Osteotomy in lateral sinus augmentation: A comparative study of rotary technique and Lateral Approach Sinus Kit®

ABSTRACT

Background: Various sinus lift techniques have been tried to minimize the rate of perforations, especially in Type I and Type II sinus membrane thickness.

Aims and Objectives: The aim and objectives of this study was to present our own experience compare and the efficacy of conventional direct sinus lift technique and direct sinus lift using LAS Kit.

Material and Methods: Our study included 14 patients in which seven patients in conventional technique and seven patients in Lateral Approach Sinus (LAS) Kit®.

Result: The results showed that the sinus membrane perforation rate, using LAS Kit® with specially designed drills, is less than that of the conventional technique, especially in Type I and II sinus membrane with the added benefit of reduced operative time. The mean operative time in conventional technique was 28.29 ± 2.21min and in LAS Kit®, it was 19.43 ± 2.88min which was statistically significantly less than the conventional technique group (P < 0.001). In both the groups, 100% implant integrity was achieved (measured using reverse torque technique) after 6 months of follow-up. It was observed that there was no statistically significant difference between the groups in pain, swelling, flap dehiscence, and infection at different time intervals.

Conclusion: We conclude that the use of LAS Kit® for sinus lift procedure in atrophied maxilla with Type I and II sinus membrane is a much safer approach over the conventional technique. Further, the results obtained also showed that blood coagulum gave better gain in bone height over a period of 6 months.

Keywords: Lateral Approach Sinus Kit®, perforation, Schneiderian membrane

INTRODUCTION

Dental implant therapy has become an excellent and safe treatment modality and esthetic alternative to solve partial and total edentulism. However, implant placement in the posterior maxillary region is often hampered significantly by anatomic limitations such as inadequate vertical dimension, poor bone quality,[1‑4] and thinning or missing cortex.[5,6] Many reports have also concluded that when shorter implants (<10 mm) are placed, they are less successful than longer implants.[7‑10] Thus, procedures named sinus floor elevation, which facilitate the placement of longer implants in the posterior maxilla, have received a lot of attention in recent years.

Maxillary sinus floor elevation (lateral antrostomy) was initially discussed by Tatum at an Alabama implant conference in 1976.[11] In 1987, Misch recommended a...
systemic approach to sinus grafting based on the height of alveolar bone. When the height of the residual ridge was 5 mm or less, he suggested that the lateral wall technique should be used, with the implant being placed either at the time of grafting or 4–6 months later. This depended on the quality and quantity of the residual ridge and the initial stability of the implant.\textsuperscript{12}

The sinus elevation procedure is usually performed with different forms of rotary surgical instruments, such as an air-driven or electric handpiece with diamond or carbide burs.\textsuperscript{13} During sinus elevation, the most frequent intraoperative complication, occurring in 7%–35% of procedures,\textsuperscript{14} is the accidental perforation of the sinus membrane either with burs during the osteotomy or with manual elevators during separation of the membrane which could allow for bacterial contamination or loose particles gaining access to the sinus cavity.\textsuperscript{15} The present retrospective study was designed to compare the efficacy of a safer lateral window approach sinus augmentation procedure using a specialized safe cutting drill with vertical stoppers for osseous window formation and subsequent membrane elevation through Lateral Approach Sinus Kit\textsuperscript{®} (LAS Kit\textsuperscript{®} – OSSTEM) [Figure 1] versus the conventional rotary technique.

**MATERIALS AND METHODS**

This prospective and randomized clinical study was conducted at from July 2016 to September 2018 and selected 14 subjects of age group 20–70 years irrespective of gender having maxillary posterior edentulous region and aimed for implant-retained prosthesis but had sinus pneumatization and deficient alveolar ridge. In this study, patients were randomly categorized into two groups with seven patients in each group. Patients underwent direct sinus lift procedure and implant placement in Group I using conventional lateral window rotary technique and in Group II using LAS Kit\textsuperscript{®} [Figure 2]. The following inclusion criteria were established:

- Patients with ASA I or II health status
- Nonsmokers
- History of the last extraction in the region should be >6 months\textsuperscript{12}
- Preoperative radiograph showing severe atrophy of maxilla and 4–6 mm of residual alveolar bone height in the posterior maxillary region for sufficient implant stability after surgery
- Absence of any pathology, maxillary sinusitis, and maxillary sinus surgery
- Patients willing to participate in this study and agreed to come for regular follow-up for 1 year.

