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Comparative Evaluation of Indirect Sinus Lift and Simultaneous Implant Placement Without and With Bone Graft

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Abstract

Aim: The aim of the present study was to evaluate, the stability of simultaneously placed implants, clinically and compare the bone level; pre-operatively, immediately post-op, after 6-months and 12-months, radiographically for the patients treated with indirect sinus elevation technique using osteotomes, without or with the use of grafting material.

Methodology: Implant placement was done using one-stage technique of indirect sinus lift using summer's osteotome technique for all cases. For patients in Group 1, no bone graft was used whereas in Group 2, bone graft was used. RESULT: Immediate evaluation of endo sinus bone gain (E_sBG_t) showed a mean of 2.18 mm for group 1 and 3.59 mm for group 2. After 6 months, it was 2.19 mm and 3.98 mm respectively. After 12 months, it was 2.77 mm and 4.09 mm respectively.

Discussion: Technique of indirect sinus lift with simultaneous implant placement proved to be less invasive without postoperative morbidity and a viable option for sinus lifting in severe atrophic maxilla where residual bone height (RBH) is in range of 4-8mm, leading to bone formation for group 1, as well as group 2. However, the use of bone graft demonstrated predictable degree of implant survival, increase in the alveolar bone height and minimal crestal bone loss.

Conclusion: The mere elevation of the sinus membrane and simultaneous implant placement results in alveolar bone height gain and osseointegration, but indirect sinus lift and simultaneous implant placement along with bone grafts had shown superior results with accelerated bone formation.

Keywords: Augmentation, sinus-lift, indirect, graft

Introduction

When teeth are extracted in the posterior maxilla, alveolar bone resorbs with expansion of the sinus. This process is known as pneumatization.[1] Inadequate height, width and density of the alveolar process are the

common limiting factors for dental implant placements in the posterior maxillary regions.[2] Therefore, using a surgical approach, known as sinus floor elevation (SFE), which can increase the height of bone available for implant placement becomes mandatory.[2] Two main techniques of SFE for dental implant placement that are in use: 1. a two-stage technique with a lateral window approach (direct sinus lift); 2. a one-stage technique using transalveolar approach (indirect sinus lift).[3] Technique-sensitivity of lateral window approach, can potentially lead to a range of morbidities and complications, as a result of the inherent traumatic nature of this technique. Therefore, a more conservative method was introduced by Summers (1994) called indirect sinus lift procedure.[2] The basis for this technique is the careful fracture of the sinus floor cortex, which induces advantageous peri-implant osteogenesis.[4] However, till date debate exists on whether the addition of a bone substitute will enhance bone formation.[5] Considering the above facts, a study was conducted to clinically and radiographically evaluate the sinus membrane elevation, increase in bone height and survival of simultaneously placed implants.

Material And Method: The randomised prospective study was designed to compare the technique of indirect sinus lift without or with bone graft, along with simultaneous implant placement. 10 patients treated of the College of Dental Sciences and Research Centre (Department of Oral and Maxillofacial Surgery), which was approved by College of Dental Sciences and Research Centre Ethics Committee (CDSRCEC) (approval number; CDSRC/TEC/20190302/09), were selected for the present study and had been followed-up for 12 months after surgery between the tenure of 2019-2021. An informed consent was taken from all patients included in the study. Patients were randomly divided into two groups, Group 1 where no bone graft was used and Group 2 where bone graft was used, post indirect sinus lift procedure. Patients were included in the study based on inclusion and exclusion criteria mentioned below:

Inclusion criteria

a. Edentulous posterior maxilla with RBH measured between the sinus floor and edentulous crest more than 4 mm and less than 8 mm.
b. Presence of healthy or restored adjacent teeth.
c. No history of sinus pathosis / any surgical procedures

Exclusion criteria

a. Uncontrolled metabolic diseases, compromised immune system, haematologic disorders, pregnancy, prior radiotherapy/chemotherapy of the maxillofacial region, bone disease, medication or any other systemic illness which may affect prognosis of the treatment.
b. Inadequate mouth opening
c. Patients with habits of smoking, tobacco chewing, alcoholism, etc.

