteotomy technique was found to be suitable for elevating the sinus membrane when less amount of sinus augmentation (up to 5 mm) is needed. When resorption is more advanced, a lateral antrostomy is required for the sake of ending up with sufficient bone height for the sake of placing adequate implant length. Both the sinus elevation technique did not seem to affect the implant success rate.

Our clinical results demonstrate that Bio-Oss is a useful scaffold for bone regeneration. It has the advantage of being stable and having an osteoconductive property that allows for direct contact with newly formed bone. The resorptive process proceeds slowly enough to provide sufficient time for bone maturation.

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