Ethical clearance was approved by the Institutional Human Ethical Committee and Institutional Research Development Committee Institutional Human Ethics Committee (IHEC) with reference no - SDCNHEC/2016/MDS/14 on 20.01.2017. Written informed consent was obtained from the selected patients and necessary all routine hematological investigations were done.

Assessment of maxillary sinus was done by (cone-beam computed tomography [CBCT]) to measure the sinus membrane thickness by using the criteria given by Rapani et al. [Figure 2 and Table 1].\textsuperscript{16}

The thickness of the sinus membrane was measured to the nearest 0.1 mm at three different sites in the maxillary sinus. To define these sites on the panoramic cone-beam CT view, the most anterior and posterior points adherent to the sinus wall were drawn vertically and then the median point of the two was drawn. For each of these three sites, the corresponding cross-sectional cone-beam CT image was retrieved and three different measurements were made. Finally, a mean of three measurements was recorded and the thickness of the sinus mucosa measured (mm) [Table 2].

**METHODS**

The surgical procedures were performed under local anesthesia under proper aseptic condition. Preoperative antibiotic coverage along with nasal decongestant and anti-allergic drugs was administered 12 h prior to surgery and was continued till the 5\textsuperscript{th} postoperative day. Patients were randomly and equally divided into two groups, Group I (direct sinus lift with rotary technique) and Group II (direct sinus lift with LAS Kit\textsuperscript{®}).

**Surgical procedure**

A crestal incision was made with vertical releasing incisions at the mesial and distal aspect of the buccal site, and a full-thickness mucoperiosteal flap was elevated, leaving the attached gingiva undisturbed on the adjacent teeth. Elevation of the flap was extended superiorly to expose the lateral wall of the maxillary sinus up to the inferior aspect of the zygoma. This step was common in both the groups.

**In Group I**

A bony window of 15–30 mm was outlined by a round bur under copious saline irrigation, using medium speed (12,000 rpm) and torque 40 Ncm, straight surgical handpiece, and a tungsten carbide bur with a 2.3 mm diameter. Inferior cut placed 0.5–1 cm above the floor of the sinus and vertical cuts (anterior and posterior) were made according to the edentulous arch and the number of implants to be placed. The bony window was rectangular in shape and all sharp
edges that could cause perforations of the Schneiderian membrane during the elevation were rounded off. An elevated antrostomy with the cortical wall intact and adherent to the Schneiderian membrane was completed. It was lifted inside the maxillary sinus and acted as the future sinus floor [Figures 3a and 4a]. The sinus membrane was gently lifted from the bony floor by means of an antral curette. It was important to free up the sinus membrane in all directions (anteriorly, posteriorly, and medially) before attempting to intrude the trapdoor inwardly. A space was created after the sinus membrane had been elevated by the intruded trapdoor. Careful elevation of Schneiderian membrane was done [Figure 4a]; bony window was left attached to the membrane and served as a new sinus floor. Implants sites were prepared with careful undersized drilling.