Lignocaine hydrochloride 2% with adrenaline 1:80,000 was used for local anaesthesia. Using a no.15 blade, an anterior releasing incision was placed, starting from the buccal vestibule with preservation of the papillae, then the incision was continued along the crest of the ridge. A full-thickness Lignocaine hydrochloride 2% with adrenaline 1:80,000 was used for local anaesthesia. Using a no.15 blade, an anterior releasing incision was placed, starting from the buccal vestibule with preservation of the papillae, then the incision was continued along the crest of the ridge. A full-thickness muco-periosteal flap was raised, thus exposing the

edentulous area. For implant site preparation, cortical bone perforation was done using an initial 2 mm pilot drill. A paralleling pin of 2 mm was used to check the alignment with adjacent teeth. Osteotomy site was further prepared with the corresponding(increasing) size of drills to a depth of 1mm short from the sinus floor which was assessed pre-operatively with the help of radiographic evaluation, inorder to avoid any sinus membrane perforation. Once the osteotomy was prepared, Summer's osteotome technique for indirect SFE with tapered osteotomes of increasing diameter were used for all the cases. With light malleting, the osteotome was pushed towards the compact bone of the sinus floor, in order to create a greenstick fracture. Shaved bone from the walls of the osteotomy is pushed toward the sinus floor. The second tapered osteotome, with a diameter slightly larger than the first one, was used with the same length as the first. Using osteotomes in increasing diameter to prepare the osteotomy site for implant placement and the fractured sinus floor was pushed axially elevating the Schneiderian membrane and expanding the bone.[6] After the osteotomy, the sinus membrane was assessed for any perforation, radiographically with the help of intra operative RVG. In 5 cases of group 2, the space created after the sinus membrane elevation was grafted using bioactive synthetic bone graft material (Colo Cast) in volumic quantity ranging between 1-1.5 cc depending on the defect created.

The implant was slowly wrenched into position at a torque of 35 Ncm to evaluate the primary stability of implant. Cover screw was placed and the buccal flap was repositioned. Tension free soft tissue closure was achieved using 3-0 silk, interrupted sutures to control the bleeding and to ensure blood clot stability and the implant was left submerged and isolated in the oral cavity. An immediate post-operative CBCT was obtained and the extent of the sinus displacement obtained and the gain in bone height was calculated. Alveolar bone height which was measured in mesial-distal and buccal-palatal views.[5]

The mean bone height at baseline: $(MBH_0) = (A_0 + B_0 + C_0 + D_0)/4$.

The mean bone height at the time point: $(MBH_t) = (A_t + B_t + C_t + D_t)/ 4$.

(Where t = immediate post-operative, at 6 or 12-months post-operation.)

Endo-sinus bone gain (EsBG) was calculated as follows:

$EsBG_t = ([A_t - A_0] + [B_t - B_0] + [C_t - C_0] + [D_t - D_0]/4$

The percentage endo-sinus bone gain ($\%E_sBG_t$) was calculated as follows:

$\%EsBG_t = ([A_t - A_0] \text{ X } 100/A_0 + [B_t - B_0] \text{ X } 100/B_0 + [C_t - C_0] \text{ X } 100/C_0 + [D_t - D_0] \text{ X } 100/D_0)/4$

