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CLINICAL CASE SERIES

USES OF LATERAL BONE WINDOW REPOSITIONING TECHNIQUE IN MAXILLARY LATERAL SINUS ELEVATION: A CLINICAL AND RADIOGRAPHIC FOLLOW-UP STUDY FOR 121 PATIENTS FOR 30 TO 90 MONTHS.

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ABSTRACT

Background: Maxillary lateral sinus elevation (LSE) is crucial for increasing vertical bone height in the posterior atrophic maxilla. It facilitates implant placement by creating adequate bone support. This case series describes the lateral bone window repositioning (WR) technique in LSE and evaluates its effectiveness in graft stabilization and clinical success through clinical and radiographic examination.

Methods: This case series included 121 patients (151 sinuses) who met specific inclusion criteria. A total of 285 implants were placed: 150 (52.6%) implants were inserted simultaneously, while 135 (47.4%) were placed 4–6 months after the MLSE procedure. All cases were followed clinically and radiographically for 30 to 90 months. Preoperative cone beam computed tomography (CBCT) scans were taken for proper evaluation of the surgical site, and postoperative CBCT scans were performed 4–6 months after LSE. Patients underwent follow-up evaluations every six months for clinical implant assessment, and periapical images were taken annually to monitor marginal bone levels. The surgical protocol involved performing a beveled osteotomy using a piezoelectric device to create a bone lid. After removal, the Schneiderian membrane was elevated to manage space for the bone graft. The bone lid was then repositioned in its original place.

Results: Among 151 LSE cases, 146 (96.7%) exhibited successful outcomes, with complete integration of the bone lid into the surrounding bone, confirmed through clinical and radiological examinations. Three failures were reported, one due to trauma and two resulting from sinus infections. Two cases were excluded due to bone window fractures during removal. Small perforations of the Schneiderian membrane occurred in 28 cases (18.5%), all successfully managed with collagen membranes.

Conclusion: The WR technique in LSE demonstrated a high success rate, repeatable results, and effective graft integration, making it a viable option for vertical bone height augmentation.

Keywords: Maxillary sinus elevation, bone window repositioning, graft stabilization, dental implants, Schneiderian membrane, bone augmentation

1. INTRODUCTION

Loss of posterior maxillary bone height is often due to physiological remodeling following tooth loss, sinus pneumatization, or both[1,2]. Various bone augmentation techniques have been developed to facilitate implant placement, including maxillary lateral sinus elevation, crestal access, and vertical osteotome-mediated sinus floor elevation. LSE is recommended for cases with ≤5 mm of subantral vertical bone height, allowing simultaneous or delayed implant placement [3–5]. Initially proposed by Tatum [6] and later

detailed by Boyne and James in 1980(7), LSE has evolved into a safe treatment modality with a low complication rate[8]. The procedure involves creating a lateral window in the sinus wall to elevate the Schneiderian membrane, filling the created space with a bone graft or blood clot [9]. The lateral bone window can either remain attached to the membrane and rotated inward or be entirely removed and replaced at its original site [10].

Covering the graft material with a membrane has been shown to enhance healing by preventing graft migration and reducing soft tissue invasion[11]. Lundgren et.al. described the WR technique in LSE. That technique consists of repositioning the removed bone plate to its original site after LSE [12]. As an autogenous barrier, the bone window will enhance new bone formation and graft integration [13]. This case series aims to evaluate the validity of WR in LSE through radiographic analysis and clinical assessment.

MATERIALS AND METHODS

After the initial clinical evaluation, a CBCT examination was performed for preoperative assessment. Four to six months after the surgery, a second CBCT examination was taken to evaluate bone height and to schedule implant placement if not done simultaneously.

Inclusion and Exclusion Criteria

Inclusion Criteria:

Participants were included in the study based on the following conditions:

1. Partial or complete edentulism in the maxillary molar region, with a residual ridge height of ≤ 5 mm.
2. Age over 20 years.
3. Overall good general health.
4. Satisfactory oral hygiene and periodontal status suitable for implant placement.
5. Willingness to provide informed consent.