**In Group II**

After raising the mucoperiosteal flap, a 5 mm wide dome drill was placed onto the surgical handpiece with a 0.5 mm drill stopper and using a speed of 1200 rpm with 35 N/cm torque. The dome drill with a stopper was placed on the lateral sinus wall at a height more superior (0.5–1 cm above the floor of the sinus) than the current height of the available bone as measured radiographically. This was done to ensure that the window created has elevated the membrane circumferentially. When maximum depth has been achieved with the 0.5 mm drill stopper present, the drill stopper changed to a 1.0 mm stopper [Figure 2], and drilling was continued. The drill stopper was sequentially increased while checking for membrane exposure. Lateral drilling continues stepping up to the next drill stop. Final window creation was made with the dome drill using 2.5 mm drill stopper [Figure 3b and c]. Side wall drill was used for widening of the window. The intact sinus membrane was noted with no bone over the membrane at the window that has been created on the lateral wall [Figure 4b]. Sinus curettes were utilized to start the sinus membrane elevation at the inferior aspect [Figure 4c], teasing the membrane from the osseous wall of the sinus interiorly. Sinus membrane’s integrity was tested by asking the patient to breathe in deeply/Valsalva maneuver while observing the membrane movement in both the groups.

In both the cases, implants of selected size were positioned [Figure 5] from the crestal surface of residual bone by using...
drills in sequential manner and extended into the space, achieving primary stabilization by the residual alveolar bone; the space between Schneiderian membrane and the sinus floor was filled with blood coagulum from the surrounding tissues. The lateral window was covered by a collagen membrane of size 10 mm × 10 mm. Then, mucoperiosteal flap was sutured using 3–0 round body Vicryl. All patients were advised to maintain good oral hygiene and to follow postoperative instruction and take the medications as prescribed (antibiotics, analgesics, anti-allergic, nasal decongestant, and antacids).

Patients were advised to follow standard postoperative instruction which included ice-pack, soft high nutrient diet. Patients were advised to avoid spitting or swishing for 24 h. Patients were advised not to irritate the wound with the tongue, or put any kind of external pressure, avoid forceful sneezing or coughing, and keep the mouth open while sneezing. Strict instructions were given to keep the area clean and take the prescribed medications for 5 days after surgery. Nasal decongestant (xylometazoline 1%) and anti-allergic drugs (levocetirizine 5 mg) were started immediately. Warm saline rinses and steam inhalation were advocated after 24–48 h postoperatively for 1 week. Mouthwash chlorhexidine (10 ml) in 1:1 was prescribed 24 h after surgery.

The patients from both the groups were followed up postoperatively at 1st, 3rd, 5th, and 7th day and radiological assessment was done at 3rd- and 6th-month intervals.

Clinical assessment of the patient was done under the following parameters:
- Intraoperatively - Operating time, sinus membrane perforation and
- Postoperatively - Gain in residual alveolar bone height, pain, swelling, dehiscence, infection, ecchymosis at different time intervals and implants stability at 6 months follow-up.

Statistical analysis
Statistical analysis was done using significance of percentage error Student’s t-test and Fisher’s exact test. \( P < 0.05 \) was considered significant. All the results were analyzed using ANOVA software.

RESULTS

The present study was undertaken to compare the direct sinus lift using conventional bur technique and LAS Kit®. A total of 14 patients were included. Clinical assessment was done Intra-operatively for operating time, sinus membrane perforation and Postoperatively for gain in residual alveolar bone height at 1st, 3rd and 6th months and pain, swelling, dehiscence, infection, ecchymosis at 1st, 3rd, 5th, and 7th postoperatively day and implant stability at 6 months follow-up.

On comparing the operating time between the groups, the mean operating time in LAS group was 19.43 ± 2.88 min; in conventional group, it was 28.29 ± 2.21 min. Hence, the mean operating time in LAS group was significantly less than the conventional group (\( P < 0.001 \) [Table 3]).

Two sinus membrane perforations [Table 4] were present in Type II thickness sinus membrane [Table 1] seen in Group I and the difference was not statistically different.

The bone thickness was increasing gradually in both the groups with no statistically significant difference between the groups (\( P > 0.05 \)). From preoperatively to 6 months, a highly significant increase in alveolar bone height was found in both the groups (\( P < 0.001 \)).

No statistically significant difference was found in proportion of various pain grades between the groups (\( P > 0.05 \)). From preoperatively to 6 months, a highly significant increase in alveolar bone height was found in both the groups (\( P < 0.001 \)).