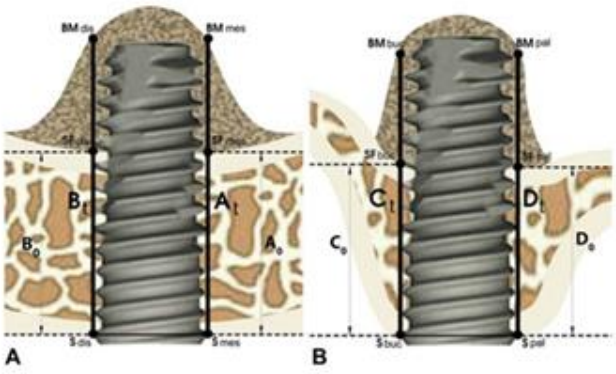
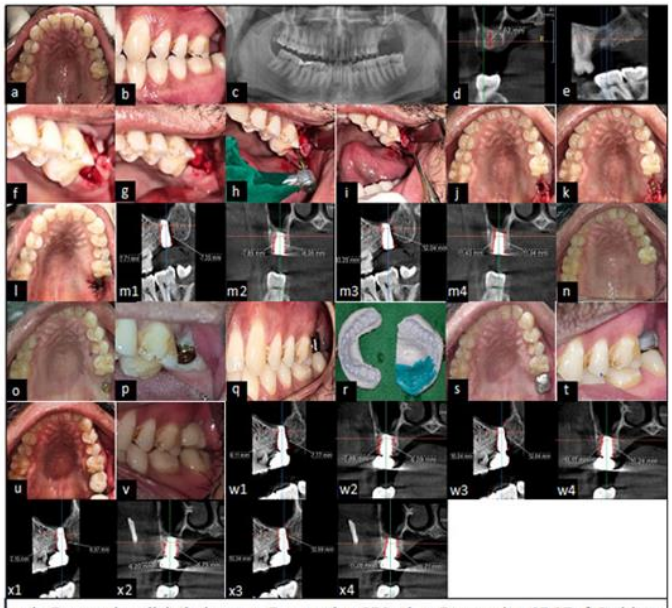


Fig 1: Schematic drawing of the linear measurements made on cone-beam computed tomographic scans in the sagittal plane (A) and coronal plane (B). A_0, B_0, C_0, and D_0 are distances from the mesial implant shoulder (S_{mes}), distal implant shoulder (S_{dis}), buccal implant shoulder (S_{buc}), and palatal implant shoulder (S_{pal}) to the sinus floor mesially (SF_{mes}), distally (SF_{dis}), buccally (S_{buc}, and palatally (S_{pal}), respectively. A_t, B_t, C_t, and D_t, are

distances from S_{mes}, S_{dis}, S_{buc}, and S_{pal} to the highest mesial bone margin (BM_{mes}), distal bone margin (BM_{dis}), buccal bone margin (BM_{buc}), and palatal bone margin (BM_{pal}), respectively.

Descriptive analysis was performed (Fig 1)[5]. Comparisons of the mean bone height, EsBG, and %EsBG between and within each group were analysed using the independent t test and Student paired t-test. A value of $P<0.05$ was considered statistically significant.[5] Post-operative instructions were given to the patients. Patients were screened clinically after 7th day, 3-months, 6-months and 12-months; also, implants were evaluated radiographically immediately post-op, after 7th day, 3-months, 6-months and 12-months. For all the cases, the second stage surgery was performed at 3 months.



a, b: Preoperative clinical picture; c: Preoperative OPG; d, e: Preoperative CBCT; f: Incision; g: reflection; h: preparation of osteotomy site; i: Indirect sinus lift procedure; j: osteotomy site; k: implant placement; l: closure using 3-0 silk suture; m: Immediate post operative CBCT m1, m2: measuring bone height at baseline (distance between implant shoulder and the original sinus floor) MBH_0; m3, m4: measuring bone height at the time point MBH_t (t = immediate post-operative); n: Site after suture removal; o, p: Gingival former placement; q: Transfer abutment placement; r: Impression using elastomeric material; s, t: Metal trial; u, v: Final restoration; w: Months post operative CBCT w1, w2: measuring MBH_0; w3, w4: measuring MBH_t (t = 6 Months post-operative); x: 12 Months post operative CBCT x1, x2: measuring MBH_0; x3, x4: measuring MBH_t (t = 12 Months post-operative)