Exclusion Criteria:

The following factors led to exclusion from the study:

1. Systemic conditions that contraindicate dental surgery, including uncontrolled metabolic disorders, history of head or neck radiotherapy, chemotherapy, or immunosuppressive therapy.
2. Local nasal pathologies that preclude maxillary lateral sinus elevation (MLSE).
3. Presence of untreated periodontal disease.
4. Heavy smoking (defined as more than 10 cigarettes per day); 5 patients were excluded on this basis.

A total of 121 patients, accounting for 151 sinuses, fulfilled these criteria and were included in the study.

Surgical Procedure

All surgeries were performed by the same trained oral surgeon (H.A.H.) and his surgical team. Local anesthesia (lidocaine with adrenaline 1:100,000) was administered, and a mucoperiosteal flap was elevated to expose the lateral sinus wall. A beveled osteotomy was performed using a Piezosurgery® touch unit (Mectron S.p.A., Genova, Italy) with specific bone tips (OT7A, OT8L, OT8R) to create a trapezoidal bone window measuring approximately 15–20 mm mesiodistally and 6–10 mm apico-coronally.

The bone window was carefully removed to avoid damage to the Schneiderian membrane, which was then elevated using sinus curettes. When residual bone height was ≤2 mm, implant placement was delayed. In 150 cases (54.3%), implants were placed simultaneously. A 50:50 mixture of autogenous bone (harvested from the tuberosity and zygomatic area using a bone scraper) and xenograft bone substitute (Bio-Oss® L) was grafted while minimizing pressure on the sinus membrane. The preserved bone lid was repositioned, and the flap was sutured using 4.0 absorbable sutures.

Postoperative care included a prescription of antibiotics (amoxicillin 500 mg TID for 7 days), NSAIDs (ibuprofen 400 mg BID for 7 days), and 0.12% chlorhexidine mouth rinse TID for 14 days. Sutures were removed after 14 days. In cases of membrane perforation, medication duration was extended to 14 days, and patients were instructed to avoid blowing their noses, coughing, or sneezing forcefully for 15 days.

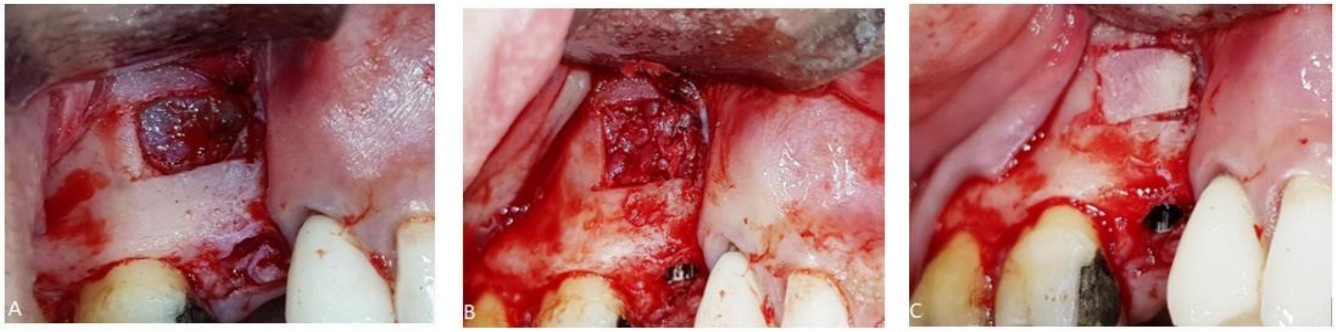

Figure1. Surgical procedure A) Flap access and the bone lid removed B) Schneiderian membrane elevation and placement of bone graft with simultaneous implant placement C) The bone lid repositioned.