Preoperatively, the mean swelling in conventional group was 86.26 ± 7.20 mm which was increased to the maximum value of 90.89 ± 5.89 mm at day 3 and then decreased to 85.33 ± 5.70 mm. While in the LAS group preoperatively, the mean swelling was 85.03 ± 5.45 mm which was increased to the maximum value of 89.54 ± 4.90 mm at day 3 and then decreased to 85.34 ± 5.64 mm at day 7. However, no

### Table 1: Classification of sinus membrane thickness[16]

| Thickness of membrane (mm) | Classification |
|----------------------------|---------------|
| 0                          | Type I        |
| 2-3.5                      | Type II       |
| 4-6                        | Type III      |
| >6                         | Type IV       |

All measurements were done in CBCT. CBCT: Cone-beam computed tomography

Figure 5: (a) Conventional (implant placement). (b) Lateral Approach Sinus Kit® (implant placement)
statistically significant difference was seen in mean swelling between the groups at any day of recording ($P > 0.05$).

Flap dehiscence and infection were absent in all the cases of both groups at day 2, day 7, day 14, and day 21.

**DISCUSSION**

The sinus elevation procedure is usually performed with different forms of rotary surgical instrumentation, such as an air-driven or electric handpiece with diamond or carbide burs.

In this study, we studied the efficacy of a safer lateral window approach sinus augmentation procedure using specialized safe cutting end drills with vertical stoppers for osseous window formation and subsequent membrane elevation through (LAS Kit® – OSTEEM) by comparing it with the conventional bur technique. In this study, we compared the use of LAS Kit® (specialized safe cutting end drills with vertical stoppers) with conventional bur technique under certain parameters.

In our study, intraoperative time was evaluated from raising of mucoperiosteal flap to window marking and from bony window creation to sinus floor elevation in each group. Incision making was the same procedure in both the groups, so it was excluded from the intraoperative time. The mean operating time of conventional group was 28.29 ± 2.21 min which was statistically significant ($P < 0.001$) [Table 3].

Delibasi and Gurler[17] in their study showed that the mean operating time of conventional technique was 20.2 ± 8.58 min (the operative time was measured from osteotomy cut to sinus floor elevation in the above-mentioned study). Our mean operating time for conventional technique was 23.86 min and LAS Kit® was 15.01 min (4.42 min from flap reflection to window marking subtracted in both the groups) [Table 3] which is coherent with the above-mentioned study; moreover, in LAS Kit® group, the time taken was less than both conventional and piezoelectric techniques reported in the above study. However, our study which observed the operating time of LAS Kit® for the first time showed that the total time required for sinus lift is comparable with piezoelectric device and when compared to conventional technique, it significantly reduced the operating time. The comparison of LAS Kit® with conventional technique in our study is a first of its kind and there is no literature review about such is available for comparison.

Out of 7 sinus lift surgeries performed using LAS Kit®, no Schneiderian membrane perforation was observed, but in conventional bur technique, 2 perforations out of 7 were observed. Therefore, the percentage of perforations in conventional group was 28.6% compared to LAS Kit® which had 0% perforations with a nonsignificant $P = 0.462$ [Table 4]. Our study is coherent with the study of Alessandro in which they reported that out of 51 patients who were treated by conventional sinus lift procedure, 27.5% had membrane perforations and 42 patients were treated with piezoelectric, the percentage of perforations was 12.7%. We have also observed that the perforations which occurred in two patients were having Type II (< 2 mm) sinus membrane thickness [Table 1]. The percentage of Type II membrane in our study was 57% of which 14.3% were treated with conventional technique and 42.86% were treated using LAS Kit®. Thus, our study showed that when sinus lift of Type I and Type II membrane was done using LAS Kit®, the chances of perforations compared to conventional technique were much lesser. Rapani et al.[16] in 2016 and van den Bergh et al.[18] in 2000 have shown in their studies the thinner the sinus membrane, the higher the risk of perforation. Our study advocates that in Type I and II sinus membrane, LAS Kit® is a better alternative than conventional bur technique.