Figure 2

Result

A total of 10 indirect sinus lift procedure was performed in 10 patients using osteotomes with simultaneous implant placement. Each site is considered as a single patient for statistical purpose. All the patients completed a 12-months follow-up. Out of 10 patients, 7 were females and 3 were males. Sex predilection seemed to favour females over male. The age range was between 21-70 years with a mean of 49 years. The duration of edentulism was in the range of 5-14 months with the average of 9.2 months. The pre-operative RBH for all the cases ranged from 4-8 mm with the mean of 6.72 mm for group 1 and 5.91mm for group 2 and a p-value of 0.99. After the surgical procedure, immediate post-operative evaluation of increased alveolar bone height and the E_sBG_t, using the CBCT showed the mean bone height ± SD for group 1 was 9.58± 1.63 mm and for group 2 was 10.23± 1.22 mm with a p-value of 0.99. The mean E_sBG_t ± SD for group 1 was 2.18±1.08 mm with a mean $\%E_sBG_t$ ± SD of 46.61% ± 15.04% and for group 2 was 3.59 ± 1.54 mm with a mean $\%E_sBG_t$± SD of 56.24 ± 37.32% and with a E_sBG_t p-value of 0.72 and $\%E_sBG_t$ of 0.66. No pathological changes were noted. On 7th day, there was a subjective sign of pain reported in 2 patients from group 1 and 3 patients from group 2. Mucosal tenderness was present for 2 cases from group 1 and for 2 cases from group 2. Local inflammation was present for 1 case from group 1 and for 2 cases from group 2. Infection and sinusitis were absent for all the cases. All the subjective signs and symptoms subsided at 3-month follow-up, with absence of any infection and sinusitis. On radiographic evaluation, at 6 months, mean alveolar bone height ± SD for group 1 was 9.10 ± 2.14 mm and for group 2 was 9.97± 2.04 mm, with a p-value of 0.98. The mean E_sBG_t ± SD for group 1 was 2.91± 1.12 mm with a mean $\%E_sBG_t$ ± SD of 44.76% ± 17.46% and for group 2 was 3.98 ± 1.45 mm with a mean $\%E_sBG_t$ ± SD of 67.56% ± 27.19% and with a

E_sBG_t p-value of 0.53 and % E_sBG_t of 0.25. At 12-months evaluation, mean alveolar bone height ± SD for group 1 was 9.88 ± 1.52 mm and for group 2 was 10.32 ± 1.60 mm, with a p-value of 0.99. The mean E_sBG_t ± SD for group 1 was 2.77 ± 1.09 mm with a mean %E_sBG_t ± SD of 38.16% ± 14.26% and for group 2 was 4.09 ± 1.41 mm with a mean %E_sBG_t ± SD of 67.5% ± 26.01% and with a E_sBG_t p-value of 0.36 and % E_sBG_t of 0.12. No pathological changes or peri-implant radiolucency was noted. On comparison overall bone height gain with a series of radiographic evaluation pre-operatively, immediately post-operatively, after 6-months and 12-months, mean bone height in group 1 pre-operatively was 6.72 mm which increased gradually to 9.88 mm at 12 months. For group 2, pre-operatively was 5.91 mm which increased gradually to 10.32 mm at 12 months (Table 1). A value of $P < 0.05$ was considered statistically significant.

Statistical Analysis	Pre-Operative	12-Months
Group 1 Mean (SD)	6.72(0.57) Mm	9.88(1.52) Mm
Group 2 Mean (SD)	5.91(1.36) Mm	10.32(1.60) Mm
P-Value	0.99	0.99

Table 1: Comparison of statistical analysis of gain in bone height (MBH_t) in mm.

On comparison of overall SFE, the length of implant protruded into sinus (E_sBG_t) was assessed using CBCT, immediately post-operatively, at 6 and 12-month period. Immediate evaluation of E_sBG_t showed a mean of of 2.18 mm for group 1 and 3.59 mm for group 2. At 6 months, mean E_sBG_t for group 1 was 2.19 mm and for group 2 was 3.98 mm. At 12 months, mean E_sBG_t was 2.77 mm for group 1 and 4.09 mm for group 2 (Table 2). A value of $P < 0.05$ was considered statistically significant.