Radiographic Examination

Preoperative CBCT scans were taken to assess residual bone. A second CBCT scan was performed 4–6 months postoperatively to evaluate new bone formation. Bone height was measured on coronal and sagittal reconstructions while bone width was evaluated using axial reconstructions. Linear measurements were taken from the alveolar ridge base to the highest point of the graft. Bone window integration was assessed and defined as a complete bony union between the bone lid and surrounding bone with no evidence of radiolucency.

All preoperative CBCT assessments were conducted using the **PaX-i3D SMART** CBCT system, with a **Field of View (FOV) of 8 × 8 cm or 10 × 10 cm**, optimized for bone height and ostium patency analysis. Standard resolution imaging was achieved with a voxel size of 0.2–0.3 mm, while exposure settings were maintained at 80–100 kept, 5–10 mA, with a scan time of 10–20 seconds.

Postoperative CBCT scans were performed 4–6 months after surgery to assess graft volume and stability, new bone formation, Schneiderian membrane integrity, and ostium patency. The same CBCT machine and imaging parameters were used for consistency across all patients.

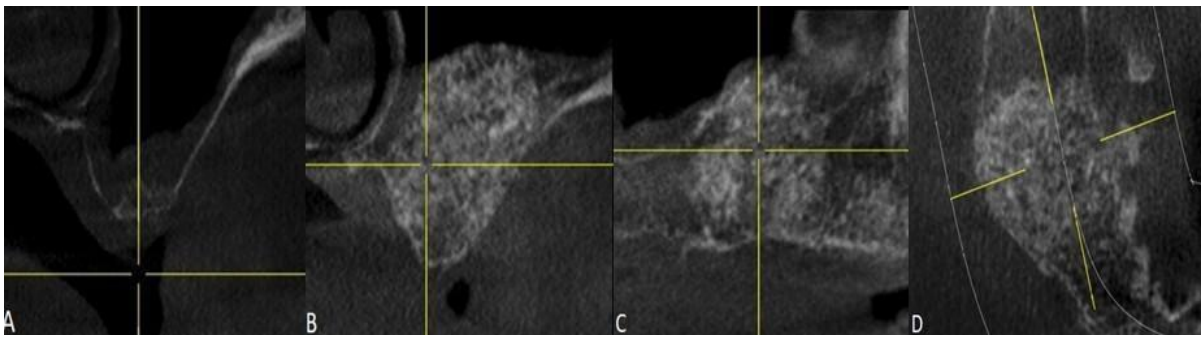

Figure 2. A) Preoperative frontal view of the surgical site. B) Bone height evaluation on the coronal plane. C) Graft height evaluation on the sagittal plane. D) Graft width on axial plane.

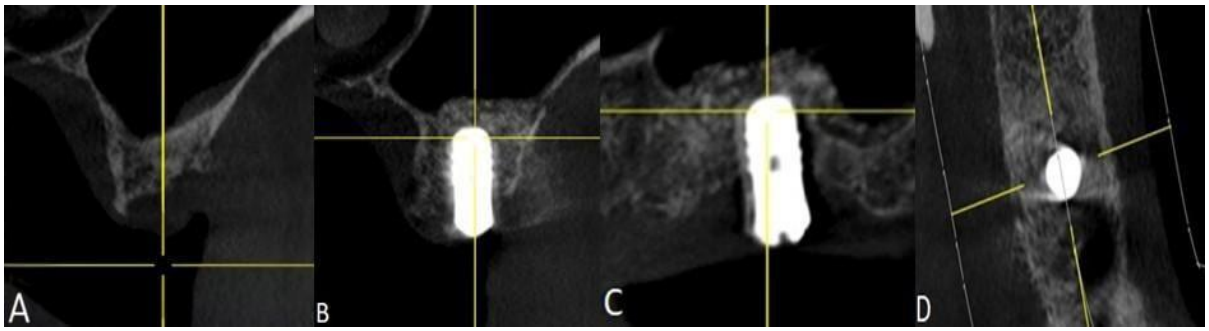

Figure 3. A) Preoperative frontal view of the surgical site. B) Frontal view of the surgical site showing bone graft with simultaneous implant placement. C) Sagittal view of the surgical site showing bone graft with simultaneous implant placement. D) Axial view of the surgical site showing bone graft with simultaneous implant placement.