Perforation of the Schneiderian membrane, a well-known complication, has been reported in various literature. Shlomi et al.[19] performed 73 sinus lift procedures in 63 patients and reported membrane perforations in 28%

### Table 2: Measurement of sinus membrane thickness

| Serial number | Anterior (mm) most point | Midpoint (mm) | Posterior (mm) | Mean (mm) | Type of membrane thickness |
|---------------|--------------------------|---------------|---------------|-----------|---------------------------|
| Example [Figure 1a] | 1 | 2 | 3 | $1+2 + 3=2.8/3=0.93$ | Type II |

### Table 3: Comparison of operating time between the groups

| Operating time | Mean±SD | $t$ | $P$ |
|----------------|---------|-----|-----|
| Conventional   | 28.29 ± 2.21 | 19.43 ± 2.88 | 6.45 | $<0.001$ |
| LAS Kit®       | 15.01 ± 4.42 | 12.21 ± 2.88 | 3.12 | $0.002$ |

LAS Kit®, operating time - Start of sinus floor elevation surgery (from flap reflection + window marking) and completion of sinus floor elevation (from window creation to sinus floor elevation). LAS: Lateral approach sinus, SD: Standard deviation

### Table 4: Comparison of sinus perforation between the groups

| Perforation | Conventional ($n=7$), $n (%)$ | LAS Kit® ($n=7$), $n (%)$ | $P$ |
|-------------|--------------------------------|----------------------------|-----|
| Absent      | 5 (71.4)                       | 7 (100.0)                  | 0.462 |
| Present     | 2 (28.6)                       | 0                          |     |
of the patients. Various factors that can influence the chance of Schneiderian membrane perforations include anatomical variations, surgeon’s experience, and previous sinus infection. Anatomical factors consist of thickness of the lateral maxillary sinus wall, convex lateral sinus wall, narrow and wide sinus, maxillary sinus septa, longitudinal septum, and root-shape configuration. It is also suggested that previous sinus surgery and absence of alveolar bone are risk factors for higher chances of Schneiderian membrane perforation.\textsuperscript{20}

Viña-Almunia et al. in a review reported that in maxillary sinus lift procedures with membrane perforation, the implant survival rate was 88.6% and in maxillary sinus lift with intact membranes, the survival rate rose to 98%.\textsuperscript{21}

Our study is coherent with the study of Kang et al.\textsuperscript{22} and Testori et al.\textsuperscript{23} Kang et al.\textsuperscript{22} in their study included 18 patients where sinus perforation occurred during sinus lift procedure. The perforations were repaired by tissue additives and collagen membrane followed by bone graft and implant placement. Their final result concluded that implant survival was 100% and there is no effect of sinus perforations which were repaired successfully.

In our study, the two perforations which occurred in conventional group were repaired successfully by using collagen membrane without any postoperative complication.

In the present study, preoperative mean alveolar bone height was 5.75 ± 1.66 in conventional group and 5.08 ± 1.13 in LAS\textsuperscript{®} group observed on CBCT examination. No statistically significant difference \( p \) value was observed preoperatively in between the groups. After 6 months, both the groups showed significant increase in alveolar bone height with a mean value of 7.04 ± 1.65 in conventional group and 7.34 ± 1.26 in LAS Kit\textsuperscript{®} group which was statistically significant \((p < 0.001)\) and in both the groups, we have used only blood coagulum instead of any other augmentation materials. Our study is coherent with the studies of Lundgren et al.\textsuperscript{,24} Kumar et al.\textsuperscript{,25} and Altintas et al.\textsuperscript{26}

In our study, pain was evaluated on VAS scale for all patients on the 2\textsuperscript{nd}, 7\textsuperscript{th}, 14\textsuperscript{th}, and 21\textsuperscript{st} days postoperatively. All the records showed no statistically significant difference of pain perception in both the groups \((p = 1.000)\).