Statistical analysis	Immediate post-operative	6 - months	12 - months
Group 1 mean (SD)	2.18 mm	2.19 mm	2.77 mm
Group 2 mean (SD)	3.59 mm	3.98 mm	4.09 mm
p-value	0.72	0.53	0.36

Table 2: Comparison of statistical analysis of endo-sinus bone gain (E_sBG_t) in mm

Discussion

An inadequate alveolar bone height is a frequent anatomical restriction for the prosthetic rehabilitation of the posterior upper jaw with endoosseous implants.[7] Duration of the edentulism is another important factor. Longer the period of edentulism, greater the loss of the alveolar height, leading to pneumatisation of the maxillary sinus and thus, rehabilitation of the edentulous posterior maxilla becomes difficult as it hinders implant placement.[8,9] Thus, the duration of edentulism is directly proportional to the increased maxillary sinus pneumatization.[10] To overcome these problems, maxillary sinus lift is a widely used. It is a well-accepted technique, which facilitates placement of longer implants.[11] The indirect sinus lift is also called as subantral sinus augmentation, subcrestal augmentation, SFE or transcrestal approach.[12] Various techniques are available for indirect sinus lift, such as summer's osteotome technique, balloon catheter, peizosurgery, etc. Summer's technique, involving a crestal approach, common to standard implant surgery, with little or no contact between the surgical instruments and the Schneiderian membrane, which reduces the risk of surgical complications. This procedure inherently causes

compaction of the alveolar ridge with added advantage of superior manual control. This technique provides a high predictable implant survival rate, with a reduced operative time compared with other indirect sinus lift procedures and offers the advantage of reduced morbidity, shorter clinical time, and reduced postoperative discomfort.[13] As, use of the osteotome technique seems to be a safe and more easy acceptable technique, all the cases included in our study were treated with indirect sinus lift using Summers's osteotome technique with simultaneous placement of implants.

In our study, for all the cases in group 1, no bone graft material was used. For such cases, after the sinus is elevated, the created space is filled with an organised blood clot with surrounding osteoprogenitor cells, which progresses to bone formation. Blood vessels are an important component of bone formation and maintenance. According to a recent clinical study by Srouji S et al. they stated that bone augmentation can be achieved without any graft materials, due to an inherent, latent osteogenic activity of the Schneiderian membrane.

For all the cases of group 2, graft material (bovine bone: colocast) was inserted within the osteotomy site. The material was pushed (placed) apically with help of larger-diameter instruments, thereby lifting the membrane and condensing graft material between the latter and sinus floor, taking care of the delicacy of the sinus membrane. The osteotome technique, enhances good bone healing by better positioning of bone grafting material, when performed in conjunction with bone grafts using broad osteotomes to elevate the sinus floor as a hydraulic plug, the hydrostatic pressure can effectively decrease the risk of Schneiderian membrane perforation.[2] The grafting material is expected to allow new natural bone formation with capillary infiltration and supporting the implants with adequate bone volume. All these cases, showed more alveolar bone height gain and endo-sinus bone formation around the implant at 12 months post-operatively, when compared with the cases of group1.

In our study, alveolar bone height was evaluated with a series of CBCT. Mean bone height in group 1 pre-operatively was 6.72 mm, which increased gradually to 9.88 mm at 12 months. For group 2, pre-operatively was 5.91 mm, which increased gradually to 10.32 mm at 12 months. The length of implant protruded into sinus (E_sBG_t) was assessed radiographically, for group 1, the immediate evaluation showed a mean of 2.18 mm and at 12-months was 2.77 mm, for the cases of group 2, immediate evaluation showed a mean of 3.59 mm and at 12 months was 4.09. These results confirm that the indirect sinus lift technique gives the possibility of an increased bone height with good long-term survival rates, allowing the insertion of adequate implants length and diameter in extreme atrophic ridge. Also, this technique proved to be less invasive with no postoperative morbidity. 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.

Conclusion

In our comparative study, within the limitation of the patient sample, we can conclude that the osteotome technique of indirect sinus lift, expands the dimensions of resorbed posterior maxillary bone vertically. Less morbidity, lower cost, and shorter clinical time was observed. E_sBG_t occurs in all 3 dimensions ranging from 2-4 mm. Although, the mere elevation of the sinus membrane and simultaneous placement of implants

result in alveolar bone height gain and osseointegration, implants placed with indirect sinus lift along with bone grafts had shown superior results with accelerated bone formation.

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