Clinical Examination

During implant placement or uncovering surgery, the surgical site was clinically examined for proper integration of the bone lid. Signs of infection, swelling, soft tissue dehiscence, and mobility of the bone lid were noted as potential

complications. Patients were followed every six months post-implant loading to monitor implant stability, pocket formation, mobility, and signs of infection or discomfort.

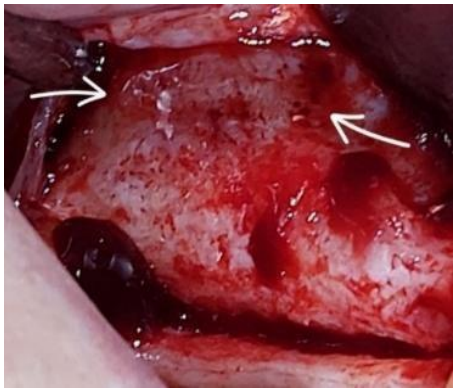

Figure 4. Complete integration of the bone lid with the surrounding bone.

RESULTS

A total of 121 patients (75 women (62%) and 46 men (38%)), aged 36–68 years (mean age: 54.2 ± 12.3 years) underwent 151 LSE procedures between June 2014 and December 2021. The follow-up durations ranged from 30 to 90 months, with the majority of patients (91 out of 121, or 75,2%) having a follow-up of 60 months. Thirty patients required bilateral sinus elevation. Five patients were excluded because of heavy smoking.

A total of 285 implants were placed: 200 Cowell Medi (KOREA Inc.) implants (66.7%) and 85 Bone Level Tapered and Tissue Level Straumann® (Basel, Switzerland) implants (33.3%). Among them, 150 (52.6%) implants were inserted simultaneously, while 135 (47.4%) were placed 4–6 months after the LSE procedure. Bone lid integration was confirmed via reentry and radiographic evaluation. The overall success rate of the WR technique was 96.7%. Of 151 cases, 146 exhibited successful bone lid integration without fibrous connective tissue invasion. Three failures were reported (one due to trauma, two (1.32%) due to sinus infections), and two cases were excluded due to bone window fractures. Schneiderian membrane small perforations were observed in 28 cases (18.54%), 17 of which were detected at the time of window separation. Of the 28 membrane perforations, all were managed using a Jason® native pericardium collagen membrane (Botiss Biomaterials GmbH, Zossen, Germany). No surgeries were aborted, no implant failures were recorded, nor any difference in implant success rates or bone integration compared to cases without perforations. No significant intraoperative or postoperative complications, such as severe hematoma or excessive swelling, were observed. The post-operative CBCT scans, taken four to six months after surgery, revealed bone resorption ranging from 8 to 12%.

TABLE 1. Sample characteristics and results

Variable	N	Mean ± SD / Percentage
Age (years)	121	54.2 ± 12.3
Female Gender	121	62%
Simultaneous Implants	151	52.60%
Delayed Implants	151	47.40%
Membrane Perforations	151	18.54%
Bone Window Fractures	151	1.32%
Implant Success Rate	151	96.70%
Mean Follow-Up (months)	121	59.17
Median Follow-Up (months)	121	60

DISCUSSION

Cone Beam Computed Tomography (CBCT) has become an indispensable tool in modern implantology, particularly for evaluating the maxillary sinus before and after sinus lift procedures. Its high-resolution, three-dimensional imaging provides critical insights into bone volume, density, and anatomical variations, aiding clinicians in surgical planning.

Before a sinus lift, a comprehensive CBCT scan is essential to evaluate several factors influencing the procedure's success:

- **Bone Height and Width**: CBCT enables precise measurement of the residual alveolar bone between the crest and sinus floor.