The pain score values in our study were coherent with that of a study conducted by Cagri Delilbasi and Gurler on 23 patients.\textsuperscript{17}

The measurements pertaining to the amount of swelling were obtained on the preoperative day and 3\textsuperscript{rd} day, 5\textsuperscript{th} day, and 7\textsuperscript{th} postoperative days, according to the parameters described earlier in the material and methods section for evaluating the presence of swelling. No statistically significant difference in swelling regression was observed in both the groups and no swelling was there after 7 days.

In a study conducted by Delilbasi and Gurler on 23 patients, in which a comparison was made between intraoperative and postoperative effects of piezosurgery and conventional rotary instruments in direct sinus lifting procedure, there was significantly more swelling in the conventional group on the 8\textsuperscript{th}, 24\textsuperscript{th}, and 36\textsuperscript{th} postoperative h compared to piezosurgery group \((p = 0.07, p = 0.02, \text{and} P = 0.08, \text{respectively})\). Swelling on the 72\textsuperscript{nd} postoperative h and on the 7\textsuperscript{th} day did not show a statistically significant difference between the groups \((p = 0.0394 \text{and} 1.00, \text{respectively})\).

In our study, none of the patients in either of the group showed any case of infection or dehiscence. After surgery, healing was uneventful for all patients.

Postoperative infections in maxillary sinus are relatively infrequent, with infection rates reported between 2% and 5.6%, with no distinction being made between true sinus and sinus graft infections. Properly performed sinus grafting does alter neither sinus function nor the characteristics of voice.\textsuperscript{23}

Patients were inspected for the presence or absence of dehiscence and infection at the operated site on the 2\textsuperscript{nd}, 7\textsuperscript{th}, 14\textsuperscript{th}, and 21\textsuperscript{st} postoperative day for both the groups.

In our study, the primary closure was obtained by a complete approximation of the raised mucoperiosteal flap. As well as the aseptic state was maintained with antiseptic mouthwash, irrigation with chlorhexidine diluted with normal saline (1:4) was done at regular follow-ups in addition to prescription of antibiotics along with anti-allergic, nasal decongestant, and analgesics. These measures might have been fruitful in preventing any kind of infection and dehiscence in our study.

In our study, all implants were clinically stable during abutment tightening. Reverse torque technique was proposed by Roberts et al.\textsuperscript{27} and developed by Johansson and Alberbrektsson (1987).\textsuperscript{28} In the present study, all implants were tested by reverse torque technique using 30 Ncm torque with wrench ratchet at the time of abutment placement (6-month follow-up). Out of 14 patients treated in our study, 100% implant stability was observed at the time of abutment placement. Our study is coherent with
the study of Simeone et al.[29] in which they showed when reverse torque technique was used in 17 patients over 40 implants, there was a complete absence of implant mobility after 6-month follow-up. Preoperative mean bone height range in our study was 5.08 mm to 5.75 mm (4–6 mm) which also helped us to provide the primary implant stability in all our cases.

LAS Kit® introduced by Osstem/Hiossen in the year 2013 was aimed to reduce the complication of sinus lift that is Schneiderian membrane perforation. Observation of our study which compared LAS Kit® with conventional bur technique of sinus lifting showed that conventional technique is a less safer approach with respect to LAS Kit® on the basis of operating time and sinus membrane perforation, in thinner (Type I and II) sinus membrane.

This prospective study gives us a vivid idea about the advantages of this newer kit over conventional bur technique though it requires a larger sampler size to strongly recommend its use in Type I and II sinus membrane.

CONCLUSION

Observation of our study which compared LAS Kit® with conventional bur technique of sinus lifting showed that conventional technique is a less safer approach with respect to LAS Kit® on the basis of operating time and sinus membrane perforation, in thinner (Type I and II) sinus membrane. This prospective study gives us a vivid idea about the advantages of this newer kit over conventional bur technique though it requires a larger sampler size to strongly recommend its use in Type I and II sinus membrane.

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Conflicts of interest
There are no conflicts of interest.

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