- **Maxillary Sinus Anatomy**: It helps identify anatomical variations, such as septa, which may complicate the procedure.
- **Schneiderian Membrane Thickness**: Assessing membrane integrity and thickness is crucial to prevent perforation.
- **Ostium and Sinus Health**: Evaluating sinus drainage pathways is essential, as blocked or inflamed sinuses increase the risk of postoperative complications.
- **Proximity to Vital Structures**: CBCT assists in mapping the infraorbital nerve and adjacent anatomical landmarks to minimize surgical risks.

A **cone beam computed tomography (CBCT) scan** after **surgery,** is used to evaluate the procedure and check for potential complications.

- Confirms that the bone graft material is properly placed.
- Assess the height and density of the newly augmented sinus floor.
- Determines if the graft has maintained its volume or if any resorption has occurred.
- Detects sinus membrane perforations.
- Identifies fluid accumulation or sinus infections (sinusitis).
- Checks for bone particles displacing into the sinus cavity.
- Measures the available bone height and width.
- Assesses bone density to determine implant stability.
- Helps in precise implant placement by avoiding anatomical structures like the maxillary sinus and nerves.
- Monitors the bone healing process over time.
- Determines the readiness for implant placement if the lift was done as a staged procedure.

In our case series, CBCT exams were done before the LSE and after 4 to 6 months. Our primary goals were the assessment of bone height, sinus anatomy, and health before and after the sinus lift procedures.

Animal models showed an acceleration of bone formation with better quality and ossification of the gap between the lid and the surrounding bone[14]. In clinical studies, the bone lid without grafting material showed adequate bone formation[15]. Lundgren et al. hypothesized that the healing process when using the bone lid technique involves the prevention of mucosal growth towards the sinus, the preservation of the maxillary sinus pneumatic conditions, and finally the blood clot stabilization and promotion of the bone formation[12]. Repositioning the removed bone window eliminates the need for additional membrane placement while providing an autogenous barrier that enhances graft stability, soft tissue migration, and new bone formation which contributes to high implant success rates[9-16]. Compared to other methods, such as window rotation or complete removal, the repositioned bone lid maintains a natural osteogenic environment and shows better osteoinductivity properties, facilitating predictable healing[18]. Using the lateral wall bone for the two-dimensional reconstruction of the severely resorbed maxilla by creating a box shape, and providing an architectural design for the augmented area confirms the osteoconductivity properties of the bone lid[19]. Jia et al. compared the lateral sinus lift with and without the bone lid repositioning with immediate implant placement, and found a 100% implant survival rate, increased alveolar ridge height, and apical bone gain in the group treated with the bone lid repositioning compared with the use of growth factors concentrated membrane[20].

Additionally, the use of piezoelectric surgery ensures precise beveled bone cuts, reducing the risk of Schneiderian membrane perforation and improving overall surgical outcomes[21]. It also provides a self-retentive characteristic for the bone lid, thus eliminating the need for rigid fixation[13,22,25]. Created margins should be as thin as possible for a better repositioning of the bone lid[26]. Non-rigid fixation methods, such as fibrin or cyanoacrylate-based surgical glue, can also be used[16]. While minor complications, such as membrane perforations were encountered in this study, all cases were successfully managed without compromising results. In all the follow-up periods, no difference was found between cases with or without membrane perforation.

Despite this case series providing strong evidence for the viability of the WR technique, this study is limited by its case series design, which lacks a control group. Therefore, while we can report on the outcomes of the WR technique, we cannot directly compare its effectiveness to other LSE techniques like complete window removal or window rotation with or without using a membrane to close the sinus window.

CONCLUSION

Within the study's limitations in this case series, the WR technique in LSE showed a high success rate and predictable results in terms of vertical bone height increase with minor complications. It offers a cost-effective and viable alternative to other procedures. Additional randomized controlled trials could provide stronger confirmation of our results.

DECLARATIONS

Competing interests

The authors have declared that no competing interests exist.

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